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How the Effects of Climate Change Will Impact the Maritime Security of the Indo-Pacific

This thesis is submitted for the degree of Doctor of Philosophy in the Department of Politics, Philosophy and Religion at Lancaster University

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Acknowledgements

To my parents who told me not to do this, your support was fundamental to this undertaking, and I will never be able to thank you enough.

To my partner, your ever-patient reminders that I need to eat, sleep, and generally be a functioning human being were truly what got me through this. I promise to dedicate the following free time to being a more attentive life companion.

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Lastly, and by no means least, to my supervisors, Basil and Andrew. I don't think I could have imagined a better combination when I set out on this journey. The analytical and methodological help you have given me has been nothing short of exceptional. So has the freedom with which you have both shared the deep subject matter expertise that you both uniquely hold, and which has been crucial to my own learning and development. It is true what they say, 'supervisors are what really makes the PhD'.

This adventure was set in motion before the great events of 2020, but truly started and was shaped by COVID. COVID enabled me the freedom and flexibility that really allowed me to make this thesis what it is.

In the space of time since I started, climate change is now a well-established security threat, or at least it is in the political discourse. Maritime security has increased in attention but remains a strategically ambiguous term. And the same could be said of the Indo-Pacific, though with the way the world is going and the geostrategic competition currently happening, one wonders what tipping point we will reach first.

I would like to set the record straight here - this research was never about saving the world. The science predicts that we are doomed, and with society seemingly becoming increasingly individualistic and polarising, I tend to agree (not that I ever used to think of myself as a realist). I do, however, believe that as a collective society, we have the capacity and capability to address the plethora of global challenges ahead, and I hope this research supports ways to integrate the adaptive response needed to tackle climate change within the context of these challenges.

Abstract

How the Effects of Climate Change Impact the Maritime Security of the Indo-Pacific

James Brennan

This thesis investigates the impacts of climate change on the maritime security of the Indo-Pacific. This research evaluates and adapts a cumulative effect assessment (CEA) framework to identify the pathways the effects of climate change will take to impact on maritime security and the securitisation of the Indo-Pacific region. In order to develop this revised CEA in the thesis, the research has developed an understanding of these complex interactions, incorporating quantitative and qualitative data from both social and natural sciences. In doing this, the feasibility of using social CEA analysis to understand the impacts of climate change was evaluated and explored. The use of unscripted interviews with practitioners, policymakers, and expert academics, supplemented the desk reviews of academic and grey literature.

The research undertaken for this thesis shows the complex and interconnected nature of the impacts of climate change on maritime security. It also shows the value of a multidisciplinary approach when analysing climate change and maritime security and developing interventions to mitigate these impacts. The way the effects of climate change will impact maritime security, are many and varied and will have implications for the current geostrategic competition in the Indo-Pacific. This research highlights the importance of the environmental dimension of maritime security and the role it plays in underpinning all the other dimensions of maritime security. It also demonstrates the important role of maritime security within the current geostrategic competition playing out in the Indo-Pacific. It then sets out how the impacts of climate change on maritime security will affect and interact with the current geostrategic competition within the Indo-Pacific.

Keywords: Maritime Security, Maritime Crime, Climate Change, Climate Security, Indo-Pacific, Effect to Impact Pathway, Cumulative Effect Assessment, Environmental Security, Human Security, Economic Security, National Security

Word Count: 65,165

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Authors Declaration

I hereby declare that this thesis is my own work and has not been submitted in substantially the same form for the award of a higher degree elsewhere. The work presented here has been produced by myself except where due acknowledgement has been made in the text.

Chapter 1: Introduction and Research Aims

"The ocean has taken up between 20–30% (very likely) of total anthropogenic CO2 emissions since the 1980s."[1] This quote from the Intergovernmental Panel on Climate Change's (IPCCs), 2019, Special Report on the Ocean and Cryosphere in a Changing Climate (SROCC), illustrates the ocean's crucial role in the earth's climate system by acting to naturally absorb human greenhouse gas emissions.[2] This uptake of emissions increases the significance of the impacts of climate change. A changing climate is expected to have significant negative impacts on marine environments and coastal ecosystems, which affects human systems that depend on them.[3] As climate change increasingly contributes to worsening environmental degradation and resource scarcity there will be profound geostrategic implications and it is already being seen that environmental issues are influencing strategic decision making.[4] This research project will analyse the impacts of the effects of climate change on maritime security and the implications this has for the Indo-Pacific region and in doing this it will show the need to better incorporate the analysis of the environment into security considerations. It is already clear that the effects of climate change on maritime environments transcends borders and will be felt predominantly in coastal areas and the maritime domain.[5]

The aim of this research is to understand the crucial role that environmental security plays within maritime security. It argues that a safe, stable, and secure maritime environment underpins all other aspects of maritime security. The thesis also shows that maritime security is crucial to the Indo-Pacific, and through this it shows that environmental security

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[1] IPCC, *Summary for Policymakers. In: IPCC Special Report on the Ocean and Cryosphere in a Changing Climate [H.-O. Pörtner, D.C. Roberts, V. Masson-Delmotte, P. Zhai, M. Tignor, E. Poloczanska, K. Mintenbeck, A. Alegría, M. Nicolai, A. Okem, J. Petzold, B. Rama, N.M. Weyer (eds.)].* (Cambridge, UK and New York, NY, USA: Cambridge University Press, 2019), https://www.ipcc.ch/srocc/chapter/summary-for-policymakers/.

[2] Sunil Kumar Agarwal and Kamlesh K Agnihotri, "UNCLOS and climate-induced maritime challenges: Strategic implications for the Indian Ocean Region," *Maritime Affairs: Journal of the National Maritime Foundation of India* 18, no. 1 (2022).

[3] Adrien Comte et al., "Conceptual advances on global scale assessments of vulnerability: Informing investments for coastal populations at risk of climate change," *Marine Policy* 99 (2019/01/01/ 2019), https://doi.org/https://doi.org/10.1016/j.marpol.2018.10.038, https://www.sciencedirect.com/science/article/pii/S0308597X18301623.

[4] Christian Bueger and Timothy Edmunds, "8. New Challenges and a Look to the Future," in *Understanding Maritime Security* (Oxford University Press, 2024).

[5] Lee Cordner, "Rethinking maritime security in the Indian Ocean Region," *Journal of the Indian Ocean Region* 6, no. 1 (2010).

is also crucial to the Indo-Pacific. Investigating the impacts of climate change on the maritime security of the Indo-Pacific and supporting these arguments the thesis also supports the development of climate change as a security issue, the conceptualisation of a more holistic framing of maritime security (reinforced by a growing emphasis on an expanded concept of security), and that the Indo-Pacific is a maritime super region.

1.1 Introduction

Scientists have been warning about the implications of global warming for decades and in 2024 the WMO concluded that there were "clear signs of human-induced climate change reached new hights" as it "was likely the first calendar year to be more than 1.5°C above the pre-industrial era".[6] It is now accepted that global surface temperature has risen by up to 1.1°C since accurate temperature records started in the 1850s.[7] It would require a massive reduction in greenhouse gas emissions to reduce the changes in the earth's natural systems, and thus reduce the increasing impact on societies over the next century.[8] There have been steady increases in temperature since the 1950s and it is increasingly emphasised that the perceived increase in frequency and intensity of extreme weather events is due to the rise in global temperature.[9]

Researchers, and governments, are beginning to realise the need to start thinking about how these impacts will affect the world we live in and what areas of (in)security need to be addressed to provide the most stable future. Indeed policy makers are starting to shift the way they address climate change to focus on the "consequences of climate change, rather

[6] "State of the Global Climate 2024," 2025, accessed 23 May, 2025, https://wmo.int/publication-series/state-of-global-climate-2024#:~:text=The%20clear%20signs%20of%20human%2Dinduced%20climate%20change,warmest%20year%20in%20the%20175%2Dyear%20observational%20record.
[7] IPCC, "Summary for Policymakers," in *Climate Change 2023: Synthesis Report. Contribution of Working Groups I, II and III to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change [Core Writing Team, H. Lee and J. Romero (eds.)].* (Geneva, Switzerland: IPCC, 2023); IPCC, *Summary for Policymakers. In: IPCC Special Report on the Ocean and Cryosphere in a Changing Climate [H.-O. Pörtner, D.C. Roberts, V. Masson-Delmotte, P. Zhai, M. Tignor, E. Poloczanska, K. Mintenbeck, A. Alegría, M. Nicolai, A. Okem, J. Petzold, B. Rama, N.M. Weyer (eds.)].*
[8] IPCC, *Summary for Policymakers. In: IPCC Special Report on the Ocean and Cryosphere in a Changing Climate [H.-O. Pörtner, D.C. Roberts, V. Masson-Delmotte, P. Zhai, M. Tignor, E. Poloczanska, K. Mintenbeck, A. Alegría, M. Nicolai, A. Okem, J. Petzold, B. Rama, N.M. Weyer (eds.)].*
[9] "The science linking extreme weather and climate change," 2023, accessed 08 September, 2024, https://environment.govt.nz/news/the-science-linking-extreme-weather-and-climate-change/.

than the phenomenon itself".[10] In this context this research provides timely support to researchers and policy makers as it provides a new way and methodology of thinking about the impacts of climate change which will be crucial to better understanding the consequences of climate change.

The ocean is the largest continuous geographical entity in the world and like the impacts of climate change, it transcends geographical and political boundaries. As "all people on Earth depend directly or indirectly on the ocean" due to the crucial role it plays in the earth's climate system understanding the impact climate change will have on the ocean will be important to addressing the consequences and impacts of climate change.[11] The marine environment, marine habitats, and especially the deep-sea environment are all understudied and lesser known, especially the intersection of the marine environment security and human interaction.[12] This contributes to the general lack of maritime domain awareness, making understanding the marine environment crucial to better understanding maritime security. This thesis through its methodology outlined in Chapter 3 seeks to support great awareness of the links between climate change and maritime security and in turn support increased maritime domain awareness, especially where it relates to environmental security.

There is a growing realisation that separating areas of the ocean into different regions does not adequately support effective solutions to maritime issues because the ocean is a globally interconnected entity. This is why understanding the maritime domain as a complex security issue that requires extensive national, cross-jurisdictional, and public-private coordination is crucial to effectively addressing the challenges present in the maritime

[10] "Counterterrorism Lessons for Climate Security: A Trade in Tradecraft," 2025, accessed 23 May, 2025, https://www.planetarysecurityinitiative.org/news/counterterrorism-lessons-climate-security-trade-tradecraft.

[11] IPCC, *Summary for Policymakers. In: IPCC Special Report on the Ocean and Cryosphere in a Changing Climate [H.-O. Pörtner, D.C. Roberts, V. Masson-Delmotte, P. Zhai, M. Tignor, E. Poloczanska, K. Mintenbeck, A. Alegría, M. Nicolai, A. Okem, J. Petzold, B. Rama, N.M. Weyer (eds.)]*.

[12] Alan J Jamieson et al., "Fear and loathing of the deep ocean: why don't people care about the deep sea?," *ICES Journal of Marine Science* 78, no. 3 (2021).
Robert McCabe, "Environmental drivers of maritime insecurity: governance, enforcement and resilience in the western Indian Ocean," *Conflict, Security & Development* 23, no. 3 (2023/05/04 2023), https://doi.org/10.1080/14678802.2023.2256251, https://doi.org/10.1080/14678802.2023.2256251.

domain.[13] In practice, these challenges of maritime insecurity are generating novel forms of association, integration, and cooperation between actors.[14] This supports the use of the term Indo-Pacific, a maritime super-region, as the geographic entity for analysis, because it allows for solutions that are not confined to singular countries.

Maritime security is a relatively new term, with academic literature on the subject picking up from about 2002.[15] Since 2014, there has been a sharp increase in the number of maritime security strategies developed by states, showing that the perceived importance of the maritime domain is increasing especially within security and policy dialogues.[16] The concept of maritime security touches on a wide range of activities (such as power projection, illegal unregulated unreported fishing, piracy, and environmental crimes) which is why it is so important.

In conjunction with the proliferation of maritime security strategies, maritime security has been brought sharply into academic focus by scholars, who started by questioning the order at sea during the age of globalisation.[17] As Otto states in 2020 "the sea has for hundreds of years been the site of geostrategic importance to which states have attached their ability to rise on the international stage".[18] In 2015 Germond explained that "The sea is now recognised as an integral part of international security agenda due to its geopolitical importance."[19]

As a security issue climate change is generally viewed as a 'threat multiplier'.[20] Pomeroy et al, using the example of fish wars and the impact these have on resource scarcity and food insecurity, argue that currently, coastal areas globally are experiencing increasing levels of

[13] Robin Mahon and Lucia Fanning, "Regional ocean governance: Polycentric arrangements and their role in global ocean governance," *Marine Policy* 107 (2019/09/01/ 2019), https://doi.org/https://doi.org/10.1016/j.marpol.2019.103590, https://www.sciencedirect.com/science/article/pii/S0308597X19302751.
[14] Christian Bueger and Timothy Edmunds, "Beyond seablindness: a new agenda for maritime security studies," *International Affairs* 93, no. 6 (2017), https://doi.org/https://doi.org/10.1016/j.marpol.2018.10.010. .pg 1293
[15] Basil Germond, "The geopolitical dimension of maritime security," *Marine Policy* 54 (2015).
[16] Lisa Otto, "Introducing Maritime Security: The Sea as a Geostrategic Space," in *Global Challenges in Maritime Security* (Springer, 2020).
[17] Bueger and Edmunds, "Beyond seablindness: a new agenda for maritime security studies."
[18] Otto, "Introducing Maritime Security: The Sea as a Geostrategic Space," 9. p.g 9.
[19] Germond, "The geopolitical dimension of maritime security."
[20] Michael Durant Thomas, *The Securitization of Climate Change: Australian and United States' Military Responses (2003 - 2013)*, The Anthropocene: Politik—Economics—Society—Science, (Springer Cham, 2017).

unrest and conflict, caused by non-traditional security threats impacting maritime security.[21] With climate change predicted to increase stress on coastal areas the chance of instability is rising and so will the possibility of interstate disputes, especially in the Indo-Pacific which is maritime in nature.[22]

Maritime security research has in the past tended to focus on micro (singular and specific) issues and/or events rather than focusing on the macro level and analysing the interlinkages between these issues.[23] This study will use the issue of the impacts of the effects of climate change to support a more holistic view of maritime security, with one of the aims of this project being to create a more coherent way to frame the concept of maritime security, the threats this encompasses, and the interactions between the threats.

This thesis concentrates on the Indo-Pacific region in part because of the magnitude and natures of both climate change and maritime security , and in part because, as will be discussed in Chapter 2, of the centrality of the ocean as the connective medium between actors in the region and also as it is central to global trade and the focus of current geostrategic tensions.[24] The Indo-Pacific is also a highly interconnected maritime entity with extensive human interactions lasting centuries.[25] There is a lack of scholarly work that focuses on maritime security issue across the breadth of the Indo-Pacific.[26] This thesis supports aims that seek to build a comprehensive understanding of maritime issues across the maritime super region that is the Indo-Pacific, especially as it relates to climate change.

The Indo-Pacific term is not new, but as discussed in Chapter 2, it is only recently that this term has become widely used in politics, and strategic and foreign policy. It is argued by

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[21] Robert Pomeroy et al., "Drivers and impacts of fisheries scarcity, competition, and conflict on maritime security," *Marine Policy* 67 (2016).
[22] Mohan Malik, *Maritime Security in the Indo-Pacific: Perspectives from China, India, and the United States* (Rowman & Littlefield, 2014).
[23] Bueger and Edmunds, "Beyond seablindness: a new agenda for maritime security studies."
[24] Alessio Patalano, James A. Russell, and Catherine L. Grant, "1. Naval Power and a Framework for Regional Security in the Indo-Pacific," in *The New Age of Naval Power in the Indo-Pacific: Strategy, Order, and Regional Security*, ed. Catherine L. Grant, Alessio Patalano, and James A. Russell (Georgetown University Press, 2023).
[25] Manjeet S. Pardesi, "The Indo-Pacific: a 'new' region or the return of history?," *Australian Journal of International Affairs* 74, no. 2 (2020/03/03 2020), https://doi.org/10.1080/10357718.2019.1693496, https://doi.org/10.1080/10357718.2019.1693496.
Valerie Hansen, *The year 1000: When explorers connected the world—and globalization began* (Simon and Schuster, 2020).
[26] Patalano, Russell, and Grant, "1. Naval Power and a Framework for Regional Security in the Indo-Pacific."

Pardesi and Paine that the last few centuries of 'western' domination have been an anomaly compared to the rest of human history, where Asia played a large role in the cultural and economic domination of the globe and that the current construction of the Indo-Pacific is indicative of a return to Asia as the strategic centre of the world.[27]

The Indo-Pacific is becoming a central region for trade and investment, containing sea lanes of communication (SLOCs) which are critical to the current flow of global trade and information.[28] The fact that four of the world's six major maritime choke points are in the Indo-Pacific contributes to the region's strategic significance. Arguably, the most important global and Indo-Pacific choke point is the Strait of Malacca which is a route for an estimated 30 percent of all goods traded globally.[29] The issue of maritime passage in the contested region is a global issue of which several countries such as Australia, China, Japan, South Korea, New Zealand, and Taiwan are all concerned.[30]

The Indo-Pacific maritime super-region, as will be shown in Chapter 2 and throughout the thesis, is made up of a variety of countries that are geographically, socially, and economically diverse. For example, Pacific countries contribute up to half of the total nations encompassed in the Indo-Pacific region, most of which are small island developing states (SIDS) and their Exclusive Economic Zones (EEZs) contain large amounts of the ocean.[31] The Pacific sub-region will be one of the areas most vulnerable to the effects of climate change and will be irreversibly changed by its impacts. It is also an area with weak capacity to respond to maritime security issues. This is caused by several factors including, economic insecurity, large EEZs with porous maritime borders, and a lack of capacity and capability to monitor their EEZs and maritime borders.[32] The Indo-Pacific region also includes two of the fastest-growing countries China and India, and four of the five biggest economies by Gross Domestic Product (GDP) (China, India, Japan, and the United States).

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[27] Pardesi, "The Indo-Pacific: a 'new' region or the return of history?."
Lincoln Paine, *The sea and civilization: a maritime history of the world* (Atlantic Books Ltd, 2014).
[28] Malik, *Maritime Security in the Indo-Pacific: Perspectives from China, India, and the United States*.
[29] Abhijit Singh, "Maritime security partner in the Indo-Pacific," *Asian Strategic Review* (2015). "Supply Chains and Transportation: These are the world's most vital waterways for global trade," World Economic Forum, 2024, accessed 19 July, 2024, https://www.weforum.org/agenda/2024/02/worlds-busiest-ocean-shipping-routes-trade/.
[30] David Brewster, "Indo-Pacific century: new concept, new challenges," (2016).
[31] Anna Naupa, "Indo-Pacific Diplomacy: A View from the Pacific Islands," *Politics & Policy* 45, no. 5 (2017).
[32] Rieko Hayakawa, "Japan's Oceania engagement and maritime security," (2018).

The Indo-Pacific has become the geographical focus for much of the international security and politics with many countries globally developing strategies for the Indo-Pacific highlighting the current prominence of the Indo-Pacific as will be further discussed in Chapter 2. However, there are differing views on the cause of the most recent construction of the Indo-Pacific with some commentators seeing the use of the Indo-Pacific terminology as a way of aligning different state's foreign policies.[33]

The effects of climate change are already being felt widely throughout the Indo-Pacific.[34] This is evidenced by the reporting on the shrinking of waterways in Vietnam, where the effects of climate change on the Mekong Delta is already impacting transportation, agriculture, and overall sustainability in the country.[35] At the same time the water shortages being seen in coastal regions of India, the occurrence of massive bushfires and record temperatures in Australia, and increasingly ferocious tropical storms felt through the Pacific, are examples where climatic changes are being felt in countries and regional settings, affecting economic development and national security.[36]

As climate change starts to impact sea level rise, soon one of the world's biggest cities, Jakarta (currently over 10.5 million people), will be faced with the issue of encroaching ocean. This will impact the security and safety of the population of the city affecting its urban geography and resilience to weather events.[37] This has consequently led to the

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[33] Rory Medcalf, "Reimagining Asia: From Asia-Pacific to Indo-Pacific," in *International Relations and Asia's Southern Tier* (Springer, 2018).
Singh, "Maritime security partner in the Indo-Pacific."
[34] Ian Hall, Troy Lee-Brown, and Rebecca Strating, *Blue Security in the Indo-Pacific* (Routledge, 2024).
[35] "Shipping and the great shrinking waterways," 2024, accessed 09 September, 2024, https://www.lowyinstitute.org/the-interpreter/shipping-great-shrinking-waterways.
"Vietnam's Climate Solutions Are Decimating the Mekong Delta," The Diplomat, 2024, accessed 09 September 2024, https://thediplomat.com/2024/02/vietnams-climate-solutions-are-decimating-the-mekong-delta/.
[36] "No crops, no brides: how rising seas are killing India's coastal villages," The Guardian, 2024, accessed 09 September, 2024, https://www.theguardian.com/global-development/2024/mar/11/india-odisha-cyclones-coastline-climate-crisis-salinity-farming-migration-cities.
"Australia's Heatwave and Bushfire: A Case for Tackling Climate Change with Energy Transition," Australian Institute of International Affairs, 2024, accessed 09 September, 2024, https://www.internationalaffairs.org.au/australianoutlook/australias-heatwave-and-bushfire-a-case-for-tackling-climate-change-with-energy-transition/.
"Climate change increases threats in South West Pacific," Prevention Web, 2021, accessed 09 September, 2024, https://www.preventionweb.net/news/climate-change-increases-threats-south-west-pacific.
[37] "Jakarta Population 2020," accessed 11 January, 2021, https://worldpopulationreview.com/world-cities/jakarta-population.

Indonesian government considering the movement of the capital to another city.[38] Similar rising sea levels across this region have the potential to create extensive forced relocations of populations who currently inhabit low-lying areas of their countries.[39]

The profound impact that COVID-19 had on social, economic, political, and security sectors showed the need to understand the issues that can arise with the occurrence of transnational events/effects.[40] With both climate change and maritime security being transnational issues impacting social, economic, political, and security, this further outlines the need for this research to support the understanding of the impact that climate change has on maritime security.

The research undertaken for this thesis is designed to support a better knowledge of the full range of climate change's impacts, while clearly illustrating the importance of understanding the full causal chains and pathways of such impacts. In doing this research it was necessary to develop a methodology that could adequately trace these pathways from the sources of human-induced climate change all the way through to the impact it has on society. This outcome significantly adds value to the academic literature and progresses the understanding of climate impacts. It also bridges the gap between the use and understanding of climate science and international security studies.

1.2 Aim of the Research

States across the Indo-Pacific, which are reliant on seas and waterways for trade, food, and tourism, need to assess how to manage the effects of climate change that impact on them. This project will be an investigation of the climate-maritime security nexus. To support policy makers and researchers better understand the consequences of climate change and

[38] "Jakarta, the fastest-sinking city in the world," BBC, 2018, accessed 19 July, 2024, https://www.bbc.com/news/world-asia-44636934; "Jakarta Population 2020."
[39] Asian Development Bank, *Climate Change and Migration in the Asia and Pacific* (2011).
[40] Rachel Fleishman Shiloh Fetzek, *Climate Security and the Strategic Energy Pathway in Southeast Asia*, The Center for Climate & Security (2021), https://imccs.org/wp-content/uploads/2021/01/Climate-Security-and-the-Strategic-Energy-Pathway-in-SOUTHEAST-Asia_February-2021.pdf.
Mohd Alsaleh, "The role of the fishery industry in the shift towards sustainable food security: a critical study of blue food," *Environmental Science and Pollution Research* 30, no. 48 (2023/10/01 2023), https://doi.org/10.1007/s11356-023-29747-4, https://doi.org/10.1007/s11356-023-29747-4.

to better understand the environmental aspects of security, the primary aim of this research is:

- To analyse how the effects of climate change will impact the maritime security of the Indo-Pacific maritime super-region.

This will be done by pioneering an interdisciplinary assessment method that supports the compiling of a database of Effect to Impact Pathway (EIP) chains. These EIP chains will be used to identify the full impact of climate change on maritime security. To support the primary aim, this thesis will also analyse the current maritime security environment of the Indo-Pacific.

My secondary aims are:

- To add to the academic literature on the construction definition of maritime security, hoping to contribute to the work on this that may end up building a more concrete definition for future work; and
- To add to the academic literature that defines the boundaries and makeup of the Indo-Pacific region.
- To support the interactions between climate science and international security studies as they attempt to respond to the impacts of climate change.

1.3 Research Question

The research addresses a fundamental question, namely:

> *How will the effects of climate change impact the maritime security of the Indo-Pacific?*

Whilst answering (or evaluating) this research question, supplementary questions are also relevant and need to be addressed, such as:

- How is maritime security constructed and how are the dimensions of maritime security developing to support the understanding of maritime security?
- What are the pathways linking the effects of climate change to maritime security impacts?

- How is the Indo-Pacific constructed and what is the maritime security environment of the region?

1.4 Thesis Structure

The thesis will be divided into nine main chapters and figure 1.1 shows a high-level overview of the structure used for this thesis.

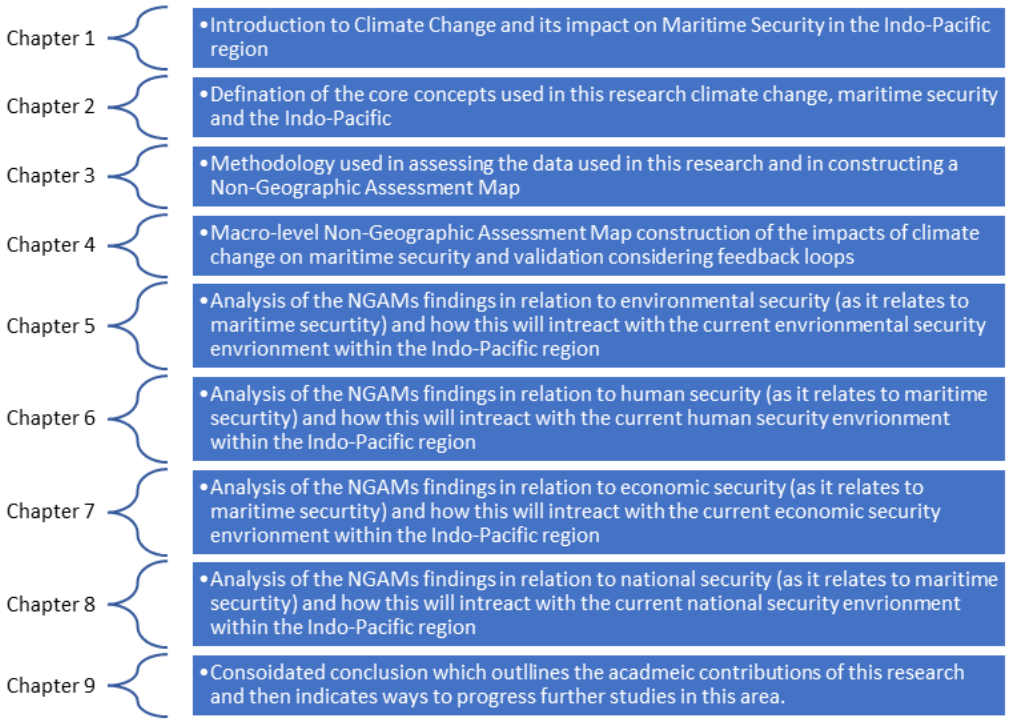

Figure 1.1 – Thesis overview

Chapter 1 introduces the salient issue of the analysing the impact the effects of climate change have on the impacts on the maritime security of the Indo-Pacific in both a qualitative and quantitative manner. As well as pointing out some of the features that intertwine these three issues. It then defines the main aims of the research in relation to these issues and the research questions this thesis aims to answer.

Chapter 2 explores the three core concepts at the centre of this research: climate change, maritime security, and the Indo-Pacific. In doing so, the chapter defines the core concepts to generate an understanding of the links between the effects of climate change and security issues, contributing to the academic discourse on the securitisation of climate change from

a global perspective and its specific impact on maritime security. The tenant of the chapter is to support the understanding of maritime security as a concept and explore how the boundaries of the concept have changed following increased attention on 'non-traditional' security issues, which has contributed to placing environmental security as a fundamental aspect of maritime security. Finally, Chapter 2 will outline the boundaries of the Indo-Pacific concept employed in this thesis; this discussion will also contribute to the ongoing academic discourse on the composition of the Indo-Pacific.

Chapter 3 outlines the methodology behind adapting a cumulative effect assessment tool to create a Non-Geographic Assessment Map (NGAM). In doing this, it details the process undertaken and assumptions used by the researcher to create the EIP chains analysed in the thesis. The chapter also describes the data sources and their authenticity, used in this research and why they were chosen for their relevance to maritime security and the Indo-Pacific region.

Chapter 4 develops a macro-level NGAM which analyses the impacts that the effects of climate change will have on maritime security as a whole. It will break this analysis down at each step of the EIP chain and discuss the interactions the EIP chains have with each other and the feedback loops they can create.

Chapters 5 to 8 uses the NGAM developed in Chapter 4 and elaborates on this by detailing by analysing the EIP chains that impact on each different dimension of maritime security. This will also support an understanding of how all the dimensions of maritime security are interlinked, as well as how they are all fundamentally underpinned by environmental security. Throughout this detailed analysis this research will also show how climate change is a maritime security issue, how maritime security could incorporate the analysis of the impacts of climate change into maritime security planning, and how maritime security and the effects and impacts of climate change increasingly supports the construction and strengthening of links within the Indo-Pacific.

Chapter 5 analyses the NGAM by the environmental security dimension of maritime security. This chapter illustrates why environmental security is so important to the wider concept of maritime security by outlining the current state of environmental security within the Indo-Pacific, and then analysing how the effects of climate change will impact environmental security. Finally, this chapter discusses how these impacts may interact with

the current state of environmental security in the Indo-Pacific to cause insecurity in the future. Chapter 5 finds that the environmental dimension of maritime security will be impacted by biodiversity loss and ecosystem changes that also underpin the other dimension of maritime security and argues that marine protected areas and nature-based solutions are useful interventions for increasing environmental security and driving cooperation.

Chapter 6 analyses the NGAM through the lens of the human security dimension of maritime security. This chapter outlines how human security fits into the wider concept of maritime security and interlinkages with the other dimensions of maritime security. The chapter developed upon issues surrounding the wellbeing and livelihoods of people within coastal communities such as, food security and social cohesion which will be heavily impacted by the effects of climate change. This analysis is conducted by outlining the current state of human security in the Indo-Pacific, and then analysing how the effects of climate change will impact environmental security. Finally, Chapter 6 discusses how these impacts may interact with the current state of human security in the Indo-Pacific and discuss the need for sustainable fisheries management, increased aquaculture and agriculture in coastal areas, and greater consideration of gendered interventions and solutions to climate change.

Chapter 7 analyses the NGAM through the lens of the economic security dimension of maritime security. This chapter elaborates upon factors which contribute to the key aspects enabling economic security to fit into the wider concept of maritime security and its interlinkages with the other dimensions. It builds upon the connections between fisheries and tourism with regards to aspects of economic security and determines that these factors will be heavily impacted by climate change. Additionally, the chapter serves to highlight and argue that as people's and communities' legitimate economic opportunities decrease, they will turn to illegitimate ways of sustaining their livelihoods. This analysis will be done by outlining the current state of economic security in the Indo-Pacific, and then subsequently analysing how the effects of climate change will impact economic security. Finally, Chapter 7 discusses how these impacts may interact with the current state of economic security in the Indo-Pacific and discuss the need to support alternative sources of income for people and communities as well as the need for sustainable fisheries management.

Chapter 8 analyses the NGAM through the lens of the national security dimension of maritime security. This chapter summarises how national security fits into the wider concept of maritime security and its interlinkages with the other dimensions. It explores the factors which illustrate that fisheries, ocean governance, and coastal infrastructure will be the most impacted aspects of national security. In doing so, the chapter outlines the current state of national security in the Indo-Pacific, and then analysing how the effects of climate change will impact national security. Finally, Chapter 8 discusses how these impacts may interact with the current state of national security in the Indo-Pacific and discuss the need for more sustainably managed fisheries, more climate-resilient infrastructure, and better equipped and resourced military forces.

Chapter 9 is the final review of the data and consolidates all the findings presented throughout this thesis. The major focus of this chapter is to outline how these findings contribute to advancing academic knowledge and discourse by providing unique contributions to analytical and methodological analysis. Lastly, the main findings of this thesis are presented in a summarised form, in conjunction with recommendations for areas of future research.

Chapter 2: Conceptual Framework and Concept Definitions

The main aim of this chapter is to define the three main concepts that will be used in this thesis and explain how they interact; Climate change, Maritime Security, and the Indo-Pacific. The chapter will also lay out the conceptual framework used to draw together the analysis of all the different concepts. In determining the definitions of the concepts used in this thesis, this section will analyse the current academic discourse which contributes to the current construction of the concepts, before stating the concept definitions that will be used in this thesis.

This chapter will also:

- determine the level of understanding of climate change within maritime security policy development;
- Critically add to the academic literature on the definition of maritime security and in so doing generate a novel, model-based approach to supporting the current understanding of maritime security, strategically building a more concrete definition for future work; and
- add to the academic literature that conceptualises the boundaries of the Indo-Pacific region.

2.1 Conceptual Framework

The primary aim of this research is to improve the understanding of how the cumulative effects of climate change and determining their impact on the maritime security of the Indo-Pacific. This will be done by using a framework of analytical steps which will aid the overall understanding of how the three main concepts are currently intertwined and how any future worsening of the effects of climate change may impact upon the maritime security of the Indo-Pacific.

The below framework, in Figure 2.1, outlines how this project aims to achieve its outcomes by defining concept definitions and analysing how these concepts interact with each other.

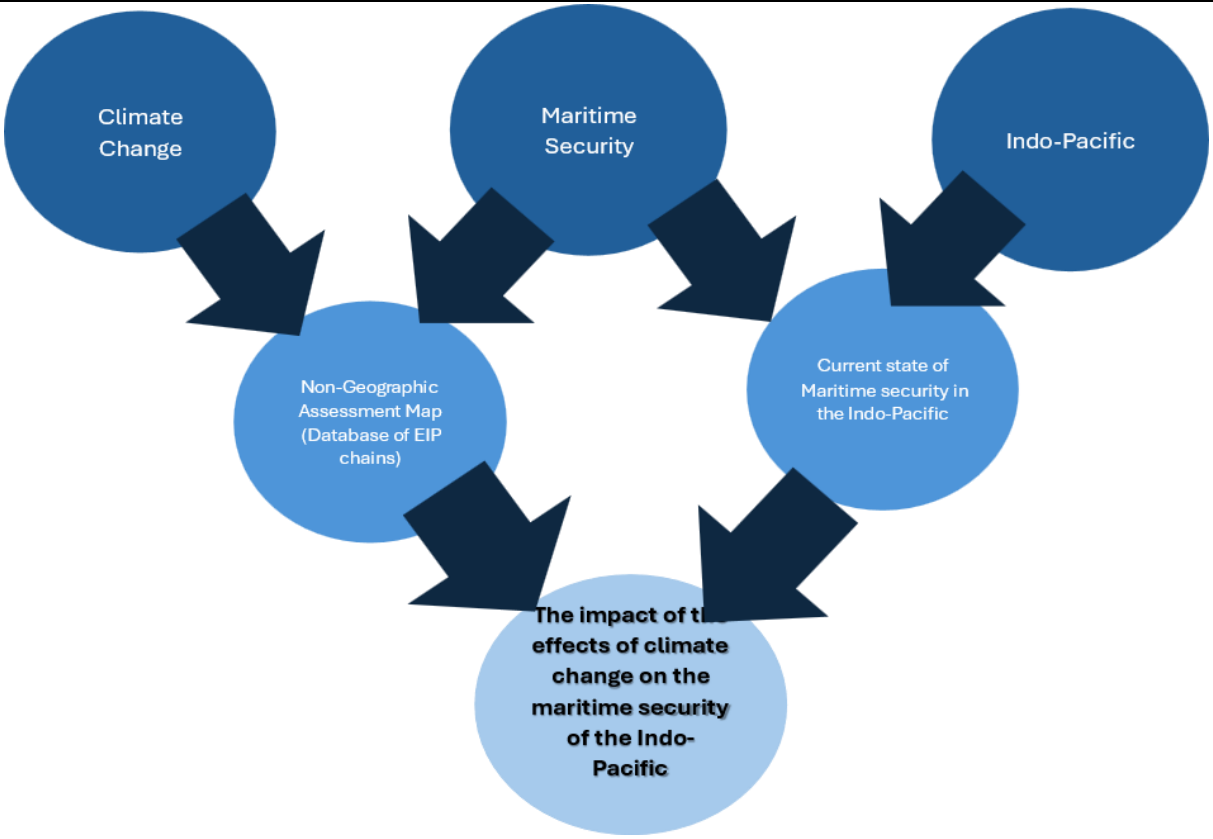

Figure 2.1 – Conceptual Framework for Analysis

The initial step of the process focuses on defining the core concepts crucial to understanding the context in which this research takes place. The three core concepts that need to be initially understood for this conceptual framework are the:

- Indo-Pacific geostrategic context: This aspect of the framework will be understood by reviewing how the Indo-Pacific has been constructed as a concept and a region and then goes on to outline the current strategic environment of the Indo-Pacific.
- Maritime Security sectors: This aspect of the framework will be understood by defining the subsections of maritime security and reviewing the evolving definition of maritime security and its dimensions.
- Climate change: This aspect of the framework will be understood by using IPCC reports to understand the full range of climate change effects and their impacts. To fully understand the implications of the impacts of climate change this research will also critically engage with the discourse on the securitisation of climate change and the views different actors take towards this.

These core concepts are then used in the next step of the conceptual framework to support the analysis of the linkages both between climate change and maritime security and between maritime security and the Indo-Pacific. The analysis of the current state of the Indo-Pacific's maritime security will be done by reviewing academic and grey literature. This analysis will also be supported by some of the findings extrapolated from the expert interviews undertaken with policymakers, practitioners, and academics.

The analysis of the linkages between climate change and maritime security will be done using the novel methodological framework outlined in Chapter 3, based on EIP chains. A database of EIP chains will be created in Chapter 4 to develop a NGAM. This will be one of this thesis' major original contributions to academic knowledge, as it is not only rare for this kind of methodology to be applied to social science, but it is even rarer for it to be applied to issues of security studies.

For the last step of the conceptual framework, Chapters 5 to 8 will support the analysis of the interactions between climate change and maritime security in the Indo-Pacific. This will be obtained by analysing the different dimensions of maritime security as they relate to the NGAM and the current state of the maritime security of the Indo-Pacific. To ensure this step of the analysis represents what is being observed/predicted by security actors, it will be cross-checked through a series of semi-structured interviews as mentioned above, using the Delphi approach to help ensure its accuracy, robustness, and relevance.

2.2 Concept Definitions

As outlined in the assessment framework three main definitions will be used in this thesis.

2.2.1 What is Climate Change?

Anthropogenic climate change caused by human activities, predominantly the emissions of greenhouse gasses (GHGs), was predicted as far back as 1896 and now the impacts of climate change are becoming observed with increasing frequency and intensity.[41] It is widely accepted by scientists and global policymakers that average global temperatures are steadily getting warmer, and this is attributed to human-related emissions of GHGs, mostly carbon dioxide (CO2).

[41] "Evidence," accessed 20 July, 2024, https://science.nasa.gov/climate-change/evidence/.

Starting in the 1700s the Industrial Revolution saw the ever-increasing GHG emissions from fossil fuels (through their extraction and use as energy) and changes in land use.[42] The IPCC has estimated that human activities have already contributed to 1.0°C of global warming which has been evidenced by the fact that 2023 was the hottest year since records began, with the average global temperature for the year 1.45°C above pre-industrial levels.[43] The IPCC stated, "It is extremely likely that more than half of the observed increase in global average surface temperature from 1951 to 2010 was caused by the anthropogenic increase in GHG concentrations and other anthropogenic forcings together."[44]

Action and advocacy on climate change have recently gained increasing urgency and prominence, with issues of climate change and environmental protection/governance becoming one of the most lobbied policy issues around the world.[45] This comes after numerous attempts over the past thirty years to gain agreement from the international community to stabilise and then halt their carbon emissions.[46] The most significant attempt was the Paris Agreement in 2015, where it was agreed that countries would aim to limit global warming to 1.5°C. There is currently minimal credible action happening, and several governments and industries recently indicated their inability to attain the targets set out previously. Without nations agreeing to take more severe action to limit emissions, global warming will continue, and the adverse impacts of climate change's effects will continue intensifying. Given the trajectory temperatures are already on and the lack of action currently being taken, it is likely that by the end of the century, global temperatures will have risen by 4.4°C using high emission scenarios.[47]

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[42] Thomas, *The Securitization of Climate Change: Australian and United States' Military Responses (2003 - 2013)*; Michael Durant Thomas, *The securitization of climate change: Australian and united states' military responses (2003-2013)*, vol. 10 (Springer, 2017).
[43]IPCC, "Summary for Policymakers."
"WMO confirms that 2023 smashes global temperature record," 2024, accessed 24 March, 2024, https://wmo.int/media/news/wmo-confirms-2023-smashes-global-temperature-record.
[44] IPCC, *Climate Change 2014: Synthesis Report. Contribution of Working Groups I, II and III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change* (Geneva, Switzerland: IPCC, 2014).
[45] Heike Böhler, Marcel Hanegraaff, and Kai Schulze, "Does climate advocacy matter? The importance of competing interest groups for national climate policies," *Climate Policy* 22, no. 8 (2022).
[46] "A brief history of climate change," 2013, accessed 20 July, 2024, https://www.bbc.com/news/science-environment-15874560.
[47] IPCC, "Summary for Policymakers."

How does climate change work?

Anthropogenic climate change and GHG emissions cause the earth to warm due to the 'greenhouse effect'. This is where radiation from the sun is trapped by GHGs in the earth's atmosphere. As the concentration of GHGs in earth's atmosphere has increased, post the Industrial Revolution (due to human activity), the 'greenhouse effect' has intensified by trapping more heat and leading to a warming planet. Figure 2.2 below shows how this works in detail.

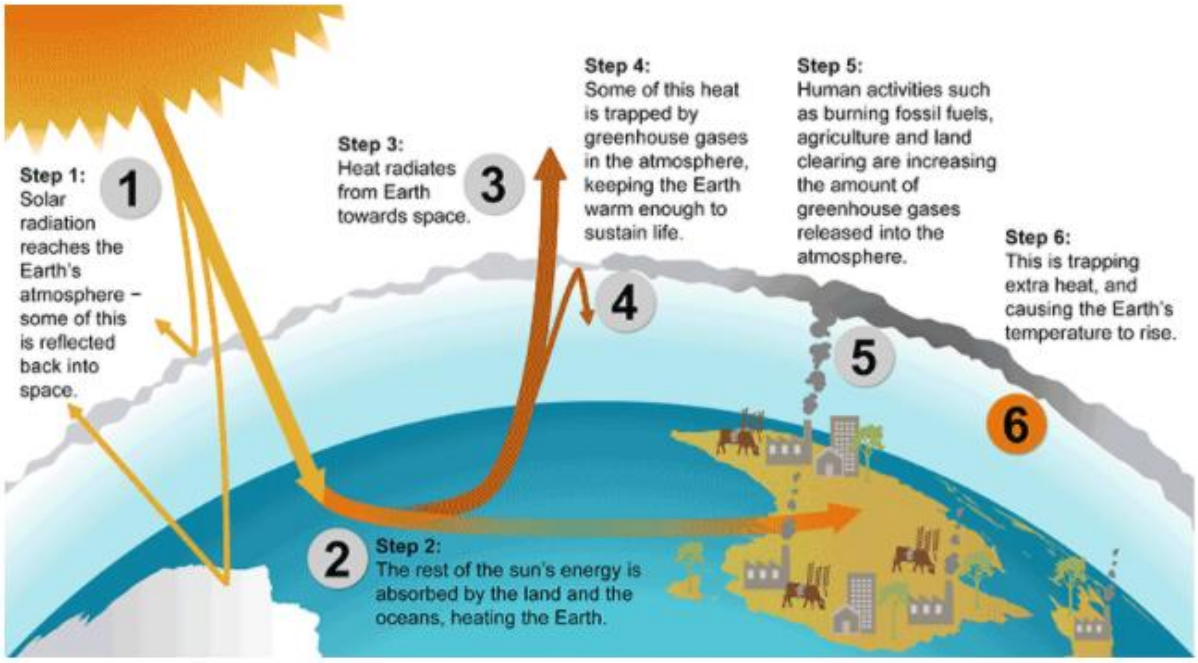

Figure 2.2 – "Greenhouse effect" by Australian Department of Agriculture, Water and the Environment [48]

As well as overall global temperature warming, anthropogenic climate change, and the continued emissions of GHGs several "widespread and rapid changes in the atmosphere, ocean, cryosphere and biosphere have occurred."[49] The IPCC also finds in its *AR6 Synthesis Report: Climate Change 2023* that human activity has contributed to the following impacts of the effects of climate change:

- "warmed the atmosphere, ocean and land."

[48] "Greenhouse effect," Australian Department of Agriculture, Water and the Environment, accessed 17 April, 2021, https://www.environment.gov.au/climate-change/climate-science-data/climate-science/greenhouse-effect.
[49] IPCC, "Summary for Policymakers."

- Caused the mean global sea level to "increase by 0.20 [0.15 to 0.25] m between 1901 and 2018."
- Increased extremes "such as heatwaves, heavy precipitation, droughts, and tropical cyclones", as well as increased the likelihood and frequency of concurrent extremes.
- "caused substantial damages, and increasingly irreversible losses, in terrestrial, freshwater, cryospheric, and coastal and open ocean ecosystems".[50]

This study's definition of climate change

For this study, the United Nations Framework Convention on Climate Change's (UNFCCC) definition of Climate change will be used to define some of the parameters of climate change. The UNFCCC definition is, "a change of climate which is attributed directly or indirectly to human activity that alters the composition of the global atmosphere and which is in addition to natural climate variability observed over comparable time periods."[51] Many researchers have used this definition of climate change in their publications over the past few decades, and it is the impacts of this that the study is aiming to observe as affecting maritime security.

The securitisation of climate change

In recent times, climate change has gained increasing attention from international actors and become increasingly integrated into the international security agenda.[52] In international relations, a security issue represents an existential threat or requires 'exceptional measures'.[53] To understand why climate change has gained its current prominence within international politics and security studies, it is useful to understand the process of the issues' securitisation. It also supports the understanding of why climate change is a prominent issue for maritime security and the Indo-Pacific.

However, in showing that climate change has become a security issue requires an understanding of the development of the field of security studies is needed. As the expanded concept of security that has grown out of the Copenhagen school of security,

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[50] IPCC, "Summary for Policymakers."
[51] United Nations, *United Nations Framework Convention on Climate Change* (1992).
[52] Maria J Trombetta, "Introduction: linking climate change and security," in *Handbook on climate change and international security* (Edward Elgar Publishing, 2023).
[53] Barry Buzan, Ole Wæver, and Jaap De Wilde, *Security: A new framework for analysis* (Lynne Rienner Publishers, 1998).

developed in 1998 by Buzan is provides the underlying support of establishing climate change as a security issue.

Before 1998, when Buzan, Waever and de Wilde, published *Security: A New Framework for Analysis*, the emphasis placed on security was primarily focused on the primacy of the state and its military. A view built up through numerous challenges to global security throughout the Cold War, and which set the context for and provided the central argument for the funding of the discipline of strategic studies.[54]

Initial dissatisfaction with the narrowness of confining security of the primacy of the state and military was raised through the 1970s and 1980s. This led to the concept expanding, including through Buzan et al, in 1998, and then Barnett, in 2003, both of whom discuss the widening of the concept of security that came at the end of the Cold War, and the subsequent increase in attention that environmental security has received.[55] Buzan et al see this as stemming from the disorientation of the strategic studies discipline during this time and the "want to construct a more radical view of security studies by exploring threats to referent objects, and the securitization of those threats, that are non-military as well as military."[56] Barnett expands on this by arguing, "conventional understandings of security were becoming less relevant, and environmental concerns were increasingly in the forefront of public concerns."[57] Indeed, the new era of global international relations, following the Cold War, meant that a re-evaluation of preconceived historical positions was crucial in building a holistic approach to security.

While the concept of security is expanding and becoming broader, there needs to be an understanding of the process it must go through to be securitised for an issue to be defined as a security issue. That security is constructed is also argued by Olesker, in 2018, where it is outlined how securitisation of an issue is created through arguing for the securitisation of an issue and an audience being convinced of the argument, as this legitimises the perceived threat.[58] Olsker goes on to state "Securitisation both requires legitimacy (of the actor, the

[54] Buzan, Wæver, and De Wilde, *Security: A new framework for analysis*.
[55] Buzan, Wæver, and De Wilde, *Security: A new framework for analysis*.
Jon Barnett, "Security and climate change," *Global environmental change* 13, no. 1 (2003).
[56] Buzan, Wæver, and De Wilde, *Security: A new framework for analysis*.
[57] Barnett, "Security and climate change."
[58] Ronnie Olesker, "The securitisation dilemma: legitimacy in securitisation studies," *Critical Studies on Security* 6, no. 3 (2018).

framing of the referent object and the proposed actions to thwart the threat) to succeed and produces further legitimacy to act."[59] The legitimacy argument is also supplemented by the contribution that Peters makes which is that "Securitisation is considered to be a gradual process through which an issue is (re)framed as a result of a series of political choices."[60]

The securitisation of climate change and its legitimisation are both underpinned by the fact that humans believe that there is at least a part of this within their control to affect. The issue of relating climate change to security has taken many forms and extraordinary measures are already being used to combat the impacts of the effects of climate change, examples of this include:

- the UN Security Council held discussions linking insecurity and climate change on at least four separate occasions 2007, 2011, 2017 and 2018;[61]
- several countries recently declaring a state of climate emergency;[62]
- at least 70 percent[63] of states have released a national security strategy which identifies climate change as a threat;[64] and
- the New Zealand Defence Force in 2018 stated that "understanding and accounting for the security impacts of climate change will be a critical component of operational planning in the years to come."[65]

These examples of extraordinary measures are also complimented by climate change becoming part of societal and political narrative since the 1980s including through the:

- Kyoto Protocol in 1992;

[59] Olesker, "The securitisation dilemma: legitimacy in securitisation studies."
[60] Katie Peters, "Disasters, climate change, and securitisation: the United Nations Security Council and the United Kingdom's security policy," *Disasters* 42 (2018).
[61] "Climate change recognized as 'threat multiplier', UN Security Council debates its impact on peace," 2019, accessed 15 November, 2023, https://news.un.org/en/story/2019/01/1031322.
[62] "UN secretary general urges all countries to declare climate emergencies," The Guardian 2020, accessed 15 November, 2023, https://www.theguardian.com/environment/2020/dec/12/un-secretary-general-all-countries-declare-climate-emergencies-antonio-guterres-climate-ambition-summit.
[63] This figure was from a 2015 study and while an updated figure could not be found it could be assumed that this figure would have increased.
[64] Shirley V Scott, "Implications of climate change for the UN Security Council: mapping the range of potential policy responses," *International Affairs* 91, no. 6 (2015).
[65] *The Climate Crisis: Defence Readiness and Response*, New Zealand Ministry of Defence (2018), https://www.defence.govt.nz/publications/publication/the-climate-crisis-defence-readiness-and-response.

- Awarding of the Nobel Peace Prize in 2007 to the Intergovernmental Panel on Climate Change and former President of the United States, Al Gore;
- Paris Agreement in 2015 and subsequent adoption of the Paris Rule book in 2018;
- School strike for climate movement organised by Greta Thunberg who was subsequently named Time Person of the Year for 2019;
- The International Tribunal for the Law of the Sea delivering an advisory opinion on climate change in May 2024; and
- Shifting business norms as companies and investment funds put in place Environmental, Social and Corporate Governance as a way of showing they are trustworthy stewards of the natural environment.[66]

These examples underscore the increasing attention that climate change is garnering and the drive for a greater analysis into understanding the effects climate change can cause. The focus of academic discussions has now turned to determining what future impacts these climate change effects might have on the overall securitisation of regional maritime environments. Some of the impacts of the effects of climate change are being observed already, while others have robust predictions for the next century.[67] Actors are using these predictions to declare a climate emergency, and this is usually an extraordinary measure deployed to combat climate change. The act of deploying extraordinary measures against the effects of climate change is legitimising the construction of climate change as a security issue.[68] The academic discourse is also showing an increased understanding and construction of climate change as a security issue, and as Nevitt points out, "conceptualizing climate change as a national security issue can play an important role in validating climate change as an issue that demands our attention and resources."[69]

Alongside the uptake in general society of climate change as a legitimate security issue, the links between climate change and security have been around since the 1970s but started in

[66] "The impact of green investors: Sustainable investing faces up to the sceptics," The Economist, updated 27/03/2021, 2021, accessed 26 September, 2021, https://www.economist.com/finance-and-economics/2021/03/27/the-impact-of-green-investors.
[67] Joshua W Busby, "Who cares about the weather?: Climate change and US national security," *Security Studies* 17, no. 3 (2008), https://doi.org/10.1080/09636410802319529.
[68] Harvey, "UN secretary general urges all countries to declare climate emergencies."
[69] Mark Patrick Nevitt, "On Environmental Law, Climate Change, & National Security Law," *Harv. Envtl. L. Rev.* 44 (2020).

earnest in the 1980s with the consideration of environmental refugees.[70] Recently, climate change has been recognised as a security issue by many regional and multilateral institutions, individual countries and cities, and by think tanks, non-governmental organisations and academics.[71] With the increase in attention being given to the issue of climate change, there has also come a need to expand how we think of climate change relating to security and the range of ways it is conceptualised.[72]

As mentioned above, since the Cold War there has been an expansion of the security concept. The widening of security into the environmental domain was seen by Homer-Dixon in 1991.[73] They outlined four main impacts that will be seen as the result of pressure from environmental degradation that creates scarcity of resources these are "reduced agricultural production, economic decline, population displacement, and disruption of regular and legitimized social relations."[74] Homer-Dixon further developed this in 1994 by outlining how environmental scarcity can cause violent conflict, by weakening state structures, through the consequences imposed upon societies by the "degradation and depletion of environmental resources."[75] Homer-Dixon also stated that "population growth and unequal resource distribution" could also lead to environmental scarcity, interaction of these pre-existing conditions with the effects of climate change, which will cause conflict.[76]

In conjunction with their comments on population growth and unequal distribution of resources, Homer-Dixon also makes a more direct comment on how climate change could be a threat multiplier and how this will affect actors and societies by saying "they [the effects of climate change] will most likely operate not as individual environmental stresses

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[70]Matt McDonald, "Climate change, security and the institutional prospects for ecological security," *Geoforum* 155 (2024/10/01/ 2024), https://doi.org/https://doi.org/10.1016/j.geoforum.2024.104096, https://www.sciencedirect.com/science/article/pii/S001671852400157X.
Mely Caballero-Anthony, "Climate security in Southeast Asia: navigating concepts, approaches and practices," *Third World Quarterly* 45, no. 14 (2024/09/21 2024), https://doi.org/10.1080/01436597.2024.2370353, https://doi.org/10.1080/01436597.2024.2370353.
Angela Oels, "From 'securitization'of climate change to'climatization 'of the security field: comparing three theoretical perspectives," in *Climate change, human security and violent conflict: Challenges for societal stability* (Springer, 2012).
[71] Matt McDonald, "Discourses of climate security," *Political geography* 33 (2013).
[72] McDonald, "Discourses of climate security."
[73] Thomas F Homer-Dixon, "On the threshold: environmental changes as causes of acute conflict," *International security* 16, no. 2 (1991).
[74] Homer-Dixon, "On the threshold: environmental changes as causes of acute conflict."
[75] Thomas F Homer-Dixon, "Environmental scarcities and violent conflict: evidence from cases," *International security* 19, no. 1 (1994).
[76] Homer-Dixon, "Environmental scarcities and violent conflict: evidence from cases."

but in interaction with other, long-present resource, demographic, and economic pressure that have gradually eroded the buffering capacity of some societies."[77] This was also shown by other studies in the 1990s, such as the impact of climate change on fresh water resources (Glick in 1993) and livelihoods (Myers in 1995) could also lead to environmental refugees as well as causing conflict.[78]

Since then, the academic discourse has continued to bring about a consensus that climate change is a security issue.[79] In 2003, Barnet started to link climate change to national security through existential crisis, internal legitimacy of the state, financial costs, and violent conflict.[80] Barnet argues that the state of the discourse up to 2003 was about 'militarising' environmental issues rather than 'securitising' them.[81] Barnett argues that it is rarely ever environmental factors alone that cause people to migrate, and that climate change as a threat multiplier, that the resilience and adaptability of communities may be stretched to their limits by climate change, this would be the point at which increase violence and criminality would then occur.[82] So it is not just about looking at climate change through a militaristic lens. Barnet, like many before, also says that more research is needed to understand how climate change interacts with other factors to cause migrations.[83]

The idea of climate change as a 'threat multiplier' firmly took hold in 2007 with the Centre for Naval Analyses report on *National Security and the Threat of Climate Change* which outlined the threat that climate change posed to the United States national security and the instability it could cause across the globe though exacerbating other security issue.[84] This supported the development of climate change as a national security issue, especially in

[77] Homer-Dixon, "Environmental scarcities and violent conflict: evidence from cases."
[78] Peter H. Gleick, "Water and Conflict: Fresh Water Resources and International Security," *International Security* 18, no. 1 (1993), https://doi.org/10.2307/2539033, http://www.jstor.org/stable/2539033.
Norman Myers and Jennifer Kent, *Environmental exodus: an emergent crisis in the global arena* (1995).
Caballero-Anthony, "Climate security in Southeast Asia: navigating concepts, approaches and practices."
[79] Caballero-Anthony, "Climate security in Southeast Asia: navigating concepts, approaches and practices."
[80] Barnett, "Security and climate change."
[81] McDonald, "Discourses of climate security."
[82] Barnett, "Security and climate change."
[83] Barnett, "Security and climate change."
[84] CNA Military Advisory Board, "National security and the threat of climate change," *Alexandria: CNA Corporation* (2007).

relation as to how it impacts the delivery of military force and power projection, including Humanitarian Assistance and Disaster Relief, both at home and abroad.[85]

In 2007, Barnett and Adger put forward an approach to the issue of climate security through the lens of human security and how human security can impact a state's ability to effectively govern itself, stating that "human security cannot be separated from the operation of states."[86] This comment implies the notion that states are critical to providing opportunities for people, creating and providing a framework of laws and legislative mandates in which a "stable environment so that livelihoods can be pursued with confidence, and providing measures to protect people when livelihoods contract."[87] Barnett and Adger then went on to elaborate on this framework by outlining the underlying conditions that lead to violent conflict (mostly the contraction of livelihood) and the relative incentives these create for people (especially young men) to involve themselves in violent or illegal activities.[88] These underlying conditions are usually influenced by the strength and quality of a country's governing policies as well as its law enforcement capabilities and capacities. With this in mind, Barnett and Adger argue that to understand the impacts of climate change on violent conflict, there is a need to understand the impacts of climate change on the ability of the state to govern.[89]

Also in 2007, Brown, Hammill, and McLeman argued that the aim of the climate-security discourse is "to marshal sufficiently compelling arguments to encourage the politicians to do something about reducing emissions and investing (carefully) in adaptation."[90] In their article, they elaborate on the reasons for the recent increase in prominence that climate-security has received, and suggest that one of the main factors is that "it is becoming increasingly clear that future climate change threatens to exacerbate existing drivers of conflict in a way that could roll back development across many countries". The second relevant point to consider is that "it is part of a clear process to invest the international

[85] Caballero-Anthony, "Climate security in Southeast Asia: navigating concepts, approaches and practices."
[86] Jon Barnett and W Neil Adger, "Climate change, human security and violent conflict," *Political geography* 26, no. 6 (2007).
[87] Barnett and Adger, "Climate change, human security and violent conflict."
[88] Barnett and Adger, "Climate change, human security and violent conflict."
[89] Barnett and Adger, "Climate change, human security and violent conflict."
[90] Oli Brown, Anne Hammill, and Robert McLeman, "Climate change as the 'new'security threat: implications for Africa," *International affairs* 83, no. 6 (2007).

debate with a greater sense of urgency."[91] This second reason has (as shown earlier in this section) been relatively successful of raising the profile of climate change and climate-security in to the international political debate, but also one issue that has meant that action on climate change is rare and slow. Pereira and Viola further discussed these points in relation to the intentions vs outcomes from the Paris Climate Agreement, "although it can be seen as a diplomatic success, from the scientific point of view the agreement is weak, inadequate, and overdue, indicating very slow progress in decarbonizing the global economy."[92]

In June 2007, the United Nations Environment Programme, in their report Sudan: post-conflict environmental assessment, suggested that, in part climate change and environmental degradation had been a driving factor in the Darfur conflict.[93] The report supports arguments made by previous scholars and illustrates the concept of climate change being a 'threat multiplier' in a real-life example.

In 2008, Busby, when comparing the impacts of climate change effects to the response seen after the 9/11 terror attacks, quite accurately evaluated that "Some natural world phenomena, in their speed and level of intensity, could bring about results that resemble those wrought by armed external attack and trigger a similar kind of crisis response."[94] Busby also argues that "the impacts of climate change will have financial costs, and in some cases these are sufficiently large to justify understanding climate change as a security issue."[95] Examples of climate impacts that cause this level of destructions and financial costs are very evident in global news stories and include Hurricane Katrina (2005), the record setting 2020 Californian Wildfires, Australian Wildfires (2019-20), and COVID-19 (2020), as well as the current (January 2025) widescale fires which are occurring in the Californian countryside as I write the corrections to this thesis.

With the concept of climate change being a 'threat multiplier' firmly established in 2007 through a number of authors as shown above, Scheffran and Battaglini took an in-depth

[91] Brown, Hammill, and McLeman, "Climate change as the 'new'security threat: implications for Africa."
[92] Joana Castro Pereira and Eduardo Viola, "Catastrophic climate change and forest tipping points: Blind spots in international politics and policy," *Global Policy* 9, no. 4 (2018).
[93] Brown, Hammill, and McLeman, "Climate change as the 'new'security threat: implications for Africa."
[94] Busby, "Who cares about the weather?: Climate change and US national security."
[95] Busby, "Who cares about the weather?: Climate change and US national security."

look at this argument in 2011.[96] They found that the 'threat multiplier' effects of climate change were more obvious in underdeveloped parts of the world, where it then increases the complexity of the obstacles to that development and stability of an area.[97] At the extreme end of the spectrum, climate change may even lead to the failure of states where governance and management structures and organisations are unable to function adequately to provide security and safety.[98] Scheffren and Battaglini outlined how this might happen "by [climate change] triggering a cycle of environmental degradation, economic decline, social unrest an political instability" and that this may have an impact which reaches far more widespread than the regionality that may at first appear as a matter of emergency, but into a re-evaluation and re-prioritisation of global security as "spill over effects can destabilize regions and expand the geographical extent of crisis, overstretching global and regional governance structures."[99] Busby also makes a similar observation to this when they state that "Even if a country is not affected directly by climate change, it may feel its own national security is threatened by the effects of climate change on another country or region."[100]

Both Smith in 2007 and Baldwin in 2014 investigated the links between climate change and migration as a security issue.[101] However, in 2016, Brzoska and Fröhlich evaluated the links between climate-induced migration and the causes of conflict, finding that there was currently not enough evidence to provide a definitive argument that climate-induced migration increases violent conflict within the region accepting the new migrants.[102] Brzoska and Fröhlich go on to point out (as do a few others) that there is no agreed-upon definition of what constitutes climate/environmentally induced migration, and there are many 'push and pull' factors when deciding to migrate. The issue with the definition aside, they also argue that current migration due to environmental impacts are "usually internal, temporary

[96] Jürgen Scheffran and Antonella Battaglini, "Climate and conflicts: the security risks of global warming," *Regional Environmental Change* 11, no. 1 (2011), https://doi.org/https://doi-org.ezproxy.lancs.ac.uk/10.1007/s10113-010-0175-8.
[97] Scheffran and Battaglini, "Climate and conflicts: the security risks of global warming."
[98] Scheffran and Battaglini, "Climate and conflicts: the security risks of global warming."
[99] Scheffran and Battaglini, "Climate and conflicts: the security risks of global warming."
[100] Busby, "Who cares about the weather?: Climate change and US national security."
[101] Paul J Smith, "Climate change, mass migration and the military response," *Orbis* 51, no. 4 (2007). Andrew Baldwin, "The political theologies of climate change-induced migration," *Critical Studies on Security* 2, no. 2 (2014).
[102] Michael Brzoska and Christiane Fröhlich, "Climate change, migration and violent conflict: vulnerabilities, pathways and adaptation strategies," *Migration and Development* 5, no. 2 (2016).

and short term."[103] This argument aside the issue of climate related mobility has grown in concern recently with the IOM developing a climate mobility road map in 2021 which seeks to support the better consideration of how climate impacts on migration, and with the New Zealand Ministry of Foreign Affairs conducting research into the current view of the pacific on climate related mobility to help understand any future migration flows and responses to this issue within the Pacific.

If this is, and stays true, it could mitigate the migration issue. However, with climate change being argued to be a threat multiplier and the full effects of climate change yet to be felt, this may change. This would then require investigation as to at what point climate change shifts environmental migration from internal to external, a situation the New Zealand Defence Force is already considering.[104] Smith outlines how militaries may be used to respond to migration, including through Humanitarian Assistance and Disaster Relief (HADR), search and rescue operations, and eliminating or restricting migration flows.[105] Baldwin proposes two approaches in which this could affect a state's security, the first is through the erosion of sovereignty and the second through political violence. Baldwin further expands on these risk factors by making the point that there is a need to look at other impacts, especially religion or traditional cultural sensitivities, when discussing the impact that migrants might have on security.[106]

Deudney (1991) and Gilbert (2021) both attested that given the nature of armed forces and the narrow scope and focus they have on security, there is a need to guard against to conflation and correlation of securitisation and militarisation.[107]

In order to contextualise this potential situation, Hsiang, Burke, and Miguel, in their 2013 study *Quantifying the Influence of Climate on Human Conflict*, quantified past climatic events that have exerted considerable influence on human conflict and found that there is a

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[103] Brzoska and Fröhlich, "Climate change, migration and violent conflict: vulnerabilities, pathways and adaptation strategies."
[104] *The Climate Crisis: Defence Readiness and Response*.
[105] Smith, "Climate change, mass migration and the military response."
[106] Baldwin, "The political theologies of climate change-induced migration."
[107] Daniel Deudney, "Muddled Thinking," *Bulletin of the Atomic Scientists* 47, no. 3 (1991/04/01 1991), https://doi.org/10.1080/00963402.1991.11459957, https://doi.org/10.1080/00963402.1991.11459957.
Emily Gilbert, "The militarization of climate change," *ACME: An International Journal for Critical Geographies* 11, no. 1 (2012).
Dhanasree Jayaram, "'Climatizing'military strategy? A case study of the Indian armed forces," in *The Climatization of Global Politics* (Springer, 2022).

causal link between climatic variations and conflict/violence.[108] The study found that one standard deviation change in the climate variables has previously generated a "14% change in the risk of intergroup conflict and a 4% change in interpersonal violence."[109]

McDonald analysed the sense of humanistic interpretations of risks on security and livelihood in their 2013 paper, and proposed that there is a distinction between how different people see climate change as affecting security, some see it as a threat to long-term human security and others see it as a threat to states and their territorial integrity in line with more traditional security concerns.[110] The climatisation of the security field occurs as agents of security look to incorporate climate change within their work and work to mitigate the lack of effective extraordinary measures that securitise climate change.[111] As shown in Hayes and Knox-Hayes' paper in 2014, there were efforts to securitise climate change in the US and EU starting in 2008.[112] Some of this, especially in the US, was to give climate change the prominence it needed to not be hamstrung by the political system.[113] Brown, Hammill, and McLeman made a similar point about climate-security being securitised to engage the political system. Hayes and Knox-Hayes also stated that there was less of a need to securitise the issue in the EU due to its societal norms, which give more respect to the global commons.[114]

Kavalski in 2023 raises the suggestion that climate change, and the responses to it, are used as a point of differentiation within current geo-strategic competition and rivalry.[115] This can be seen across the Indo-Pacific, both in the way that states provide development assistance to developing countries and in how different countries seek to present themselves on the world stage and use the issue of climate change to increase their visibility at multilateral

[108] Solomon M Hsiang, Marshall Burke, and Edward Miguel, "Quantifying the influence of climate on human conflict," *Science* 341, no. 6151 (2013).
[109] Hsiang, Burke, and Miguel, "Quantifying the influence of climate on human conflict."
[110] McDonald, "Discourses of climate security."
[111] Oels, "From 'securitization'of climate change to'climatization 'of the security field: comparing three theoretical perspectives."
[112] Jarrod Hayes and Janelle Knox-Hayes, "Security in climate change discourse: analyzing the divergence between US and EU approaches to policy," *Global Environmental Politics* 14, no. 2 (2014).
[113] Hayes and Knox-Hayes, "Security in climate change discourse: analyzing the divergence between US and EU approaches to policy."
[114] Hayes and Knox-Hayes, "Security in climate change discourse: analyzing the divergence between US and EU approaches to policy."
[115] Emilian Kavalski, "National security and climate change," in *Handbook on climate change and international security*, ed. Maria J Trombetta (Edward Elgar Publishing, 2023).

meetings. The Pacific countries show an example of this though the *2018 Boe Declaration on Regional Security*, the Pacific Islands Forum Leaders declared an importance "on an expanded concept of security inclusive of human security, humanitarian assistance, prioritising environmental security, and regional cooperation in building resilience to disasters and climate change, including through regional cooperation and support" and above all reaffirmed "that climate change remains the single greatest threat to the livelihoods, security and wellbeing of the peoples of the Pacific and our commitment to progress the implementation of the Paris Agreement"[116]. The Pacific Island Forum has also been vocal in outlining the link between climate change and the continued existence of sovereignty and statehood, including through the Communique of the 51st Pacific Islands Forum Leaders Meeting where "Leaders reconfirmed that climate change remains the single greatest existential threat facing the Blue Pacific" which led to the Pacific Islands Forum Leaders issuing the *2023 Declaration on the Continuity of Statehood and the Protection of Persons in the Face of Climate Change-related Sea-Level Rise*, which set out the Pacific Island Forum's position that states will continue to exist even if their land mass is consumed by rising sea levels.[117]

All of this points to the indication that there is a need for responses to climate change to be "both feasible and flexible".[118] Climate change has proliferated into foreign policy as a way in which to raise its profile as a security issue and mainstream the issue associated with an expanded concept of security, including the securitisation of the maritime environment globally and regionally.[119] With the links between climate change and security supporting the proliferation of climate change considerations, it is important to note that the relationship between climate change and security depends on which of the many lens you are using when analysing and interpreting the interactions.[120]

This thesis will be specific in viewing the interactions climate change has with security, in particular maritime security, through the evaluation of a few different viewpoints which will

[116] "Boe Declaration on Regional Security," Pacific Islands Forum, 2018, https://www.forumsec.org/2018/09/05/boe-declaration-on-regional-security/.
[117] Pacific Islands Forum, *2023 Declaration on the Continuity of Statehood and the Protection of Persons in the Face of Climate Change-Related Sea-Level Rise* (2023), https://forumsec.org/publications/2023-declaration-continuity-statehood-and-protection-persons-face-climate-change.
[118] Kavalski, "National security and climate change."
[119] Kavalski, "National security and climate change."
[120][120] McDonald, "Climate change, security and the institutional prospects for ecological security."

place different dimensions of maritime security at the heart of the analysis. For instance, Chapter 5: Environmental Security will focus on the natural environment being the referent object and thus it analyses the impacts on the natural maritime and coastal environments, including ecosystems, in detail. In Chapter 6: Human Security, the Individual will be the referent object being studied, but this chapter will also look at how individuals or numbers of individuals or communities or societies interact with each other and the impact of climate change on them. In Chapter 7: Economic Security, it will analyse the interactions of climate change and security and how these impact on objects that generate economic revenue or livelihoods. Finally, Chapter 8: National Security will analyse the interactions of climate change and security and how these impact the ability of the state to provide stability and security, including through power projection.

With the gradual process of climate change becoming part of the security, political, and social discourse, the exceptional measures undertaken by states, and the framing of climate change as an existential issue for states, this section has shown the securitisation of climate change and supported the continued academic discourse on the securitisation of climate change. In this thesis, Chapters 5 to 8, analyse the impact of the effects of climate change on the maritime security of the Indo-Pacific, supporting the continued integration of climate change within the security discourse and starting to support the analysis of climate change as a security issue and its impact on international relations.

Over the past 15 years, the scope and volume of literature analysing the interactions between climate change and security has grown significantly, showing the increasing relevance and urgency of the issue.[121] This expansion of climate security literature has occurred alongside the general expansion of the concept of security, which now includes greater elements of human and ecological issues.[122] That being said, Busby in 2021 argues that there is still a lack of understanding of how to "prevent climate-related conflicts" and the best interventions to support this aim.[123] This thesis supports the aim of better

[121] Nina Von Uexkull and Halvard Buhaug, "Security implications of climate change: A decade of scientific progress," (SAGE Publications Sage UK: London, England, 2021).
Joshua W Busby, "Beyond internal conflict: The emergent practice of climate security," *Journal of Peace Research* 58, no. 1 (2021).
[122] Busby, "Beyond internal conflict: The emergent practice of climate security."
McDonald, "Climate change, security and the institutional prospects for ecological security."
[123] Busby, "Beyond internal conflict: The emergent practice of climate security."

understanding appropriate areas for interventions and is part of a recent trend of focusing on the identification of understanding specific and unique causal processes.[124] This is done through the framework developed in Chapter 3, which maps out individual causality chains that show how the individual effects of climate change impact on the security of the maritime domain in the Indo-Pacific. This in turn supports as adding to literature on the securitisation of climate change by using the framework outlined in Chapter 3 to provide evidence that climate change is a direct threat to security, developing the framing beyond the current framing of climate change as a 'threat multiplier'.

As a security issue, the effects of climate change can impact on pre-existing conditions such as resource scarcity, weak governance, lack of social cohesion, low economic prosperity, demands on military assets and capabilities, and increases in violence. Ide et al. find that climate-related disasters provide an opportunity for armed groups to escalate current unrest and conflict, in line with the idea that climate change is a 'threat multiplier', meaning that countries where there are ongoing conflicts are present are most likely to see escalations in unrest following a climate-related disaster.[125]

All of this can lead to increased migration, conflict, criminality, loss of sovereignty, collapse of state/state failure and further resource scarcity. This thesis supports the idea of an "ecological security discourse" put forward by McDonald, as it supports the framing of climate change as a direct and immediate security threat and encourages different levels of lenses through which actors can focus on these concerns.[126]

Based on the current state of literature, a good working definition for climate security to be used in this study comes from Thomas in 2013 and is defined as such "the absence of threats to individuals, states and the international system that arise from anthropogenic warming."[127] This definition is particularly useful because it attributes the changing climate

[124] Von Uexkull and Buhaug, "Security implications of climate change: A decade of scientific progress."
[125] Tobias Ide et al., "Multi-method evidence for when and how climate-related disasters contribute to armed conflict risk," *Global Environmental Change* 62 (2020/05/01/ 2020), https://doi.org/https://doi.org/10.1016/j.gloenvcha.2020.102063, https://www.sciencedirect.com/science/article/pii/S0959378019307307.
Katharine J. Mach et al., "Climate as a risk factor for armed conflict," *Nature* 571, no. 7764 (2019/07/01 2019), https://doi.org/10.1038/s41586-019-1300-6, https://doi.org/10.1038/s41586-019-1300-6.
[126] McDonald, "Climate change, security and the institutional prospects for ecological security."
[127] Thomas, *The securitization of climate change: Australian and united states' military responses (2003-2013)*, 10.

to the actions of humankind and paints a picture of what a climate-secure world would be like, i.e., the absence of threats. The definition also fits well, as this study aims to determine the insecurity caused by the impacts of climate change on the Maritime Security domain. By focusing on the human-induced aspects of climate change, this definition underscores the responsibility of societies and governments to address and mitigate these threats.

This study will investigate the 'adaptation' aspect of security rather than the 'mitigation' aspect of climate change. While the 'mitigation' of further emissions, warming, and change is needed, there is an increasingly substantiated line of thought that no matter what we do now, a certain level of change has been 'locked in,' and this is what will cause security issues in the future. Adaptation involves adjusting policies, practices, and infrastructure to minimise the damage caused by these inevitable changes. It is also a lot easier to evaluate on a regional scale the securitisation of 'adaptation,' as this can be undertaken by regional-level units and has a direct impact. In contrast, mitigation can be taken regionally, but without 'mitigation' being globally securitised, the security actions taken regionally will have a lot less of an impact.

Key threats to the domain of maritime security include rising sea levels, which can lead to the loss of coastal territories and the displacement of populations, thereby exacerbating territorial disputes and migration pressures. Additionally, the increasing frequency and intensity of extreme weather events can disrupt maritime trade routes, damage critical infrastructure, and strain emergency response capabilities. Ocean acidification and warming can also affect marine biodiversity, leading to the depletion of fish stocks and impacting food security for communities dependent on fishing. These environmental changes can create new security challenges, such as increased piracy, illegal fishing, and smuggling, as individuals and groups seek alternative means of livelihood. By focusing on adaptation, this study aims to provide actionable insights into how maritime security can be enhanced to address these emerging threats and ensure the resilience of the Indo-Pacific region.

In 1998, Buzan and Weaver started the discussion on the best framework to properly investigate environmental security. As in their views, there needs to be an understanding of all the chains of cause-effect relationships and the placement of actors and regions in

relation to these.[128] While these frameworks have come a long way, there is still no agreed-upon way of tracking the effects of environmental changes from their cause to their impact on human systems and this is what the next section aims to achieve.

2.2.2 What is Maritime Security?

This section will define maritime security through understanding the history of the concept of maritime security and analysing the current literature, before developing the framing of the concept that will be used for this thesis.

Across academic literature, the term maritime security is not defined in a systematic way, which leads to the term meaning different things to every researcher.[129] Currently, the concept of 'maritime security' is being used as a 'buzzword' or 'umbrella term' vaguely referring to what, in the maritime domain, is fashionable to focus on.[130] This variability in the interpretation of the concept creates challenges for how we address issues within the boundaries of this project. To address this point, this section sets out a brief history of what maritime security has meant at various points, and how current theories and frameworks define the term.

Maritime security is often viewed through a similar lens as land-based security, as it has many of the same challenges. The main difference of maritime security is that it takes place within a different medium (i.e. instead of something hard you walk on, you have something liquid that you move through). This basic difference has resulted in many areas where governance and ownership of the ocean are absent, as it is harder to occupy and defend ocean-based territory and interests.[131] Such a difference can, in some ways, be mitigated using technology, which can, in some instances, replicate what is implemented on land.[132]

History

For the majority of history, maritime security has been seen in its most basic sense as part of a power projection strategy and used in the context of controlling distant areas and territories to provide land-based security.[133] Those states that were successful at generating

[128] Barry Buzan et al., *Security: A new framework for analysis* (Lynne Rienner Publishers, 1998).
[129] Dirk Siebels, *Maritime Security in East and West Africa* (Springer, 2020).
[130] Christian Bueger, "What is maritime security?," *Marine Policy* 53 (2015).
[131] Basil Germond, *The Maritime Dimension of European Security: Seapower and the European Union* (Springer, 2015).
[132] Germond, *The Maritime Dimension of European Security: Seapower and the European Union*.
[133] Germond, "The geopolitical dimension of maritime security."

a powerful presence at sea found that “there was something uniquely cost-effective about sea-power”.[134] This solidified their control of distant areas and those that were “best able to exploit its attributes profited hugely”.[135] As such, especially during the modernity era, maritime security or more accurately maritime force projection has proved crucial to “the development and consolidation of the (modern) legal, economic, political, and structures still dominant in the twenty-first century.”[136] These developments, together with the consolidation of societal structures, underpinned empire-building and hegemonic cycles such as the British Empire and the hegemony of the United States in the early 2000s.[137]

The ocean, with the concept of maritime force projection in mind, has been viewed as a void between points.[138] This view is again rooted in the theme of empire building, with the colonial European power's desire to keep open and protect commercial networks and trade routes.[139] This view and treatment of ocean space is undoubtedly one of the key integral components that underpins the transformation of society and the current dynamic of the global economy.[140]

Throughout history maritime constabulary forces have played different roles. For instance, in the present, they are seen as providers of maritime security, with constabulary functions increasingly undertaken by non-military actors such as coast guards, who are crucial to upholding the rights of coastal states.[141] Historically, constabulary functions have been carried out by armed forces and these functions have played a crucial role in power projection and securing trade routes.[142] An example of this is how the British maritime empire introduced a more holistic concept of maritime power. This was done by focusing,

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[134] Geoffrey Till, *Seapower: A guide for the twenty-first century*, vol. 51 (Routledge London, 2013).
[135] Till, *Seapower: A guide for the twenty-first century*, 51.
[136] "Maritime power shapes the world order – and is undergoing a sea change," 2024, accessed 24 May, 2024, https://theconversation.com/maritime-power-shapes-the-world-order-and-is-undergoing-a-sea-change-222081. (pg. 78)
[137] Germond, "Maritime power shapes the world order – and is undergoing a sea change." (pg. 33 – 34) Till, *Seapower: A guide for the twenty-first century*, 51.
[138] Philip E. Steinberg, "Navigating to Multiple Horizons: Toward a Geography of Ocean-Space," *The Professional Geographer* 51, no. 3 (1999/08/01 1999), https://doi.org/10.1111/0033-0124.00172, https://doi.org/10.1111/0033-0124.00172.
[139] Barry J. Ryan, "The disciplined sea: a history of maritime security and zonation," *International Affairs* 95, no. 5 (2019), https://doi.org/10.1093/ia/iiz098, https://doi.org/10.1093/ia/iiz098.
[140] Philip E Steinberg, "The maritime mystique: sustainable development, capital mobility, and nostalgia in the world ocean," *Environment and Planning D: Society and Space* 17, no. 4 (1999).
[141] Germond, "The geopolitical dimension of maritime security."
[142] Germond, "The geopolitical dimension of maritime security."

not only on their maritime power compared to other competing states but also compared to other causes of maritime insecurity such as private citizens or neutral forces, while also viewing maritime issues as issues of criminality rather than war.[143]

The establishment of the International Maritime Organisation, in 1956, also supported the shift towards maritime security concerning itself with what happens on a boat, as it introduced the concept of criminality "on the boat" as it attempted to bring together a multi-faceted security framework for the shipping industry.[144] Moving beyond maritime power projection, maritime security (and the ocean in general) was then viewed as 'issues that happen on a boat', with the boat being seen as an extension of land. This concept fails to give adequate consideration to the fluid and dynamic nature of the ocean and the environment beneath the waves.[145] The widening of what is considered a security issue in the maritime domain has grown, following increases in fixed capital investments in the ocean such as oil rigs, economic opportunities such as deep-sea mining, and the recognition that biodiversity loss is degrading the ocean environment.[146]

Since the adoption of the United Nations Convention on the Law of the Sea (UNCLOS) which helped implement "a law-based matrix of good order over the continuing turbulence of maritime politics", the spatial politics of the ocean has moved forward at a rapid pace.[147] This increase in spatial politics and the continued uptake of a law-based matrix at sea saw maritime security from the late 1990s to the early 2000s focusing on illegal activities at sea.[148] This was further exacerbated by the terrorist attacks in the United States, on the 9th of September 2001, which brought terrorism to the forefront of wider security considerations and with it to the forefront of security at sea.[149] This increased focus on terrorism in the maritime domain also coincided with increases in Somali-based piracy off

[143] Ryan, "The disciplined sea: a history of maritime security and zonation."
[144] Rosalie Balkin, "The International Maritime Organization and Maritime Security," *Tul. Mar. LJ* 30 (2006).
[145] Philip E. Steinberg, "Of other seas: metaphors and materialities in maritime regions," *Atlantic Studies* 10, no. 2 (2013/06/01 2013), https://doi.org/10.1080/14788810.2013.785192, https://doi.org/10.1080/14788810.2013.785192.
[146] Steinberg, "The maritime mystique: sustainable development, capital mobility, and nostalgia in the world ocean."
[147] Ryan, "The disciplined sea: a history of maritime security and zonation."
[148] Germond, "The geopolitical dimension of maritime security."
[149] Germond, "The geopolitical dimension of maritime security."

the east of Africa in the early 2000s, which firmly brought modern piracy into the fold of maritime security.[150]

Marine resources, such as fishing and resource extraction, have been increasingly brought into the concern of maritime security. This is because the global fish catch has increased tenfold since the end of the Second World War leading to stretched resources for food from maritime sources, and because of the increased global dependence on fossil fuels for energy and development.[151] The securitisation of fisheries can be traced to several fish wars. For example, the Cod Wars between the United Kingdom and Iceland in various stages, between the 1950s and 1970s. The issue of illegal unregulated and unreported fishing (IUUF) has also supported the inclusion of maritime resources being considered a maritime security issue as IUUF can cause economic and environmental harm by placing increased strain on already reduced fish stocks.[152]

Current Theories

The previous sub-section shows that the concept of maritime security might have started with a narrow focus, but it has continually expanded to incorporate more issues that take place within the maritime domain. Maritime security is now a stand-alone area of research, but there is still no agreed definition of the concept, and it means different things to different actors.[153] SIDS within the Indo-Pacific are worried about the existential threat of rising sea levels. Fishermen are concerned about the migration of and access to fish stocks. Admirals are worried about force projection in an increasingly vulnerable and volatile environment. Commercial shipping is worried about the safety of sea lines of communication and threats posed by piracy in disrupting supply chains and the security of global trade.

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[150] Sascha Pristrom et al., "A study of maritime security and piracy," *Maritime Policy & Management* 40, no. 7 (2013).
[151] Steinberg, "Navigating to Multiple Horizons: Toward a Geography of Ocean-Space."
[152] Andrea A. Stefanus and John A. E. Vervaele, "Fishy business: regulatory and enforcement challenges of transnational organised IUU fishing crimes," *Trends in Organized Crime* 24, no. 4 (2021/12/01 2021), https://doi.org/10.1007/s12117-021-09425-y, https://doi.org/10.1007/s12117-021-09425-y.
[153] Christian Bueger, Timothy Edmunds, and Robert McCabe, "Into the sea: capacity-building innovations and the maritime security challenge," *Third World Quarterly* 41, no. 2 (2020/02/01 2020), https://doi.org/10.1080/01436597.2019.1660632, https://doi.org/10.1080/01436597.2019.1660632.

In 2008, the United Nations Secretary-General's Report on the Oceans and Law of the Sea defined the problem very succinctly, explaining the issues facing maritime security as a concept:

> *There is no universally accepted definition of the term "maritime security". Much like the concept of "national security", it may differ in meaning, depending on the context and the users. At its narrowest conception, maritime security involves protection from direct threats to the territorial integrity of a State, such as an armed attack from a military vessel. Most definitions also usually include security from crimes at sea, such as piracy, armed robbery against ships, and terrorist acts. However, intentional and unlawful damage to the marine environment, including from illegal dumping and the discharge of pollutants from vessels, and depletion of natural resources, such as from IUU fishing, can also threaten the interests of States, particularly coastal States. Various approaches have been taken to maritime security, depending on the State's perspective of the interests that may be threatened, either directly or indirectly, by activities in the oceans and seas.*[154]

'Non-traditional' aspects of security have become increasingly prevalent within the academic discourse of maritime security since the early 2010s, highlighting issues such as economic and environmental security.[155] This evolution of the concept of maritime security is in line with the expansion of the general concept of security, as it widens from the traditional narrowness of a sole military focus, to incorporate more issues into a holistic view of security (an example of this is the securitisation of climate change mentioned above). With this expansion of security, the concept of maritime security has defined itself as a subfield within strategic studies and international relations.[156]

As the concept of maritime security became established and expanded, attempts were made to further define the concept and categorise the issues that were discussed under this topic. In 2013, Geoffrey Till came up with four attributes that defined the oceans' importance to humanity. He stated that these attributes determine the functions of navies

[154] United Nations, *Oceans and the law of the sea. Report of the Secretary-General* (10 March 2008).
[155] Germond, "The geopolitical dimension of maritime security."
[156] Christopher Rahman, "Concepts of maritime security: A strategic perspective on alternative visions for good order and security at sea, with policy implications for New Zealand," (2009).

and argued that the concept of maritime security should be structured in line with these four attributes, which are:

- "The sea as a resource;
- The sea as a medium of transport;
- The sea as a medium of information;
- The sea as a medium for dominion."[157]

In 2015, Christian Bueger, in his paper *What is Maritime Security?* set out a methodical and comprehensive attempt to define the meaning of maritime security by relating the concept to actors who act under the auspices of maritime security.[158] Bueger devised a maritime security matrix (shown below in Figure 2.3), through which he sets out to organise "a web of relations, replaces or subsumes older, established concepts, as well as relates to more recently developed ones."[159] Through this process, Bueger developed four main dimensions of maritime security: 1) National Security; 2) Marine Environment; 3) Economic Development; and 4) Human Security. These dimensions capture the main concerns of actors in the maritime domain, and Bueger does note that not all actors will concern themselves with every dimension. [160] The four dimensions of maritime security align with Buzan et al's, five dimensions of security outlined in 1998 – military, political, societal, economic, and environmental - with Bueger going on to combine the military and political dimensions into a single dimension called national security.[161]

[157] Till, *Seapower: A guide for the twenty-first century*, 51.
[158] Bueger, "What is maritime security?."
[159] Bueger, "What is maritime security?."
[160] Bueger, "What is maritime security?."
[161] Buzan, Wæver, and De Wilde, *Security: A new framework for analysis*.

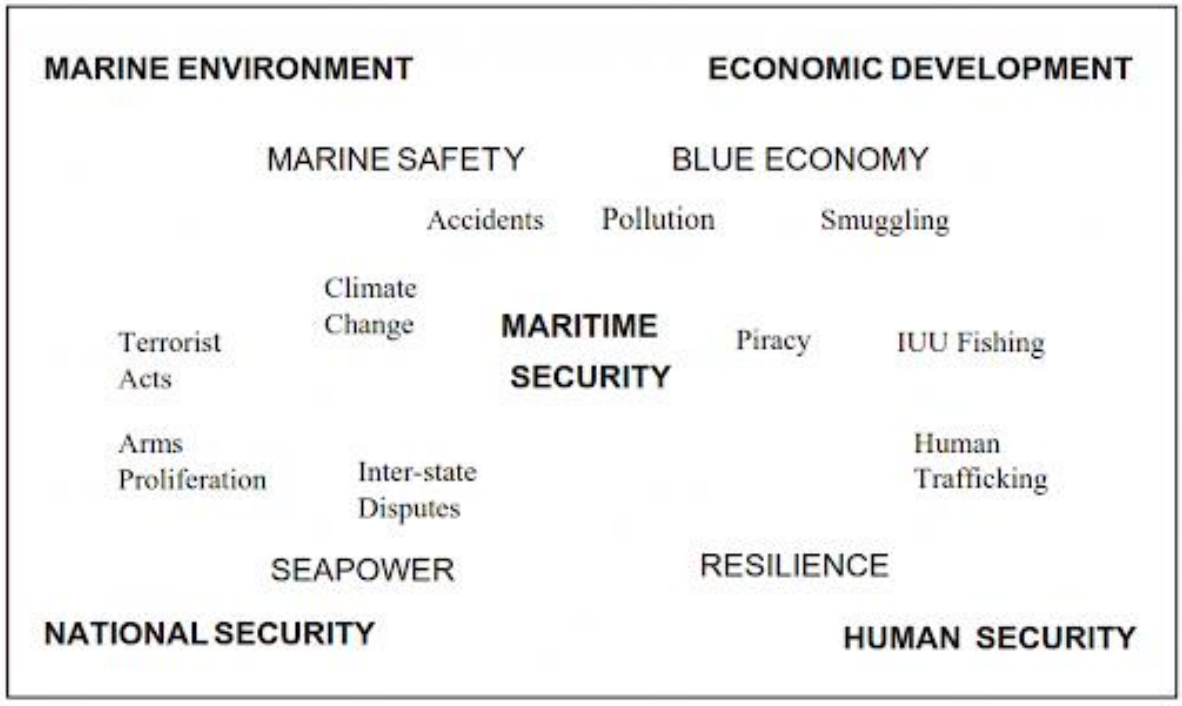

Figure 2.3 – Maritime security matrix, Bueger 2015[162]

In 2015, Germond in his book *The Maritime Dimension of European Security: Seapower and the European Union* proposed a framework to analyse security in the maritime domain, as shown in Figure 2.4. Within this Germond also has 4 components 1) The projection of security, 2) the non-military dimension of security, 3) the environmental dimension of security, and 4) Securitisation and representations.[163] While these are very broad, when used in conjunction with Bueger's matrix, this would offer a way of capturing the characteristics of maritime security, especially interconnected and liminality.

[162] Bueger, "What is maritime security?."
[163] Germond, *The Maritime Dimension of European Security: Seapower and the European Union*.

	Components of security	*Role of the sea*	*Key traits and goals*
1	The projection of security	The sea as a means to project security	• Interventions • Exercising sea control
2	The non-military dimension of security	The sea as an object to secure	• Maritime security • Controlling human activities at sea
3	The environmental dimension of security	The sea as an object to protect	• Sustainable development • Controlling human activities at sea
4	Securitisation and representations	The sea as a battle-ground of ideas	• Discourses • Definition of 'truths'

Figure 2.4 – The maritime dimension of security and its four components, Germond 2015[164]

In summary, the aspects and dimensions presented by the authors Till, Bueger and Germond all break maritime security down into four similar thematic areas as shown in Table 2.1. These areas show the convergence of basic thoughts when looking at the maritime domain and how different aspects are being considered in academia.

Ultimately, the definition of maritime security depends on which actor you are asking and what lens is being applied to the specific viewpoint of the event. However, as Germond states, "Maritime security is intrinsically geopolitical, since it is about projecting public power beyond one's external boundary within the 'global' maritime domain."[165] This illustrates the need for an overarching framework of maritime security that allows different actors to situate themselves within or across, to help build a cohesive and robust concept of maritime security, allowing for cross-sectoral, cross-disciplinary discussions and interactions.

[164] Germond, *The Maritime Dimension of European Security: Seapower and the European Union*. Pg 15.
[165] Germond, "The geopolitical dimension of maritime security."

Table 2.1 – Comparison of the dimensions of security and maritime security

<table>
<tr><th>Buzan</th><th colspan="3">Till</th><th>Bueger</th><th colspan="2">Germond</th></tr>
<tr><td>Military</td><td rowspan="2">Sea as a medium for domination</td><td rowspan="7">Sea as a medium of information</td><td rowspan="7">Sea as a medium of transport</td><td rowspan="3">National Security</td><td rowspan="2">The Projection of Security</td><td rowspan="7">Securitisation and representations</td></tr>
<tr><td rowspan="2">Political</td></tr>
<tr><td rowspan="3">Environmental</td><td rowspan="5">Sea as a resource</td></tr>
<tr><td rowspan="2">Marine Environment</td><td rowspan="2">The environmental security dimension of security</td></tr>
<tr><td rowspan="2">Economic</td><td rowspan="3">The non-military dimension of security</td></tr>
<tr><td>Economic Development</td></tr>
<tr><td>Societal</td><td>Human Security</td></tr>
</table>

Definition of Maritime Security

Defining the boundaries of the concept of maritime security is important for developing an understanding of the term, deciding the scope of the study and developing an analysis that provides solutions to maritime security issues. Deciding what is a maritime security issue is complicated, and further complexity is added by four characteristics that are outlined by Bueger and Edmunds, which are: 1) interconnected, 2) liminality, 3) transnational, and 4) cross-jurisdictional.[166]

[166] Bueger and Edmunds, "Beyond seablindness: a new agenda for maritime security studies."

The complexity of maritime security is also exacerbated by the interconnected nature of issues that are present within the maritime domain.[167] This is an issue that will be explored in every chapter henceforth, as climate change and environmental security are issues that interlink all dimensions of maritime security.

The issue of liminality complicates defining maritime security and setting boundaries around what is the maritime domain. Liminality in a maritime security context is the understanding that you cannot consider maritime security issues as being purely of the maritime domain, and these issues must be considered in conjunction with the land-based issues that impact it.[168] The interviews taken as part of this study with maritime security experts from different regions demonstrate a broad agreement that there are some actions taken on land which should be considered part of maritime security, as these actions have a direct and attributable link to the security of the maritime domain.[169] The area in which these land-based actions and influences occur is roughly defined as up to 100km inland, and this part of the coastal area is called the littoral region.[170] As will be shown later in this study, coastal communities are influential in securing the maritime domain (see Chapter 6: Human Security). As such, the littoral region should play an integral part in the understanding of maritime security.

Like climate change, maritime security is an issue that is transnational and cross-jurisdictional in nature. This adds complexity to determining exactly what maritime security is and to addressing its challenges, as these characteristics require consensus between actors.

As already discussed in this section, maritime security has different meanings for each actor, which significantly increases the complexity of maritime security issues. Due to this, ensuring a holistic approach to maritime security in this thesis will be key for ensuring that the analysis is useful to a broad range of maritime security actors. As such, there needs to

[167] James Brennan and Basil Germond, "A methodology for analysing the impacts of climate change on maritime security," *Climatic Change* 177, no. 1 (2024/01/10 2024), https://doi.org/10.1007/s10584-023-03676-0, https://doi.org/10.1007/s10584-023-03676-0.
[168] Bueger and Edmunds, "Beyond seablindness: a new agenda for maritime security studies."
[169] Interview C, D, E, F, and H
[170] Interview F

be a definition which will support analysing the complex interlinking issue of the impacts of the effects of climate change on the maritime security of the Indo-Pacific.

The definition of maritime security concerns itself with the causes of insecurity that arise from or occur within the maritime domain. The littoral areas of this study will take a holistic view of security and will be analysed in line with the four dimensions of maritime security as shown below. These are a combination of the aspects described by Bueger in 2015 and Buzan et al in 1998 and used by Brennan and Germond in 2024. The four dimensions of maritime security which will be used for this thesis are:

1. **Environmental Security**—This includes issues relating to the integrity of the natural environment of the maritime domain, such as:
    a. Marine pollution – plastics, oil spills, runoff
    b. Ecosystem changes – coral bleaching, biodiversity loss, invasive species, migration, ocean acidification, ocean warming
    c. Environmental degradation – IUUF, harmful algal blooms, ocean deoxygenation
2. **Human Security**—This includes issues relating to:
    a. Human activity at sea, such as human trafficking and slavery.
    b. Food security, where this relates to coastal subsistence agriculture or fishing.
    c. Societal issues, such as loss of culture and traditions, equity and inclusion, gender-based violence, and human wellbeing and mental health[171]
    d. Water security, where this relates to basic human needs.
3. **Economic Security**—This relates to:
    a. Global supply chains – commercial shipping is a crucial link to the global economy, and sea-based trade routes are important for both exporters and importers as goods of all types traverse the globe.
    b. Aquaculture and fish stocks – Fish are a valuable commodity, and fishing revenues are a key source of economic revenue for SIDS and countries with large EEZs.

[171] Societal issues are considered under human security where they are concern about interactions between individuals, where societal issues escalate to a point where they cause significant intra or inter state security issues this would be considered under the national security issue.

c. Deep sea mining – in recent times, deep sea mining has become increasingly talked about as a way to gain economic revenue, especially for SIDS who otherwise have limited opportunities for economic development and diversification.
d. Energy – renewable energy from the ocean, such as wave and offshore power.
e. Tourism – tourism opportunities provided by the maritime domain.

4. **National Security**—This includes issues generally dealt with by state actors, such as:
    a. Sea power, power projection and domination of the sea, which can include the organisation of navies, the defence of territory (both terrestrial and maritime), anti-piracy, and geopolitical rivalries.
    b. Global political issues, such as global international law in the case of the maritime domain the most predominantly but not exclusively the United Nations Convention on the Law of the Sea. Interactions with other international institutions, such as the International Maritime Organisation.
    c. The existential risk to nation-states from sea level rise and climate change-induced uninhabitability of nation-states, which is most pressingly relevant to SIDS.

Historically, the attempts to define maritime security have shown that the links between all the dimensions operating in the maritime domain are many and varied (see Table 2.1). The interconnected links between the dimensions are also highlighted by the dimensions' definitions above. Through this study, it will become apparent that the integrity of the natural environment within the maritime domain is crucial to all other aspects of security and this is why this author thinks the best way of visualising the sectors of maritime security is like a pyramid as shown below in Figure 2.5, where environmental security being the base for all other aspects of security, followed by human, economic and national security. In a way, this also replicates how the impacts of maritime security narrow their focus toward issues of national security.

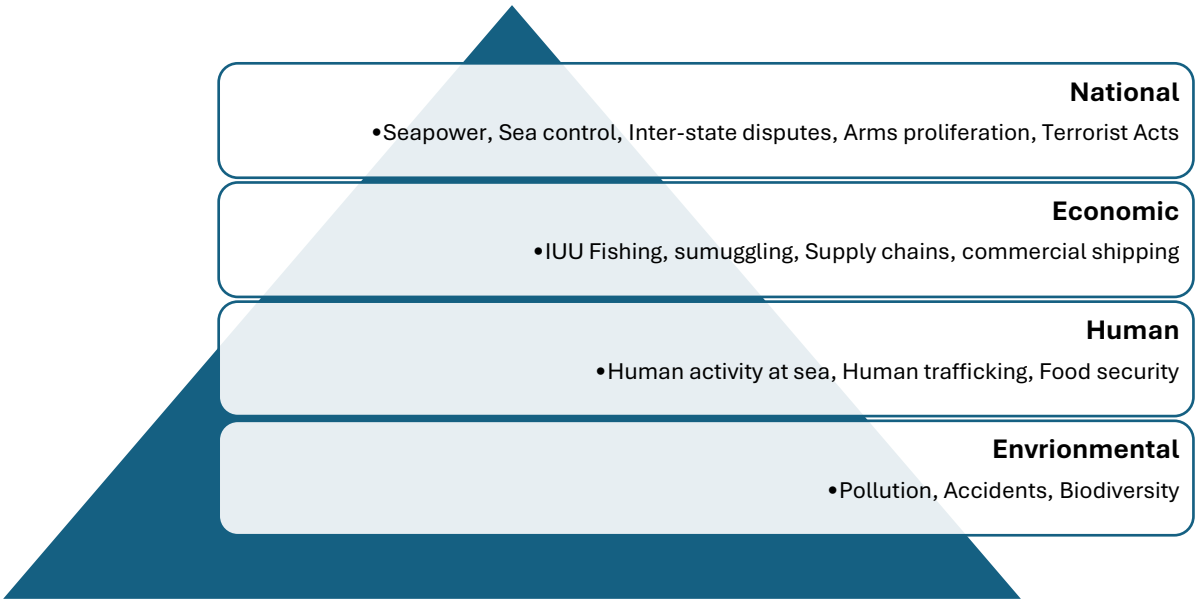

Figure 2.5 – Maritime security as a pyramid

Viewing maritime security as a pyramid allows different actors to engage with the dimension of maritime security that is most relevant to them, while also allowing for the consideration of important interlinked and fundamental issues that support a holistic approach to maritime security.

Why it matters

The maritime domain is of crucial importance to security, and defining the concept of maritime security gives a clear and coherent definition which can support the analysis of the impacts that the effects of climate change will have on maritime security. It will do this by systematically laying out the different sectors of maritime security and their subsequent components and linkages. This definition also provides a crucial part that is needed for the analytical framework outline in Figure 2.1. This is not to say that maritime security will stay the same forever, and we are already seeing how technological advances can change our sense of distance and ability to operate in different domains. States are now more capable of tackling threats at their earliest possible point of intervention, as well as continuing to project power as far away as possible.[172]

The definition of the concept of maritime security brings together three conceptualisations of maritime security that have been put forward over the past 20 years and aligned these

[172] Germond, *The Maritime Dimension of European Security: Seapower and the European Union*.

with the conceptualisation of security put forward by Buzan et al in 1998. This provides a basis through which to put in place boundaries around the concept of maritime security so that the impacts of other factors (in this case climate change) can be studied analytically, and the findings of the research can be used in ways that are relevant for the different actors in the maritime domain.

2.2.3 What is the Indo-Pacific?

Over the past decade, the Indo-Pacific terminology has been used with increasing frequency. This sub-section demonstrates that maritime issues and the Indo-Pacific region are inextricably linked, making the Indo-Pacific an ideal geographic area for studying the impacts of climate change on maritime security. The interconnectedness of maritime security and the Indo-Pacific region provides a valuable lens through which to understand the ongoing geostrategic competition. The recent resurgence of the Indo-Pacific terminology can be viewed through the framework of constructed realism, where geopolitical competition is a driving force shaping the region. This perspective acknowledges that the world is defined by its geopolitical realities, but also recognises that the Indo-Pacific has become a well-established concept and entity among practitioners and political elites, as evidenced by the extensive policy and academic literature on the subject.

The Indo-Pacific region, as defined in various governmental policies, encompasses a vast and strategically significant area that includes the Indian Ocean and the western and central Pacific Ocean. This broad region is characterised by its diverse political, economic, and security dynamics, which are influenced by the interests and actions of major powers such as the United States, China, India, Japan, and Australia. The terminology used in policies within governments reflects the strategic importance of the Indo-Pacific, highlighting its role as a central arena for geopolitical competition and cooperation.

Maritime security issues in the Indo-Pacific are therefore multifaceted, encompassing traditional security concerns such as territorial disputes, naval power projection, and freedom of navigation, as well as non-traditional security challenges like piracy, illegal fishing, and environmental degradation. The impacts of climate change, including rising sea levels, extreme weather events, and shifts in marine ecosystems, further complicate the security landscape, necessitating a comprehensive and adaptive approach to maritime security.

By examining maritime security through the lens of geostrategic competition, this study aims to elucidate the complex interplay between climate change and regional security dynamics. The Indo-Pacific region's strategic significance is underscored by its critical sea lanes of communication, which are vital for global trade and energy supplies. As climate change exacerbates existing security challenges and introduces new threats, the need for robust and coordinated maritime security strategies becomes increasingly apparent.

This thesis will explore how the evolving definitions and borders within the Indo-Pacific region, driven by environmental changes and geopolitical shifts, impact maritime security. It will analyse the policies and strategies adopted by regional actors to address these challenges, highlighting the importance of cooperation and collaboration in ensuring a stable and secure Indo-Pacific. By integrating the concepts of climate security and geostrategic competition, this study will provide a comprehensive understanding of the region's security dynamics and offer insights into the development of effective maritime security frameworks.

The recent return to the Indo-Pacific terminology as constructed realism, where the world is what it is with geopolitical competition being a driving force, but also that as shown in the sub-section on countries views of the Indo-Pacific and the plethora of policy and academic literature on the Indo-Pacific, the region itself is now a concept and entity that is well established among practitioners and political elites.[173]

This sub-section will begin by exploring the theoretical framework behind the construction of regions, with a particular focus on maritime regions. It will delve into the processes and factors that contribute to the formation of regions, including geographical, cultural, economic, and political elements. Following this theoretical foundation, the sub-section will illustrate how the Indo-Pacific region has been constructed through a combination of human and geopolitical interactions. It will examine the historical and contemporary dynamics that have shaped the Indo-Pacific, highlighting the role of strategic interests, trade routes, and diplomatic engagements.

[173]Patalano, Russell, and Grant, "1. Naval Power and a Framework for Regional Security in the Indo-Pacific."

The sub-section will then demonstrate how the Indo-Pacific has been integrated into policy and strategy by various states and international organisations. It will analyse the strategic documents and policy statements that have formalised the concept of the Indo-Pacific, emphasising the region's significance in global geopolitics. By doing so, it will provide a comprehensive understanding of how the Indo-Pacific has evolved from a geographical expression to a pivotal strategic construct.

Finally, the sub-section will establish the definition of the Indo-Pacific that will be utilised throughout this thesis. This definition will be informed by the theoretical insights and empirical evidence presented earlier in the sub-section. It will provide a clear and precise conceptualisation of the Indo-Pacific, serving as a foundational reference for the subsequent analysis of maritime security and climate change impacts within the region.

How Regions are Constructed

The study of how regions are constructed is an art more than a science. In their 2004 book, Buzan and Waever outlined their theoretical approach to defining a Regional Security Complex (RSC). They used the RSC theory to determine how regions are understood, developed, and defined by international relations and security issues. They argue that there are three categories for geographical areas under RSC theory: 1) region; 2) sub-region, and 3) super-complex. Their book, which was framed in the context of the post-Cold War era, provides a good basis for supporting the construction of the Indo-Pacific. According to Buzan and Weaver, a RSC is embodied by four variables:

1. boundary, which differentiates the RSC from its neighbours;
2. anarchic structure, which means that the RSC must be composed of two or more autonomous units;
3. polarity, which covers the distribution of power among the units; and
4. social construction, which covers the patterns of amity and enmity among the units.[174]

As will be shown in this sub-section, the boundaries that differentiate the Indo-Pacific from other regions are the connections between the littoral and oceanic states of the Indian and

[174] Barry Buzan and Ole Wæver, *Regions and Powers : The Structure of International Security* (Cambridge, UNITED KINGDOM: Cambridge University Press, 2003). http://ebookcentral.proquest.com/lib/lancaster/detail.action?docID=221064.

Pacific Oceans and the Oceans themselves, meaning that the Indo-Pacific is inherently a maritime region. It will also be shown that while the Indo-Pacific's structure may not be fully anarchic, there are at least two very different units within the Indo-Pacific, which can be seen through regional groupings such as the ASEAN, the IORA, and the PIF. The polarity of the Indo-Pacific is one of the strongest arguments for the construction of it as an RSC. As shown below, many states see the Indo-Pacific as a way of conceptualising the rise of China, the geostrategic competition between China and the United States (and to a small degree India, and again to an even smaller degree some 'western countries'). And finally, it will also show the social construction of the Indo-Pacific, in the form of Indo-Pacific strategies, and the connections between those in the Indo-Pacific that consist of the trading and competition over resources, but also the movement of people and ideas within the boundaries of the Indo-Pacific.

The importance of the ocean has become of heightened importance due to the central role oceans are playing in economic security, environmental security, human security, geopolitical competition, as well as science and technology.[175] This means that they need to be fully understood for the role they play in supporting the construction of regions. The Indo-Pacific has also been recognised as a biogeographic region by scientists who investigate the movement and interactions of marine species and ocean currents.[176] Indeed, the first use of the Indo-Pacific terminology was by the German geographer Karl Haushofer, as a way of visualising an anticolonial future to the imperial colonies throughout Asia in an attempt to undermine Germany's western rivals.[177]

When analysing maritime regions in 2013, Steinberg argued that "it is only through engaging with the ocean in all its material complexity that we can develop the fluid perspective that

[175] Yue Sun et al., "The construction and governance of regional maritime security order in the South China Sea: Conference report," *Marine Policy* 126 (2021/04/01/ 2021), https://doi.org/https://doi.org/10.1016/j.marpol.2021.104438, https://www.sciencedirect.com/science/article/pii/S0308597X21000488.
[176] C Raja Mohan, "Chapter One: Introduction," in *Samudra Manthan: Sino-Indian Rivalry in the Indo-Pacific* (Brookings Institution Press, 2012).
Rory Medcalf, "Indo-Pacific Visions," *Asia policy* 14, no. 3 (2019).
Shreesh Kumar and Akriti Khajuria, "Strategic Reorientation: Assessing the Geopolitical Transition from Asia-Pacific to the Indo-Pacific," *Available at SSRN 4842120* (2024).
[177] Hansong Li, "The "Indo-Pacific": intellectual origins and international visions in global contexts," *Modern Intellectual History* 19, no. 3 (2022).

allows us to use the sea to look beyond the sea."[178] In this statement by Steinberg, he is highlighting that to truly understand a maritime region, you need to understand the natural and geophysical interactions happening within a maritime area to fully understand how it comes together as a construct. In the Indo-Pacific, this is especially important as the region is so large that some constructions of it have it encompassing 50 percent of the Earth's surface and containing various different and sometimes contrasting cultures, societies, communities and economies.[179]

In his paper, Steinberg highlights the difference between land-oriented thought and maritime-oriented thought (as previously discussed in section 2.2.2 What is Maritime Security) and the dimensional fluidity of the ocean that makes it so hard to control.[180] Both in maritime security and in the understanding of interactions within regions, there needs to be a move away from seeing the ocean "as blue, flat, and unchanging: stable in both space and time" towards the complex environment it is.[181] This is especially true as shipping and maritime trade are an important source of interactions that link together the entirety of the Indo-Pacific, and historically, they used to also facilitate the flow of people and ideas.[182]

How the Indo-Pacific has been constructed?

The current centre of geopolitical competition is a maritime region that is encompassed by the terminology of the Indo-Pacific.[183] As noted above, the first use of the Indo-Pacific as a concept was by a geographer, as a way of visualising an anticolonial future and it has been argued by others, including Medcalf in 2018, He and Feng in 2020, and Pardesi in 2020, that the region which is now termed the Indo-Pacific has in one form or another been the historical strategic reality for Asia since at least the 1800s.[184] Pardesi, in his 2020 paper, links the construction of an Indo-Pacific region to the actions of historical powers in the region,

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[178] Steinberg, "Of other seas: metaphors and materialities in maritime regions."
[179] Shishir Upadhyaya, "Harmonizing maritime governance in the Indo-Pacific region," *Journal of the Indian Ocean Region* 18, no. 2 (2022).
[180] Steinberg, "Of other seas: metaphors and materialities in maritime regions."
[181] Steinberg, "Of other seas: metaphors and materialities in maritime regions."
[182]Upadhyaya, "Harmonizing maritime governance in the Indo-Pacific region."
Hansen, *The year 1000: When explorers connected the world—and globalization began*.
[183] Bueger and Edmunds, "8. New Challenges and a Look to the Future."
[184]Medcalf, "Reimagining Asia: From Asia-Pacific to Indo-Pacific."
Kai He and Huiyun Feng, "The institutionalization of the Indo-Pacific: Problems and prospects," *International Affairs* 96, no. 1 (2020).
Pardesi, "The Indo-Pacific: a 'new' region or the return of history?."

such as “British India, Qing China, Imperial Japan, and the United States” and this consolidated strategic system within the region.[185]

In his paper, Pardesi goes on to assert that both the Indian and Western Pacific Oceans, as well as the “distinct sub-regions of Asia—Northeast, Southeast, and South Asia”, are becoming a single maritime-based entity.[186] In arguing for a single maritime entity Pardesi noted that land-based developments within the Indo-Pacific must be taken into consideration, which comes back to the issue of liminality raised in the section on maritime security.[187] This means that in undertaking an analysis of the Indo-Pacific as a maritime entity, land-based impacts must also be understood as impacting security within the maritime domain. This is also a consideration that has to be taken into consideration when looking at maritime security, as shown previously in this chapter, and reiterates the rationale of the Indo-Pacific being a good geographical framing for this research.

In the 1990s, India developed a ‘Look East’ policy as a way of positioning itself following the Cold War, as it looked to strengthen ties with South East Asia, East Asia, and China.[188] In the early 2000s, China started a slow expansion into the India Ocean Region (IOR) in an attempt to alleviate the perceived vulnerabilities caused by the maritime choke point in the Malacca Straight, through which much of the world’s trade and energy flows. China’s expanded presence in the IOR included supporting the building of Ports in Sri Lanka, Pakistan, and Myanmar. These strategic locations throughout the IOR, in conjunction with the ‘land bridges’ that China was also pursuing at the time, were the beginning of China’s strategic foray into the IOR.[189]

In 2007, Japan’s then-Prime Minister, Shinzo Abe, declared the confluence of the two seas between the Indian and Pacific Oceans as being central to current strategic issues for both

[185] Pardesi, "The Indo-Pacific: a ‘new’ region or the return of history?."
[186] Pardesi, "The Indo-Pacific: a ‘new’ region or the return of history?."
[187] Pardesi, "The Indo-Pacific: a ‘new’ region or the return of history?."
[188] Chietigj Bajpaee, "Reinvigorating India’s ‘Act East’ Policy in an age of renewed power politics," *The Pacific Review* 36, no. 3 (2023/05/04 2023), https://doi.org/10.1080/09512748.2022.2110609, https://doi.org/10.1080/09512748.2022.2110609.
Lakhan Mehrotra, "India's Look East Policy: Its Origin and Development," *Indian Foreign Affairs Journal* 7, no. 1 (2012).
[189] Gurpreet S Khurana, "China's ‘String of Pearls’ in the Indian Ocean and Its Security Implications," *Strategic Analysis* 32, no. 1 (2008).

Japan and India.[190] The imagery of the confluence of the two seas promoted a way of framing the interconnectedness of the sub-regions of the Indian and Pacific oceans and highlighted the similarities and shared concerns that Japan and India as maritime states, and underscored their reliance on sea lines of communication.[191] Soon after declaring the confluence of the two seas, Shinzo Abe, alongside then Vice President of the United States, Dick Cheney, spearheaded the initial creation of 'the Quad'.[192] The first iteration of the Quad (Quad 1.0) was a military-focused grouping of four relatively like-minded Indo-Pacific nations, Australia, India, Japan, and the United States. This grouping was aimed at generating dialogue and developing stronger strategic ties between the group's members.[193] The Quad 1.0 ended up being a fleeting experiment that failed due to several factors, one of which was the criticism Australia drew from China for participating in the grouping, and this ultimately led to Australia's withdrawal, but this would be revived later.[194]

Building on China's expansion into the IOR in the early 2000s, their attentions turned seaward and westward under a strategy which would ultimately be developed into the Belt and Road Initiative (BRI).[195] The 'Road' aspect of the BRI refers to building a '21st Century Maritime Silk Road' which will encompass an array of actual and imagined maritime trade routes, with the end destination being Europe, but with branches to East African states.[196] The BRI was seen as a way of using China's excess productive capacity, which had been accumulated since 2008 and exacerbated due to Beijing's stimulus response to the 2008 global financial crisis.[197] The BRI was also seen as a way to build influence through investing billions of dollars in funding to states in the Indo-Pacific and Eurasia, mostly through

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[190] Hidetaka Yoshimatsu, "The Indo-Pacific in Japan's strategy towards India," *Contemporary Politics* 25, no. 4 (2019).
[191] Yoshimatsu, "The Indo-Pacific in Japan's strategy towards India."
[192] Rahul Roy-Chaudhury and Kate Sullivan de Estrada, "India, the Indo-Pacific and the Quad," *Survival* 60, no. 3 (2018).
Yuichi Hosoya, "FOIP 2.0: The evolution of Japan's free and open Indo-Pacific strategy," *Asia-Pacific Review* 26, no. 1 (2019).
[193] Hosoya, "FOIP 2.0: The evolution of Japan's free and open Indo-Pacific strategy."
[194] Roy-Chaudhury and de Estrada, "India, the Indo-Pacific and the Quad."
Hosoya, "FOIP 2.0: The evolution of Japan's free and open Indo-Pacific strategy."

[196] Jean-Marc F. Blanchard and Colin Flint, "The Geopolitics of China's Maritime Silk Road Initiative," Geopolitics 22, no. 2 (2017/04/03 2017), https://doi.org/10.1080/14650045.2017.1291503, https://doi.org/10.1080/14650045.2017.1291503.

infrastructure projects, with some academics even arguing that the land aspect of the BRI will support China's ambitions to act as both a continental and maritime power.[198]

The BRI has also seen China's attention on Pacific Island countries grow. Initially, this was over competition for diplomatic recognition between itself and Taiwan, but more recently, its attention in the Pacific has been more strategically and military-focused with its aims of more robustly challenging the supremacy of the United States beyond the first island chain.[199] The concept of the island chains by China is that they are "foreign fortifications designed to "contain" Chinese force protection."[200] There are generally accepted three island chains, the first island chain goes from the south of Japan to Taiwan to the South China Sea, the second island chain runs from the middle of Japan to Guam to Palau to Indonesia, and the third island chain runs from Alaska to Hawaii to New Zealand.[201]

In 2011, the United States, under the Obama administration, announced the 'Pivot to Asia'.[202] This pivot signalled the United States' intention to rebalance its strategic focus from its early 2000s focus on stability in the Middle East, toward greater attention on East Asia, where China was becoming an increasingly assertive actor and needed to be counterbalanced more effectively.[203] Ultimately, through the pivot, the United States aimed to "preserve and enhance a stable and diversified security order in which countries pursue their national objectives peacefully and in accordance with international law and shared norms and principles."[204] The United States aimed to achieve this through deepening its existing networks and relationships with countries in the region, as well as, supporting and strengthening allies and partners to work towards this goal in Asia.[205]

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[200] Andrew S Erickson and Joel Wuthnow, "Barriers, springboards and benchmarks: China conceptualizes the Pacific "Island Chains"," *The China Quarterly* 225 (2016).
[201] Office of the Secretary of Defense Washington DC, "Military and Security Developments Involving the People's Republic of China 2012 (Annual Report to Congress)," (2012).
"China's Reach Has Grown; So Should the Island Chains," Asia Maritime Transparench Initiative, 2018, accessed 15 August, 2024, https://amti.csis.org/chinas-reach-grown-island-chains/.
[202] "The U.S Pivot to Asia and American Grand Strategy," Council on Foreign Relations, accessed 31 March, 2024, https://www.cfr.org/project/us-pivot-asia-and-american-grand-strategy.
[203] "The 'Lost Decade' of the UD Pivot to Asia: Insights from Richard Fontaine," The Diplomat, 2024, accessed 31 March, 2024, https://thediplomat.com/2024/03/the-lost-decade-of-the-us-pivot-to-asia/.
[204] "FACT SHEET: Advancing the Rebalance to Asia and the Pacific," The White House, 2015, accessed 31 March, 2024, https://obamawhitehouse.archives.gov/the-press-office/2015/11/16/fact-sheet-advancing-rebalance-asia-and-pacific.
[205] Office of the Press Secretary, "FACT SHEET: Advancing the Rebalance to Asia and the Pacific."

In 2014, India's 'Look East' policy was renamed the 'Act East' policy and reinvigorated under Prime Minister Narendra Modi, which sought to cement India's position as the dominant power in the IOR and South Asia, partially in response to the increasing militarisation and securitisation of the IOR by external countries, especially China.[206] Since then, it has placed an increasing focus on becoming the main power in the IOR, through developing its blue water navy capabilities and making a point of ensuring that they are first to respond to HADR operations in the IOR, to convey that India is closer and more prepared compared to China.[207] India's reinvigorated 'Act East' policy also looks to prepare and situate India to better respond to the renewed strategic competition that is being played out, with Russian aggression and increasing tensions between China and, predominantly, the United States.[208]

Arguably, as a counter to China's increasing assertiveness, Japan, in 2016, laid out its vision of a 'Free and Open Indo-Pacific' (FOIP), which is a conceptual evolution of the confluence of the two seas ideology.[209] It was initially aimed at highlighting the connections between Asia and Africa, especially economically, however, the FOIP has enough flexibility as a construct to allow it to incorporate other views and preferences.[210] Japan's FOIP strategy now also places a strong emphasis on the Pacific Islands and how Japan might try to switch its engagement to a more proactive and engaged approach throughout the Pacific.[211]

The Quad was revived in 2017 on the sidelines of an Association of Southeast Asian Nations (ASEAN) meeting in the Philippines and this current iteration – the Quad 2.0 - reflects the original framing of the Quad 1.0 and the convergence of the two seas which looks to securitise the convergence of the Indian and Pacific Oceans, the associated choke points, and the sea lanes of communication that link the two. Thus, the Quad 2.0 aims to ensure the freedom of navigation between the two oceans, which is of paramount importance to

[206] "Among the Sea Powers: Australia's Maritime Strategy in the Indo-Pacific," Australian Institute of International Affairs, 2022, accessed 29 August, 2023, https://www.internationalaffairs.org.au/australianoutlook/among-the-sea-powers-australias-maritime-strategy-in-the-indo-pacific/.
[207] Roy-Chaudhury and de Estrada, "India, the Indo-Pacific and the Quad."
[208] Bajpaee, "Reinvigorating India's 'Act East' Policy in an age of renewed power politics."
[209] Yoshimatsu, "The Indo-Pacific in Japan's strategy towards India."
[210] Kai He and Mingjiang Li, "Understanding the dynamics of the Indo-Pacific: US–China strategic competition, regional actors, and beyond," *International Affairs* 96, no. 1 (2020).
[211] HDP Envall, "The Pacific Islands in Japan's 'Free and Open Indo-Pacific'," *Security Challenges* 16, no. 1 (2020).

the continuation of the world's current geostrategic balance.[212] However, Quad 2.0 is more than just a traditional militaristic dialogue focused on supporting both efforts to contain China's increasing assertiveness, as it also incorporates non-traditional security elements, such as vaccine support during the COVID-19 pandemic.[213] With this expanded focus on non-traditional security issues, this could see the Quad become a potential forum for more strategic action on climate change.[214] However, Jaffery and Pervez, in 2024, argued that those arguing for the future of the Indo-Pacific to be linked to the future of the Quad, are seeing the construction of both as being rooted in 'threat-oriented' motives.[215]

Choong argues that the Indo-Pacific has four crucial areas of tension, which make the chance of war within the Indo-Pacific more likely these are "the Korean peninsula, the East China Sea, the South China Sea and the Taiwan Strait".[216] These flash points support the construction of the Indo-Pacific by providing the basis to form either adversary or aligned connections between states that occupy and operate within the Indo-Pacific region.

There is also an argument that the Indo-Pacific is further reinforced by East Asia's energy dependency on oil flowing through the Indian Ocean.[217] However, with climate change mitigation pushing the drive for renewable energies, this could see a shift in energy sources and less of a dependency on the carbon-based sources that are transported through the Indian Ocean. Therefore, while it can be a big part of the initial construction of the Indo-Pacific, looking forward to the continued use of the term, there needs to be a wider view of the underlying relationships within the region.

As evidenced above and shown below, the Indo-Pacific has long been a lived reality for the inhabitants of the region and is now being incorporated into the strategic narratives and geopolitical lexicon. The current geopolitical competition is supporting the cementing of the

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[212] Roy-Chaudhury and de Estrada, "India, the Indo-Pacific and the Quad."
[213] Sumitha Narayanan Kutty and Rajesh Basrur, "The Quad: What it is–and what it is not," *The Diplomat* 24 (2021).
[214] Kutty and Basrur, "The Quad: What it is–and what it is not."
[215] Tayyaba Jaffery and Muhammad Shoaib Pervez, "Conceptualising a Heterarchical Regional Security Complex: The Case of the QUAD," *The International Spectator* 59, no. 4 (2024/10/01 2024), https://doi.org/10.1080/03932729.2024.2371589, https://doi.org/10.1080/03932729.2024.2371589. Adarsh Badri, "Quad and the Indo-Pacific: Examining the Balance of Interest Theory in Quad Coalition," *Strategic Analysis* 46, no. 6 (2022/11/02 2022), https://doi.org/10.1080/09700161.2022.2149981, https://doi.org/10.1080/09700161.2022.2149981.
[216] William Choong, "The return of the Indo-Pacific strategy: an assessment," *Australian Journal of International Affairs* 73, no. 5 (2019).
[217] Medcalf, "Reimagining Asia: From Asia-Pacific to Indo-Pacific."

Indo-Pacific as a significant concept and bringing prominence to the term. This geopolitical rivalry is driving states to frame their strategies and policies with a focus on the Indo-Pacific, particularly emphasising disputes over maritime boundaries. These disputes are increasing the prominence of maritime security within the Indo-Pacific, as maritime boundaries are crucial as they delineate state rights and sovereignty over vast areas of the maritime domain, which are rich in resources and strategic value.

The next sub-section will support the thesis by exploring how various states are prioritising the Indo-Pacific in their geopolitical agendas. The emphasis on maritime boundary disputes highlights the importance of these boundaries in securing access to valuable maritime resources, such as fisheries, oil, and gas reserves, as well as maintaining control over critical sea lanes of communication. These disputes are not merely about territorial claims but are deeply intertwined with national security, economic interests, and regional stability.

Moreover, the increasing salience of the Indo-Pacific concept is reflected in the strategic documents and policy statements of major regional and extra-regional powers. Countries like the United States, China, India, Japan, and Australia are actively shaping their foreign and defence policies to address the challenges and opportunities presented by the Indo-Pacific. This strategic focus underscores the region's significance in global geopolitics and the need for robust maritime security frameworks to manage the complex interplay of interests and threats.

Countries' Views on the Indo-Pacific

The Indo-Pacific's evolving geopolitical landscape necessitates a comprehensive understanding of how maritime security issues are framed and addressed by different states. By examining these approaches, we can gain insights into the broader implications of geopolitical competition in the region. This analysis will provide a deeper understanding of the Indo-Pacific's role in shaping the future of regional and global security dynamics, including maritime security.

The previous sub-section shows that the Indo-Pacific is an area of increasing geostrategic competition, but there are still differing views on how the Indo-Pacific terminology is used. Understanding how different states perceive and interact with the Indo-Pacific as a construct and countries within it, provides a view to how the connections within the region support the realisation of the Indo-Pacific as a region.

The initial champions of the renewed use of the Indo-Pacific terminology were Australian and Japanese policymakers who were concerned with China's continued ambition in the region.[218] This was best described by Medcalf, in 2018, who argued that the Indo-Pacific is a "maritime "super-region"" that is defined by "a set of geopolitical power relationships".[219] However, it is also necessary to understand how the countries of the Indo-Pacific or with interests in the Indo-Pacific perceive the current construct of the Indo-Pacific. The below section will briefly summarise the definitions of the Indo-Pacific as defined by such countries.

Australia

Australia was the first to use the term Indo-Pacific in official documents.[220] Australia is taking a two-pronged approach to the Indo-Pacific. They are a dependent ally of the US and, as such, are supporting the US's approach to the construction of the Indo-Pacific. However, they are also trying to take a middle power approach to the Indo-Pacific and obtain more of a leadership and mediation role through various institutional means and military means, as seen through the AUKUS agreement to acquire nuclear-powered submarine capability.[221] Australia sits in the middle of this geopolitical construction and has a vested interest in developing the construction of the Indo-Pacific, as a way of boosting its maritime security, and an obvious example of this is the AUKUS agreement. Similarly, Japan and India have also been pushing this agenda, as can be seen with the resurgence of the Quad in recent years.

Association of Southeast Asian Nations

ASEAN has been the main regional Asia-Pacific institution since the Cold War.[222] ASEAN centrality continues to be asserted by its members, which will be a useful position for its members if mini-laterals continue to increase in number, especially within the Indo-

[218] Mark Beeson, "Institutionalizing the Indo-Pacific: The challenges of regional cooperation," *East Asia* 35, no. 2 (2018).
[219] Medcalf, "Reimagining Asia: From Asia-Pacific to Indo-Pacific."
[220] He and Li, "Understanding the dynamics of the Indo-Pacific: US–China strategic competition, regional actors, and beyond."
[221] He and Li, "Understanding the dynamics of the Indo-Pacific: US–China strategic competition, regional actors, and beyond."
[222] He and Li, "Understanding the dynamics of the Indo-Pacific: US–China strategic competition, regional actors, and beyond."

Pacific.223 ASEAN has also been seen to be trying to reduce any negative effects on multilateralism that might be brought about by the Indo-Pacific term.[224]

ASEAN has been seen as hedging its approach to the Indo-Pacific construct as it tries to stay independent of the strategic rivalry between China and the United States.[225] The countries that make up ASEAN each have different and distinct views regarding China and the United States (some of which will be discussed further in this section). This supports ASEAN's ability to hedge (or play both sides), and a single ASEAN country may have different leanings towards either country, depending on the point in time that you are analysing.226 For example, the Philippines under President Duterte enjoyed relatively close ties with China even though they have a military alliance with the United States and are in direct competition with China in the South China Sea.227 Deferring picking sides and trying to ensure ASEAN has relationships with great powers reflects the current balance of power within the global system.228

In 2019, ASEAN published the *ASEAN outlook on the Indo-Pacific.* This was regarded as a way to offer up a different view, independent of great power politics and the views of other Indo-Pacific stakeholders.[229] While the ASEAN outlook did not set out geographic boundaries for the Indo-Pacific it did set out that it viewed the "the Asia-Pacific and Indian Ocean regions, not as contiguous territorial spaces but as a closely integrated and interconnected region" and that with Southeast Asia at the centre of the Indo-Pacific's dynamics, ASEAN centrality should be an "underlying principle for promoting cooperation in the Indo-Pacific region".[230]

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[223] Hoang Thi Ha, "Understanding the institutional challenge of Indo-Pacific minilaterals to ASEAN," *Contemporary Southeast Asia* 44, no. 1 (2022).
[224] He and Li, "Understanding the dynamics of the Indo-Pacific: US–China strategic competition, regional actors, and beyond."
[225] He and Li, "Understanding the dynamics of the Indo-Pacific: US–China strategic competition, regional actors, and beyond."
[226] See Seng Tan, "Consigned to hedge: south-east Asia and America's 'free and open Indo-Pacific' strategy," *International Affairs* 96, no. 1 (2020), https://doi.org/10.1093/ia/iiz227, https://doi.org/10.1093/ia/iiz227.
[227] Tan, "Consigned to hedge: south-east Asia and America's 'free and open Indo-Pacific' strategy."
[228] Yuzhu Wang, "Hedging strategy: Concept, behavior, and implications for China-ASEAN relations," *East Asian Affairs* 1, no. 02 (2021).
[229] Dewi Fortuna Anwar, "Indonesia and the ASEAN outlook on the Indo-Pacific," *International Affairs* 96, no. 1 (2020), https://doi.org/10.1093/ia/iiz223, https://doi.org/10.1093/ia/iiz223.
[230] "ASEAN outlook on the Indo-Pacific," 2019, https://asean.org/wp-content/uploads/2021/01/ASEAN-Outlook-on-the-Indo-Pacific_FINAL_22062019.pdf.

China

China has extensive economic interests across the Pacific and Indian Oceans and has sought to expand these through its BRI as described above.[231] China does not define the Indo-Pacific and is reluctant to acknowledge that it is part of the Indo-Pacific, or even use the term to define any area in which it undertakes activities.[232] However, China has harshly criticised the use of the Indo-Pacific terminology as they see it as being used by the United States and its allies to contain China politically and militarily.[233] China pushes back on the Indo-Pacific terminology but sees the basis for its engagement in coordinating big powers to create a strong regional system.[234]

European Union (EU)

The EU defines the Indo-Pacific region as an area "spanning from the east coast of Africa to the Pacific Island States" and takes the approach that the Indo-Pacific region is "one of cooperation not confrontation" and will pursue "multifaceted engagement with China".[235] The EU has increased its engagement within the Indo-Pacific.[236] The EU's Indo-Pacific Strategy states that "the European Union and Indo-Pacific countries have a stake in each other's prosperity and security" and that the two regions "share the same interest in upholding the rules-based international order".[237] However, questions remain about continued EU engagement in the Indo-Pacific, especially after Russia's war in Ukraine threatening the European continent at home.[238]

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[231] He and Li, "Understanding the dynamics of the Indo-Pacific: US–China strategic competition, regional actors, and beyond."
[232] Igor Denisov et al., "Russia, China, and the concept of Indo-Pacific," *Journal of Eurasian Studies* 12, no. 1 (2021).
[233] He and Li, "Understanding the dynamics of the Indo-Pacific: US–China strategic competition, regional actors, and beyond."
Denisov et al., "Russia, China, and the concept of Indo-Pacific."
[234] Denisov et al., "Russia, China, and the concept of Indo-Pacific."
[235] European Union External Action Service, *EU Indo-Pacific Strategy* (2024).
"Questions and Answers: EU Strategy for Cooperation in the Indo-Pacific," 2021, accessed 31 March, 2024, https://ec.europa.eu/commission/presscorner/detail/en/qanda_21_4709.
[236] "Europe in the Indo-Pacific Hub," accessed 31 March, 2024, https://hcss.nl/europe-in-the-indo-pacific-hub/.
[237] European Union External Action Service, *EU Indo-Pacific Strategy*.
[238] Giulio Pugliese, "The European Union's Security Intervention in the Indo-Pacific: Between Multilateralism and Mercantile Interests," *Journal of Intervention and Statebuilding* 17, no. 1 (2023).

France

France has sovereign territories across the Indo-Pacific, which gives it great interest in the stability and security of the region, and is key to the argument that France is an Indo-Pacific power.[239] France's Indo-Pacific Strategy sees the region as being one with "polarizing tensions and significant global issues".[240] France's Indo-Pacific strategy does not define the geographic limits of the Indo-Pacific, but it does directly state that "China's power is increasing, and its territorial claims are expressed with greater and greater strength" as well as that "competition between China and the US is increasing".[241] This has led some to argue that France is shaping its narrative and positioning to increase collaboration with partners as a way of countering Chinese influence in the region.[242]

India

India views the Indo-Pacific concept primarily through a security lens, and it is using the concept to counter China's rise.[243] India is currently pursuing this tactic cautiously, and this approach may end up not working as neither China nor the US will be pleased by India's approach.[244] Within the Indo-Pacific, India sees the IOR as its sphere of influence and main focus, as it is also a highly strategic maritime area with increasing geostrategic importance and holding within it many important choke points.[245] As mentioned above, India has a reinvigorated 'Act East' policy, which reflects India's increased focus on engaging with Southeast Asia as a way of countering China's assertiveness and trying to solidify itself as the dominant power in South Asia.[246]

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[239] John Bradford, "Japan Takes the Lead in Western Pacific Maritime Security," *asia policy* 28, no. 2 (2021).
[240] Ministry for Europe and Foreign Affairs, *French strategy in the Indo-Pacific* (2022).
[241] Ministry for Europe and Foreign Affairs, *French strategy in the Indo-Pacific*.
[242] Mukesh Shankar Bharti, Suprabha Kumari, and Sushant Shankar Bharti, "Indo-French Comprehensive Bilateral Cooperation: A Roadmap to Indo-Pacific Parks Partnership and Beyond," *Economic and Regional Studies / Studia Ekonomiczne i Regionalne* 15, no. 3 (2022), https://doi.org/10.2478/ers-2022-0020.
[243] He and Li, "Understanding the dynamics of the Indo-Pacific: US–China strategic competition, regional actors, and beyond."
[244] He and Li, "Understanding the dynamics of the Indo-Pacific: US–China strategic competition, regional actors, and beyond."
[245] Joshy M. Paul, "India–Japan maritime security cooperation: Secondary states' soft balancing in the Indo-Pacific," Article, *Maritime Affairs: Journal of the National Maritime Foundation of India* 15, no. 2 (2019), https://doi.org/10.1080/09733159.2019.1710384, https://search.ebscohost.com/login.aspx?direct=true&db=asn&AN=141995458&site=ehost-live&authtype=ip,shib&user=s1523151.
[246] Chan, "Among the Sea Powers: Australia's Maritime Strategy in the Indo-Pacific."

In recent history, India has been focused more on being a continental power than a maritime one, with its land-based security policies taking priority.[247] However, with the increased use of the term 'maritime security' and the increased attention the Indo-Pacific is getting, India is starting to focus on the opportunities the Indo-Pacific may bring, especially through collaboration with partners who will support their aims of countering China's assertions.[248]

Indonesia

The Indo-Pacific is very much a lived reality for Indonesia as it sits straddling the convergence of the Indian and Pacific Oceans.[249] Indonesia's approach to the Indo-Pacific is driven by its relationships with Australia, China, India, Japan, and the United States.[250] It is also taking a middle power approach to the construction of the Indo-Pacific, albeit a more cautious one than Australia, as it seeks to be a state not beholden to either China or the United States.[251] Indonesia has seen this construction as a way to increase its standing within ASEAN as well as to help entrench ASEAN centrality within the architecture of the Indo-Pacific.[252]

Indonesia was first talked about as a Global Maritime Fulcrum (GMF) in 2014.[253] The GMF initiative was driven by Indonesia's president, Joko Widodo, who relates the GMF to the ideas of Indonesia's seafaring history, archipelagic nature, and the changing strategic environment.[254] The GMF had five pillars: rebuilding Indonesia's maritime culture, managing

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[247] Darshana M. Baruah, *India in the Indo-Pacific: New Delhi's Theater of Opportunity* (Carnegie Endowment for Intenational Peace, 2020), https://carnegieendowment.org/2020/06/30/india-in-indo-pacific-new-delhi-s-theater-of-opportunity-pub-82205.
[248] Darshana M. Baruah, *India in the Indo-Pacific: New Delhi's Theater of Opportunity*.
[249] David Scott, "Indonesia grapples with the Indo-Pacific: Outreach, strategic discourse, and diplomacy," *Journal of Current Southeast Asian Affairs* 38, no. 2 (2019).
[250] Scott, "Indonesia grapples with the Indo-Pacific: Outreach, strategic discourse, and diplomacy."
[251] He and Li, "Understanding the dynamics of the Indo-Pacific: US–China strategic competition, regional actors, and beyond."
[252] He and Li, "Understanding the dynamics of the Indo-Pacific: US–China strategic competition, regional actors, and beyond."
[253] Ismail Ali and Singgih Tri Sulistiyono, "A reflection of "indonesian maritime fulcrum" initiative: Maritime history and geopolitical changes," *Journal of Maritime Studies and National Integration* 4, no. 1 (2020).
I Gusti Bagus Dharma Agastia, "Joko Widodo's Fleeting Maritime Ambitions: An Actor-Specific Analysis of Indonesia's Global Maritime Fulcrum," *Journal of Asian Security and International Affairs* 8, no. 3 (2021), https://doi.org/10.1177/23477970211039306, https://journals.sagepub.com/doi/abs/10.1177/23477970211039306.
[254] Ali and Sulistiyono, "A reflection of "indonesian maritime fulcrum" initiative: Maritime history and geopolitical changes."

and maintaining Indonesia's marine resources, developing its maritime infrastructure and connectivity, progressing its maritime diplomacy to increase cooperation in the maritime domain, and building its maritime defence forces.[255] The GMF was devised to support Indonesia's development into a global maritime power and hub that sits at the axis of two major oceans, but due to a lack of direction and ad-hoc decisions, the GMF has struggled and subsequently fallen out of the political discourse within Indonesia, as President Widodo turns more towards land-based infrastructure.[256]

Indonesia takes a leadership role within ASEAN but is careful to ensure that it is not seen as a regional hegemon and aims to 'lead from behind' by using ASEAN as a forum through which to promote policies and pursue initiatives.[257] Indonesia also looks to promote regional cohesion and cooperation by using ASEAN and promoting its centrality as the "primary convenor of regional dialogues and forums involving its many dialogue partners".[258] Indonesia continued to promote ASEAN's centrality to the region throughout the development of the *ASEAN outlook on the Indo-Pacific*.[259]

Japan

Japan was the leader in developing the FOIP concept, through which it sought to take a leadership role in the Indo-Pacific by engaging extra-regional powers to build a multipolar regional order.[260] The FOIP has a broad remit as discussed in the previous sub-section and looks at the connections from Asia to both Africa and the Pacific. Japan's FOIP is in response

Agastia, "Joko Widodo's Fleeting Maritime Ambitions: An Actor-Specific Analysis of Indonesia's Global Maritime Fulcrum."

[255] Ali and Sulistiyono, "A reflection of "indonesian maritime fulcrum" initiative: Maritime history and geopolitical changes."

Agastia, "Joko Widodo's Fleeting Maritime Ambitions: An Actor-Specific Analysis of Indonesia's Global Maritime Fulcrum."; Mohamad Rosyidin, "The cult of glory: national myth and the idea of Global Maritime Fulcrum in Indonesia's foreign policy, 2014–2019," *South East Asia Research* 29, no. 3 (2021); "Speech by President of the Republic of Indonesia Joko Widodo at the 9th East Asia Summit, in Nay Pyi Taw, Myanmar, 13 November 2014," Cabinet Secretariat of the Republic of Indonesia, https://setkab.go.id/pidato-presiden-ri-joko-widodo-pada-ktt-ke-9-asia-timur-di-nay-pyi-taw-myanmar-13-november-2014/.

[256] Agastia, "Joko Widodo's Fleeting Maritime Ambitions: An Actor-Specific Analysis of Indonesia's Global Maritime Fulcrum."

[257] Anwar, "Indonesia and the ASEAN outlook on the Indo-Pacific."

[258]Anwar, "Indonesia and the ASEAN outlook on the Indo-Pacific."

[259] Anwar, "Indonesia and the ASEAN outlook on the Indo-Pacific."

[260] Chan, "Among the Sea Powers: Australia's Maritime Strategy in the Indo-Pacific."

to China's BRI and operates in similar areas.[261] The FOIP includes Japan increasing its strategic ambitions within the Pacific, as well as, engaging with China and encouraging it to engage constructively with the current international rules-based order.[262] Japan's view of the Indo-Pacific's geography is that it extends from Japan's east coast to the east coast of Africa.[263]

Latin America

While adjacent to the Indo-Pacific with its west coast sitting on the Pacific Ocean, the Indo-Pacific term is little used in the South American political lexicon, and there is no defined strategy or vision for how to engage with the Indo-Pacific.[264] In Latin America, they also see an issue of balancing both China and the United States as important political and trading partners.[265] However, this has yet to drive a need to engage with the Indo-Pacific region in the way that others are now constructing their engagement with the region.

New Zealand

New Zealand sees itself as an Indo-Pacific country and has signed up to the Indo-Pacific Economic Framework and is one of the North Atlantic Treaty Organization's four Indo-Pacific Partners.[266] New Zealand uses the word 'region' to describe both the Indo-Pacific and the Pacific, but to denote closer relationships with the Pacific, New Zealand often refers to the Pacific as 'neighbours' or the 'neighbourhood'.[267]

New Zealand officially defines the Indo-Pacific as broadly encompassing "the Indian and Pacific Oceans," and it "is increasingly used in security contexts in preference to other

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[261] Aurelio Insisa and Giulio Pugliese, "The free and open Indo-Pacific versus the belt and road: spheres of influence and Sino-Japanese relations," *The Pacific Review* 35, no. 3 (2022/05/20 2022), https://doi.org/10.1080/09512748.2020.1862899, https://doi.org/10.1080/09512748.2020.1862899.
[262] "Japan," accessed 31 March, 2024, https://www.sciencespo.fr/ceri/observatory-indo-pacific/japan/.
[263] Roy-Chaudhury and de Estrada, "India, the Indo-Pacific and the Quad."
[264] "Latin America and the Indo-Pacific," Australian Institute of International Affairs, 2023, https://www.internationalaffairs.org.au/australianoutlook/latin-america-and-the-indo-pacific/.
[265] Jenne, "Latin America and the Indo-Pacific."
[266] "Government to sign groundbreaking Indo-Pacific agreements," Beehive.govt.nz, 2024, https://www.beehive.govt.nz/release/government-sign-groundbreaking-indo-pacific-agreements. "Prime Minister leads Indo-Pacific Four at NATO," Beehive.govt.nz, 2024, https://www.beehive.govt.nz/release/prime-minister-leads-indo-pacific-four-nato.
[267] "Prime Minister's Foreign Policy Speech to NZIIA," Beehive.govt.nz, 2023, https://www.beehive.govt.nz/speech/prime-ministers-foreign-policy-speech-nziia.

concepts and terms such as the "Asia-Pacific".[268] New Zealand includes issues such as "cross-Strait tensions" (assumingly relating to the Taiwan Strait), "incidents and tensions in the South and East China Seas", "North Korea's nuclear and missile development", and "conflicts in and through space and cyber-space" as being Indo-Pacific issues.[269] New Zealand, potentially because it has a geographic focus on the Pacific, talks about the Pacific under the term Indo-Pacific and views the Pacific as falling prey to the same strategic competition playing out in the wider Indo-Pacific region. This is because the Pacific Ocean is also becoming a more contested entity, particularly regarding fisheries. But it has also now been articulated by New Zealand that they are worried about "the establishment of a military base or dual-use facility in the Pacific by a state that does not share New Zealand's values or security interests".[270]

Pacific Islands

There is increasing geostrategic competition taking place within the Pacific, and Pacific countries are skilled at playing the different interested parties to ensure that their individual needs are met.[271] However, Pacific states are concerned with the events unravelling in the South China Sea and China's activities in the Pacific, especially concerning the sea lines of communication.[272]

While being a crucial part of others' framing of the Indo-Pacific, the Pacific Islands have not generally considered themselves as part of the Indo-Pacific and are wary of using the concept.[273] This is because it blurs the boundaries of the Pacific as its own region, and Pacific countries are worried about being incorporated into a region that includes over half

[268] New Zealand Ministry of Defence, *Defence Assessment 2021: he moana pukepuke e ekengia e te waka / a rough sea can still be navigated* (2021), https://www.defence.govt.nz/assets/publication/file/Defence-Assessment-2021.pdf.
[269] New Zealand Ministry of Defence, *Defence Assessment 2021: he moana pukepuke e ekengia e te waka / a rough sea can still be navigated*
[270] New Zealand Ministry of Defence, *Defence Assessment 2021: he moana pukepuke e ekengia e te waka / a rough sea can still be navigated*
[271] Meg Keen and Alan Tidwell, *Geopolitics in the Pacific Islands: Playing for advantage*, Lowy Institute (2024), https://www.lowyinstitute.org/publications/geopolitics-pacific-islands-playing-advantage.
[272] New Zealand Ministry of Defence, *Defence Assessment 2021: he moana pukepuke e ekengia e te waka / a rough sea can still be navigated*
[273] "What Australia's 'Indo-Pacific' aid policy tells the Pacific about its priorities," The Strategist, Australian Stratgic Policy Institute, 2023, accessed 28 August, 2023, https://www.aspistrategist.org.au/what-australias-indo-pacific-aid-policy-tells-the-pacific-about-its-priorities/.

of the world's population, as they may lose their identity and what influence they have managed to carve out for themselves.[274]

United Kingdom

In 2021, the UK Government published its report *Global Britain in a Competitive Age: the Integrated Review of Security, Defence, Development and Foreign Policy*, which sparked the UK's Indo-Pacific Tilt. This was in part due to the critical nature of the region to the UK's economic and security interests.[275] While the UK's approach to the Indo-Pacific has seen a modest increase in its presence within the region, the UK's tilt towards the Indo-Pacific has not been fully achieved. It has, however, been successful at building relationships with partners in the region, most notably through the AUKUS agreement with Australia and the United States.[276]

United States

The United States 'pivot to Asia' (discussed above) was the prelude to the use of the Indo-Pacific and was very much in response to the growth of strategic competition within Asia. In 2021, the United States National Security Council declassified, in part, the *U.S Strategic Framework for the Indo-Pacific* which was developed under the Trump administration between 2017 and 2021, which aimed to "maintain U.S. strategic primacy in the Indo-Pacific region and promote a liberal economic order" especially in the face of competition with China and ensuring that it "does not threaten the United States and its allies".[277]
In its *2022 Indo-Pacific strategy of the United States* the United States outlined that "the United States is an Indo-Pacific power".[278] In the same strategy, it also outlined the boundaries it uses to define the geographic area of the Indo-Pacific. These mirror the area covered by its Indo-Pacific command and goes from the Western shores of the US to the Western point of India, but excludes the westernmost parts of the Indian Ocean.[279]

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[274] Herr, "What Australia's 'Indo-Pacific' aid policy tells the Pacific about its priorities."
[275] House of Commons Defence Committee, *UK Defence and the Indo-Pacific* (2023), https://committees.parliament.uk/publications/41808/documents/207298/default/.
[276] House of Commons Defence Committee, *UK Defence and the Indo-Pacific*.
[277] *U.S. Strategic Framework of the Indo-Pacific*, (2018), https://trumpwhitehouse.archives.gov/wp-content/uploads/2021/01/IPS-Final-Declass.pdf.
[278] *Indo-Pacific Strategy of the United States*, (2022), https://www.whitehouse.gov/wp-content/uploads/2022/02/U.S.-Indo-Pacific-Strategy.pdf.
[279] Roy-Chaudhury and de Estrada, "India, the Indo-Pacific and the Quad."

Historically, India has not been part of the United States' strategic Asian policy, but recently it has begun incorporating India into this policy, which is one of the main drivers behind the use of the term Indo-Pacific.[280] In the first Trump administration's Indo-Pacific strategic framework, the United States aimed to “accelerate India’s rise and capacity to serve as a net provider of security and Major Defense Partner”.[281] This shows an increased view of a holistic approach to the United States' view of Asia.[282]

Definition of the Indo-Pacific

Steinberg notes that “Typically, the geographic scope of each region is defined by a central sea and – depending on the disciplinary focus of the conference, working group, book, or journal – its limits are those of that sea's historical, cultural, economic, or geopolitical watershed.”[283] This argument can be seen through the previous subsection showing the views of many states that the Indo-Pacific is a predominantly maritime construct, with their definitions placing an emphasis on relationships to the Indian and Pacific oceans.

The maritime domain is also where, as discussed previously, historical great powers, such as the United Kingdom and the United States, have been able to project power with relative efficiency. The recent use of the concept has grown out of the increasing geostrategic competition across the region, which has been driven by the escalation in competition between the United States and China, as well as increased strategic competition from India.[284] The creation of the Indo-Pacific has tried to give boundaries to the current geostrategic competition and frame it as taking place within a singular geographic region, but this does not mean that geostrategic competition is the only focus of the Indo-Pacific.[285]

For this study, because of how maritime regions are constructed and because of the interactions and framings of the Indo-Pacific as a region, which are outlined in previous sections, the geographical area that will be defined as the Indo-Pacific region for this study is represented in Figure 2.7. These geographical boundaries support a flexible demarcation

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[280] Paul, "India–Japan maritime security cooperation: Secondary states' soft balancing in the Indo-Pacific."
[281] *U.S. Strategic Framework of the Indo-Pacific*.
[282] Paul, "India–Japan maritime security cooperation: Secondary states' soft balancing in the Indo-Pacific."
[283] Steinberg, "Of other seas: metaphors and materialities in maritime regions."
[284] David Scott, "The Indo-Pacific in US strategy: Responding to power shifts," *Rising powers quarterly* 2, no. 2 (2018).
[285] Medcalf, "Indo-Pacific Visions."

of the region, which is useful for this study's analysis of both maritime security and climate change. This is because, as stated in previous sections, both these issues are transnational and cross-jurisdictional and in particular because this research needs to give an acknowledgement to the fact that the ocean is constantly in a fluid state, and there needs to be an appropriate level of understanding of land-based impacts on maritime-based security issues. But this flexible demarcation is because the Indo-Pacific is a maritime super-region, as it is a geographic entity connected by the medium of water. It is a region with a flow and liquidity of goods, people, fish, and water. These linkages and interdependencies intertwine the economic, human and environmental security of countries and communities across both the Pacific and Indian Oceans.[286] This is why the geographical scope cannot be too limited, but it also can't be too vast, otherwise it would be a world view, so the compromise to this is the Indo-Pacific.

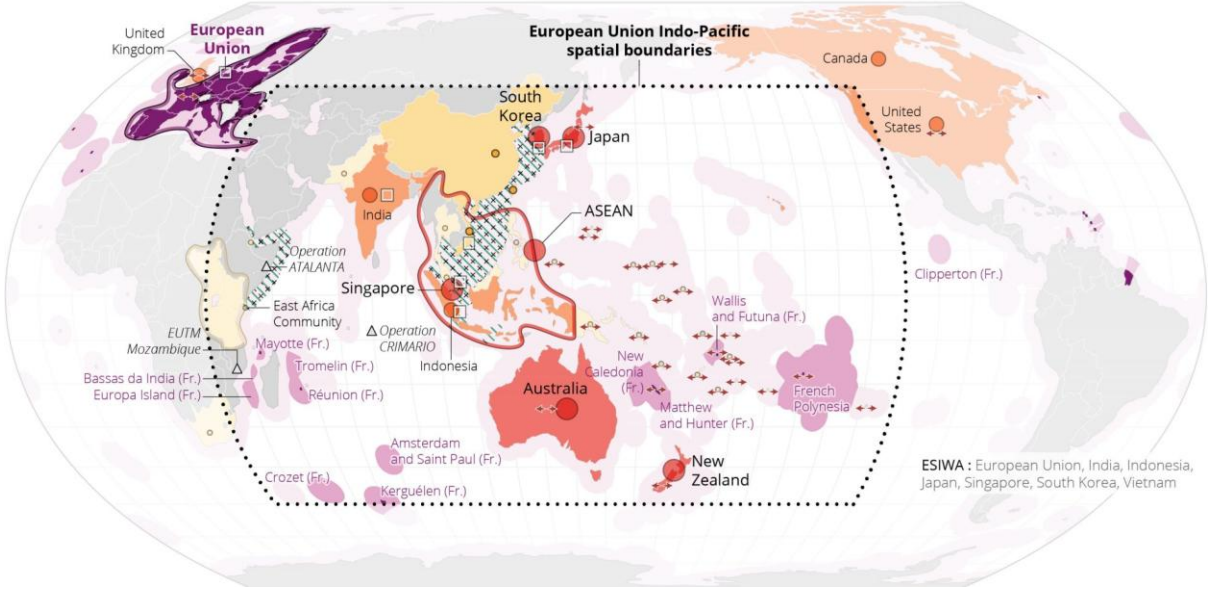

Figure 2.6 – Indo-Pacific seen from European Union, 2021, Observatory Indo-Pacific[287]

Conclusion

The Indo-Pacific, as shown above, has become a geopolitical reality, but while the term itself has found its way into international relations terminology, it is a massive geographic region

[286] Malik, *Maritime Security in the Indo-Pacific: Perspectives from China, India, and the United States*.
[287]"European Union," accessed 03 April, 2024, https://www.sciencespo.fr/ceri/observatory-indo-pacific/eu/. Observatory of the Indo-Pacific, "European Union."

which is poorly defined and has inconsistently applied boundaries.[288] The Indo-Pacific is both a political and security construct built by politicians, strategists, policymakers, and academics. But it is also a tangible entity built by the interactions that occur between actors within the region, such as shipping, migration, strategic competition, and resources. Because of this, the Indo-Pacific, like maritime security, will mean different things to different actors.[289] Currently, the Indo-Pacific is a very topical region and term and is currently at the centre of a lot of international relations research and events.

The rise of the Indo-Pacific terminology may have been around for a while, but its current prominence is underlined by increasing Chinese assertiveness, and the need of other countries to incorporate China's expansion efforts into a singular concept through which they can balance resources and develop analysis and responses. Reinforced by constructs such as 'Twenty-First-Century Maritime Silk Road', the 'Free and Open Indo-Pacific', and the Quad, the Indo-Pacific has garnered a lot of attention in the past decade.[290] The Indo-Pacific mostly contains developing countries, with its geographical boundaries being made up of developed states; most of which have some sort of geopolitical tension with China (Australia, India, Japan, New Zealand, South Korea, and the United States). Even countries that do not immediately border the Indo-Pacific's geographic boundaries have developed Indo-Pacific strategies, such as the European Union, and the United Kingdom.

The issue of the impacts of climate change on geopolitics is an important one, and as a maritime super-region, the Indo-Pacific is both a strategically contested environment and is already bearing the initial impacts of the effects of climate change. This can be seen by sea level rise threatening the very existence of low-lying island states, ocean acidification, and increasing variability of weather patterns, which has seen long droughts followed by

[288] Kei Hakata and Brendon J Cannon, "The Indo-Pacific as an emerging geography of strategies," in *Indo-Pacific Strategies* (Routledge, 2022).
[289] Brendon J Cannon and Ash Rossiter, "The'Indo-Pacific': Regional Dynamics in the 21st Century's New Geopolitical Center of Gravity," *Rising Powers Quarterly* 3, no. 2 (2018).
[290] Tim Summers, "Maritime politics as discourse in the Indo/Asia-Pacific," *Territory, Politics, Governance* 11, no. 3 (2023/04/03 2023), https://doi.org/10.1080/21622671.2021.1886977, https://doi.org/10.1080/21622671.2021.1886977.
Badri, "Quad and the Indo-Pacific: Examining the Balance of Interest Theory in Quad Coalition."

massive rains which in 2022 saw large swathes of Pakistan become flooded, displacing eight million people and directly impacting over 30 million.[291]

The Indo-Pacific lends itself to being a good area of focus for this study, as this thesis aims to understand the interactions of the impacts of the effects of climate change on geopolitics, and the Indo-Pacific has accessible and available secondary data that can be collated through desk research, such as the array of Indo-Pacific strategies. The Indo-Pacific is also a good geographical focus, as the Indo-Pacific construct is seen as a way of engaging more states in regional maritime politics, as maritime disputes are a core cause of the construction of the Indo-Pacific.[292] The Indo-Pacific construct signifies the centrality of the ocean to geopolitical competition, especially within the Indian and Pacific oceans and the role that maritime forces and power play within the competition.[293]

The Indian Ocean has seen increased interactions between the major powers of the IOR as the world moves to one that is more multipolar, as well as the region's middle powers are also seeing the opportunity to act towards their best interests either by themselves or through cooperation.[294] These interactions and competition have brought together a more cohesive IOR, which will, in turn, be a crucial part of the Indo-Pacific.

While the Indo-Pacific may be too complex given the range of countries, the size of the geographic area and the current geostrategic context, complexities of the real world should not be shied away from. Especially as climate change has no concept of location, geopolitics, or statehood and understanding how all of these issues interact with each other is of paramount importance, and even if this project is an initial stab in the dark, starting somewhere is better than not starting at all.

2.3 Conclusion

This chapter has outlined the conceptual framework of this thesis that will be used for analysing the three main concepts in this research. As the impacts of climate change will be

[291] "Over a year after Pakistan floods, survivors battle climate anxiety," Al Jazeera, 2023, accessed 16 September, 2024, https://www.aljazeera.com/gallery/2023/10/24/photos-over-a-year-after-pakistan-floods-survivors-battle-climate-anxiety.
[292] Summers, "Maritime politics as discourse in the Indo/Asia-Pacific."
[293] Patalano, Russell, and Grant, "1. Naval Power and a Framework for Regional Security in the Indo-Pacific."
[294] David Brewster, "Introduction," in *Cross currents: the new geopolitics of the Indian Ocean*, ed. David Brewster, Samuel Bashfield, and Justin Burke (National Security College Press, 2024).

unevenly distributed across the dimensions of maritime security, the sub-regions of the Indo-Pacific, and the people and communities that live and work within the dimensions and sub-regions,[295] this conceptual framework supports the understanding of the linkages between the different concepts and why they are important to study, especially given the context and background. This chapter started by outlining how these three main concepts were interlinked by defining them:

- Climate change is defined as changes to the Earth's climate primarily driven by human activity, which alters the composition of the global atmosphere.
- Maritime security is defined as a way of categorising security issues within the maritime domain and littoral regions. These security issues are divided into four categories, which are environmental security, human security, economic security, and national security.
- The Indo-Pacific is defined as a maritime super-region that is contained within the area from the east coast of Africa to the west coast of the United States. The boundaries to the Indo-Pacific are flexible and provide strategic ambiguity to actors.

Climate change, maritime security, and the Indo-Pacific are inextricably interlinked issues that will have an impact on the future of global security.[296] So fully understanding the interactions between these issues is of crucial importance, especially as maritime security is increasingly becoming a strategic priority and because the severe negative impacts climate change is causing in the maritime domain are also becoming an established part of strategic decision making.[297] Climate change is one of the biggest security threats and will impact the maritime domain in ways that affect the environmental, human, economic, and national dimensions of maritime security, all of which will be further complicated by the current

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[295] Elena M. Finkbeiner et al., "Exploring trade-offs in climate change response in the context of Pacific Island fisheries," *Marine Policy* 88 (2018/02/01/ 2018), https://doi.org/https://doi.org/10.1016/j.marpol.2017.09.032, https://www.sciencedirect.com/science/article/pii/S0308597X17301872.

[296] Kate Clayton, *Operationalising the Quad: Maritime security and climate change in the Indo-Pacific*, United States Studies Center (2024), https://www.ussc.edu.au/maritime-security-and-climate-change-in-the-indo-pacific.
"The Quad, Maritime Security, and Climate Change," 2024, accessed 06 February, 2025, https://toda.org/global-outlook/2024/the-quad-maritime-security-and-climate-change.html.

[297] Basil Germond and Antonios D Mazaris, "Climate change and maritime security," *Marine Policy* 99 (2019), https://doi.org/https://doi.org/10.1016/j.marpol.2018.10.010.
Bueger and Edmunds, "8. New Challenges and a Look to the Future."

state of the Indo-Pacific and current global geostrategic competition, which currently has a major focus on the Indo-Pacific.[298]

This research in the following chapters shows the linkages between climate change and insecurity, and like other supports the hypothesis that climate change, in particular the impacts on the environmental dimension of maritime security, can cause increases in crime, instability, and insecurity due to increases in displacement, loss of livelihoods, and resource competition.[299]

Climate change and maritime security both have impacts that are global in nature, with both concepts being fluid, transboundary, and cross-jurisdictional in nature.[300] There still exists a lack of understanding of how the effects of climate change impact maritime security.[301] Scheffran and Battaglini have described how the effects of climate change can trigger “a cycle of environmental degradation, economic decline, social unrest and political instability” and how these will have flow-on effects that impact global security as they “destabilize regions and expand the geographical extent of crisis, overstretching global and regional governance structures”.[302] This highlights a need to address the climate change-maritime security nexus as it will, among many other things, support the understanding of the multidimensional and synergistic interactions of these concepts and will add to the small but emerging field of research on climate change and maritime security.[303]

Brennan and Germond, in their 2024 paper, highlight "that the links and dependencies between climate change and maritime security are multifaceted and impact societies, especially on vulnerable populations."[304] They go on to advocate that an "innovative

[298] Germond and Mazaris, "Climate change and maritime security."
[299] Clayton, *Operationalising the Quad: Maritime security and climate change in the Indo-Pacific*.
[300] Germond and Mazaris, "Climate change and maritime security."
[301] Brennan and Germond, "A methodology for analysing the impacts of climate change on maritime security."
[302] Scheffran and Battaglini, "Climate and conflicts: the security risks of global warming."
[303] Basil Germond, Jess Hindley, and James Brennan, "The impacts of climate change on maritime security and ocean sustainability," in *Global Challenges in Maritime Security: Sustainability and the Sea*, ed. Lisa Otto and Anja Menzel (Springer Cham, 2024).

Germond and Mazaris, "Climate change and maritime security."
[304] Brennan and Germond, "A methodology for analysing the impacts of climate change on maritime security."

framework for analysis is needed to assess these links and dependencies."[305] A framework is set out in Chapter 3 and provides a crucial element to the conceptual framework of the thesis and is one of the main contributions to academia from this research.

The natures of both climate change and maritime security lend themselves to being best analysed through a geographic scope that is not too constrained. As such, the Indo-Pacific as a maritime super-region plays this role very well, as it is a fluid and flexible construct. The Indo-Pacific is a maritime super-region where climate impacts are already being felt with severe consequences, as well as being at the centre of geostrategic competition in which maritime security plays an integral part. This makes the research outlined in this thesis timely to inform decision-makers as they plot a way forward.

Maritime security and the Indo-Pacific go hand in hand for with the region being not only the current centre for geo-strategic competition but also a critical transit route for shipping, with key supply lines and vulnerable choke points throughout the region.[306] It is also home to a vast proportion of the global population, many of whom rely on the maritime for not only the transit of goods but also as a source of food and livelihoods. This research will highlight the linkages and interactions between maritime security and the Indo-Pacific maritime super-region and argue why there is a need for increased action to prevent the insecurity climate change causes in the maritime domain, especially within the Indo-Pacific.

Through developing this section, it has contributed to the academic discourse on all three concepts by contributing to the securitisation of climate change, adding to the definition of maritime security, and adding to the discourse on the construction of the Indo-Pacific. The next chapter will outline a technical assessment tool that will help derive the interactions between climate change and maritime security by looking into cumulative effect assessments and adopting them to build a database of EIP chains and outline how to develop these chains. These chains will, through a step-by-step method, outline how climate impacts will affect maritime security. Chapters 5, 6, 7 and 8 will then discuss how these impacts interact with the Indo-Pacific.

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[305] Brennan and Germond, "A methodology for analysing the impacts of climate change on maritime security."

[306] Benedetta Girardi, *Maritime Security for resilient global Supply Chains in the wider Indo-Pacific* (The Hague Centre fror Strategic Studies, 2024), https://hcss.nl/report/maritime-security-for-resilient-global-supply-chains-in-the-wider-indo-pacific/.

Chapter 3: Methodology and data collection: Non-Geographic Assessment maps

This chapter outlines the methodology used to collect scientific data for this research and the process through which the data was analysed. This process for collection and analysis provides a novel way to support the integration of climate science into social science studies and policy-making. In developing the methodology, this chapter provides the rationale behind any assumptions that needed to be made when translating the scientific data and analysis to foreign policy/security studies. This chapter also provides the reasoning behind basing the data collection framework on the Cumulative Effect Assessment (CEA) methodology and the logic of using Effects to Impacts Pathway (EIP) chains in order to trace and tag the effects of climate change to impacts on maritime security in the Indo-Pacific.

The focus of this chapter is therefore to demonstrate the functionality of using a framework based on a CEA methodology and EIP chains to assess the multidimensional and synergistic interactions between climate change and maritime insecurity. In demonstrating this functionality, this thesis takes the data collection methodology beyond the proof of concept, which was also developed as part of this research and was published by Brennan and Germond in 2024.[307]

The methodology for collecting the scientific data used in this research and translating/analysing it to support foreign policy and security studies analysis is a crucial aspect of this thesis's unique contributions to furthering academic knowledge. Understanding the interactions of climate change and maritime security through a Non-Geographic Assessment Map will also support an increased awareness and use of the impacts of climate change in maritime security planning and analysis, which will help increase maritime domain awareness.

[307] Brennan and Germond, "A methodology for analysing the impacts of climate change on maritime security."

3.1 What are Assessment Maps?

To support the conceptual framework of this thesis, outlined at the beginning of Chapter 2, especially in understanding the interactions and links between climate change and maritime security, there needs to be a method for analysing the linkages between the two issues in detail. This will better support the analysis of the impacts felt by the environment, humans, societies, economies and nations. Through the process of undertaking the research at the heart of this study, a methodology called a Non-Geographic Assessment Map (NGAM), was proposed and was (as mentioned above) derived in the conceptual framework first published as a proof of concept by Brennan and Germond in 2024.[308] This chapter builds on the proof of concept to further develop the process that the NGAM methodology uses.

The NGAM methodology was created using a process adapted from a CEA methodology, as will be, argued below, because it is an effective way of showing and tracing how the changes in the natural environment can impact on sectors of society, with a sector being defined by non-geographic characteristics. Brennan and Germond proved this by using the four dimensions of maritime security as the sectors of society with non-geographic characteristics and showed how the four dimensions were impacted by climate change.[309]

CEAs are currently used in environmental sciences to understand the impact of human activities on the natural environment.[310] This makes CEAs a useful analysis tool which can be adapted to identify the impacts of the effects of climate change on maritime security.[311] This section shows that CEAs can be adapted using the inherent flexibility of CEA methodologies to focus on sectors of society rather than geographic locations.[312] This section will also show how the CEA methodology allows for identifying multiple impact pathways that stem from

[308] Brennan and Germond, "A methodology for analysing the impacts of climate change on maritime security."
[309] Brennan and Germond, "A methodology for analysing the impacts of climate change on maritime security."
[310] Pezhman Roudgarmi, "Cumulative Effects Assessment (CEA), A Review," *Journal of Environmental Assessment Policy and Management* 20, no. 2 (2018), https://doi.org/https://www.jstor.org/stable/90022927, https://www-jstor-org.ezproxy.lancs.ac.uk/stable/90022927.
[311] Antonios D. Mazaris and Basil Germond, "Bridging the gap between climate change and maritime security: Towards a comprehensive framework for planning," *Science of The Total Environment* 635 (2018), https://doi.org/https://doi.org/10.1016/j.scitotenv.2018.04.136, http://www.sciencedirect.com/science/article/pii/S004896971831297X.
[312] Brennan and Germond, "A methodology for analysing the impacts of climate change on maritime security."

the same activity and may act in multiplicative and synergistic ways, as well as showing that different impacts may mitigate other impacts.[313] By exploiting the versatility of CEAs, NGAMs as an assessment tool allow for the identification of multiple impacts that are occurring at the same time and facilitate the visual representation of the complexities and interactions of these impacts.[314]

Using a CEA-based framework will allow the analysis of many different effects and impacts that are present across the different domains of maritime security. A model will therefore illustrate how they interact with each other. This is very important because, as Spijkers states in 2017, "the relation between environmental change and social conflict is not straightforward, but rather represents a nexus where various causal factors interlink."[315] This nexus will also continue to expand in the future with the increase of maritime activities, and as the competition for both maritime space and resources also increases, causing conflict not just between different states but also different sectors. [316] This is also why this research uses the framing of maritime security as a pyramid (see section 2.2.2 What is Maritime Security) as it supports the understanding of how a healthy environment can provide a base for multiple dimensions of security.

In their article, Brennan and Germond undertake a proof-of-concept for developing an NGAM by creating a database of hundreds of individual EIP chains. These EIP chains were constructed by adapting the basic concepts as presented by Judd et al (2015) (and illustrated diagrammatically in Figure 3.1), but slightly revisiting the main constructs to make them more relevant to the case study.

[313] Mazaris and Germond, "Bridging the gap between climate change and maritime security: Towards a comprehensive framework for planning."
[314] Brennan and Germond, "A methodology for analysing the impacts of climate change on maritime security."
[315] Jessica Spijkers and Wiebren J Boonstra, "Environmental change and social conflict: the northeast Atlantic mackerel dispute," *Regional Environmental Change* 17, no. 6 (2017).
[316] Freya Goodsir et al., "A spatially resolved pressure-based approach to evaluate combined effects of human activities and management in marine ecosystems," *ICES Journal of Marine Science* 72, no. 8 (2015).

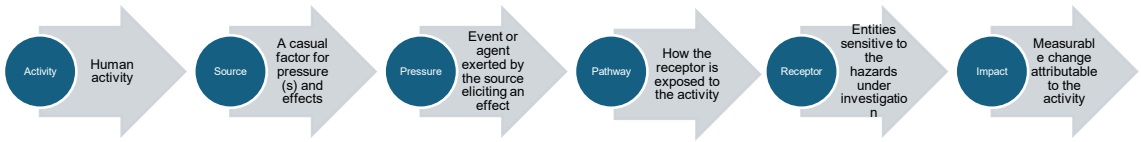

Figure 3.1 – A visual representation of a Judd, Backhaus and Goodsir's Effect to Impact Pathway chain.

Source: Brennan and Germond 2024, based on Judd, Backhaus and Goodsir (2015)

3.1.1 What is a Cumulative Effect Assessment?

CEAs are an environmental impact assessment tool, designed to holistically evaluate the combined impact that human activity has on the natural environment.[317] CEAs have mostly been used by marine scientists to predict the expected impacts of human activities on maritime ecosystems.[318] CEAs are underpinned by the concept that the impacts of the activity being analysed are not independent of each other and can act in ways which are additive, multiplicative, synergistic or mitigative.[319]

In 2008, Halpern et al argued there was a need for understanding the distribution of human impacts so that they can be accurately evaluated for the "trade-offs (or compatibility) between human uses of the oceans and protection of ecosystems and the services they provide."[320] Such an overall assessment of consequences may help in the rationalisation of human services and the implications these have on the overall environmental impact.[321] In the same paper, Halpern et al developed what is considered the most standard approach to CEA. This is where different effects are given a weighting per 1 km^2 of ocean, with each

[317] Roudgarmi, "Cumulative Effects Assessment (CEA), A Review."
Vanessa Stelzenmüller et al., "A risk-based approach to cumulative effect assessments for marine management," *Science of The Total Environment* 612 (2018/01/15/ 2018), https://doi.org/https://doi.org/10.1016/j.scitotenv.2017.08.289, http://www.sciencedirect.com/science/article/pii/S0048969717323100.
[318] Elena Gissi et al., "A review of the combined effects of climate change and other local human stressors on the marine environment," *Science of the Total Environment* (2020), https://doi.org/https://doi.org/10.1016/j.scitotenv.2020.142564.
[319] A. D. Judd, T. Backhaus, and F. Goodsir, "An effective set of principles for practical implementation of marine cumulative effects assessment," *Environmental Science & Policy* 54 (2015/12/01/ 2015), https://doi.org/https://doi.org/10.1016/j.envsci.2015.07.008, http://www.sciencedirect.com/science/article/pii/S1462901115300344.
Roudgarmi, "Cumulative Effects Assessment (CEA), A Review."
[320] Benjamin S Halpern et al., "A global map of human impact on marine ecosystems," *science* 319, no. 5865 (2008).
[321] Halpern et al., "A global map of human impact on marine ecosystems."

section of the ocean being analysed for multiple effects. These mappings of the different effects and their impacts were then layered on top of each other to produce a heat map of where the effects are having the most impact.[322]

Halpern and Fujita further developed this idea in 2013 to give a simpler explanation for CEA's, proposing that "calculating and mapping cumulative impacts is deceptively simple, in that one merely needs to map the intensity of each stressor, map the location of each habitat type, and apply a vulnerability weight that translates the intensity of a stressor into its predicted impact on the habitat, creating a single 'currency' of stressor impact. One can then sum these expected impacts into a total cumulative impact score."[323] Essentially, a CEA is the summation of the total impacts of multiple activities that are causing pressure within a certain geographical area and the impacts they cause.[324]

One issue with using CEAs is how they deal with spatial constraints and at what level it is best to analyse certain impacts. Examining the picture too granularly may lead to the loss of the big picture. Whereas, solely looking at the big picture may lead to the overlooking of some smaller issues. Therivel and Ross discuss this issue of spatial scale and detail of a CEA and propose that the spatial level of a CEA ultimately needs to ensure that the CEA is properly inclusive of all impacts and that the inclusion of "small actions is essential for effective CEA".[325] This shows that it is important to map all the effects and impacts for the different societal sectors, and that is what this research does. This is because it allows both strategic level assessments and localised assessments to be adequately sighted on macro and micro issues, allowing actors working at different levels to use these accordingly to help develop the best outcomes when dealing with cumulative impacts.

Judd et al in 2015 undertook an assessment of the state of CEAs, their underlying principles and definitions and the level of consistency with which these are applied, with the finding that "the term 'cumulative effects assessment' is frequently used yet the underlying

[322] Halpern et al., "A global map of human impact on marine ecosystems."
[323] Benjamin S Halpern and Rod Fujita, "Assumptions, challenges, and future directions in cumulative impact analysis," *Ecosphere* 4, no. 10 (2013), https://doi.org/https://doi.org/10.1890/ES13-00181.1.
[324] Judd, Backhaus, and Goodsir, "An effective set of principles for practical implementation of marine cumulative effects assessment."
[325] Riki Therivel and Bill Ross, "Cumulative effects assessment: does scale matter?," *Environmental impact assessment review* 27, no. 5 (2007).

principles and definitions are poorly specified."[326] In their paper, they also illustrate that CEAs have two "main paths" which depend on whether the CEA is constructed from a legal or a scientific point of view.[327] The legal point of view tends to be concentrated around the "consideration of which human activities, plans or projects need to be included in the study and then to determine the associated environmental effects and sensitive ecosystem component."[328] However, the scientific point of view tends to reflect other aspects such as: "how environmental pressures interact to effect ecosystem components and then track these back to the causal human activities."[329]

Gissi et al, in 2020, stated that CEAs could be considered as "holistic evaluations of the combined effects of LS [Local stressors] and natural processes on the environment"[330] and that CEAs are an "increasingly applied framework that integrates information on multiple stressors and their interactions in order to estimate the cumulative expected impacts upon selected biotic components in marine and coastal regions worldwide."[331]

So while CEAs are useful for understanding multiple and cumulative impacts arising from singular activities as pointed out by Brennan and Germond in 2024 "using CEAs as a way of analysing social/societal impacts is rare" and "a challenging process because of the complex pathways activities take to impact on societies and individuals, and the difference in interpretation of how different impacts will affect different individuals".[332] However, one has to consider that:

> *CEAs as a process for the systematic analysis and evaluation of the impacts of environmental change provide a good assessment basis for the analysis of the impacts caused by climate change on society. This is because CEAs provide an*

[326] Judd, Backhaus, and Goodsir, "An effective set of principles for practical implementation of marine cumulative effects assessment."
[327] Judd, Backhaus, and Goodsir, "An effective set of principles for practical implementation of marine cumulative effects assessment."
[328] Judd, Backhaus, and Goodsir, "An effective set of principles for practical implementation of marine cumulative effects assessment."
[329] Judd, Backhaus, and Goodsir, "An effective set of principles for practical implementation of marine cumulative effects assessment."
[330] Gissi et al., "A review of the combined effects of climate change and other local human stressors on the marine environment."
[331] Gissi et al., "A review of the combined effects of climate change and other local human stressors on the marine environment."
[332] Brennan and Germond, "A methodology for analysing the impacts of climate change on maritime security."

operational framework for mapping activities and sources, and the pressures they create that produce cumulative effects on both natural systems and human systems before they impact on states, sectors of the society and individuals.[333]

3.1.2 What are Effect to Impact Pathway Chains?

The previous sub-section has shown that CEAs, while not usually used for analysing societal impacts, are a good methodological process to analyse activities with multiple interlinking impacts. Using a CEA to analyse societal impacts can be done by constructing an NGAM from an adapted EIP method, initially developed by Judd et al. in 2015 (see visualisation above in Figure 3.1). This is because the EIP chains can be used as a way of determining the cause, effect, and impact relationship, which supports the assessment of societal impacts of environmental changes rather than just the environmental effects of human activities.

Correspondingly, for this study, the different aspects of the EIP chain will be defined as below (and represented in Figure 3.2): [334]

- Activity: “Human activity”. In this study, this will be human-induced greenhouse gas emissions.
- Source: “as a ‘causal factor for pressure(s) and effects’.” In this study, this will be on climate change effects.
- Pressure: “event or agent exerted by the source eliciting an effect”. In this study, this will be the systematic changes to the climate system.
- Pathway: “How the receptor is exposed to the activity”. Changes to the physical environment that interact with the object/area being studied. In this study, this will be the interaction between the climate system and the natural environment.
- Receptor: “Entities sensitive to the hazards under investigation” An identifiable linkage between the pathway and the impact. In this study, this will be a part of the natural environment.

[333] Brennan and Germond, "A methodology for analysing the impacts of climate change on maritime security."
[334] Brennan and Germond, "A methodology for analysing the impacts of climate change on maritime security."

- Impact: “Measurable change attributable to the activity”. In this study, this is the occurrence of the underlying vulnerabilities that create a security issue in the maritime domain.

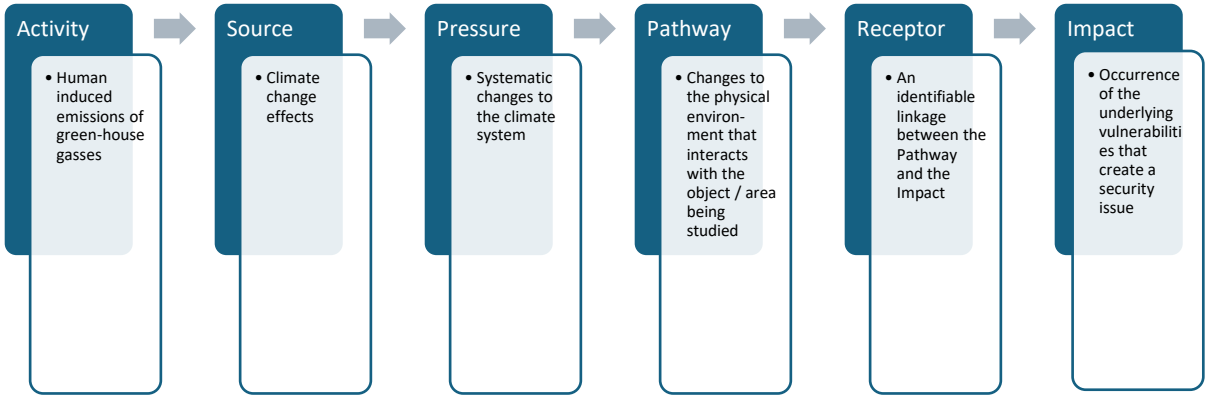

Figure 3.2: Visual representation of the variables used in this study

Source: Authors, based on Brennan and Germond 2024

3.1.3 How to Build an Assessment Map?

An NGAM is a visualisation of a database of EIP chains that are all constructed to identify the impact that a certain activity or activities are having on a particular sector of society. To build an NGAM using the EIP method, the following four steps need to be considered with a high degree of critical evaluation:

1. Firstly, the object or sector of society being impacted needs to be identified and consideration placed on the activities which are impacting on this object. (In this study, the sector is maritime security and the activity impacting it is human-induced greenhouse gas emissions).
2. Secondly, data sources need to be found. These sources need to provide validated evidence required to map out each stage of the EIP chain. This builds a reliable database that will underpin the visualisation of the NGAM (The data source for this study is the 2019 IPCC *Special Report on the Ocean and Cryosphere in a Changing Climate).*
    a. Once the data source has been chosen, the data needs to be extracted from the source. For this research, this involved reading through the entirety of

the SROCC to find where it described the relationship between sequential parts of the EIP chain. All the data that was extracted from the SROCC had to meet the requirements laid out in the following sub-section on '*The data sources to develop the EIP database'.*

b. All of these individual relationships were then put into a spreadsheet. So, where it said that a 'source' led to a 'pressure', or 'pressure' to 'pathway, or 'pathway' to 'receptor' or 'receptor' to 'impact' (with sources, pressures, pathways, receptors, and impacts being defined in figure 3.2), these were put into an Excel spreadsheet that became the EIP database.
c. Within this spreadsheet, different parts of the EIP chains were then connected with each other. This was where similar effects at the same point in the EIP chain were grouped, so you could see the points that came before and after a 'pressure' (for example), these were then pieced together by grouping these parts through the whole EIP chain i.e starting with the 'pressure' then 'pathway' all the way through to 'receptor'. This showed how the EIP chains would flow on, and this is how the EIP chains were filled out.
d. Any incomplete EIP chains were discarded before analysis.
e. Following this process and because of the definitions of the various points of the EIP chains, the same issues can be recorded at different points of the EIP chain.

3. Thirdly, each EIP chain needs to be tagged to a sub-sector of the referent object to allow for overall traceability within the model (in this study, the sub-sectors are the sub-sectors of maritime security, which are environment, human, economic, and national security).
4. Lastly, once these steps of critical evaluation of data and identification of key contributing factors are completed, the data within such field sets can be analysed with a degree of confidence of authenticity and impact (This analysis is done in the discussion sections of chapters 4, 5, 6, 7, and 8).

Identifying the referent object

As shown in Chapter 2, this study recognises the securitisation of climate change, the increased prominence of the maritime domain, and the increasing interlinkages between

the two, especially in the Indo-Pacific. Constructing an NGAM by using EIP chains, as outlined above, can support the identification and analysis of the impacts that the effects of climate change will have on the maritime domain, advancing the understanding of the climate change-maritime security nexus. It will also support efforts to increase maritime domain awareness and contribute to the literature of what are maritime security issues.

To build an NGAM, the area or object of analysis needs to be determined. The area or object does not need to be a physical environment, but it can be a socially defined system or object, upon which external factors impact. For this study, the object of analysis is maritime security as defined in Chapter 2 (sub-section 2.2.2).

In this study, an expanded concept of security is used, incorporating areas of so-called 'traditional' and 'non-traditional' security. In doing this, the author of this study notes that the boundaries of security are constructed by those with the means and political will to securitise an issue (as shown in the concept definitions sections in Chapter 2). By tagging each EIP to the four different dimensions of maritime security (Environmental, Human, Economic, and National), it allows for the identification of impacts on different referent objects and levels of security.[335] The example used in the proof of concept was:

> *The Economic Security sector allows for the identification of security issues that impact the economic stability of a state such as vulnerable shipping lanes leading to disruptions in the supply of goods or energy which can in turn impact the survival of a state or can compound security issues in a way that multiplies an existing threat in to becoming a question of existentialism for a state*.[336]

The data sources to develop the EIP database

To support the development of a method of analysis that overcomes some of the issues that arise when studying novel challenges, this study will use scientifically robust data. This data will be sourced from the United Nations' Intergovernmental Panel on Climate Change's (IPCC) 2019 *Special Report on the Ocean and Cryosphere in a Changing Climate* (SROCC). IPCC assessments are widely regarded as the gold standard for scientific understanding of

[335] Brennan and Germond, "A methodology for analysing the impacts of climate change on maritime security."
[336] Brennan and Germond, "A methodology for analysing the impacts of climate change on maritime security."

climate change.[337] The assurance provided by using IPCC data is that the IPCC does not conduct its own research. Instead, it has hundreds of dedicated global experts who identify and review data and agree on the strength of scientific argument in different areas, and where appropriate, indicate the need for further data collection and future research.

For this study, the SROCC will be used for data collection. Data will be collected from the SROCC where emission pathways are stated as 'RCP 2.6', or where no emission pathway is stated, as in this case, it is assumed that the effect will occur in all future scenarios with their stated confidence and likelihood. For data to be collected, it must also have a stated confidence level of 'very high', 'high', and 'medium' and a stated likelihood of 'virtually certain', 'very likely', and 'likely'. In instances where the SROCC stated that certain effects or impacts were already being observed, these were included. This is to strengthen the findings from this research, as they are likely enough to happen and strongly supported by science.

The full extent of the impacts of the effects of climate change will always be uncertain and related to the continued emission of greenhouse gases. However, there is a need to initiate the conversation about how these impacts will interact with maritime security, and having scientifically confident projections is crucial to that. As future projections and data become more certain, the EIP chain database and NGAM can be updated.

Tagging against maritime security sectors

This study will tag its individual EIP chains against the four dimensions of maritime security. As outlined in Chapter 2, these four dimensions are Environmental Security, Human Security, Economic Security, and National Security. Assumptions may need to be made that an EIP chain will actually impact the dimension of maritime security. In this case, the author of this study will make the assumption that the EIP has a direct link to that dimension (i.e. the tagging of EIP chains does not take into account second-order impacts). For example, where there is an EIP with an 'Impact' of 'Decreased coastal agriculture', this has a direct link to 'Human Security' (via food security issues) and 'Economic Security' (via reduced

[337] IPCC, *IPCC Special Report on the Ocean and Cryosphere in a Changing Climate [H.-O. Pörtner, D.C. Roberts, V. Masson-Delmotte, P. Zhai, M. Tignor, E. Poloczanska, K. Mintenbeck, A. Alegría, M. Nicolai, A. Okem, J. Petzold, B. Rama, N.M. Weyer (eds.)]* (Cambridge, UK and New York, NY, USA,: Cambridge University Press, 2019), https://www.ipcc.ch/srocc/.

farming income), but it only has an indirect link to the 'National Security' sector (as it would take a lot of coastal farming to be disrupted to pose a threat to a nation, or for coastal agriculture to be a major part of the nation's food supply to cause this to create a national food security issue). It will thus only be tagged against 'Human Security' and 'Economic Security', not 'National Security'.

The tagging of EIP chains is inherently qualitative, so to generate an NGAM a mix of qualitative and quantitative analysis of the data from the SROCC was needed. In future research, the EIP chains could be evaluated by a panel of experts to ensure a level of agreement around appropriate tagging. The interviews undertaken during this study, are also designed to test the qualitative analysis of the EIP chains and support the findings.

Additive and mitigative aspects

An important consideration to note when analysing the EIP chains is, as mentioned by Germond and Mazaris, "the dependencies between climate change and maritime security are not unidirectional".[338] By this, they mean that the pressures that climate change can cause can be "additive, multiplicative, synergistic and antagonistic".[339] This is the underlying principle of EIP chains, which means that feedback loops can be caused where parts of one chain exacerbate earlier parts in that chain or in other chains. It also means that different EIP chains can either multiply their impact or mitigate others' impact, which means there must be the possibility of positive and negative EIP chains.

Whether EIP chains are considered positive or negative depends on the lens through which the EIP chains are viewed and the actors enacting the particular issues. But in many instances, positive elements can be found as second-order impacts. This means that the EIP chains can have an inherently negative impact, with some unintended positive consequences.

One example of this is the lack of fishing due to there being fewer fish. This could potentially lead to less forced labour on board fishing vessels. As a result, this would be picked up by a negative EIP chain that signals the lack of fish, or reduced income from fishing, but the second-order impact would be less forced labour at sea, which could be viewed through

[338] Germond and Mazaris, "Climate change and maritime security."
[339] Germond and Mazaris, "Climate change and maritime security."

some lenses as a positive outcome from a situation. However, while the second-order impact could be positive, the third-order impact could again then be negative i.e. the people who are not in forced labour engage in illicit activities within their communities, such as smuggling or engage in irregular migration. This points to the EIP chains being the first step in generating a wider understanding of the impacts of the effects of climate change, but more dedicated and focused studies need to be done to focus on the full sequence of second, third, and probably even fourth-order impacts.

Feedback loops

As mentioned previously, EIP chains can be multiplicative, additive, and synergistic, with feedback loops playing an important part in understanding how different parts of EIP chains interact with each other, and thus their effects on various impacts throughout this study. The impacts of the effects of climate change on maritime security can also feed back into further environmentally degrading actions as impacted actors engage in criminal activities at sea, such as IUUF or piracy, or criminality and violence within coastal communities. [340] This can impact the functionality of a sustainable blue economy and marine biodiversity protection efforts.[341]

Germond and Mazaris, also note that feedback loops highlight key interactions between environmental and human systems and human and economic systems.[342] Feedback loops, as mentioned by Brennan and Germond in 2024, can occur naturally within marine systems and given that climate change is considered a threat multiplier, it is no surprise that these happen when looking into the impacts of the effects of climate change.[343]

For the purposes of time and complexity, the EIP database has not been critically analysed for a specific feedback loop. This could be viewed as a weakness of the methodology used. However, in each chapter analysing maritime security findings from the NGAM, examples of where feedback loops would be assumed to occur are identified to show the potential usefulness of these feedback loops in understanding the full impacts of the EIP chains. Further studies could explore incorporating these feedback loops in more detail. As this

[340] Germond and Mazaris, "Climate change and maritime security."
[341] Germond and Mazaris, "Climate change and maritime security."
[342] Germond and Mazaris, "Climate change and maritime security."
[343] Brennan and Germond, "A methodology for analysing the impacts of climate change on maritime security."

study is binary in nature (i.e. an impact either exists or it doesn't) this also reduces the utility of including feedback loops, as there is no imperial weighting on the severity of the impact and the findings will be considering interventions because an impact already exists.

Analysing the data

The data collected, processed and analysed to create the EIP database that comprises the NGAM, will be presented and discussed in chapters 4, 5, 6, 7, and 8. Chapter 4 presents a macro-level analysis of the entire NGAM, while chapters 5, 6, 7, and 8 will analyse individual dimensions of maritime security.

The data in the NGAMs is initially analysed by looking at the frequency with which effects happen within certain parts of EIP chains.

EIP chains are inherently binary and are used to see if an impact will happen or not. The frequency of occurrence does not necessarily indicate that these are the most severe impacts. However, due to the way the IPCC constructs its reports, the most frequently identified effects and impacts are likely to be the ones with the most robust science behind them and the most confidence in the impacts being felt. This will enable policymakers who are developing interventions with the confidence that they are intervening to resolve impacts that will likely come to fruition.

IPCC reports are compiled by reviewing current peer-reviewed literature and rather than conducting new primary research, therefore, IPCC reports are only able to include data with which there has been a body of literature previously developed around and published in a searchable context. Given that the report used to collate data for the construction of the NGAM in this research was published in 2019, this does, in a way, represent a point in time in relation to our scientific knowledge, understanding, and the confidence in that knowledge. Newer reports (published since 2019) could provide different EIP chains that are built on a better and more up-to-date understanding of data and the current state of the Earth's climatic systems, and this could be beneficial for future research given the momentum with which climatic changes are currently happening.

Because of the data source used, the analysis has a greater focus on the natural environment and, in a way, is a good indication of what effects in the natural environment will impact maritime security. The way in which IPCC reports are compiled, and the

restrictions on the data that could be used from the SROCC, also creates some obvious biases within the data and subsequent quantitative analysis. The interviews aimed to overcome these issues through interviews and using contextual understandings of the Indo-Pacific to situate the natural environment aspects within the discussion sections of each chapter.

The interviews also offered a useful analytical tool by comparing the reality seen by maritime security academics, experts, practitioners, and policy makers and the observed frequency of impacts within natural science research. This is especially relevant where the interviews raised impacts and issues as being more important than other concerns that were raised in the SROCC. This reinforced the need for more holistic approaches to security analysis and identified areas that could be investigated further.

In addressing some of the significant biases in the data collection and analysis models, in the future, EIP chains could be weighted with monetary or cultural values placed on the impacts of climate change. In doing this, it will be interesting to see how any linkages or synergies can be found from the continued understanding of calculating losses and damages from climate change. It is already noted that between 1993 and 2022, extreme weather events have caused USD 4.2 trillion in direct economic losses and caused the loss of 765,00 lives.[344] UNDRR argues that investing $1 in disaster reduction and prevention activities saves $15 in post-disaster recovery.[345]

EIPs could also be considered alongside a more detailed understanding of a specific country's vulnerability and exposure to climate risk. This will also support states and policymakers to understand what aspects of maritime security they should focus on. Using some of the understandings and findings of the UN's multidimensional vulnerability index could help tailor some of the findings and understanding of this analysis to different states.

[344] Lina Adil et al., *Climate Risk Index 2025: Who suffers most from extreme weather events?* (Germanwatch, 2025), https://www.germanwatch.org/en/cri.
[345] "Our work," accessed 15 February, 2025, https://www.undrr.org/our-work/our-impact.

3.2 Data for understanding the Indo-Pacific and maritime security context

In addition to the primary data found in the SROCC and to support the analysis of the EIP database within the Indo-Pacific geography, this study needs to analyse the current maritime security context of the Indo-Pacific. To understand the current maritime security environment of the Indo-Pacific, the present study will analyse data in three ways:

1. Academic sources – These will be found by conducting a reference search using Lancaster University's Library OneSearch and Google Scholar as primary data repositories. Keywords 'maritime security', 'Indo-Pacific', 'climate security' and 'climate change' have been used to generate a dataset of the most relevant academic publications.
2. Grey literature – this is literature produced outside of traditional academic publishing and includes reports published by think tanks, governments, United Nations agencies, and businesses. Grey literature will be found by using Google, as well as by following relevant agencies on LinkedIn. Keywords 'maritime security', 'Indo-Pacific', 'climate security' and 'climate change' have been used to locate the most relevant literature.
3. Interviews – these were an essential way of collecting data that supports and strengthens the findings of the NGAM. Interviews also created an informed understanding of how policymakers, decision-makers, practitioners, academics, and experts interpret both maritime security and climate change. It will then seek to analyse how maritime security and climate change interact with each other and how this is related to policy/decision-making.

3.2.1 Interviews

Interview participants involved in this research were selected as being representative of people in roles/positions of policy-making decisions related to maritime security (in the broadest sense of the term) and/or climate change. As such, requests for interviews were sent to a broad range of government agencies, armed forces, and think tanks, to generate a breadth of understanding and opinions on the issues. The number of participants interviewed was 11. This was determined by those who responded positively to enquiries to

be interviewed; there was a 28.2% response rate to the 39 requests for interview. Table 3.1 provides a breakdown by profession of those who positively responded to interviews.

Table 3.1 – Number of Interviewees by profession

Profession	Number
Academic	3
Expert / Consultant	4
Armed Forces (inc, ex)	3
United Nations Employees	1
Total	**11**

Interviews were undertaken with the aim of providing a cross-checking and triangulation function, which has supported the analysis of the NGAM findings from the IPCC report. These interviews were taken under a fluid, semi-structured, process intended to support free-flowing, conversational, interviews with the questions acting as conversational prompts for the discussion. These questions were also set up to help the researcher understand the level of understanding and conceptual viewpoints of each participant. These questions asked the interviewee to give an understanding or explanation of how they viewed maritime security, climate change, and the Indo-Pacific. The interviewees were then asked about how they saw the intersection of climate change and maritime (in)security currently playing out in their field of expertise, and then they were asked to pass any thoughts or comments that they had on the visualisations of the EIP databases (as seen in the Annex's). Lastly, the interviewees were then asked to give a future view of how they saw the issue of climate change and maritime security interacting. A full list of interview questions can be found in Annex One.

Ethics Approval

To undertake interviews, ethics approval was sought. The ethics application form was reviewed by the supervisory team and submitted to the university committee responsible for research ethics. Ethics approval was given on 06 July 2021 - reference FL20145 and amended on 04 April 2023 – REAMS ID 3426.

In the ethics approval, it was agreed that interviewees would be given anonymity to help protect against any risks arising from partaking in the interviews, including the inadvertent

release of classified or sensitive information. Anonymity was also guaranteed to interviewees in a desire to maximise participation in the sample.

3.3 Limitations and Constraints to this Research

Within the research undertaken, there are were a few constraints and limitations which could impact the evaluation of results obtained in the study. These, in many ways, leave open the opportunity for future research that continues building on this study. These limitations and constraints relate to the:

- Data source:
    - The SROCC has a focus on the natural environment and scientific research related to the ocean and cryosphere. This means that there is limited analysis within the SROCC on the societal impact of climate change, and where these impacts are discussed, the evaluation is conducted in limited terms. However, this effect has been countered by the use of interviews with practitioners, social science academics, and policymakers who explored the nuances of the societal impact of climate change using real-life experiences.
    - There could also be a limitation due to the fact that scientists have a slight 'sea-blindness' as they focus on more land-based sources of social impacts. This term 'sea-blindness' relates to limitations in holistic appreciation of the issues and could explain why the impacts identified within the SROCC are discussed in vague terms.[346] A more detailed analysis of this comes through in the interviews, where a maritime overview is obtained.
    - The process for data collection used limited assumptions to create this NGAM, unlike the proof of concept. This could have also contributed to exacerbating some of the biases towards impacts on the natural environment as part of the SROCC and the limited use of social and national security impacts.

[346] Celine Germond-Duret and Basil Germond, "Media coverage of the blue economy in British newspapers: Sea blindness and sustainable development," *The Geographical Journal* 189, no. 2 (2023/06/01 2023), https://doi.org/https://doi.org/10.1111/geoj.12433, https://doi.org/10.1111/geoj.12433.

- Continued emission of greenhouse gas emissions:
    - The impacts of the effects of climate change will ultimately be determined by the scale of greenhouse gas emissions. With greenhouse gas emissions continuing to rise this could cause impacts to be quicker and more severe than on the emission pathway chosen for analysis. This includes pushing the earth's natural environments beyond its thresholds and closer towards, much hypothesised, but yet unknown self-reinforcing tipping points within the earth's atmospheric systems. Such as low-latitude coral reefs die off, West Antarctic ice sheet loss, Atlantic Meridional Overturning Circulation cessation, and the Boreal permafrost collapse.[347]
- Binary analysis of the data:
    - The data from the SROCC used in this thesis is analysed primarily in a binary nature (i.e. is the EIP chain present or not). This was done for reasons of efficacy and efficiency in relation to the time available to undertake this study. This means that aspects relating to feedback loops and second and third-order impacts are not properly analysed within this thesis. However, examples are given to show that these might be incorporated within future analysis.
    - The binary analysis of the data also meant understanding issues relating to vulnerability and adaptation resilience. In future research, this could be incorporated through quantifying the impact of a specific EIP chain, and this could be done by including more quantitative data on maritime crime, the vulnerability of countries to climate change and maritime insecurity, and other societal factors as discussed under second-order impacts.
- Time scales:
    - The different actors often analyse this research using different time scales to undertake their evaluation. The SROCC has time-bound projections out to 2100, whereas several policy documents were time-bound out to 2030 (the Sustainable Development Goals) or 2050 (the 2050 strategy for the Blue

[347] "Tipping Elements – big risks in the Earth System," accessed 07 September, 2024, https://www.pik-potsdam.de/en/output/infodesk/tipping-elements/tipping-elements.

Pacific continent). When conducting the interviews, the author asked practitioners and policymakers to think 5 to 10 years out. This has supported a greater integrated analysis of the impacts and interventions, as impacts have a longer time scale and this is what the interventions aim to avoid, as these need to be put in place much sooner, so in a way this fits with the dichotomy of the need to take the action now (i.e. interventions formed through policy documents) vs the impacts that will take hold in the future (i.e. the changing on the natural environment as projected in scientific research).

- Number of interviews
    - This was determined by those who responded to the request for an interview. However, the research managed to get 11 responses, which sits within most recommendations for saturation in this type of research project and using interviews for triangulation purposes.[348] Future research could build around this by undertaking in-person interviews or focus groups within the region. Whilst a greater number of respondents would lead to statistical enhancement of the data, it may not add significant depth to the overall identification and critical evaluation of the issues.

[348] Monique Hennink and Bonnie N. Kaiser, "Sample sizes for saturation in qualitative research: A systematic review of empirical tests," *Social Science & Medicine* 292 (2022/01/01/ 2022), https://doi.org/https://doi.org/10.1016/j.socscimed.2021.114523, https://www.sciencedirect.com/science/article/pii/S0277953621008558.

Chapter 4: A Non-Geographic Assessment Map of Climate Change on Maritime Security

As outlined (in Chapter 3, and by Brennan and Germond in 2024) NGAMs that consist of a database of EIP chains, which supports the development of a more detailed understanding of the relationships between 'activities' and the 'impacts' these have on certain sectors of society or security. The visualisation of these EIP chains, as shown in the Annex's, are useful illustrative tools that support this detailed understanding of the interactions between 'activities' and 'impacts', as well as the interactions that happen between EIP chains. The development of NGAM will improve maritime domain awareness and policy responses to the impacts of climate change.

This chapter constructs and analyses an NGAM that shows the linkages between 'activities' causing climate change and the 'impacts' this has on maritime security, at a macro level. Through the construction of an NGAM, this chapter, will outline the importance of the environmental dimension of maritime security as it underpins all the other dimensions and highlights the importance of protecting ecosystems and halting biodiversity loss. The construction of the macro-level NGAM will show the importance of making interventions earlier in the EIP chain as this will support increased human wellbeing, that tourism is particularly vulnerable to the impacts of climate change, and that feedback loops are critical to fully understanding the impacts of climate change on maritime security.

As laid out in Chapter 3 this NGAM will be constructed using data from the SROCC, that have specific emission pathways and meet certain confidence and likelihood levels. To construct the NGAM, this data will be analysed through a framework adapted from EIP methodologies (shown previously in Figure 3.2.).

4.1 Descriptive overview

This chapter analyses the NGAM that was constructed using the data extrapolated from the SROCC, using the methodology outlined in Chapter 3. The database that was used to create this a macro-level NGAM can be found in Annex Two, which is the basis of the analysis in this research. The macro-level NGAM which looks at the linkages between climate change

and maritime security was developed from 554 individual EIP chains and the visualisation of this NGAM can be seen in Figure 4.1.

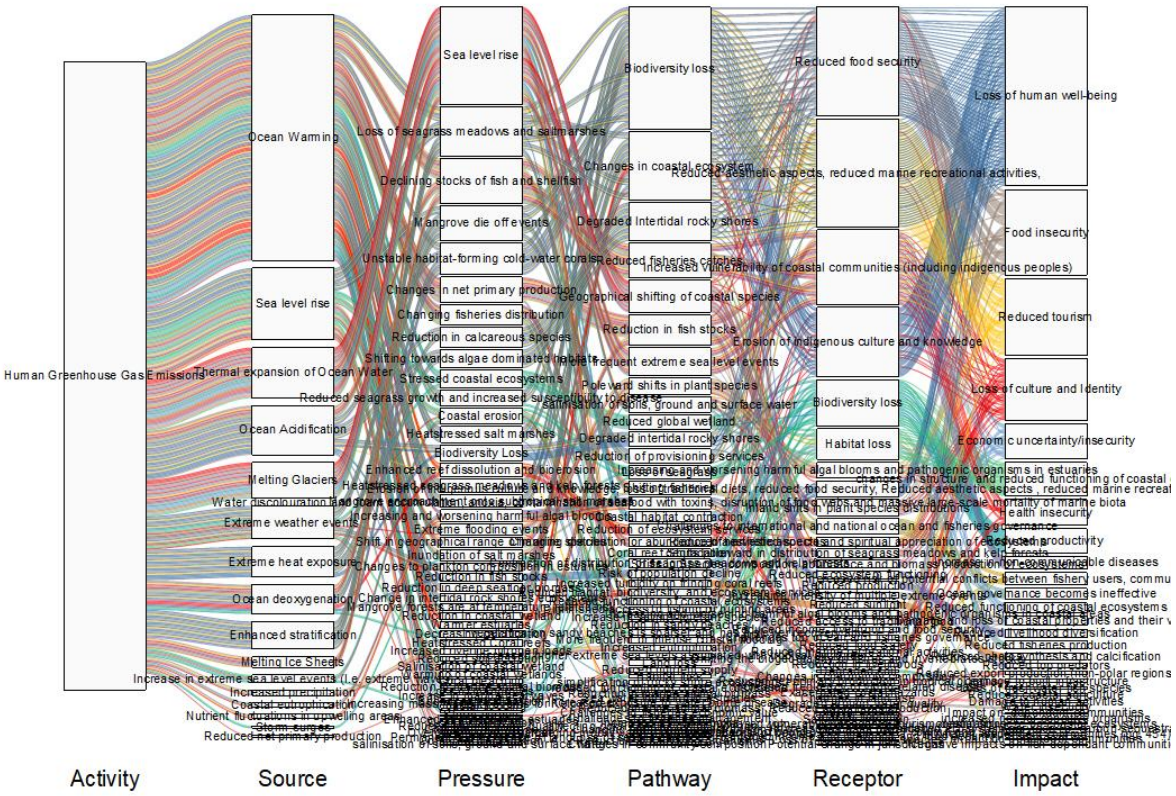

Figure 4.1 – A visualisation of all EIP chains within the NGAM[349]

Below are findings from analysing the different parts of the EIP chain 'sources', 'pathways', 'receptors' and 'impacts'. This highlights the interlinkages and connections between not only climate change and maritime security, but also between the EIP chains, showcasing the complex nature of the issue.

In analysing parts of the EIP chains, the number of occurrences and the frequency of the appearance of these effects within EIP chains included in the database is highlighted. This supports an understanding of both what the science is telling us are the best known and most concrete effects that might be felt, but also which effects to create interventions around, as the most frequently occurring will flow on to more impacts, especially earlier in the EIP chains. It is important to note that frequency and number of occurrences does not

[349] An enlargement of this figure can be found in Annex Two

necessarily translate to having the most impactful effect, as this will need to be considered alongside other issues such as the economic and non-economic of value of the losses and damages, lives lost, and the overall destabilising effect that these effects could have on security. It is also worth noting that understanding the full implications of these effects will need to be considered in relation to all other effects, as they are synergistic, multiplicative, and cumulative.

4.1.1 Source- a 'causal factor for pressure(s) and effects'

There are 16 different 'sources' that were identified as occurring through the construction of this NGAM and the EIP chains. The three most frequent 'sources' identified through the construction of the EIP chain database are 'Ocean Warming', 'Sea level rise', and 'Ocean Acidification' which account for 65.70 percent of the EIP chains identified. With 'Ocean warming' alone, being the source for 41.70 percent of the EIP chains.

Table 4.1 – NGAM 'source'

Sources	Number of occurrences	frequency of occurrence
Ocean Warming	231	41.70%
Sea level rise	68	12.27%
Ocean Acidification	65	11.73%
Thermal expansion of Ocean Water	38	6.86%
Ocean deoxygenation	29	5.23%
Melting Glaciers	27	4.87%
Extreme weather events	25	4.51%
Extreme heat exposure	23	4.15%
Enhanced stratification	21	3.79%
Melting Ice Sheets	8	1.44%
Increase in extreme sea level events (I.e. extreme waves)	6	1.08%
Increased precipitation	4	0.72%
Coastal eutrophication	3	0.54%
Nutrient fluctuations in upwelling areas	3	0.54%
Storm surges	2	0.36%
Reduced net primary production	1	0.18%
Grand Total	**554**	**100.00%**

4.1.2 Pressure – the event or agent exerted by the source eliciting an effect

There are 50 different 'pressures' that occur, of which the three most frequent 'pressures' are 'Sea level rise', 'Loss of seagrass meadows and saltmarshes' and 'Declining stocks of fish and shellfish' which occur in 73 EIP chains. The top eight 'pressures' account for 50.54 percent of influence in the EIP chains. With the most frequent pressure being 'sea level rise' as well as the second most occurring source this highlights the need to better understand and analyse feedback loops, as acting to stop or mitigate the impacts sea level rise will not only be valuable to reducing the impacts of the EIP chains where sea level rise is a pressure but also those where it is a source.

To understand how the key 'pressures' are manifested by the effects of climate change it would be good to understand the main sources impacting on them. For 'Sea level rise' this is manifested by sources of 'Thermal expansion of water', 'Melting glacier', and 'melting ice sheets', for the 'pressure' of 'loss of seagrass meadows and saltmarshes' this is manifested through sources 'enhance stratification', 'ocean warming', and ' sea level rise' and for the 'pressure' of 'declining stocks of fish and shellfish' it is manifested by 'Ocean warming', 'Ocean acidification', and 'Ocean deoxygenation'.

Table 4.2 - NGAM 'pressures'

Pressure	Number of occurrences	Frequency of occurrence
Sea level rise	73	13.18%
Loss of seagrass meadows and saltmarshes	44	7.94%
Declining stocks of fish and shellfish	34	6.14%
Mangrove die off events	33	5.96%
Reduction in fish stocks	27	4.87%
Changes in net primary production	26	4.69%
Unstable habitat-forming cold-water corals	24	4.33%
Biodiversity Loss	19	3.43%
Heat stressed salt marshes	19	3.43%
Changing fisheries distribution	15	2.71%
Reduction in calcareous species	15	2.71%
Shifting towards algae dominated habitats	14	2.53%
Change in intertidal rock shores ecosystems	13	2.35%
Stressed coastal ecosystems	13	2.35%
Coastal erosion	12	2.17%
Decreasing calcification	12	2.17%
Reduced seagrass growth and increased susceptibility to disease	12	2.17%

Coral bleaching	10	1.81%
Enhanced reef dissolution and bioerosion	10	1.81%
Heat stressed seagrass meadows and kelp forests	10	1.81%
Mangrove encroachment onto subtropical salt marshes	10	1.81%
Increasing and worsening harmful algal blooms	9	1.62%
Extreme flooding events	8	1.44%
Inundation of salt marshes	8	1.44%
Overgrowth of macroalgae	8	1.44%
Shift in geographical range of marine species	8	1.44%
Changes to plankton composition in estuaries	6	1.08%
Reduction in deep seafloor biomass	6	1.08%
Heat stressed Coral reefs	5	0.90%
Mangrove forests are at temperature related risk	5	0.90%
Reduction in coastal wetland	5	0.90%
Warmer estuaries	5	0.90%
Increased riverine nitrogen loads	4	0.72%
Reduced soil accretion	4	0.72%
Salinisation of coastal wetland	4	0.72%
Warming of coastal wetlands	4	0.72%
Coastal flooding	2	0.36%
Enhanced stratification	2	0.36%
Increase in marine heatwaves	2	0.36%
Increasing mass mortality events for Kelp Forest	2	0.36%
Loss of mangroves	2	0.36%
Reduction in marine animal biomass	2	0.36%
Changing sea-scape	1	0.18%
Coral reef degradation	1	0.18%
Enhanced stratification in estuaries	1	0.18%
Ocean stratification	1	0.18%
Permanent submergence of land	1	0.18%
Reduced ground water quality	1	0.18%
salinisation of soils, ground and surface water	1	0.18%
Storm surges	1	0.18%
Grand Total	**554**	**100.00%**

4.1.3 Pathway – exposing the receptor to the activity

There are 48 different ‘pathways’ that occur and the three most frequently occurring ‘pathways’ are ‘Biodiversity loss’, ‘Changes in coastal ecosystem’ and ‘Reduction in fish stocks’ which occur as the pathway for 31.32 percent of the individual EIP chains. The top seven pathways account for 52.36 percent of the EIP chains. With the top pathway being

'sea level rise' as well as the second most occurring pathway, acting to stop or mitigate the impacts sea level rise will be a valuable action in building future security.

In understanding the flow of EIP chains, understanding which 'pressures' contribute to the manifestation of the most frequently occurring pathways is important. For the 'pathway' of 'Biodiversity loss' it is primarily fed through the 'pressures' of 'Unstable habitat-forming cold-water corals', 'Loss of seagrass meadows and salt marshes', and 'Mangrove die off events'. The 'pathway' of 'Changes in coastal ecosystems' is fed through eight different 'pressures', but the 'pressure 'with the most EIP chains flowing onto this 'pathway' is the pressure of 'Loss of seagrass meadows and saltmarshes', and for the 'pathway 'of 'Reduction in fish stocks' is fed through the 'pressures' of 'Changes in net primary production' and 'Shift in geographical range of marine species'.

Table 4.3 – NGAM 'pathways'

Pathway	Number of occurrences	Frequency of occurrence
Biodiversity loss	92	16.61%
Changes in coastal ecosystem	51	9.21%
Reduction in fish stocks	30	5.42%
Degraded Intertidal rocky shores	29	5.23%
Risk of population decline	27	4.87%
Reduced fisheries catches	26	4.69%
Geographical shifting of coastal species	24	4.33%
simplification of rocky shore ecosystems	24	4.33%
More frequent extreme sea level events	21	3.79%
Reduced functioning of coastal ecosystems	21	3.79%
Reduction of provisioning services	18	3.25%
Poleward shifts in plant species	12	2.17%
salinisation of soils, ground and surface water	12	2.17%
Degraded intertidal rocky shores	11	1.99%
Reduced global wetland	11	1.99%
Loss of seagrass	10	1.81%
Shifting fisheries	10	1.81%
Water discolouration and foam accumulation, anoxia, contamination of seafood with toxins, disruption of food webs and massive large-scale mortality of marine biota	9	1.62%
Coastal habitat contraction	8	1.44%
Loss of sessile calcified organisms	8	1.44%
Reduction in calcifying organisms	8	1.44%
Reduction of ecosystem services	8	1.44%

Changing distribution or abundance of harvested species	7	1.26%
Contraction of distribution of seagrass meadows and kelp forests	6	1.08%
Coral reef degradation	6	1.08%
Increased turbidity on fringing coral reefs	5	0.90%
Reduced habitat, biodiversity, and ecosystem services	5	0.90%
Diminished access to fishing or hunting areas	4	0.72%
Increase in salinity-tolerant species	4	0.72%
Increased eutrophication	4	0.72%
Increased higher extreme sea levels associated with tropical cyclones	4	0.72%
Land loss	4	0.72%
More frequent or intense coastal flooding	4	0.72%
Reduction in sandy beaches	4	0.72%
vegetation on sandy beaches is sparser and has a slower recovery time	4	0.72%
Habitat loss	3	0.54%
Reduced nutrient supply	3	0.54%
Challenges to fisheries economic value	2	0.36%
Challenges to fisheries management	2	0.36%
Increased exposure to water borne disease	2	0.36%
Reduced marine animal biomass	2	0.36%
Reduction in marine animal biomass	2	0.36%
Sea water intrusion in estuaries	2	0.36%
affecting coral species distribution (pg. 497)	1	0.18%
Changes in community composition	1	0.18%
Changing coral species distribution	1	0.18%
Changing mobility and residence patterns (of people)	1	0.18%
Increased risk of hypoxia	1	0.18%
Grand Total	**554**	**100.00%**

4.1.4 Receptor – the entities sensitive to the hazards under investigation

In the NGAM, there are 42 different receptors. The three most frequently occurring 'receptors' are 'Reduced aesthetic aspects, reduced marine recreational activities', 'Reduced food security', and 'Erosion of indigenous culture and knowledge' which are present in 51.81 percent of the EIP chains within the NGAM.

To understand how the 'receptors' play their role within the EIP chains it is important to place them in the context of how they are manifested by the 'pathways'. For the three most

frequently occurring 'receptors' within the NGAM, the 'pathways' are for the 'receptor' of 'Reduced aesthetic aspects, reduced marine recreational activities' is fed by the 'pathways' of 'Biodiversity loss' and 'Changes in coastal ecosystem'. For the 'receptor' of 'Reduced food security' it is primarily fed through the 'pathways' of 'Biodiversity loss', 'Changes in coastal ecosystem', and 'Degraded Intertidal rocky shores' and for the 'receptor' of 'Erosion of indigenous culture and knowledge' it is fed through 'Biodiversity loss', 'Changes in coastal ecosystem', and 'Degraded Intertidal rocky shores'. It is interesting to note that the 'pathway' of 'Biodiversity loss' flows onto all three of the most frequently occurring 'receptors'.

Table 4.4 – NGAM 'receptors'

Receptor	Number of occurrences	Frequency of occurrence
Reduced aesthetic aspects, reduced marine recreational activities	117	21.12%
Reduced food security	106	19.13%
Erosion of indigenous culture and knowledge	64	11.55%
Increased vulnerability of coastal communities (including indigenous peoples)	56	10.11%
Biodiversity loss	35	6.32%
Reduced access to traditional food	28	5.05%
Habitat loss	23	4.15%
Challenges to international and national ocean and fisheries governance	16	2.89%
Increasing and worsening harmful algal blooms and pathogenic organisms in estuaries	12	2.17%
Inland shits in plant species distributions	12	2.17%
Reduced aesthetic aspects and spiritual appreciation of ecosystems	7	1.26%
Reduced ecosystem functioning	6	1.08%
Reduced production	6	1.08%
Shifts in Species composition, abundance and biomass production of ecosystems	6	1.08%
Shifts poleward in distribution of seagrass meadows and kelp forests	6	1.08%
Increasing intensity of multiple extreme events	5	0.90%
Reduced sunlight	5	0.90%
Increasing and worsening harmful algal blooms and pathogenic organisms in coastal areas	4	0.72%

Reduced income, livelihood and food security	4	0.72%
Reduced food Safety	3	0.54%
Reduced marine recreational activities	3	0.54%
Reduction in livelihoods	3	0.54%
Shifting the biogeography of fishes and invertebrates stocks	3	0.54%
Changes in community composition	2	0.36%
Changes in land use	2	0.36%
Degraded ground water quality	2	0.36%
Degraded soil	2	0.36%
Exacerbated costal hazards	2	0.36%
Increased frequency of vibrio-related disease	2	0.36%
Reduced net primary production in tropical oceans	2	0.36%
Coastal erosion	1	0.18%
Coastal flooding	1	0.18%
Increased coastal acidification	1	0.18%
Increased vulnerability of coastal tourism destinations	1	0.18%
Loss of freshwater fish species	1	0.18%
Potential change in jurisdictions	1	0.18%
Reduced functioning of the deep water column and seafloor	1	0.18%
Reduced income and livelihood and food security	1	0.18%
Reduced net primary production	1	0.18%
Salt water intrusion	1	0.18%
Grand total	**554**	**100.00%**

4.1.5 Impact – a measurable change attributable to the activity

In this NGAM there are 30 different 'impacts'. The four most frequent 'impacts' that occur within the EIP chains are 'Loss of human well-being, 'Food insecurity', 'Loss of culture and Identity' and 'Reduced tourism' and these account for 69.49 percent of the EIP chains that occur.

As the final part of an EIP chain, understanding how the 'impacts' are manifested by the preceding receptors supports the understanding and analysis of the entirety of the EIP chains. For the 'impact' of 'Loss of human well-being' this is primarily manifested through the 'receptors' of 'Erosion of indigenous culture and knowledge', 'Reduced aesthetic aspects, reduced marine recreational activities' and 'Reduced food security'. For the

'impact' of 'Food insecurity' this is manifested by the 'receptors' of 'Reduced food security', and 'Increased vulnerability of coastal communities (including indigenous peoples)'. Finally, for the 'impact' of 'Loss of culture and identity' this is manifested by the 'receptors' of 'Reduced aesthetic aspects, reduced marine recreational activities', 'Reduced access to traditional food', and 'Erosion of indigenous culture and knowledge'.

Table 4.5 – NGAM 'impacts'

Impact	Number of occurrences	Frequency of occurrence
Loss of human well-being	171	30.87%
Food insecurity	76	13.72%
Loss of culture and Identity	69	12.45%
Reduced tourism	69	12.45%
Economic uncertainty/insecurity	26	4.69%
Changes in structure and reduced functioning of coastal ecosystems	25	4.51%
Health insecurity	19	3.43%
Reduced productivity	18	3.25%
Increase in non-communicable diseases	9	1.62%
Increased risk of potential conflicts between fishery users, communities and authorities	9	1.62%
Ocean governance becomes ineffective	8	1.44%
Damage and loss of coastal properties and their value	7	1.26%
Reduced functioning of coastal ecosystems	7	1.26%
Reduced fisheries production	6	1.08%
Reduced livelihood diversification	6	1.08%
Reduced photosynthesis and calcification	5	0.90%
Damage to built infrastructure	3	0.54%
Impact on dependent communities	3	0.54%
Reduced export production (non-polar regions)	3	0.54%
Reduced top predators	3	0.54%
Damage to human activities	2	0.36%
Loss of freshwater fish species	2	0.36%
Reduced coastal agriculture	2	0.36%
Water insecurity	2	0.36%
coastal squeeze on coastal ecosystems	1	0.18%
increased risk for sensitive organisms	1	0.18%
Negative impacts on fish-dependant communities	1	0.18%
reduced ecosystem services i.e. carbon sequestration	1	0.18%
Grand Total	**554**	**100.00%**

4.2 Feedback Loops

Identifying feedback loops that occur within, and between, EIP chains is an important piece of analysis that gives a greater understanding of the synergistic, additive and multiplicative traits of the effects of climate change and their impacts. Understanding how feedback loops work is crucial to identifying the best responses to climate change, as they support the development of a more holistic picture of how climate change interacts with natural and social systems.[350] Identifying feedback loops also supports the understanding of how impacts are manifested and fully analysing the flow of the EIP chains that are present within the NGAM.

In this study feedback loops are identified through understanding that there are similar effects present at different stages of EIP chains and how this impact might multiply the impact of these chains, such as:

- Receptor of 'Biodiversity loss' feeds back into the pathway 'Biodiversity loss' and into the source 'Biodiversity loss'
- Pressure 'Sea level rise' feeds back into the source 'Sea level rise'
- Pathway 'Reduction in fish stocks' feeds back into the pressure 'Reduction in fish stocks'
- Impact 'Reduced fisheries production' feeds back into the pathway 'Reduced fisheries catches'
- Pathway 'Loss of seagrass' feeds back into the pressure 'Loss of seagrass meadows'
- Pathway 'Coral reef degradation' feeds back into the pressure 'Coral reef degradation'
- Impact 'Reduced productivity' feeds back into the pressure 'Changes in net primary production'
- A visual representation of these feedback loops can be seen in Figure 4.2.

[350] Mazaris and Germond, "Bridging the gap between climate change and maritime security: Towards a comprehensive framework for planning."

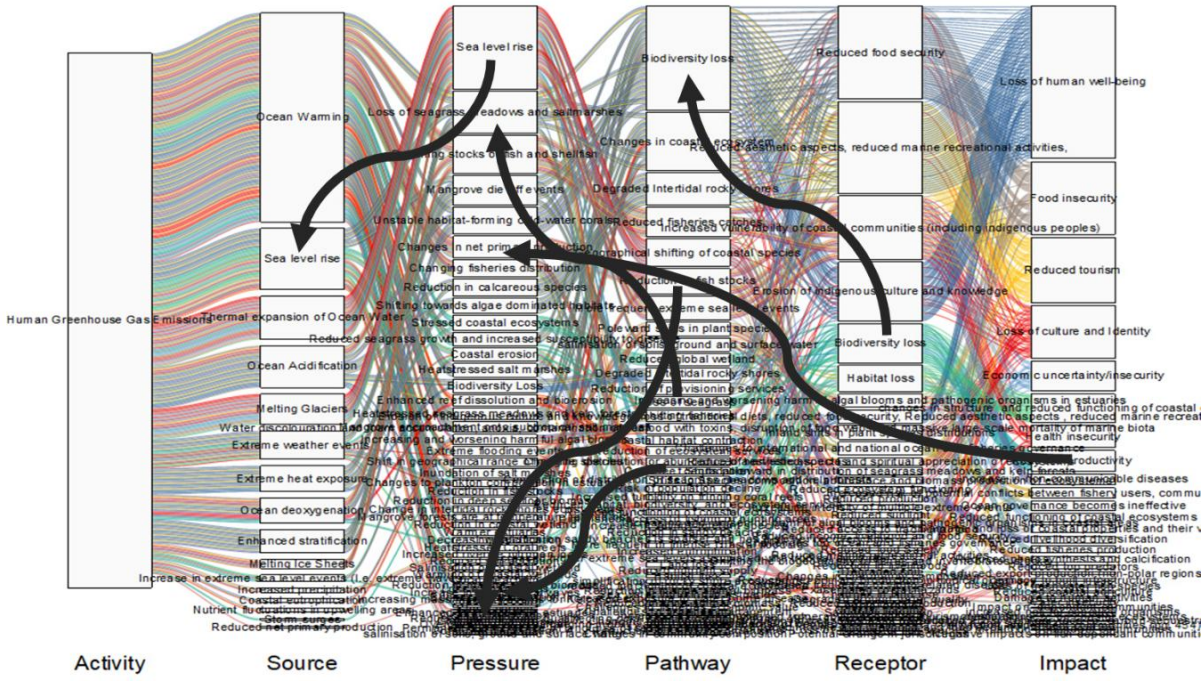

Figure 4.2 - A visual representation of feedback loops within the NGAM[351]

This is not an exhaustive list of all the feedback loops (for reasons mentioned in Chapter 3). The feedback loops listed above are identified as where EIP chains have elements that are similar somewhere within the chain. For example and to better illustrate the impact of feedback loops figure 4.3 has focused on EIP chains with 'biodiversity loss either as a receptor, pathway, or pressure. 'Biodiversity loss' as a receptor feeds back into the pathway 'Biodiversity loss' and into the pressure 'Biodiversity loss' this then multiplies the assumed impact of the EIP chains where 'Biodiversity loss' is either the pathway or the source. For the pressure, 'Biodiversity loss' this multiplication looks to almost double the impact of the EIP chains stemming from this pressure. This is because everything that accumulates through the EIP chain where 'Biodiversity loss' is a receptor, is assumed to accumulate to generate more effect on the EIP chains where 'Biodiversity loss' is a pathway or source. This example shows just how multiplicative the effects of climate change can be on maritime

[351] An enlargement of this figure can be found in Annex Three

security and the need to build in interventions that support actions at various points within EIP chains.

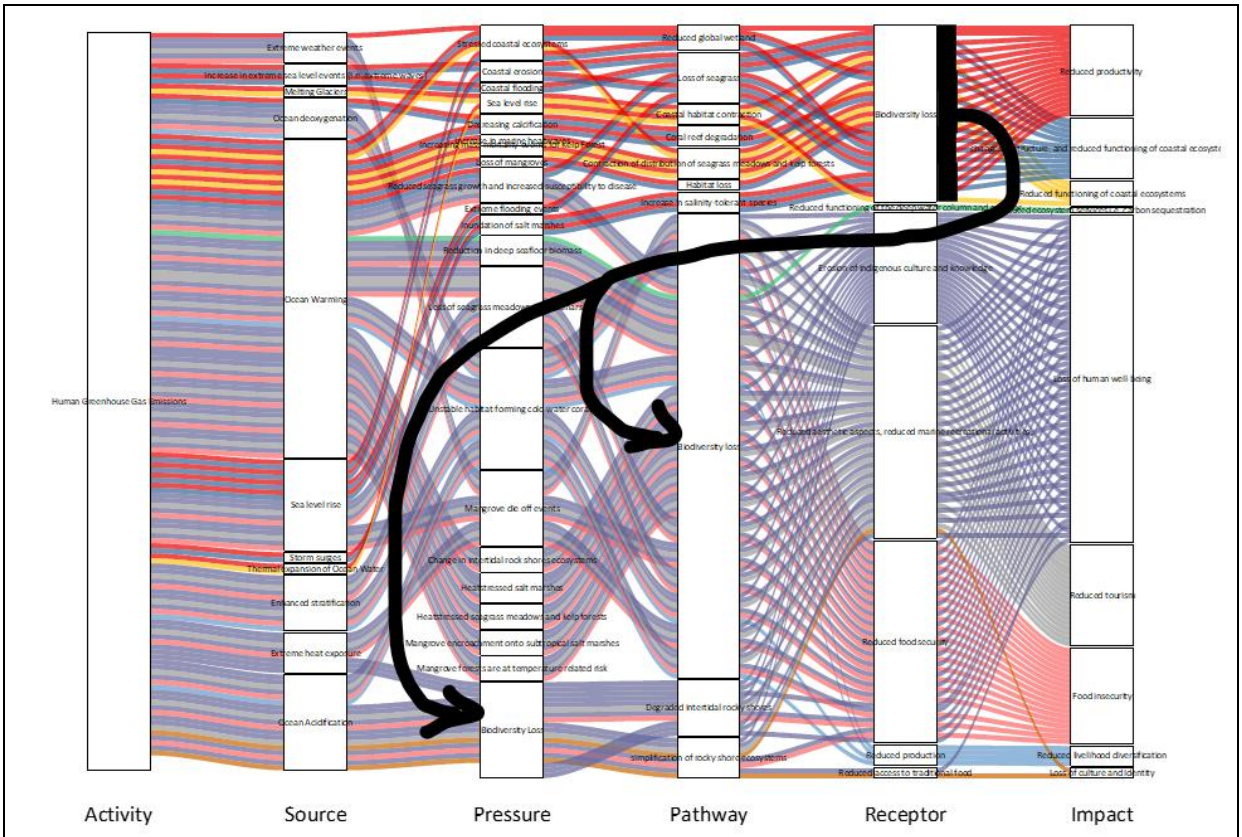

Figure 4.3 – A visual representation of the 'Biodiversity loss' feedback loop[352]

These feedback loops will exacerbate the rest of the EIP chains that flow on from where they are fed back into the chain. So, in analysing future research the impacts that have a feedback loop feed into them will have a higher concern attached to them. Pinpointing where feedback loops are present is also a good way of understanding where to place effort for interventions as intervening at these points will have greater value. Feedback loops also highlight the complex and interactive nature of the effects of climate change and thus the complexity of responses needed to address its impacts.

4.3 Conclusion

This chapter has shown the practicality and utility of the NGAM methodology developed for this research and outlined in Chapter 2 and in Brennan and Germond 2024. Through

[352] An enlargement of this figure can be found in Annex Four

developing a NGAM and analysing the data within the NGAM the findings have highlighted the interconnected nature of the effects of climate change and their impacts on maritime security, as illustrated in Figure 4.1, and the underpinning of maritime security by a safe, stable and secure natural environment. The NGAM also shows the large variety of effects and impacts that climate change has on maritime security, as it identifies 554 individual EIP chains which contribute to 30 different impacts.

This chapter's findings support the identification and analysis of interventions to improve maritime security, especially by ensuring environmental aspects are considered in interventions. While mitigation of future greenhouse gas emissions is crucial to minimising the future impacts of climate change other interventions could focus on limiting the temperature rise of the ocean, limiting the levels at which the sea levels will rise (both of which are the most frequent sources within the NGAM), and adapting to the impacts by protecting coastal ecosystems and biodiversity, including by supporting mangrove, seagrass, and salt marsh restoration and protection.

The NGAM, through the EIP chains contained within it, has shown that intervening earlier in the EIP chain will support increased human wellbeing. This is because human wellbeing is inextricably linked to the natural environment that humans find themselves in, especially in coastal areas (this is also the underlying argument for the representation of maritime security as a pyramid, see the maritime security section).[353] The EIP chains have also shown that the climate change effects that impact human wellbeing and also impact food security, especially in coastal areas where the reliance on food grown through substance agriculture is higher. This is because coastal communities will be more severely impacted by the negative impacts of sea level rise and near-shore fishing.[354]

[353] Maree Fudge, Emily Ogier, and Karen A. Alexander, "Marine and coastal places: Wellbeing in a blue economy," *Environmental Science & Policy* 144 (2023/06/01/ 2023), https://doi.org/https://doi.org/10.1016/j.envsci.2023.03.002, https://www.sciencedirect.com/science/article/pii/S1462901123000667.
[354] Jirawat Panpeng and Mokbul Morshed Ahmad, "Vulnerability of fishing communities from sea-level change: a study of laemsing district in chanthaburi province, Thailand," *Sustainability* 9, no. 8 (2017). Valentina Savo, Cedar Morton, and Dana Lepofsky, "Impacts of climate change for coastal fishers and implications for fisheries," *Fish and Fisheries* 18, no. 5 (2017).

Through the NGAM tourism is also shown as being vulnerable to the impacts of the effects of climate change.[355] This is especially true for SIDS, where ecological tourism is economically important, and their natural ecosystems are increasingly impacted by biodiversity loss.[356] All these examples demonstrate the underlying point that the environmental dimension of maritime security underpins the other aspects of maritime security. This is why environmental security is the base for the definition of maritime security used in this thesis (as argued in Chapter 2).

This chapter has also shown the critical importance of feedback loops and ensuring that these are adequately considered in the analysis of the effects of climate change. As marine environments are complex ecosystems with many varied interactions within them the feedback loops support a further and more detailed understanding of the magnitude of the climate changes impacts on these systems. To ensure the interventions are sustainable and effective it is also crucial to understand how the feedback loops may multiply or exacerbate the impacts of the effects of climate change.

An interesting finding is that the most frequently occurring effect from the prior step in the EIP chain does not always support the manifestation of the most frequently occurring effect in the next step of the EIP chain. For example, the pressure of 'sea level rise' was not a primary influencing factor in the most frequently occurring pathways. However, when looking at the effects that cause the manifestation of the effects, the next step was that 'biodiversity loss' supported the manifestation of the most frequently occurring pathways and receptors.

This chapter has shown how to create a macro-level NGAM that can be used to analyse the effects of the impacts of climate change. In the next four chapters, this macro-level NGAM will be analysed through the lens of the four different dimensions of maritime security, as

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[355] Jonathon Day, "Tourism, hospitality, and environmental sustainability on the Small Island Developing States," *Current Opinion in Environmental Sustainability* 59 (2022/12/01/ 2022), https://doi.org/https://doi.org/10.1016/j.cosust.2022.101233, https://www.sciencedirect.com/science/article/pii/S1877343522000859.

[356] Franziska Wolf et al., "Small island developing states, tourism and climate change," *Journal of Sustainable Tourism* 32, no. 9 (2024/09/01 2024), https://doi.org/10.1080/09669582.2022.2112203, https://doi.org/10.1080/09669582.2022.2112203; Wolf et al., "Small island developing states, tourism and climate change."; Jonathon Day, "Tourism, hospitality, and environmental sustainability on the Small Island Developing States," *Current Opinion in Environmental Sustainability* 59 (2022/12/01/ 2022), https://doi.org/https://doi.org/10.1016/j.cosust.2022.101233, https://www.sciencedirect.com/science/article/pii/S1877343522000859.

set out in Chapter 2. This will support a deeper understanding of how climate change is impacting the maritime security of the Indo-Pacific, which is the current centre of global geopolitical tensions, especially in the maritime domain.

Chapter 5: Environmental Security

Marine and coastal ecosystems are complex systems with many and varied interactions and a healthy maritime environment is crucial to sustaining life on Earth.[357] Across the Indo-Pacific, environmental security is a crucial part of securing the maritime environment, underpinning and supporting livelihoods and economies.[358] It is acknowledged, but not well understood, that environmental issues can impact and affect international relations and cooperation, including geostrategic goals and ambitions.[359] One example of this was that the United Nations Convention on the Law of the Sea (UNCLOS) established extensive and specific state obligations for the protection and preservation of the marine environment.[360]

In this chapter, the challenges impacting environmental security in the maritime and coastal domains will be highlighted through understanding and investigating the links between the effects of climate change and the natural environment. These links will show how these effects impact the Indo-Pacific's maritime security and explore how interventions can support the mitigation and adaptation of these effects. Understanding these links and potential interventions is crucial, because a healthy environment is the foundation of building a peaceful and secure Indo-Pacific with billions of people across the region relying on the maritime environment for food, health, livelihoods, and recreation.[361].

There are many challenges facing environmental security in the Indo-Pacific, some of which stem from the wide range of environments that contain a rich biodiversity of maritime species.[362] As will be shown in increasing detail throughout the next four chapters, the natural environment of the Indo-Pacific contributes to the human, economic, and national

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[357] Ewan Trégarot et al., "Effects of climate change on marine coastal ecosystems – A review to guide research and management," *Biological Conservation* 289 (2024/01/01/ 2024), https://doi.org/https://doi.org/10.1016/j.biocon.2023.110394, https://www.sciencedirect.com/science/article/pii/S0006320723004950.
[358] Sarah Lothian et al., *Issue 10: Capacity-building under the BBNJ Agreement: Benefits, Opportunities and Implementation Challenges for Southeast Asia* (2025), https://www.latrobe.edu.au/__data/assets/pdf_file/0005/1652531/bs10.pdf.
[359] Sohini Bose, Sayanangshu Modak, and Anasua Basu Ray Chaudhury, *Threats to the Environment in the Indo-Pacific: Strategic Implications* Observer Research Foundation (2022), https://www.orfonline.org/research/threats-to-the-environment-in-the-indo-pacific.
[360] "Girt by Sea, and by the Law of the Sea: Why UNCLOS Matters to Australia," Fulcrum, 2022, accessed 29 May, 2024, https://fulcrum.sg/girt-by-sea-and-by-the-law-of-the-sea-why-unclos-matters-to-australia/.
[361] Asian Development Bank, *Healthy Oceans Implementation Plan 2022-2024* (2022).
[362] Elizabeth Christina Miller et al., "Explaining the ocean's richest biodiversity hotspot and global patterns of fish diversity," *Proceedings of the Royal Society B* 285, no. 1888 (2018).

dimensions of maritime security, because the coastal and ocean ecosystem's ability to provide services that support these dimensions will be impacted by climate change.[363]

This chapter will start by outlining the current context of the natural marine and coastal environments of the Indo-Pacific to outline the current state of environmental security within the region. It will then go on to describe the findings that were developed through the NGAM process as outlined in Chapter 4. This will further support the argument and grow the evidence base, that the links between the natural environment and maritime security are many, varied, complex, and interconnected. Finally, it will analyse and discuss these findings in the context of the interviews and the Indo-Pacific environment to identify vulnerabilities, and places for intervention and contribute to the discourse of environmental security playing a crucial role as the base for a holistic approach to maritime security.

The analysis in this chapter supports the argument that environmental security underpins the other dimensions of maritime security, especially human and economic security, thus highlighting the importance of the integrity of the marine environment. This chapter then states that supporting the habitats of fisheries will be important for all aspects of security in the maritime domain and maritime protected areas are a good way of doing this. It is also states that a changing coastal and marine environments, especially how these create a coastal squeeze for people and resources, is of particular importance when looking to build stability and security.

5.1 The Natural Maritime Environment in the Indo-Pacific

The ocean is the medium for which many of the activities that contribute to maritime insecurity take place and is a critical supporting factor to a range of other activities that provide maritime security. So, understanding how climate change impacts the health of the ocean and the marine environment is crucially important. This sub-section goes on to talk about some of the key issues to the environmental security dimension of maritime security within the Indo-Pacific.

[363] IUCN, *Issues Brief: The ocean and climate change* (2017), https://www.iucn.org/resources/issues-brief/ocean-and-climate-change.

The Indo-Pacific as defined in Chapter 2 is a vast maritime region made up of two oceans, that hold within them a large array of marine and coastal ecosystems with it being home to most of the world's mangrove forests and coral reefs, the Mariana Trench, and the largest archipelagic states in the world. The areas in this region incorporate many incredible ecosystems that are rich with unique biodiversity. The World Economic Forum in 2021 calculated that in Southeast Asia just over 40 percent of species could be extinct by 2100, which could put at risk 60 percent of the Asia-Pacific's GDP.[364] This shows the importance of maintaining a healthy natural environment.

5.1.1 Marine Pollution

Globally and within the Indo-Pacific, plastic pollution is an ever-increasing problem, accounting for up to 80% of marine litter, as it is harming the region's marine environment, habitat, and biodiversity.[365] Plastic pollution also impacts on food security, the health and wellbeing of coastal communities, and damages the value chain linked to maritime activities.[366] Plastic pollution comes from leakage in solid waste management systems and the endemic use of plastic wrapping, packaging, and products which find their way into the ocean.[367] Globally, waste management is highly susceptible to illicit and illegal activities, which are in many cases transnational.[368] Maritime plastic pollution does not just originate within the Indo-Pacific but may move from different global marine zones as 'floating islands' made up of plastic have been seen to make their way to the region from other parts of the globe.[369]

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[364] "How to address Asia Pacific's biodiversity crisis and encourage nature-positive growth," World Economic Forum, 2021, accessed 18 March, 2024, https://www.weforum.org/agenda/2021/09/how-to-address-asia-pacific-s-biodiversity-crisis-and-encourage-nature-positive-growth/.

[365] Peter A. Todd, Xueyuan Ong, and Loke Ming Chou, "Impacts of pollution on marine life in Southeast Asia," *Biodiversity and Conservation* 19, no. 4 (2010/04/01 2010), https://doi.org/10.1007/s10531-010-9778-0, https://doi.org/10.1007/s10531-010-9778-0.

"Project set to help Indo-Pacific region fight plastic pollution," United Nations Conference on Trade and Development, 2023, accessed 27 September, 2023, https://unctad.org/news/project-set-help-indo-pacific-region-fight-plastic-pollution.

[366] E Tan et al., "A review of plastic and microplastic pollution towards the Malaysian marine environment" (paper presented at the IOP Conference Series: Earth and Environmental Science, 2022).

[367] Asian Development Bank, *Healthy Oceans Implementation Plan 2022-2024*.

[368] Geneva Centre for Security Sector Governance, *Stocktaking of security sector roles in climate and environmental security: Report on the Philippines* (2023).

[369] "Project set to help Indo-Pacific region fight plastic pollution."

Discarded fishing gear is also a major contributor to plastic pollution in the ocean.[370] But fishing in general can cause marine habitat destruction through indiscriminate and unstainable fishing methods.[371] This increases the mortality of non-targeted species, impacts biodiversity, and changes the structure and makeup of entire ecosystems.[372]

The Indo-Pacific also has a history of oil spills that show the danger and damage that can be caused by these events, with oil spills impacting the environmental and food security provided by marine environments.[373] In July 2020, the MV Wakashio ran aground on a reef off the coast of Mauritius. During this incident around 1,000 tonnes of bunker fuel leaked into the ocean, damaging an ecologically sensitive site and causing a catastrophe that impacted the environment, economy, food, and health security of Mauritius.[374] In 2022, 50,000 litres of oil leaked from an undersea pipeline off the coast of Thailand impacting an area of 47sq km before drifting onto the Rayong shoreline. The 2022 leak was the second such leak to occur in that same region of Thailand as another pipeline had also leaked in 2013 which also caused environmental and economic damage to the region.[375]

5.1.2 Ecosystem Changes

A healthy ecosystem increases the resilience of coastal communities to the adverse impacts of climate change and natural disasters, and in some instances, it can also act as a buffer to economic disruptions.[376] Mangroves, coral, and seagrasses provide a buffer to the impacts of extreme weather, carbon sinks, and provide opportunities to gain economic revenue through tourism.[377]

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[370] "Ghost fishing gear," 2020, accessed 20 August, 2024, https://www.worldwildlife.org/stories/ghost-fishing-gear#:~:text=Fishing%20gear%20accounts%20for%20roughly,a%20name%3A%20ghost%20fishing%20gear.

[371] WICHIN SUEBPALA et al., "Ecological Impacts of Fishing Gears in Thailand: Knowledge and Gaps," *Asian Fisheries Science* 30, no. 4 (2017).

[372] SUEBPALA et al., "Ecological Impacts of Fishing Gears in Thailand: Knowledge and Gaps."

[373] Ana Paula Zapelini de Melo et al., "Disasters with oil spills in the oceans: Impacts on food safety and analytical control methods," *Food Research International* 157 (2022).

[374] David Brewster et al., "The Australia-France-India Strategic Partnership," (2023).

[375] "Oil spill reaches shoreline in eastern Thailand," accessed 11 MArch, 2024, https://www.reuters.com/world/asia-pacific/oil-workers-race-protect-beaches-spill-off-thai-coast-2022-01-28/.

[376] Asian Development Bank, *Healthy Oceans Implementation Plan 2022-2024*.
H Portner et al., "IPBES-IPCC CO-Sponsored Workshop Biodiversity and climate change" (paper presented at the IPBES-IPCC co-sponsored workshop on biodiversity and climate change, 2021).

[377] Asian Development Bank, *Healthy Oceans Implementation Plan 2022-2024*.

With coral bleaching events occurring with increasing frequency and intensity, continuing on humankind's current emission trajectory could mean that 90 percent of coral reefs die.[378] As the Indo-Pacific is home to "76% of reef-building coral species" and "37% of coral reef fish species",[379] it is imperative that coral reefs are protected.

As mentioned above, the Indo-Pacific region includes the majority of the earth's mangrove forests.[380] One study found that in some cases, the sediment accumulation in mangrove forests will keep pace with the rate of sea level rise, but in the majority of places this won't be the case, and by the end of the century the most at-risk mangrove forests could already be submerged.[381]

Seagrasses are particularly useful to SIDS, especially those in the Pacific. As mentioned above, they provide a range of benefits such as effective carbon storage, food and water security, and coastal protection.[382] Within the Indo-Pacific seagrasses seem to be relatively healthy but globally they are declining and are increasingly threatened by several challenges including climate change and changing land uses.[383]

5.1.3 Environmental Degradation

Within the Indo-Pacific is the South China Sea, which is currently one of the flash points of current ongoing strategic competition in the region. In the South China Sea, China has undertaken environmentally harmful activities such as reclaiming land on top of fragile coral

[378] Asian Development Bank, *Healthy Oceans Implementation Plan 2022-2024*.
[379] Idham Khalil et al., "Modelling and forecasting the effects of increasing sea surface temperature on coral bleaching in the Indo-Pacific region," *International Journal of Remote Sensing* 44, no. 1 (2023/01/02 2023), https://doi.org/10.1080/01431161.2022.2161850, https://doi.org/10.1080/01431161.2022.2161850.
[380] Catherine E. Lovelock et al., "The vulnerability of Indo-Pacific mangrove forests to sea-level rise," *Nature* 526, no. 7574 (2015/10/01 2015), https://doi.org/10.1038/nature15538, https://doi.org/10.1038/nature15538.
[381] Lovelock et al., "The vulnerability of Indo-Pacific mangrove forests to sea-level rise."
[382] Gilianne Brodie et al., "Seagrasses and seagrass habitats in Pacific small island developing states: Potential loss of benefits via human disturbance and climate change," *Marine Pollution Bulletin* 160 (2020/11/01/ 2020), https://doi.org/https://doi.org/10.1016/j.marpolbul.2020.111573, https://www.sciencedirect.com/science/article/pii/S0025326X20306913.
[383] Brodie et al., "Seagrasses and seagrass habitats in Pacific small island developing states: Potential loss of benefits via human disturbance and climate change."

reefs to build military outposts. Reclaiming this land included dredging up at least 100 square miles of coral reefs.[384]

Environmentally damaging dredging is not only driven by China's geostrategic ambitions but also by the current increase in global urbanisation, which is increasing the demand for sand. This is used in massive quantities as sand is the key component in making asphalt and concrete.[385] Sand dredging churns up sediment, which creates clouds in the water that kill fish and block sunlight so that underwater vegetation cannot grow.[386] It also destroys the existing habitat at the bottom of the ocean and the sediment clouds can drift far from the original site of extraction which increases the impact the activity has on the marine environment.[387]

Environmental damage in the Indo-Pacific can also come from activities such as bottom trawling and IUU fishing. IUU fishing threatens the marine environment and biodiversity, due to reducing fish stocks and destroying habitats including corals.[388] IUU fishing also often includes using illegal forms of fishing gear or the discarding of this gear, especially if they get caught in bottom structures. Additionally, IUU fishing also undermines national and regional efforts to ensure fisheries are sustainably managed, by ignoring catch quotas or fishing in protected areas. Other ways of IUU fishing include using explosives or poisons to fish, which can directly degrade the marine environment.[389]

Deep sea mining while not currently being a major activity in the Indo-Pacific, is starting to garner more and more attention. The International Seabed Authority's (ISA) two-year deadline to finalise the rules for environmental regulation around deep-sea mining expired

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[384] "Oceans under pressure: China's challenge to the maritime order," Britain's World, Council on Geostrategy, 2024, accessed 17 March, 2024, https://www.geostrategy.org.uk/britains-world/oceans-under-pressure-chinas-challenge-to-the-maritime-order/.
[385] "Sand mining is close to being an environmental crisis. Here's why – and what can be done about it," 2023, accessed 20 August, 2024, https://www.weforum.org/agenda/2023/09/global-sand-mining-demand-impacting-environment/.
[386] "Sand mining: the global environmental crisis you've probably never heard of," The Guardian, 2017, accessed 27 September, 2023, https://www.theguardian.com/cities/2017/feb/27/sand-mining-global-environmental-crisis-never-heard.
[387] Beiser, "Sand mining: the global environmental crisis you've probably never heard of."
[388] "Illegal, Unreported, and Unregulated (IUU) Fishing," accessed 18 March, 2024, https://imo.org/en/OurWork/IIIS/Pages/IUU-FISHING.aspx.
[389] "Southeast Asia's Fisheries Near Collapse from Overfishing," The Asia Foundation, 2018, accessed 18 March, 2024, https://asiafoundation.org/2018/03/28/southeast-asias-fisheries-near-collapse-overfishing/.

in July 2023, after Nauru triggered the need for this by signalling its intent to begin the commercial exploitation of the seabed, back in 2021.[390] This now means that the ISA must "consider" and "provisionally approve" exploration applications, regardless of what rules end up being put in place.[391] This would allow for the extraction of deep-sea resources, on the high seas. Many of these resources have the potential to be useful in the green transition as well as becoming a useful economic driver for many developing states.[392] However, extraction without care or appropriate guidelines could significantly degrade the maritime environment.

It is understood that climate change will also exacerbate the degradation of the marine environment and the security-related impacts that are associated with issues such as coral reef degradation, reduction in fisheries, and coastal erosion.

5.1.4 Other Impacts on the Maritime Domain

In their 2021 Environmental Risk Outlook, Verisk Maplecroft stated that "99 of the world's 100 riskiest cities are in Asia, including 37 in China and 43 in India."[393] The Indo-Pacific has several other natural environmental features within it that can cause damage or harm. There is the 'Ring of Fire' which is "a path along the Pacific Ocean characterized by active volcanoes and frequent earthquakes".[394] Within the Indo-Pacific there is also the risk of earthquakes that cause Tsunamis as seen on Boxing Day in 2004. More recently, there was the Tonga eruption which demonstrates how the marine environment can impact maritime security from Humanitarian Assistance and Disaster Response aspects.

The marine environment of the Indo-Pacific contains a number of geographic features that act as 'choke-points' for sea lanes that ships must transit, such as the Singapore and

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[390] "The looming threat of deep-sea mining," BBC Future, BBC, 2023, accessed 29 September, 2023, https://www.bbc.com/future/article/20230310-what-does-the-high-seas-treaty-mean-for-deep-sea-mining.
[391] Pradeep A. Singh, "The Invocation of the 'Two-Year Rule' at the International Seabed Authority: Legal Consequences and Implications," *The International Journal of Marine and Coastal Law* 37, no. 3 (18 Jul. 2022 2022), https://doi.org/https://doi.org/10.1163/15718085-bja10098, https://brill.com/view/journals/estu/37/3/article-p375_1.xml.
[392] "What We Know About Deep-sea Mining — and What We Don't," World Resources Institute, 2024, accessed 20 August, 2024, https://www.wri.org/insights/deep-sea-mining-explained.
[393] "Asian cities in eye of environmental storm – global ranking: Environmental Risk Outlook 2021," Verisk Maplecroft, 2021, accessed 18 March, 2024, https://www.maplecroft.com/insights/analysis/asian-cities-in-eye-of-environmental-storm-global-ranking/.
[394] "Ring of Fire," National Geographic, accessed 13 September, 2023, https://education.nationalgeographic.org/resource/ring-fire/.

Malacca straights.[395] The semi-enclosed geography of the South-China Sea also adds another dimension to the marine environment which acts as a natural barrier to expansion outside the sea and reduced access to the larger expanse of the Pacific Ocean.[396] The semi-enclosed nature of the South-China Sea also provides an environment for competition as boundaries within the sea are contested by many different states.[397]

5.2 Findings

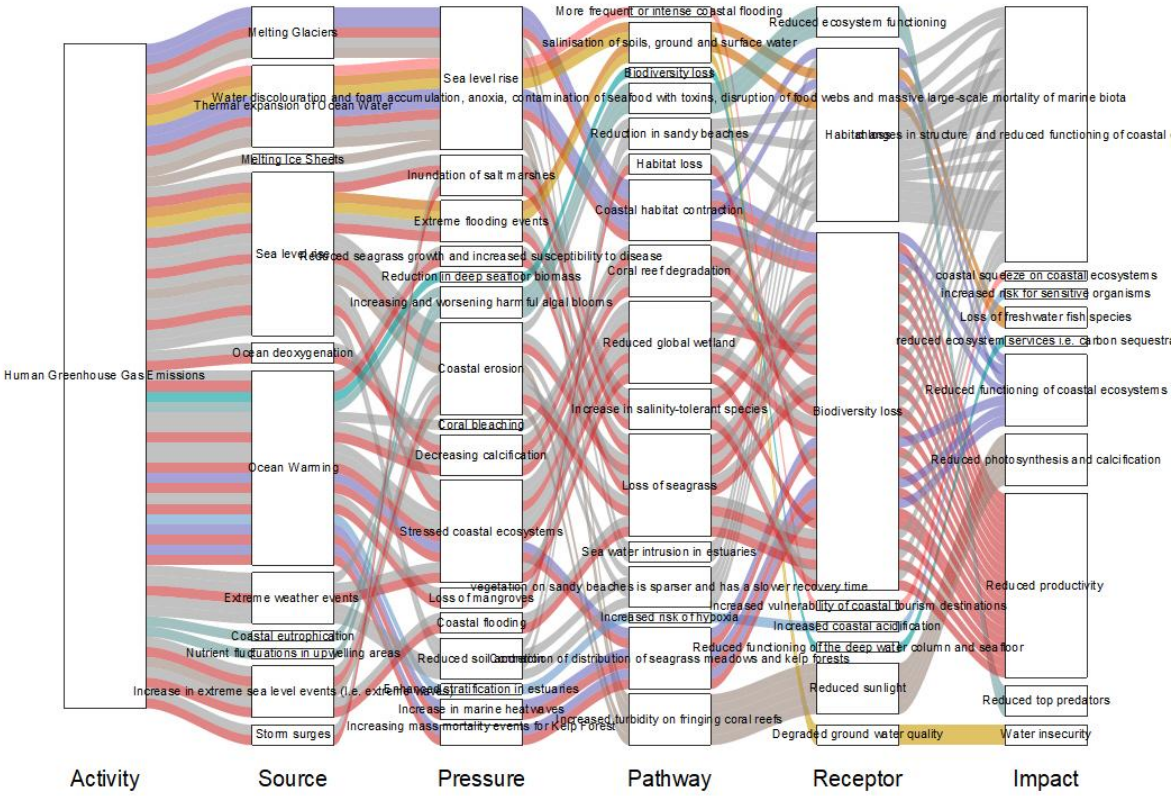

Figure 5.1 – A visual representation of the NGAM for environmental security[398]

Table 5.1 shows the 'pathways' contained within the EIP chains that are tagged as impacting environmental security. 'Loss of seagrass', 'Reduced global wetland', 'Coastal habitat

[395] David Letts, "Maritime security in South East Asia," in *Law of the Sea in South East Asia* (Routledge, 2019).
[396] Letts, "Maritime security in South East Asia."
[397] Letts, "Maritime security in South East Asia."
[398] An enlargement of this figure can be found in Annex Five

contraction', and 'Contraction of distribution of seagrass meadows and kelp forests' occur in 46 percent of all EIP chains contributing to environmental security. All of these pathways are good intervention areas for the two most frequent receptors and the most frequent impact. These pathways also provide good interventions for economic impacts and human security impacts such as tourism and food security.

As mentioned in Chapter 4 following the flow through of the EIP chains of the effects of climate change, understanding how they eventually manifest as impacts is a crucial aspect of analysis. For environmental security's two most frequently occurring 'pathways' the preceding 'pressures' are: for the 'pathways' that occur as 'Loss of seagrass', the 'pressures' are 'Coastal erosion', 'Coastal flooding', 'Extreme flooding events', and 'Reduced seagrass growth and increased susceptibility to disease'; and the 'pathways' that occur as 'Reduced global wetland' these are preceded by the 'pressure' of 'Stressed coastal ecosystems'.

Table 5.1 – Environmental security 'pathways'

Pathway	Number of occurrences	Frequency of occurrence
Loss of seagrass	10	15.38%
Reduced global wetland	8	12.31%
Coastal habitat contraction	6	9.23%
Contraction of distribution of seagrass meadows and kelp forests	6	9.23%
Coral reef degradation	5	7.69%
Increased turbidity on fringing coral reefs	5	7.69%
Increase in salinity-tolerant species	4	6.15%
salinisation of soils, ground and surface water	4	6.15%
vegetation on sandy beaches is sparser and has a slower recovery time	4	6.15%
Reduction in sandy beaches	3	4.62%
Water discolouration and foam accumulation, anoxia, contamination of seafood with toxins, disruption of food webs and massive large-scale mortality of marine biota	3	4.62%
Habitat loss	2	3.08%
Sea water intrusion in estuaries	2	3.08%
Biodiversity loss	1	1.54%
Increased risk of hypoxia	1	1.54%
More frequent or intense coastal flooding	1	1.54%
Grand Total	**65**	**100.00%**

The ‘receptors’ that occur in EIP chains tagged against environmental security are shown in Table 5.2. ‘Biodiversity loss’ and ‘habitat loss’ are the two most frequently occurring ‘receptors’ as these occur in over 75 percent of the EIP chains. They are two very interrelated issues that also interrelate with ‘Increased vulnerability of coastal tourism destinations’ which will impact on economic security.

For the ‘receptor’ of ‘Biodiversity loss’ it is preceded by the ‘pathways’ of ‘Coastal habitat contraction’, ‘Contraction of distribution of seagrass meadows and kelp forests’, ‘Coral reef degradation’, ‘Habitat loss’, ‘Increase in salinity-tolerant species’, ‘Loss of seagrass’, and ‘Reduced global wetland’. For the ‘receptor’ of ‘Habitat loss’ this is preceded by the ‘pathways’ of ‘Coastal habitat contraction’, ‘Coral reef degradation’, ‘Reduced global wetland’, ‘Reduction in sandy beaches’, ‘salinisation of soils, ground and surface water’, ‘Sea water intrusion in estuaries’, and ‘vegetation on sandy beaches is sparser and has a slower recovery time’

Table 5.2 – Environmental security ‘receptors’

Receptor	Number of occurrences	Frequency of occurrence
Biodiversity loss	35	53.85%
Habitat loss	17	26.15%
Reduced sunlight	5	7.69%
Reduced ecosystem functioning	3	4.62%
Degraded ground water quality	2	3.08%
Increased coastal acidification	1	1.54%
Increased vulnerability of coastal tourism destinations	1	1.54%
Reduced functioning of the deep water column and seafloor	1	1.54%
Grand Total	**65**	**100.00%**

Table 5.3 shows the ‘impacts’ that occur in the EIP chains tagged against environmental security with ‘changes in structure and reduced functioning of coastal ecosystems’, ‘Reduced productivity’ and ‘Reduced functioning of coastal ecosystems’ occurring as the ‘impact’ for more than 75 percent the EIP chains. While only representing 3 percent of the chains, the impact of ‘Water insecurity’ is already an issue in many places. In combination with ‘coastal squeeze’ this will exacerbate water insecurity issues impacting on Human security and potentially exacerbate national security issues.

The ‘impact’ of ‘changes in structure and reduced functioning of coastal ecosystems’ is preceded by the ‘receptors’ of ‘Biodiversity loss’, and ‘Habitat loss’ and the ‘impact’ of ‘Reduced productivity’ is preceded by the ‘receptor’ of ‘Biodiversity loss’.

Table 5.3 – Environmental security ‘impacts’

Impact	Number of occurrences	Frequency of occurrence
changes in structure and reduced functioning of coastal ecosystems	25	38.46%
Reduced productivity	18	27.69%
Reduced functioning of coastal ecosystems	7	10.77%
Reduced photosynthesis and calcification	5	7.69%
Reduced top predators	3	4.62%
Loss of freshwater fish species	2	3.08%
Water insecurity	2	3.08%
coastal squeeze on coastal ecosystems	1	1.54%
increased risk for sensitive organisms	1	1.54%
reduced ecosystem services i.e. carbon sequestration	1	1.54%
Grand Total	**65**	**100.00%**

5.3 Feedback Loops

To understand how the EIP chains tagged as impacting environmental security fully interact with each other and in synergistic, multiplicative, and additive ways, examples of where feedback loops could be assumed as existing have been identified. For environmental security these feedback loops are:

- The receptor 'Habitat loss' to the pathway 'Habitat loss'
- The receptor 'Biodiversity loss' to the pathway 'Biodiversity loss'
- The impact 'Reduced functioning of coastal ecosystems' to the receptor 'Reduced ecosystem functioning'

These feedback loops are similar to those identified in Chapter 4 for the macro NGAM. Given the environmental nature of these feedback loops this also supports the argument of environmental security being the basis of holistic maritime security as discussed in Chapter 2.

A visual representation of these feedback loops can be seen in Figure 5.2.

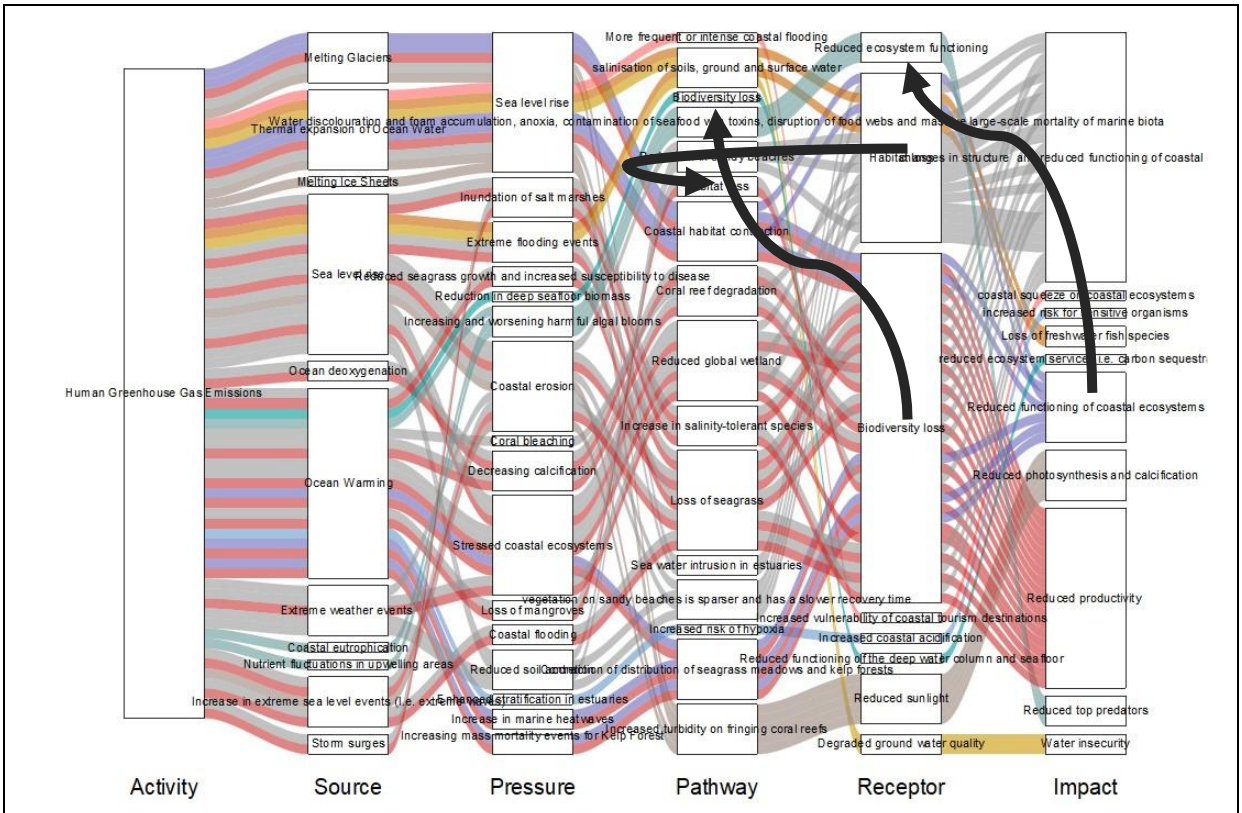

Figure 5.2 - A visual representation of environmental security feedback loops[399]

Focusing on the feedback loop of the 'receptor' 'biodiversity loss' to 'pathway' 'biodiversity loss' as visualised below in figure 5.3, this shows how much of a multiplicative effect feedback loops can have on EIP chains and the impacts of them. Figure 5.3 shows specifically the vast increase in EIPs that would flow through the receptor if taken into account.

[399] An enlargement of this figure can be found in Annex Six

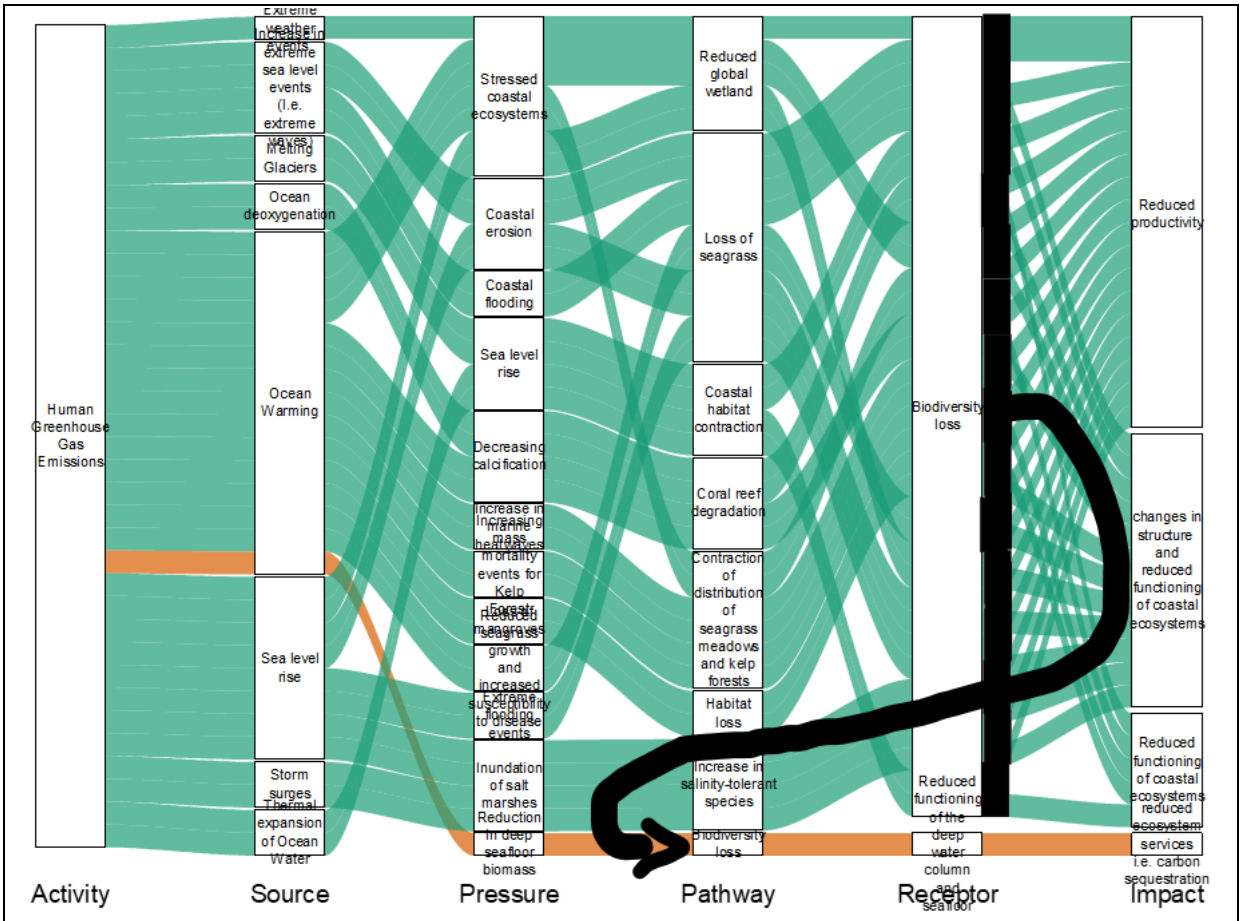

Figure 5.3 - A visual representation of the biodiversity loss feedback loop as it relates to environmental security dimension of maritime security[400]

5.3 Discussion

As shown throughout various parts of this thesis so far and the previous section showing the findings of the NGAM specific to the environmental security dimension of maritime security, building marine and coastal environmental resilience will support the security of the Indo-Pacific in many ways as "Coastal and marine ecosystems are vital for the economic, environmental, and sociocultural well-being of Indo-Pacific countries".[401] This is backed up by the findings outlined in this chapter, as they show through the feedback loops that have been identified and through the identification of biodiversity and habitat loss being preceding influences on multiple parts of the EIP chains. This highlights the link between

[400] An enlargement of this figure can be found in Annex Seven
[401] Shushant VC Parashar, "Blue Economy in the Indo-Pacific: The Need to Create a Cooperative Framework," *Journal of Indo-Pacific Affairs* 7, no. 2 (2024).

climate change's impacts and the degradation of environmental security in the maritime domain. This supports the argument that the environmental integrity of the maritime domain, underpins the security of most of the other elements of maritime security (as outlined in Chapter 2 and shown through Chapters 4, 6,7, and 8), meaning that undertaking interventions to support a healthy maritime environment is of paramount importance.

As discussed previously in this chapter, the Indo-Pacific's marine environment is already in a precarious state. The impacts caused by the effects of climate change and highlighted in the findings section above, that are degrading the natural environment in the maritime domain are multifaceted and interact with all other aspects of maritime security.[402] Whether this is due to more frequent and severe extreme weather events requiring increased HADR responses (as to be discussed further in the national security Chapter), the loss of functioning ecosystems leading to the collapse of fisheries (as to be discussed further in the human, economic, and national security chapters), the intrusion of saltwater causing the salination of coastal communities growing land and freshwater leading to resource competition and loss of self-sustaining practices, or sea level rise threatening the habitability and existence of entire nations (as to be discussed further in the national security chapter). This shows that the integrity of the marine environment is important as it is the base that provides for greater living standards, economic growth, and a stable geostrategic environment. With these issues being the genesis for manifestations and fuel for crime within the maritime and coastal domains.[403]

There are also many ways in which the impacts of environmental degradation can push people and communities to engage in illegal activities which causes instability (these will be discussed in more detail in Chapter 6: Human Security and Chapter 7: Economic Security) and can also create a feedback loop that amplifies environmental degradation.[404] This is because "criminal activities at sea can in turn put further pressures on marine ecosystems

[402] McCabe, "Environmental drivers of maritime insecurity: governance, enforcement and resilience in the western Indian Ocean."
[403] McCabe, "Environmental drivers of maritime insecurity: governance, enforcement and resilience in the western Indian Ocean."
[404] Zubeda Anjum Niazi, "Future of Maritime Secuirty: Navigating Complex Waters in the Indo-Pacific," *Journal of Indo-Pacific Affairs* 7, no. 2 (2024).

stability and functionality" and have a cumulative or multiplicative impact on maritime security.[405]

Interventions that prevent and adapt to the most frequent impact 'changes in structure and reduced functioning of coastal ecosystems' , especially in coastal communities or for coastal fisheries will make a significant difference in terms of security as well as sustainability.[406] There is currently much work underway analysing the impact of climate change on tuna fisheries, which is important as it is an industry worth at least $40 billion a year globally.[407] However, it is coastal fisheries that play a more direct and important role in supporting coastal communities. Fisheries not only support the food security of coastal communities and small island states, but they underpin support towards positive and sustainable livelihoods through also generating an income which reduces poverty.[408] This is especially true in the western Indian Ocean as coastal states in this area of the Indo-Pacific are predominately focused around small-scale and artisanal fishing enterprises, that are especially vulnerable to environmental degradation and impacts of climate change.[409] However, over the last few years, a decrease in fish stocks has been reported due to unsustainable fishing practices. According to one estimate of the 441 fish stocks about which information is available, "47% of the stocks were fully exploited, 18% were overexploited, 9% were depleted and 1% was recovering."[410] No matter which types of fish stocks you aim to support and/or protect, restoring their habitats such as seagrasses, kelp forests, mangroves, and coral reefs will be extremely important and will provide an important intervention that acts to support not only aspects of EIP chains the refer to 'Biodiversity loss' but also aspects of EIP chains that touch on the issue of fish stocks and fisheries governance (this issue is predominantly discussed in Chapter 8).

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[405] Germond and Mazaris, "Climate change and maritime security."
[406] Trégarot et al., "Effects of climate change on marine coastal ecosystems – A review to guide research and management."
[407] "Global Tuna Fisheries—Worth $40 Billion a Year—Still Face Threats," The Pew Charitable Trusts, 2022, accessed 20 August, 2024, https://www.pewtrusts.org/en/research-and-analysis/articles/2023/04/28/global-tuna-fisheries-worth-40-billion-a-year-still-face-threats.
[408] "Saving coastal fisheries in the Pacific: food, livelihoods and community security," Pacific Security College, 2021, accessed 20 August, 2024, https://pacificsecurity.net/saving-coastal-fisheries-in-the-pacific-food-livelihoods-and-community-security/.
[409] McCabe, "Environmental drivers of maritime insecurity: governance, enforcement and resilience in the western Indian Ocean."
[410] Jayati Srivastava, "Dynamics of environmental security in the Indo-Pacific," *Handbook of Indo-Pacific Studies* (2023).

Environmental security interventions that support efforts toward sustainable fish stocks and conservation, will reduce the most frequent impact found through the NGAM 'changes in structure and reduced functioning of coastal ecosystems'. These interventions should also minimise issues in the Indo-Pacific relating to fisheries governance that are caused by resource scarcity.[411] Other environmental security interventions such as acting to support seagrasses, kelps, mangroves, and coral reefs will act as habitat restoration, carbon sequestration, and supporting research for understanding their benefits to aquaculture benefits as a way of supporting food security can provide a healthy, prosperous, and secure maritime environment which will support ecological repair and socio-economic prospects of coastal communities.[412]

Supporting the restoration of habitats such as mangrove forests, kelp forests and seagrasses also supports the sequestration of carbon dioxide.[413] With seagrasses being some of the "most efficient sinks of carbon on Earth."[414] Sequestering carbon helps with the reduction of GHG concentrations in the atmosphere which supports the minimisation of impacts stemming from sources such as 'Ocean Warming', 'Ocean deoxygenation', 'Ocean Acidification', and 'Sea level rise'.[415]

Interventions in setting up marine protected areas (MPAs) would also support issues such as 'biodiversity loss' and 'habitat loss, both of which are frequently occurring 'receptors' as well as changes in structure and reduced functioning of coastal ecosystems' which is the

[411] Merrick Burden and Rod Fujita, "Better fisheries management can help reduce conflict, improve food security, and increase economic productivity in the face of climate change," *Marine Policy* 108 (2019/10/01/ 2019), https://doi.org/https://doi.org/10.1016/j.marpol.2019.103610, https://www.sciencedirect.com/science/article/pii/S0308597X18308959.
[412] Dominic McAfee et al., "Multi-habitat seascape restoration: optimising marine restoration for coastal repair and social benefit," *Frontiers in Marine Science* 9 (2022).
Taryn Garlock et al., "Aquaculture: The missing contributor in the food security agenda," *Global Food Security* 32 (2022/03/01/ 2022), https://doi.org/https://doi.org/10.1016/j.gfs.2022.100620, https://www.sciencedirect.com/science/article/pii/S2211912422000116.
[413] "Why protecting the ocean and wetlands can help fight the climate crisis," 2022, accessed 25 April, 2025, https://www.unep.org/news-and-stories/story/why-protecting-ocean-and-wetlands-can-help-fight-climate-crisis.
[414] E. Maggie Sogin et al., "Sugars dominate the seagrass rhizosphere," *Nature Ecology & Evolution* 6, no. 7 (2022/07/01 2022), https://doi.org/10.1038/s41559-022-01740-z, https://doi.org/10.1038/s41559-022-01740-z.
[415] "Ocean warming," Issues Brief, 2017, accessed 25 April, 2025, https://iucn.org/resources/issues-brief/ocean-warming.

most frequently occurring impact .[416] Currently, less than three percent of the global ocean is protected through MPAs, further highlighting the need to support and increase efforts to protect the ocean.[417] Indeed, even identifying areas which are key to marine and coastal biodiversity would be a supportive intervention and deliver better outcomes and a more targeted maritime are geospatial governance.[418]

MPAs were also mentioned by Brennan and Germond in 2024, as a singularly focused intervention supporting the strengthening of the integrity of the marine environment.[419] There are already in place high-level ambitions to support the creation of MPAs with a number of countries having pledged to support the protection of at least 30% of the world's land and ocean by 2030.[420] In a 2024 report, it was calculated that the Indo-Pacific contains at least 33 percent of the world's 100 largest MPAs, with 0.04 percent being in the western Indo-Pacific, 5.25 percent being in the central Indo-Pacific and Australasia, 27.81 percent in the eastern Indo-Pacific.[421] Designating an area as an MPA is one thing, ensuring that its designation is respected is another. As will be discussed in Chapter 8: National Security; the capacity of nations to monitor and control their maritime domain is crucial in many aspects and to ensuring that MPAs are actually protected areas.

Figure 5.3 which shows all of the EIP chains attributed for environmental security's most frequent impact 'changes in structure and reduced functioning of coastal ecosystems' shows the how addressing this impact through MPAs and restoration of habitats such as seagrasses work as good interventions as this traces the impact back through to the effects that are

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[416] Subrata Sarker, Md Jalilur Rahman, and Md Abdul Wahab, "Modelling the role of marine protected area in biodiversity conservation," *Journal of Sea Research* 196 (2023/12/01/ 2023), https://doi.org/https://doi.org/10.1016/j.seares.2023.102457, https://www.sciencedirect.com/science/article/pii/S1385110123001260.

[417] "30 x 30 — Protecting at least 30% of the ocean by 2030," accessed 17 March, 2024, https://marine-conservation.org/30x30/.

[418] Solange Fermepin et al., "Global marine conservation priorities for sustaining marine productivity, preserving biodiversity and addressing climate change," *Marine Policy* 161 (2024/03/01/ 2024), https://doi.org/https://doi.org/10.1016/j.marpol.2024.106016, https://www.sciencedirect.com/science/article/pii/S0308597X24000149.

[419] Brennan and Germond, "A methodology for analysing the impacts of climate change on maritime security."

[420] "What is the '30 by 30' goal - and can it save global biodiversity?," Reuters, 2022, accessed 17 March, 2024, https://www.reuters.com/article/idUSL8N32R3GW/.

[421] Elizabeth P. Pike et al., "Ocean protection quality is lagging behind quantity: Applying a scientific framework to assess real marine protected area progress against the 30 by 30 target," *Conservation Letters* 17, no. 3 (2024), https://doi.org/https://doi.org/10.1111/conl.13020, https://conbio.onlinelibrary.wiley.com/doi/abs/10.1111/conl.13020.

felt. As will also be discussed in the next chapter interventions around MPAs can support human wellbeing and the preservation of culture.

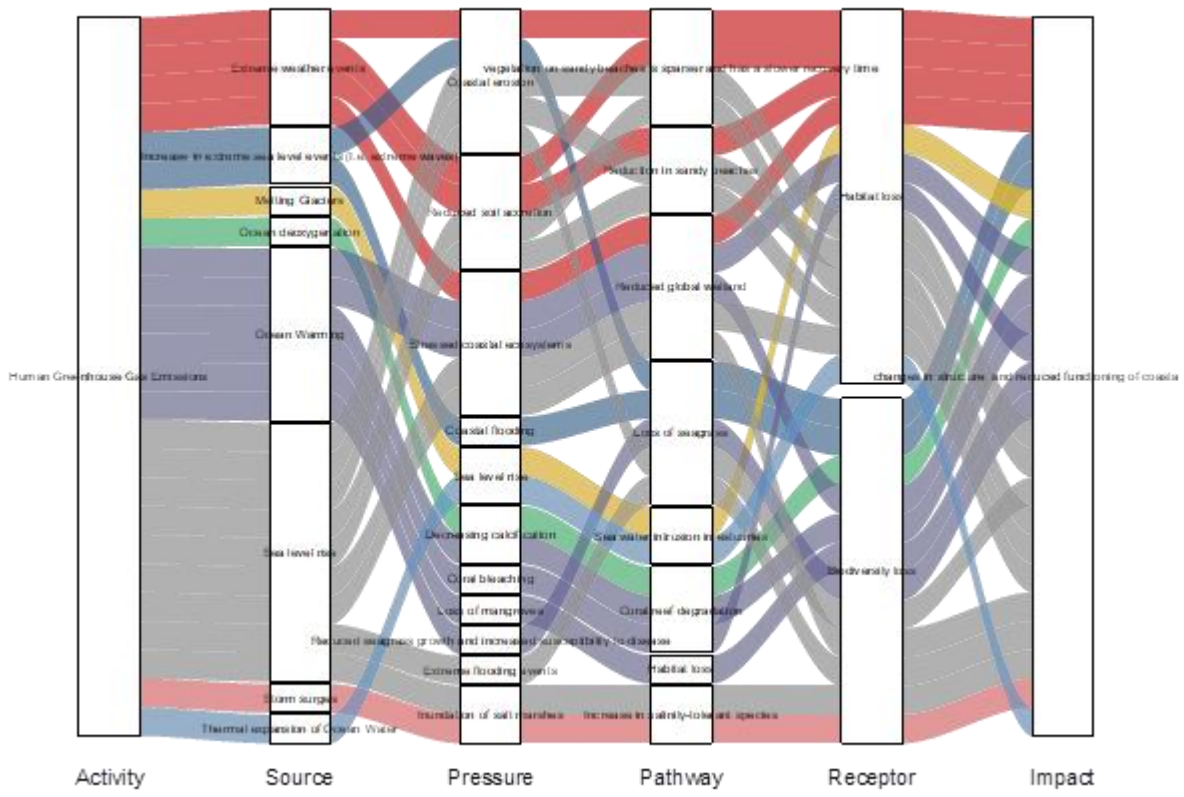

Figure 5.4 – A visual representation of the EIP chains for the impact 'changes in structure and reduced functioning of coastal ecosystems'[422]

When evaluating the dimension of environmental security, and more so than the other dimensions of maritime security, the best intervention that supports the overall increase in environmental security would be the reduction and mitigation of greenhouse gas emissions as a way of minimising future sea-level rise and also ocean warming, ocean acidification, and

[422] An enlargement of this figure can be found in Annex Eight

deoxygenation.[423] It also lessens the burden on the marine environment to act as a carbon sequestration tool.[424]

These findings ultimately show that environmental security provides a strong base for supporting the other aspects of maritime security. A safe, stable, and prosperous marine environment will provide a natural environment within which to achieve human security, economic security, and national security.

In most of the interviews that were conducted, the topic of environmental security was discussed as an important aspect of maritime security. In general, participants were of the consensus that a wider, more holistic view of security was needed to address the future challenges to maritime security. A holistic view of security is already being pushed hard for by the Pacific, which started through the 2018 Boe Declaration.[425] This called for an expanded concept of security which included the impacts of climate change. To this end, Fiji's Prime Minister Sitiveni Rabuka, has called for an 'Ocean of Peace' to be created which aims to cover not just geostrategic issues but also environmental issues.[426]

One interesting impact that came through in an interview, but not from the analysis of data in the SROCC, is the threat posed by zoonotic diseases which are classed as an environmental threat.[427] ASEAN has recognised the threat posed by Zoonotic threats and outbreaks as it is a key aspect of its ASEAN One Health initiative.[428] However, zoonotic diseases could in theory go alongside the receptor in the 'human security' section which is 'increasing and worsening harmful algal blooms and pathogenic organisms' as a zoonotic disease could be classified as a pathogenic organism. This will be touched on more in the

[423] Robert J. Nicholls and Jason A. Lowe, "Benefits of mitigation of climate change for coastal areas," *Global Environmental Change* 14, no. 3 (2004/10/01/ 2004), https://doi.org/https://doi.org/10.1016/j.gloenvcha.2004.04.005, https://www.sciencedirect.com/science/article/pii/S0959378004000445.
[424] "What role do the oceans play in regulating the climate and supporting life on Earth?," 2023, accessed 20 August, 2024, https://www.lse.ac.uk/granthaminstitute/explainers/what-role-do-the-oceans-play-in-regulating-the-climate-and-supporting-life-on-earth/.
[425] "Boe Declaration on Regional Security."
[426] "A Pacific "zone of peace" – what will it entail?," Lowy Institute, 2023, accessed 06 May, 2024, https://www.lowyinstitute.org/the-interpreter/pacific-zone-peace-what-will-it-entail.
[427] Interview K
[428] Mely Caballero-Anthony et al., "Climate change and its impact on peace and security in Southeast Asia," (2023).

human security aspect, but it is again another example of how a secure natural environment underpins all other aspects of maritime security.

Another environmental security issue, which has implications for the other dimensions of maritime security, was the shifting plant species. This is a 'receptor' in economic security and human security as it impacts on food, health and economic outcomes. This theme was observed during the interviews in that shifting distributions of plant species will also impact the drug trade, as it will influence where plant-based drugs will be grown.[429] This in turn will have implications for smuggling routes and illegitimate economic opportunities for coastal communities. Additionally, there will be flow-on implications for law enforcement and national security agencies as they will be required to respond to these changes.

National security and environmental security have another linkage that was highlighted in an interview regarding the use of navy ships, such as hydrographic and science ships that support the undertaking of scientific work, especially in the areas of climate change.[430] An example of this can be seen in the ultimately ill-fated mission of the New Zealand Defence Force's HMNZS Manawatu, which was a specialist hydrographic and dive vessel conducting a hydrographic survey of a reef just off the coast of Samoa when it capsized.[431]

The theme of the changing littoral environment was also discussed in interviews, as well as being the primary security issue connected to maritime security.[432] This relates to many different pathways, receptors, and impacts under environmental security, including those related to ocean warming and acidification, and sea-level rise.[433] However, one which warrants a discussion regarding the littoral is the costal squeeze, although this was not frequently identified within the NGAM. The coastal squeeze primarily driven by sea level rise is most acutely felt in small island states. It is reducing the amount of area considered as a coastal environment, meaning that all the activities that currently happen in the coastal

[429] Interview K
[430] Interview F
[431] "NZ Navy ship runs aground off Samoa, catches fire and sinks," 2024, accessed 13 April, 2025, https://www.rnz.co.nz/news/national/529935/nz-navy-ship-runs-aground-off-samoa-catches-fire-and-sinks.
[432] Interview E, J, and K
[433] Ryan Guild, Xiuquan Wang, and Pedro A Quijón, "Climate change impacts on coastal ecosystems," *Environmental Research: Climate* 3, no. 4 (2025).

environment or littoral will have to take place in a smaller space.[434] This will drive the competition for land and resources not just between plants and animals, but also between humans.[435] In a world with reduced coastal environments, better and more attuned planning will be needed to integrate nature into the solutions.[436] Understanding the littoral environment is important for maritime domain awareness, and understanding how to manage this environment given the oncoming coastal squeeze will be of paramount importance.

5.3 Conclusion

If the natural environment of the Indo-Pacific continues on its current trajectory of deterioration, in conjunction with other environmentally harmful practices and disasters that take place in the region, it will mean that environmental insecurity will worsen and continue to act as a destabilising issue. There are many ways in which to support the restoration of a secure and healthy natural environment, but these within the region will require coordination and collaboration. Environmental security in the maritime domain could be an issue for which countries to find common ground, as the future impacts of climate change on maritime security will be far more severe than anything that can be brought about through geostrategic competition. As emphasised by the Pacific Island Forum Secretary-General in June 2024, “Geopolitical manoeuvring means nothing to Pacific peoples who have water lapping at their doorsteps due to sea level rise.”[437]

It is already starting to be seen that climate change and environmental challenges in the Indo-Pacific region can be a driving force for cooperation, as seen with the Indo-Pacific

[434] Gary Griggs and Borja G Reguero, "Coastal adaptation to climate change and sea-level rise," *Water* 13, no. 16 (2021).
[435] Kelly L. Leo et al., "Coastal habitat squeeze: A review of adaptation solutions for saltmarsh, mangrove and beach habitats," *Ocean & Coastal Management* 175 (2019/06/01/ 2019), https://doi.org/https://doi.org/10.1016/j.ocecoaman.2019.03.019, https://www.sciencedirect.com/science/article/pii/S0964569118307476.
[436] Leo et al., "Coastal habitat squeeze: A review of adaptation solutions for saltmarsh, mangrove and beach habitats."
[437] "REMARKS: Keynote speech by Secretary General Baron Waqa at Pacific National and Regional Security Conference," 2024, accessed 18 September, 2024, https://forumsec.org/publications/remarks-keynote-speech-secretary-general-baron-waqa-pacific-national-and-regional.

Oceans Initiative launched by Indian Prime Minister Narendra Modi at the 2019 East Asia Summit, which will be built on in the chapter discussing national security.[438]

As environmental security underpins most of the issues that amount to maritime security, it is important to ensure that these are considered in any response to a maritime security issue. Ensuring where possible nature-based solutions to these issues are used will work to support a healthy and secure natural environment, as well as prevent exceeding planetary boundaries and tipping points which some scientists claim we are dangerously close to crossing.

[438] "Marine ecology is a key to maritime cooperation in the Indo-Pacific," Australian Strategic Policy Institiute, 2022, accessed 06 May, 20204, https://www.aspistrategist.org.au/marine-ecology-is-a-key-to-maritime-cooperation-in-the-indo-pacific/.

Chapter 6: Human Security

Maritime and coastal ecosystems support human security in a variety of interconnected ways, so understanding these interactions is crucial to better adapting and mitigating the impacts of climate change in the maritime domain.[439] This is especially true, as a holistic approach to security is taken in this study, human security is crucial to expanding the concept of security beyond traditional definitions focused on hard power and military policies, by focusing on the resilience of people and communities.[440] By doing this, the human security chapter aims to understand the key issues impacting on an individual's, communities and societies' insecurity, including understanding how this will affect an individual's quality of life and how resilient humans are.[441] Human security changes the focus of the referent object from states to people. In the maritime domain, this covers a wide range of issues which focus on human resilience, including food and water, the safety of seafarers, shelter, human wellbeing, and poverty.[442]

Human security is the second level in the pyramid of maritime security (shown in Chapter 2), as having a solid base of a secure natural marine environment provides for many aspects of human security. This is especially true for the poor and those in poverty who end up being the worst impacted by environmental degradation.[443]

This chapter will outline the current Indo-Pacific context of the human security dimension of maritime security. It will then go on to outline the findings that were developed through the construction of the NGAM, as outlined in Chapter 4, showing the impacts that are most strongly associated with climate change, such as food insecurity, worsening personal wellbeing, increased strains of social cohesion, and losses of culture and identity. Finally, it

[439] L. M. Wedding et al., "Integrating the multiple perspectives of people and nature in place-based marine spatial planning," *npj Ocean Sustainability* 3, no. 1 (2024/09/10 2024), https://doi.org/10.1038/s44183-024-00071-9, https://doi.org/10.1038/s44183-024-00071-9.
[440] Rebecca Strating, Sunil Rao, and Sallie Yea, "Human rights at sea: The limits of inter-state cooperation in addressing forced labour on fishing vessels," *Marine Policy* 159 (2024/01/01/ 2024), https://doi.org/https://doi.org/10.1016/j.marpol.2023.105934, https://www.sciencedirect.com/science/article/pii/S0308597X23004670.
[441] Matt McDonald, "Human security and the construction of security," *Global Society* 16, no. 3 (2002).
[442] Bueger, "What is maritime security?."
[443] "On envrionmental degradation and its impact on inequality in Asia and the Pacific," Economic and Social Commission for Asia and the Pacific, 2018, accessed 18 March, 2024, https://www.unescap.org/blog/on-environmental-degradation-and-its-impact-on-inequality-in-asia-and-the-pacific.

will analyse and discuss these findings in the context of the interviews that were undertaken, and the Indo-Pacific context to identify vulnerabilities and the most effective places for interventions, such as supporting communities to stay in place, developing sustainable management of fisheries, and reducing gender inequality.

Through this chapter, analysis of the data collected and in the current context of the Indo-Pacific will highlight the best areas for interventions to support increased human resilience and security in the face of climate change, in order to strengthen social cohesion, ensure people's livelihoods are resilient to climate impacts, and put in place mitigation strategies to deal with climate-induced migration. Through the identification of interactions between the EIP chains, this chapter also supports the argument that environmental security underpins the other dimensions of maritime security.

6.1 The Human Security Environment in the Indo-Pacific

Humans have a right to a healthy maritime environment, and given the importance of the ocean to human security due to the rapidly growing and evolving role the ocean plays in supporting the demand for food, energy, transport, trade, and recreation this is increasingly important.[444] Globally, since COVID-19, the Human Development Index monitored by the United Nations Development Programme has fallen and a sense of insecurity has grown.[445] Climate change can impact human security, especially in the maritime domain, by impacts which exacerbate issues such as food and water security, well-being and mental health, and livelihoods and the safety of those working in the maritime domain.[446]

[444] Nathan J. Bennett, Elisa Morgera, and David Boyd, "The human right to a clean, healthy and sustainable ocean," *npj Ocean Sustainability* 3, no. 1 (2024/04/08 2024), https://doi.org/10.1038/s44183-024-00057-7, https://doi.org/10.1038/s44183-024-00057-7.
Jan-Gunnar Winther et al., "Integrated ocean management for a sustainable ocean economy," *Nature Ecology & Evolution* 4, no. 11 (2020/11/01 2020), https://doi.org/10.1038/s41559-020-1259-6, https://doi.org/10.1038/s41559-020-1259-6.
[445] Heriberto Tapia and Pedro Conceição, "New threats to human security in the anthropocene :demanding greater solidarity : 2022 special report," (New York :: United Nations Development Programme, 2022 2022). https://digitallibrary.un.org/record/3958751/files/srhs2022.pdf https://digitallibrary.un.org/record/3958751/files/srhs2022_fr.pdf https://digitallibrary.un.org/record/3958751/files/srhs2022_es.pdf.
[446] Brennan and Germond, "A methodology for analysing the impacts of climate change on maritime security."

Across the region, millions are vulnerable to multiple causes of insecurity, as human insecurity is a crucial part of maritime security.[447] Nearly fifty percent of the world's population lives within 200km of a coastline, with the coastline of the Indo-Pacific being particularly densely populated.[448] With so much of the world's population residing so close to the coast, the vulnerability of coastal populations has a massive role to play in the human security of the Indo-Pacific. The Indo-Pacific has been the location of two of the top three worst natural disasters in the 21st century.[449] Within the Indo-Pacific, there are many developing countries which struggle to support the resilient and sustainable development of their coastal populations.

"Leave no one behind" is the underlying principle of the 2030 Sustainable Development Goals, and at the halfway mark one in five SDG targets are regressing and the Asia-Pacific is set to miss 90 percent of its targets without a significant increase in effort.[450] According to the Asia and the Pacific SDG Progress Report 2023, "the least progress made by States in the region since 2015 has been on Goals 8 and 17, along with clean water and sanitation (Goal 6), responsible consumption and production (Goal 12) and life below water (Goal 14)."[451] This sub-section goes on to talk about some of the key issues to the human security dimension of maritime security within the Indo-Pacific.

6.1.1 Human Wellbeing

Human wellbeing is a crucial aspect of human security and is part of understanding the linkage between human wellbeing and the maritime domain. International human rights also contribute to human wellbeing, which are just as applicable at sea as on land. However, these are complex and cross-jurisdictional, making it hard to regulate and address human

[447] "2024 Asia-Pacific Human Development Report :making Our Future: New Directions for Human Development in Asia and the Pacific," ([New York] :: UNDP, 2023-11-06
6 Nov. 2023 2023). https://digitallibrary.un.org/record/4027300/files/1388650EN.pdf.
[448] Lalitha Ramadorai, "Marine Environment in the Indo-Pacific Region and Security," *POLITICO* 4, no. 1 (2015).
[449] Shishir Upadhyaya, "Naval humanitarian assistance and disaster relief (HA/DR) operations in the Indo-Pacific region: need for fresh thinking," *Journal of the Indian Ocean Region* 18, no. 3 (2022/09/02 2022), https://doi.org/10.1080/19480881.2023.2198887, https://doi.org/10.1080/19480881.2023.2198887.
[450] United Nations, *The Sustainable Development Goals Report 2023: Special edition* (2023), https://unstats.un.org/sdgs/report/2023/.
[451] United Nations Economic and Social Commission for Asia and the Pacific, *ASIA AND THE PACIFIC SDG PROGRESS REPORT 2023: Championing sustainability despite adversities* (2023), https://reliefweb.int/attachments/9fffea72-f500-41e6-b315-401cdde0dbce/ESCAP-2023-FS-SDG-Progress-Report.pdf.

rights abuses at sea.[452] Human rights violations are commonplace at sea and these violations present an increasing threat to maritime security.[453]

Working in the maritime domain is the primary activity that humans undertake in the maritime domain and globally, roughly 27 million people are fishing at any point in time.[454] Unfortunately, human trafficking and forced labour are explicitly interlinked with the fishing industry.[455] This is in part due to the complex legal environments that activities at sea operate in between, local and international laws, and because the ocean acts as a buffer between people and law enforcement.[456]

Since COVID-19, human (and drug) trafficking has increased.[457] COVID-19 highlighted the plight of seafarers and the conditions they work under, not just from forced labour, but also through the abandonment of seafarers at ports across the world as companies went bust, with no wages, vessel costs not covered, and no provisions.[458]

Human wellbeing is also driven by economic livelihoods generated from fisheries and in turn fisheries governance involves a complex array of social-cultural interactions.[459] Fisheries were already highlighted in Chapter 5: Environmental Security as being a big issue. Chapter 7: Economic Security and Chapter 8: National Security will also show that climate change's

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[452] Strating, Rao, and Yea, "Human rights at sea: The limits of inter-state cooperation in addressing forced labour on fishing vessels."
[453] Sofia Galani, "Assessing Maritime Security and Human Rights: The Role of the EU and its Member States in the Protection of Human Rights in the Maritime Domain," *The International Journal of Marine and Coastal Law* 35, no. 2 (19 Feb. 2020 2020), https://doi.org/https://doi.org/10.1163/15718085-23441006, https://brill.com/view/journals/estu/35/2/article-p325_6.xml.
[454] Strating, Rao, and Yea, "Human rights at sea: The limits of inter-state cooperation in addressing forced labour on fishing vessels."
[455] Strating, Rao, and Yea, "Human rights at sea: The limits of inter-state cooperation in addressing forced labour on fishing vessels."
[456] Strating, Rao, and Yea, "Human rights at sea: The limits of inter-state cooperation in addressing forced labour on fishing vessels."
[457] Hillary Briffa et al., *Policy Brief: Enhancing maritime security in the Indo-Pacific* Griffith Asia Institute (2023).
[458] Helen Sampson, "'Beyond the State': The limits of international regulation and the example of abandoned seafarers," *Marine Policy* 140 (2022).
[459] Sarah Coulthard, Derek Johnson, and J. Allister McGregor, "Poverty, sustainability and human wellbeing: A social wellbeing approach to the global fisheries crisis," *Global Environmental Change* 21, no. 2 (2011/05/01/ 2011), https://doi.org/https://doi.org/10.1016/j.gloenvcha.2011.01.003, https://www.sciencedirect.com/science/article/pii/S0959378011000045.
Abigail S. Golden et al., "Enhancing the adaptive capacity of fisheries to climate change: Bridging academic theory and management practice through practitioner interviews," *Marine Policy* 168 (2024/10/01/ 2024), https://doi.org/https://doi.org/10.1016/j.marpol.2024.106321, https://www.sciencedirect.com/science/article/pii/S0308597X24003191.

effects on fisheries will impact all dimensions of maritime security. The impact of fisheries on human security is mostly through small-scale fisheries, which are thought to make up the majority of employment in fisheries, with many people's livelihoods across the Indo-Pacific depending on small-scale fishing.[460] Fishers who focus on singular fish stocks or species are also more susceptible to the negative impacts of climate change and will be among the worst affected.[461] Indeed as these fishers' livelihoods, they enter into illegal fishing practices which further diminishes fish stock, threatens endangered species, and destroys vulnerable ecosystems, all of which further undermine the ability for livelihood generation and human security.[462]

Across the Indo-Pacific millions are living in poverty. This is further compounded by rapidly growing and urbanising populations.[463] As people's economic opportunities decline, people are left searching for other opportunities, leaving them vulnerable to transnational organised crime (TNOC), as TNOC groups promise them a better life.[464] TNOC groups use this promise as a way to exploit people and can further exacerbate the issue of forced labour and human trafficking, but it can also lead to other forms of exploitation.[465]

Living close to the coast is a source of food, livelihoods, and culture. However, it is also a large source of threats to the vast number of people living in the littoral area across the Indo-Pacific, and understanding these threats is critical to understanding human security.[466]

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[460] "Preserving Southeast Asian fisheries: From the national to the local," Asia & The Pacific Policy Society, 2022, accessed 04 December, 2023, https://www.policyforum.net/preserving-southeast-asian-fisheries/.
Veitayako, "Saving coastal fisheries in the Pacific: food, livelihoods and community security."
"Western Indian Ocean," accessed 21 August, 2024, https://www.bluenaturealliance.org/locations/western-indian-ocean/.

[461] Golden et al., "Enhancing the adaptive capacity of fisheries to climate change: Bridging academic theory and management practice through practitioner interviews."

[462] Christian Bueger and Timothy Edmunds, "Blue crime: Conceptualising transnational organised crime at sea," *Marine Policy* 119 (2020/09/01/ 2020), https://doi.org/https://doi.org/10.1016/j.marpol.2020.104067, https://www.sciencedirect.com/science/article/pii/S0308597X20300270.

[463] International Military Council on Climate and Security, *The World Climate and Security Report 2020* (2020).

[464] Moenieba Isaacs and Emma Witbooi, "Fisheries crime, human rights and small-scale fisheries in South Africa: A case of bigger fish to fry," *Marine Policy* 105 (2019/07/01/ 2019), https://doi.org/https://doi.org/10.1016/j.marpol.2018.12.023, https://www.sciencedirect.com/science/article/pii/S0308597X18309503.

[465] Joseph Green et al., *Indo-Pacific 2050 Climate Change Impact Analysis: Anticipating Climate Change Impacts to Enahnce Climate Secuirty Across the Region* (Pacific Disaster Center, 2023).

[466] N. L. Andrew et al., "Coastal proximity of populations in 22 Pacific Island Countries and Territories," *PLoS One* 14, no. 9 (2019), https://doi.org/10.1371/journal.pone.0223249.

One of the main vulnerabilities to living in the littoral is the impact this can have on shelter; the Indo-Pacific is the "most disaster-prone" region and is vulnerable to frequent storms and sea level rise.[467]

The safety of workers should also consider heat stress, which is an issue that many countries within the Indo-Pacific have to deal with and the associated health and economic related consequences.[468] Heat stress is likely to cause people to slow down and become less productive, limiting the number of working hours, and potentially reducing people's incomes.[469] This is predicted to impact those working in agriculture and construction the most, but in the maritime domain, other issues such as port workers (to be covered in the economic section) and naval personnel (to be covered in the national security section) are likely to be impacted.[470]

6.1.2 Food Security

In the Indo-Pacific food security is a massive problem and the current state of food (in)security within the region is not good.[471] It is estimated that over 370 million people in the region are undernourished which accounts for almost 50 percent of those that are undernourished globally.[472]

The region's population is set to increase over the next couple of decades placing further strain on food systems to meet the need and ensure everybody has access to nutritious

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[467] Shiloh Fetzek et al., *Climate and Security in the Indo-Asia Pacific 2020* (Expert Group of the International Military Council on Climate and Security: an institute of the Council on Strategic Risks Center for Climate and Security, 2020).

[468] "Extreme heatwaves in south and south-east Asia are a sign of things to come," The Conversation, 2024, accessed 21 August, 2024, https://theconversation.com/extreme-heatwaves-in-south-and-south-east-asia-are-a-sign-of-things-to-come-229832.
Rajashree Kotharkar and Aveek Ghosh, "Review of heat wave studies and related urban policies in South Asia," *Urban Climate* 36 (2021/03/01/ 2021), https://doi.org/https://doi.org/10.1016/j.uclim.2021.100777, https://www.sciencedirect.com/science/article/pii/S2212095521000080.

[469] T. V. Lakshmi Kumar et al., "Impact of climate change induced heat stress on the people working in the coastal cities of India," *Natural Hazards* 121, no. 2 (2025/01/01 2025), https://doi.org/10.1007/s11069-024-06872-y, https://doi.org/10.1007/s11069-024-06872-y.

[470] Tord Kjellström et al., *Working on a warmer planet: The impact of heat stress on labour productivity and decent work* (ILO, 2019).

[471] "Food security an issue in the Indo-Pacific," 2022, accessed 08 May, 2024, https://www.latrobe.edu.au/news/announcements/2022/food-security-an-issue-in-the-indo-pacific.

[472] "Australia cultivating food security projects across Indo-Pacific," 2024, accessed 08 May, 2024, https://ipdefenseforum.com/2024/01/australia-cultivating-food-security-projects-across-indo-pacific/#:~:text=More%20than%20370%20million%20people,Nations%20Food%20and%20Agricultural%20Organization.

food.[473] Within ASEAN 99 percent of the cereal produced is rice or maize.[474] This makes the region susceptible to any form of event that would directly or indirectly impact these crops.

Land degradation is already becoming an issue in the Indo-Pacific, and the compounding impacts of climate change will further increase land degradation and reduce soil productivity.[475] Smallhold farmers, which would include people undertaking subsistence agriculture in coastal areas, rural populations, and indigenous communities are the most vulnerable to food insecurity.[476]

Within the Indo-Pacific communities are heavily dependent on fishing.[477] This means the region has some of the highest rates of aquatic food consumption per capita, which is already predicted to be impacted by climate change.[478]

Issues around food security can also relate to supply chain issues, which increase the cost of healthier foods and perpetuate the issues of non-communicable diseases (NCDs) such as diabetes, which are highly prevalent in SIDS.[479] This is because people in SIDS increasingly rely on imported food, and this increases their dependence on food that is "relatively cheap, energy-dense, highly or ultra-processed and of low nutritional quality".[480] Supply chain issues can also relate to the treatment of NCDs as without an effective supply chain for medicines there will be issues around access to medicine and treatment.[481]

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[473] Pushpanathan Sundram, "Food security in ASEAN: progress, challenges and future," Original Research, *Frontiers in Sustainable Food Systems* 7 (2023-October-10 2023), https://doi.org/10.3389/fsufs.2023.1260619, https://www.frontiersin.org/articles/10.3389/fsufs.2023.1260619.
[474] Sundram, "ASEAN Food Security in Perspective."
[475] Sundram, "ASEAN Food Security in Perspective."
[476] Sundram, "ASEAN Food Security in Perspective."
[477] Security, *The World Climate and Security Report 2020*.
[478] Brennan and Germond, "A methodology for analysing the impacts of climate change on maritime security."
[479] Cassandra Halliday et al., "Trends in food supply, diet, and the risk of non-communicable diseases in three Small Island Developing States: implications for policy and research," Original Research, *Frontiers in Sustainable Food Systems* 7 (2023-June-12 2023), https://doi.org/10.3389/fsufs.2023.1058540, https://www.frontiersin.org/journals/sustainable-food-systems/articles/10.3389/fsufs.2023.1058540.
[480] Halliday et al., "Trends in food supply, diet."
[481] Cécile Macé et al., "Access to medicines for NCD prevention and control," in *Noncommunicable Diseases* (Routledge, 2023).

Unsafe food also has a big impact on human health. It also reduces productivity and uses up healthcare resources; every year in the Indo-Pacific at least 275 million people are taken ill due to consuming unsafe food and at least 22,500 people die.[482]

6.1.3 Water Security

Having access to clean and safe water is paramount for ensuring survival where this relates to basic human needs. The Indo-Pacific has an array of water challenges that are caused by the region's natural environment and geostrategic challenges.[483] While many states in the Indo-Pacific have been strengthening their water security in recent years through better water management policies and capabilities, there remains substantial water insecurity and challenges throughout the region.[484]

Water security issues can stem from multiple factors. These include the occurrence of too much water (flooding), not enough water (drought), water contamination and pollution, or cross-border water management issues.[485] Brennan and Germond in 2024, conclude that all of the dimensions of maritime security can contribute to water insecurity, especially for coastal populations.[486] It has been determined that approximately 50 percent of the Indo-Pacific's workforce is engaged in water-related sectors including agriculture, mining and fisheries.[487] This means that water insecurity is an issue that will impact people's livelihood as well as directly impacting their health or own security.

6.1.4 Societal Issues

Gender and social inclusion across the Indo-Pacific is a massive problem. When analysing the impact of climate change on maritime security it is important to remember that security

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[482] "Food Safety Activities," accessed 09 May, 2024, https://www.fao.org/asiapacific/perspectives/one-health/food-safety/es/#:~:text=Highly%20diverse%20food%20culture%20in,Asia%20and%20the%20Pacific%20region.

[483] Ethan Allen, "Addressing the Diversity of Water Challenges in the Indo-Pacific: Need for Broad Cooperative Approaches," *Journal of Indo-Pacific Affairs* 7, no. 2 (2024).

[484] Australian Strategic Policy Institute, *The geopolitics of climate and security in the Indo-Pacific* (2022), https://ad-aspi.s3.ap-southeast-2.amazonaws.com/2022-02/Climate%20and%20security%20in%20the%20Indo-Pacific_0.pdf?VersionId=qP0ZzIQQiSLU1ymakusX2a9NrL2R6Jf_.

[485] Allen, "Addressing the Diversity of Water Challenges in the Indo-Pacific: Need for Broad Cooperative Approaches."

[486] Brennan and Germond, "A methodology for analysing the impacts of climate change on maritime security."

[487] Australian Strategic Policy Institute, *The geopolitics of climate and security in the Indo-Pacific*.

issues are not gender-neutral and affect women and men differently.[488] The role of women is often not adequately considered due to activities in the maritime domain such as fishing, sailing, and piracy being considered masculine activities.[489] Women have a key role in supporting maritime security, however, there are inequalities when it comes to the involvement of women in decision-making where it relates to both maritime security and climate change.[490]

COVID-19 highlighted the issues relating to gender inequality when responding to human security issues. When COVID-19 hit the Indo-Pacific, women were the most impacted and bore a disproportionate burden of dealing with the pandemic.[491] COVID-19 also showed the impacts that external events can have on societies as it exacerbated the issue of gender-based violence.[492] In the Pacific, it is estimated that up to 68 percent of women have experienced some form of physical or sexual abuse from their partners.[493] Within Asia, it is more likely for a woman to be killed at home than anywhere else.[494] Women are also more likely to be more harshly exposed to insecurity during conflict and migration, with women experiencing sexual assault, gender-based violence, and forced marriage.[495]

In the Indo-Pacific women face distinct challenges and barriers in participating in economic opportunities.[496] Women face limited access to early warnings of disasters and healthcare, face worse education outcomes, and are disproportionately impacted by water, sanitation

[488] Ioannis Chapsos and Elizabeth Ann Norman, "Is maritime security gender-blind?," *Marine Policy* 147 (2023).
[489] Jane Freedman, "Gender perspectives on maritime security," in *Routledge Handbook of Maritime Security* (Routledge, 2022).
[490] Chapsos and Norman, "Is maritime security gender-blind?."
[491] "2024 Asia-Pacific Human Development Report :making Our Future: New Directions for Human Development in Asia and the Pacific."
[492] M. Nagashima-Hayashi et al., "Gender-Based Violence in the Asia-Pacific Region during COVID-19: A Hidden Pandemic behind Closed Doors," *Int J Environ Res Public Health* 19, no. 4 (Feb 16 2022), https://doi.org/10.3390/ijerph19042239.
[493] "Ending Violence Against Women and Girls," accessed 11 May, 2024, https://asiapacific.unwomen.org/en/countries/fiji/ending-violence-against-women.
[494] Nagashima-Hayashi et al., "Gender-Based Violence in the Asia-Pacific Region during COVID-19: A Hidden Pandemic behind Closed Doors."
[495] Maryruth Belsey Priebe, "Women Parliamentarians' Impact in Indo-Pacific Gender-Responsive and Climate-Compatible Security Policy Making."
[496] Anil Sooklal, "The Indo-Pacific, an emerging paradigm for peace, cooperation, sustainable development and mutual prosperity," *Journal of the Indian Ocean Region* 18, no. 3 (2022/09/02 2022), https://doi.org/10.1080/19480881.2023.2172814, https://doi.org/10.1080/19480881.2023.2172814.

and hygiene issues.[497] Women's insecurity is also compounded due to their lack of representation in decision-making, with the Pacific suffering from some of the lowest levels of political representation by women in the world.[498]

Wealth inequality contributes to negative outcomes for individuals and nations.[499] Inequality is an entrenched issue across the Indo-Pacific. Specifically, countries such as China, India, Myanmar, Sri Lanka and Thailand are where this issue is particularly bad.[500] Globally, the richest 10 percent hold more than 50 percent of the world's total income.[501] In 2015 the poor were already "just one natural disaster away from destitution."[502] COVID-19 managed to wipe out 30 years of development progress, and this is a worrying starting position as the impacts of climate change are starting to worsen and is projected to drive around 100 million more people globally into extreme poverty.[503]

The impacts of the COVID-19 pandemic are yet to be fully recognised but have undeniably slowed progress towards the SDGs. It has affected the most vulnerable worst, increasing poverty, reducing health outcomes, increasing deaths from disasters, and increasing food prices.[504] This has exposed and exacerbated current inequalities throughout societies.[505]

The Indo-Pacific is a large ocean-based region that has a wide variety of cultural and religious ideas that influence identities, traditions and heritage; however, these ideas sometimes can be contested both within and between countries.[506] There are already longstanding conflicts within the Indo-Pacific, such as in Indonesia, the Philippines, and

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[497] Priebe, "Women Parliamentarians' Impact in Indo-Pacific Gender-Responsive and Climate-Compatible Security Policy Making."
[498] "Women, Peace, and Security in the Pacific," 2023, accessed 11 May, 2024, https://thediplomat.com/2023/09/women-peace-and-security-in-the-pacific/.
[499] Stephen Kidd; Diloá Athias; Silvia Nastasi; Anca Pop, *Inequality and social security in the Asia-Pacific region*, United Nations Development Programme (2022).
[500] "2024 Asia-Pacific Human Development Report :making Our Future: New Directions for Human Development in Asia and the Pacific."
[501] "2024 Asia-Pacific Human Development Report :making Our Future: New Directions for Human Development in Asia and the Pacific."
[502] Australian Strategic Policy Institute, *The geopolitics of climate and security in the Indo-Pacific*.
[503] Australian Strategic Policy Institute, *The geopolitics of climate and security in the Indo-Pacific*.
[504] United Nations Economic and Social Commission for Asia and the Pacific, *ASIA AND THE PACIFIC SDG PROGRESS REPORT 2023: Championing sustainability despite adversities*.
[505] United Nations Economic and Social Commission for Asia and the Pacific, *ASIA AND THE PACIFIC SDG PROGRESS REPORT 2023: Championing sustainability despite adversities*.
[506] Timothy Doyle, "The rise and return of the Indo-Pacific: oceans, seas and civilisational linkages," *East Asia* 35 (2018).

Myanmar that are caused by ethnic and religious divides.[507] The conflict in Myanmar demonstrates the impact religious conflict can have as it is already pushing people toward forced migration. This migration has grabbed headlines as the Rohingya people look to undertake irregular migration by sea and it is estimated that in 2023, 569 Rohingya died at sea with 4,490 people embarking on a sea journey.[508] This is an obvious example of how land-based ethnic conflict can impact people's human security, thus creating a maritime security issue as people look to achieve better security outcomes.

Within the Indo-Pacific, there are issues around customary rights, traditional land ownership, and indigenous sovereignty. There are examples where these tensions have caused direct conflict such as in West Papua and Bougainville where indigenous societies and sovereignty are in conflict with that of an overarching state.[509] The stresses brought about by climate change could magnify these conflicts and tensions.

6.1.5 Other

Health Insecurity

The delivery and quality of healthcare varies wildly across the Indo-Pacific. Understanding the impact of climate change on human health is important, as across the Indo-Pacific there are many different health-climate-related issues and these issues will further exacerbate existing health inequalities as they impact the most vulnerable such as children, the elderly, low socioeconomic communities, and indigenous peoples the most.[510] Climate-health-related impacts are expected to increase morbidity and mortality through exposure to increased "heatwaves and other extreme weather and climate events, diseases associated with exposure to poor air quality (including ozone and aeroallergens), effects on the emergence and distribution of vector-, water- and food-borne infectious diseases, health

[507] Australian Strategic Policy Institute, *The geopolitics of climate and security in the Indo-Pacific*.
[508] "UNHCR: 569 Rohingya died at sea in 2023, highest in nine years," Al Jazeera, 2024, accessed 10 August, 2024, https://www.aljazeera.com/news/2024/1/24/unhcr-569-rohingya-died-at-sea-in-2023-highest-in-nine-years.
[509] Rory Medcalf, "Toward principled pragmatism in Indigenous diplomacy in the Indo-Pacific," *Australian Journal of International Affairs* 77, no. 6 (2023/11/02 2023), https://doi.org/10.1080/10357718.2023.2268035, https://doi.org/10.1080/10357718.2023.2268035.
[510] Australian Strategic Policy Institute, *The geopolitics of climate and security in the Indo-Pacific*.

impacts due to reductions in food availability and the nutrient density of food, and the consequences of climate-related migration and conflict."[511]

Dengue fever is already a big health risk within the Pacific and in 2020 the region suffered an outbreak of dengue fever while also dealing with the COVID-19 pandemic and the aftermath of Tropical Cyclone Harold.[512] This shows the vulnerability of this particular part of the Indo-Pacific to both the health-related impacts of climate change and to the multiplying effects that the different impacts of climate change can have.

The Pacific also faces health insecurity from noncommunicable diseases such as diabetes and cardiovascular diseases, driven by issues such as lifestyle choices diet, alcohol abuse, inactivity, and smoking.[513] As mentioned previously, some of these issues are compounded due to the supply chain issues and the cost of transportation of things such as fresh vegetables, which are integral for optimising health outcomes.

Mental Health

Mental health issues have increased significantly across the Indo-Pacific since 2020. This could in part be due to COVID-19 and the associated impacts.[514] However, impacts related to the effects of climate change such as "heat, humidity, rainfall, drought, wildfires, and floods" have in a 2021 study by Charlson et al, been found to impact people's mental health.[515] COVID-19 did highlight the benefits of positive mental health outcomes and the varying levels in mental health systems across the region.[516]

Humanitarian Emergencies

With "over half of the world's natural disasters" the Indo-Pacific is the "world's most vulnerable region", there are many countries across the region that frequently experience natural disasters and call upon their own and other armed forces to deliver Humanitarian

[511] Australian Strategic Policy Institute, *The geopolitics of climate and security in the Indo-Pacific*.
[512] Australian Strategic Policy Institute, *The geopolitics of climate and security in the Indo-Pacific*.
[513] "Addressing noncommunicable diseases in the Pacific islands," accessed 09 May, 2024, https://www.who.int/westernpacific/activities/addressing-ncds-in-the-pacific.
[514] Australian Strategic Policy Institute, *The geopolitics of climate and security in the Indo-Pacific*.
[515] Fiona Charlson et al., "Climate change and mental health: a scoping review," *International journal of environmental research and public health* 18, no. 9 (2021).
[516] World Health Organization, "Addressing noncommunicable diseases in the Pacific islands."

Assistance and Disaster Response (HADR).[517] It is estimated that across the Indo-Pacific between 2010 to 2021 there were at least 225 million displacements with weather-related hazards being responsible for 95 percent of these displacements.[518]

6.2 Findings

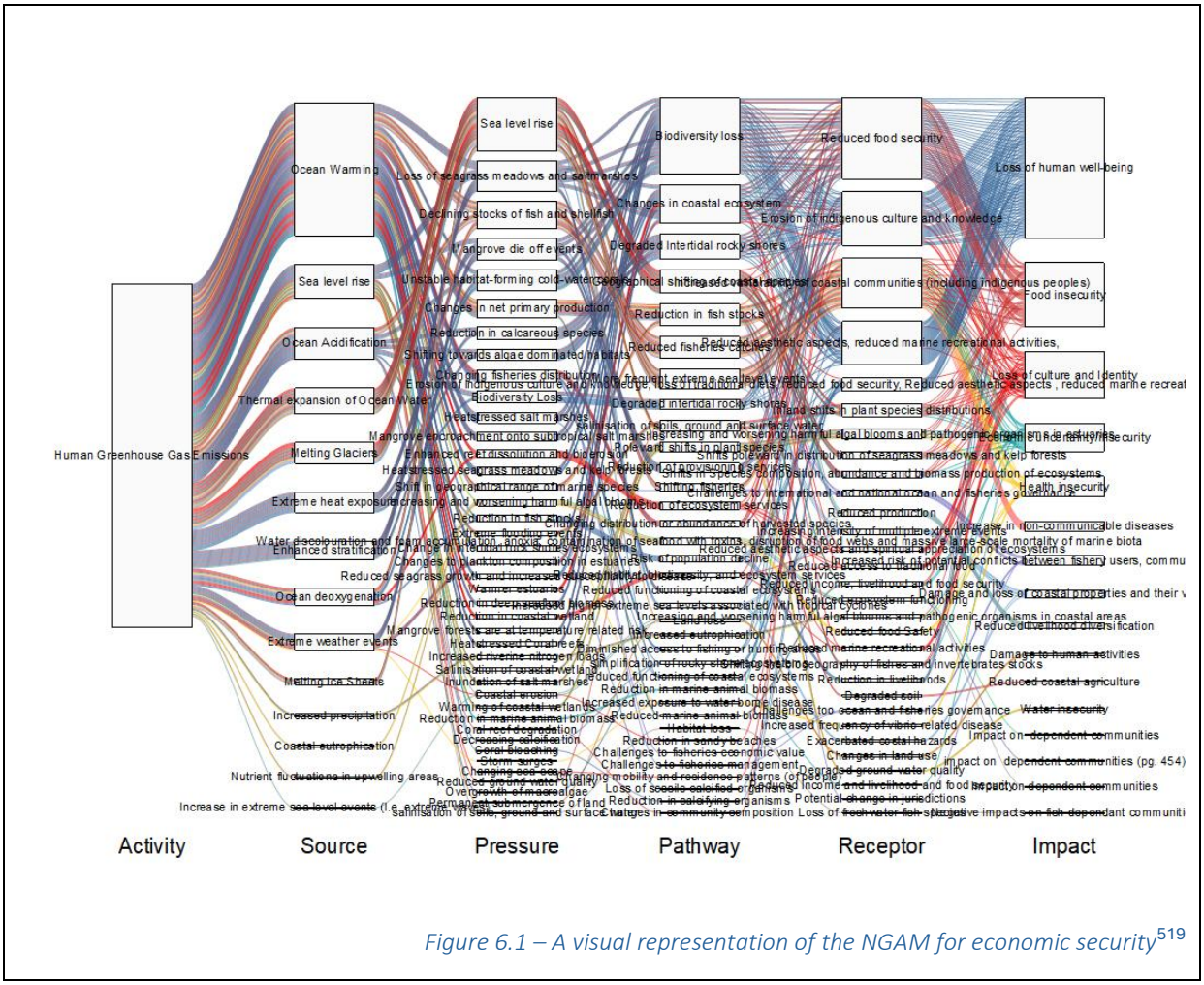

Figure 6.1 – A visual representation of the NGAM for economic security[519]

Table 6.1 shows the pathways for EIP chains that are tagged against human security within the NGAM developed in Chapter 4. The distribution of the 'pathways' is spread more evenly compared to the 'receptors' and 'impacts' which are more concentrated. The six most frequently occurring pathways account for 59.81 percent of EIP chains. There is a big link here between human security and environmental security with many of the 'pathways' also

[517] Upadhyaya, "Naval humanitarian assistance and disaster relief (HA/DR) operations in the Indo-Pacific region: need for fresh thinking."
[518] Internal Displacement Monitoring Centre, *Disaster Displacement in the Asia and the Pacific* (2022).
[519] An enlargement of this figure can be found in Annex Nine

being present under environmental security. This goes to show the underpinning nature of environmental security (reiterating the structure of maritime security as presented in Chapter 2).

In analysing the flow of the effects of climate change through to their impacts on human security (as mentioned in Chapter 4), understanding the aspects of the previous part of the EIP chain that flow onto the current part is crucial. For human security the main preceding 'pressures 'that flowed onto the 'pathway' of 'Biodiversity loss' are 'Unstable habitat-forming cold-water corals', 'Loss of seagrass meadows and saltmarshes', and 'Mangrove die off events' and for the 'pathway' of 'changes in coastal ecosystem' the main preceding pressure is 'Loss of seagrass meadows and saltmarshes'.

Table 6.1 – Human security 'pathways'

Pathway	Number of occurrences	Frequency of occurrence
Biodiversity loss	71	18.64%
Changes in coastal ecosystem	36	9.45%
Reduction in fish stocks	25	6.56%
Degraded Intertidal rocky shores	23	6.04%
Geographical shifting of coastal species	22	5.77%
Risk of population decline	21	5.51%
Reduced fisheries catches	20	5.25%
More frequent extreme sea level events	18	4.72%
simplification of rocky shore ecosystems	18	4.72%
Reduced functioning of coastal ecosystems	16	4.20%
Reduction of provisioning services	14	3.67%
Degraded intertidal rocky shores	10	2.62%
salinisation of soils, ground and surface water	10	2.62%
Poleward shifts in plant species	9	2.36%
Reduction of ecosystem services	7	1.84%
Shifting fisheries	7	1.84%
Changing distribution or abundance of harvested species	6	1.57%
Loss of sessile calcified organisms	6	1.57%
Reduction in calcifying organisms	6	1.57%
Water discolouration and foam accumulation, anoxia, contamination of seafood with toxins, disruption of food webs and massive large-scale mortality of marine biota	6	1.57%
Increased higher extreme sea levels associated with tropical cyclones	4	1.05%
Land loss	4	1.05%
Reduced habitat, biodiversity, and ecosystem services	4	1.05%
Diminished access to fishing or hunting areas	3	0.79%

Increased eutrophication	3	0.79%
Increased exposure to water borne disease	2	0.52%
Reduced marine animal biomass	2	0.52%
Reduction in marine animal biomass	2	0.52%
Challenges to fisheries economic value	1	0.26%
Challenges to fisheries management	1	0.26%
Changes in community composition	1	0.26%
Changing mobility and residence patterns (of people)	1	0.26%
Habitat loss	1	0.26%
Reduction in sandy beaches	1	0.26%
Grand Total	**381**	**100.00%**

Table 6.2 shows the receptors that occur in EIP chains tagged as human security, with the four most frequently occurring receptors accounting for just over two thirds of all EIP chains receptors. 'Reduced food security' strongly links the receptors of human security and economic security (this will be discussed more in the next chapter) which showed that not only environmental security is linked to human security, but that human security is linked to economic security. This provides further reinforcement for the argument that environmental security provides the basis for maritime security which supports human security, which in turn supports economic security (see Figure 2.5 – maritime security as a pyramid).

Preceding the main 'receptors' occurring in EIP chains for human security, were for the 'receptor' of 'Reduced food security' the 'pathways' of Biodiversity loss', 'Changes in coastal ecosystem', and 'Degraded Intertidal rocky shores'. For the 'receptor' of 'Reduced aesthetic aspects, reduced marine recreational activities' the main pathways are 'Biodiversity loss', and 'Changes in coastal ecosystem' and for the 'receptor' of 'Erosion of indigenous culture and knowledge' the main pathways are 'Biodiversity loss', 'Changes in coastal ecosystem', and 'Degraded Intertidal rocky shores'.

Table 6.2 – Human security 'receptors'

Receptor	Number of occurrences	Frequency of occurrence
Reduced food security	100	26.25%
Reduced aesthetic aspects, reduced marine recreational activities	65	17.06%
Erosion of indigenous culture and knowledge	50	13.12%

Increased vulnerability of coastal communities (including indigenous peoples)	47	12.34%
Reduced access to traditional food	28	7.35%
Inland shits in plant species distributions	12	3.15%
Increasing and worsening harmful algal blooms and pathogenic organisms in estuaries	9	2.36%
Challenges to international and national ocean and fisheries governance	8	2.10%
Reduced production	6	1.57%
Shifts in Species composition, abundance and biomass production of ecosystems	6	1.57%
Shifts poleward in distribution of seagrass meadows and kelp forests	6	1.57%
Increasing intensity of multiple extreme events	5	1.31%
Reduced aesthetic aspects and spiritual appreciation of ecosystems	4	1.05%
Reduced income, livelihood and food security	4	1.05%
Increasing and worsening harmful algal blooms and pathogenic organisms in coastal areas	3	0.79%
Reduced ecosystem functioning	3	0.79%
Reduced food Safety	3	0.79%
Reduced marine recreational activities	3	0.79%
Reduction in livelihoods	3	0.79%
Shifting the biogeography of fishes and invertebrates stocks	3	0.79%
Changes in land use	2	0.52%
Degraded ground water quality	2	0.52%
Degraded soil	2	0.52%
Exacerbated costal hazards	2	0.52%
Increased frequency of vibrio-related disease	2	0.52%
Loss of freshwater fish species	1	0.26%
Potential change in jurisdictions	1	0.26%
Reduced income and livelihood and food security	1	0.26%
Grand Total	**381**	**100.00%**

Table 6.3 shows the impacts occurring in the EIP chains tagged against human security, with the three most frequently occurring 'impacts' being 'loss of human well-being', 'food insecurity', and 'Loss of culture and identity'. These 'impacts' account for 73.21 percent of the EIP chains. Many of the impacts tagged as human security will influence people's mental health such as well-being, culture and identity, economic and livelihoods, and health issues. 'Water insecurity' is also attributable to human security but it has a much lower occurrence

as the ‘impact’ for EIP chains that are tagged against human security than it does as an ‘impact’ for EIP chains tagged against environmental security ‘impacts’.

The main ‘receptors’ for the ‘impacts’ occurring in EIP chains tagged against human security are for the ‘impact’ of ‘Loss of human well-being’ the main ‘receptors’ are ‘Reduced aesthetic aspects, reduced marine recreational activities’, ‘Reduced food security’, and ‘Erosion of indigenous culture and knowledge’. For the ‘impact’ of ‘Food insecurity’ the main receptors are ‘Reduced food security’ and ‘Increased vulnerability of coastal communities (including indigenous peoples)’ and for the ‘impact’ of ‘Loss of culture and identity’ the main ‘receptors’ are ‘Reduced aesthetic aspects, reduced marine recreational activities’, ‘Reduced access to traditional food’, and ‘Erosion of indigenous culture and knowledge’.

Table 6.3 – Human security ‘impacts’

Impact	Number of occurrences	Frequency of occurrence
Loss of human well-being	156	40.94%
Food insecurity	72	18.90%
Loss of culture and Identity	67	17.59%
Economic uncertainty/insecurity	26	6.82%
Health insecurity	19	4.99%
Increase in non-communicable diseases	9	2.36%
Increased risk of potential conflicts between fishery users, communities and authorities	9	2.36%
Damage and loss of coastal properties and their value	7	1.84%
Reduced livelihood diversification	6	1.57%
Impact on dependent communities	3	0.79%
Damage to human activities	2	0.52%
Reduced coastal agriculture	2	0.52%
Water insecurity	2	0.52%
Negative impacts on fish-dependant communities	1	0.26%
Grand Total	**381**	**100.00%**

6.3 Feedback Loops

For human security, there are a couple of feedback loops which could be worth investigating in future studies which are:

- The impact of 'Loss of culture and Identity' to the receptor 'Erosion of indigenous culture and knowledge'

- The impact of 'Increased risk of potential conflicts between fishery users, communities and authorities' to the pathway 'Diminished access to fishing or hunting areas'
- The pathway of 'Biodiversity loss' to the pressure 'Biodiversity loss'

A visual representation of this can be seen in Figure 6.2.

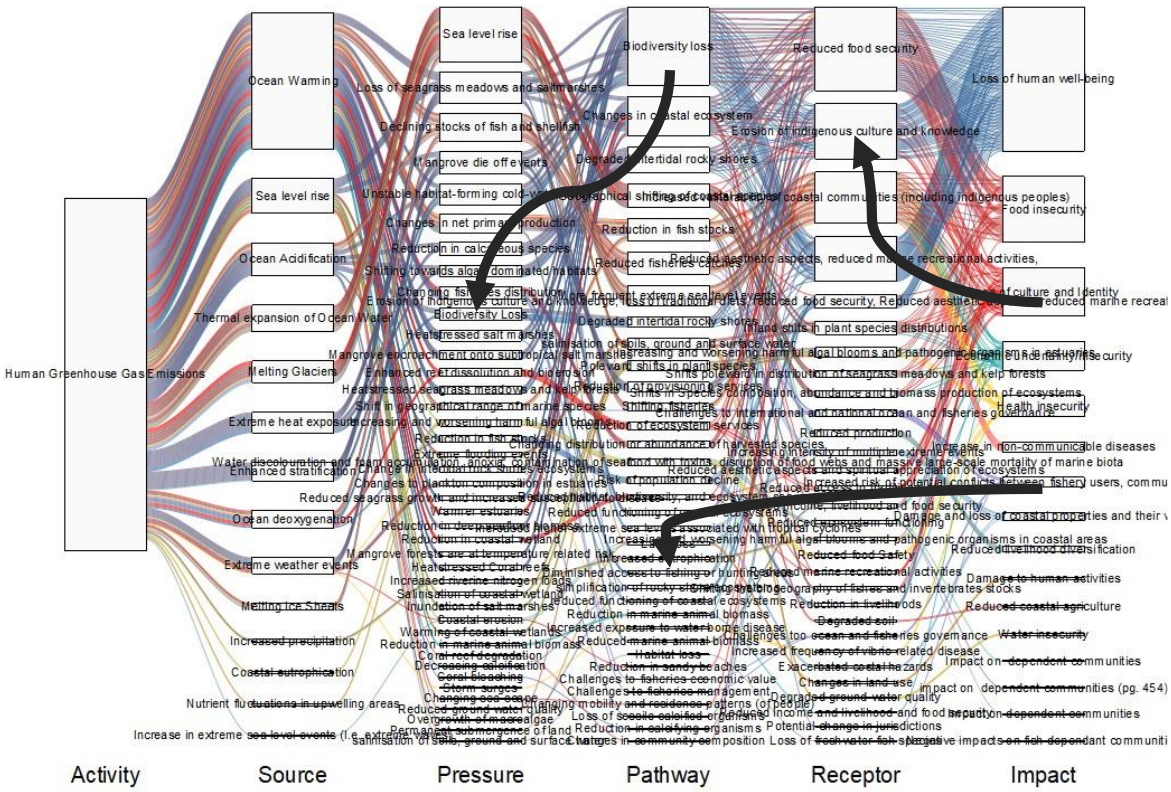

Figure 6.2 – A visual representation of human security's feedback loops[520]

A feedback loop of 'Biodiversity loss' has also been identified in Chapters 4 and 5; again this underlines the impact that the natural environment has on all aspects of maritime security. The second feedback loop identified above highlights the multiplicative links between the EIP chains by identifying that where the impact of the effects of climate change leads to conflict, this can lead to fewer fishing areas, forcing more people into competition over existing fishing areas and creating further conflict. Thus, these feedback loops will serve to exacerbate the relevant impacts that flow on from the point of the EIP chain that these feedback loops feed into.

[520] An enlargement of this figure can be found in Annex Ten

Figure 6.3 shows the feedback loop for the impact of 'Loss of culture and Identity' exacerbating and multiplying the receptor of 'Erosion of indigenous culture and knowledge'. As with the feedback loop example in Chapter 4, this shows an almost doubling of the number of EIPs that would flow through the receptor if taken into account.

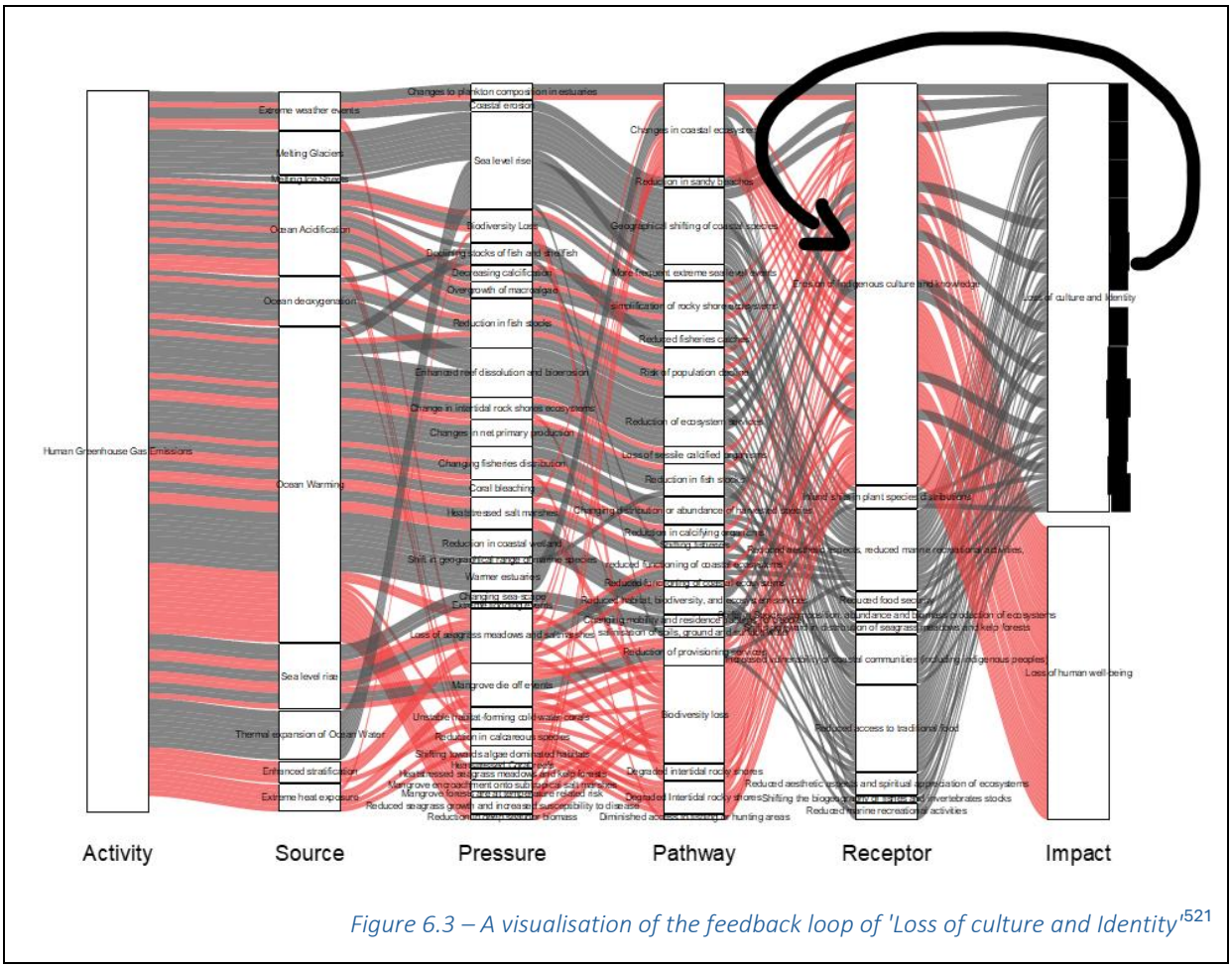

Figure 6.3 – A visualisation of the feedback loop of 'Loss of culture and Identity'[521]

6.4 Discussion

As shown earlier in this section when outlining the current state of human security in the Indo-Pacific, human security is vital to building a stable Indo-Pacific. Supporting people to feel more secure and stay in place is integral for supporting countries to have healthy and prosperous populations, but it will also reduce the potential for friction as people move to find a safer, more secure environment. As the impacts of climate change continue to

[521] An enlargement of this figure can be found in Annex Eleven

increase it will limit an individual's choices and impact people's spaces in new and severe ways.[522]

As outlined in the context setting section of this chapter, most of the Indo-Pacific population is highly dependent on fishing for the bulk of their diet and are increasingly vulnerable as climate impacts increase.[523] This is especially true for coastal communities in developing countries that are reliant upon the marine and coastal environments and the resources they provide.[524] Issues of food insecurity relating to the destruction of fish habitats will be most impacted in the coral triangle, where 76 percent of the world's coral reefs are located, as coral reefs are some of the most vulnerable marine ecosystems, especially where this relates to issues such as ocean warming.[525]

In this chapter, food security is discussed as a human security issue through and this can be seen in the NGAM findings and highlighted below in figure 6.4, which visualises all the EIP chains connected to the impact of 'Food insecurity', which is the second most frequent impact tagged against human security. Food insecurity can also be seen in some SIDS, as saltwater intrusion and degraded soil quality has already been observed as impacting taro farming.[526] The NGAM shows that this impact from climate change will negatively affect sustainable development efforts, especially within coastal communities.[527] Figure 6.4 supports the understanding of the interconnected and complex EIPs that contribute to this impact and makes the argument for supporting interventions that increase the food security of coastal communities such as, increasing the productivity of coastal ecosystems, increasing

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[522] Justin Michael James Dell, "Is the Dam Finally Breaking? Extreme Weather Events, Public Perceptions of Climate Change, and Policymaking," *Navigating a Global Crisis: Climate Change and NATO* Winter 2023 (2023).

[523] Security, *The World Climate and Security Report 2020*.
Vicky W. Y. Lam et al., "Climate change, tropical fisheries and prospects for sustainable development," *Nature Reviews Earth & Environment* 1, no. 9 (2020/09/01 2020), https://doi.org/10.1038/s43017-020-0071-9, https://doi.org/10.1038/s43017-020-0071-9.

[524] Lara Paige Brodie et al., "A new framework on climate-induced food-security risk for small-scale fishing communities in Tanzania," *Food Security* 16, no. 5 (2024/10/01 2024), https://doi.org/10.1007/s12571-024-01472-x, https://doi.org/10.1007/s12571-024-01472-x.

[525]"Where we work: Coral Triangle," Coral Reef Alliance, accessed 21 June, 2025, https://coral.org/en/where-we-work/coral-triangle/.
Lam et al., "Climate change, tropical fisheries and prospects for sustainable development."

[526] Ma Laurice Jamero et al., "In-situ adaptation against climate change can enable relocation of impoverished small islands," *Marine Policy* 108 (2019/10/01/ 2019), https://doi.org/https://doi.org/10.1016/j.marpol.2019.103614, https://www.sciencedirect.com/science/article/pii/S0308597X18303324.

[527] Lam et al., "Climate change, tropical fisheries and prospects for sustainable development."

the sustainable management of fisheries, increasing aquaculture production, and supporting climate-resilient subsistence agriculture.

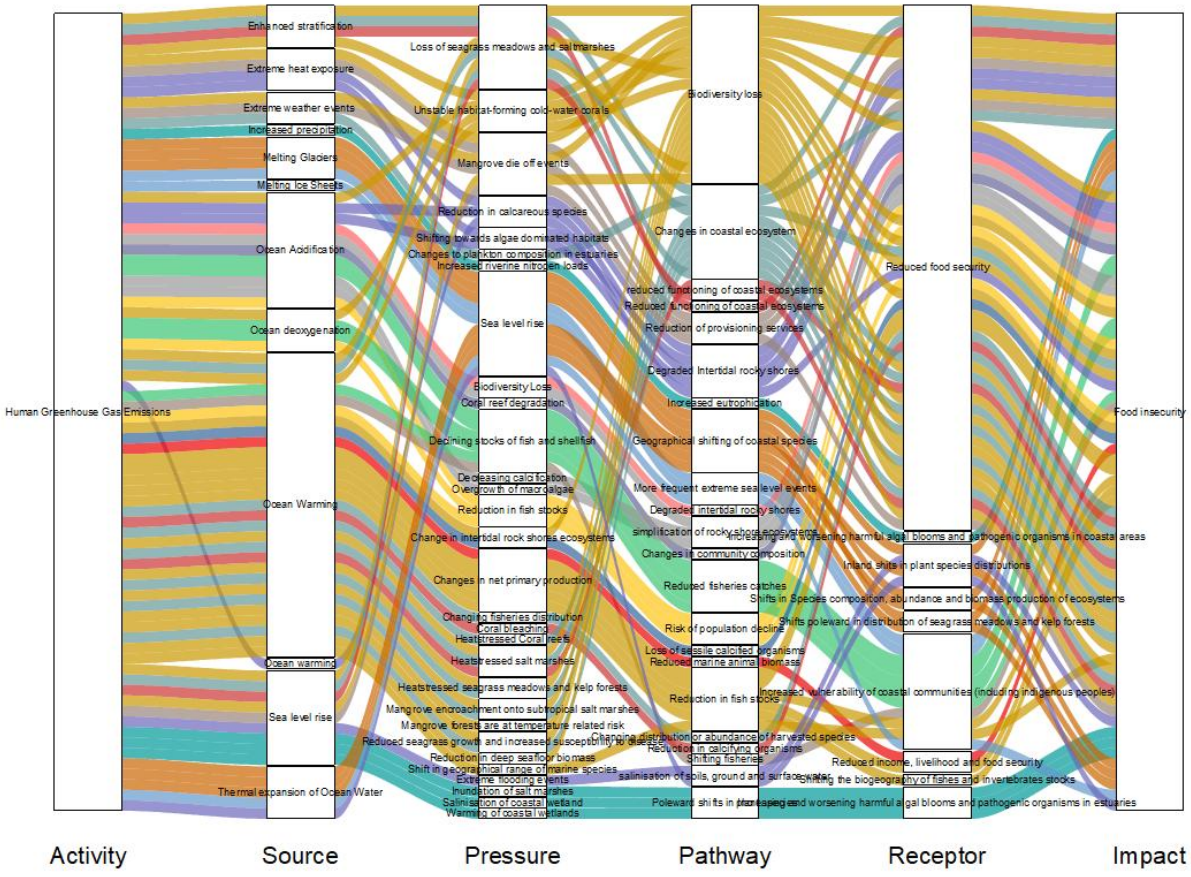

Figure 6.4 – A visualisation of the impact 'Food insecurity'[528]

Health insecurity is also an issue to pay attention to, as the occurrence of more warm and wet days bring with them impacts upon public health.[529] Human health, including mental health, is closely integrated and dependent on a healthy natural environment, planetary systems, and ecosystems.[530] Access to clean and healthy ocean areas are associated with increased mental wellbeing.[531] Within interviews, it was alluded to, that as these impacts increase, mental health will suffer.[532] This is because people will turn to alcohol and drug

[528] An enlargement of this figure can be found in Annex Twelve
[529] E. A. Hernández-Delgado, "The emerging threats of climate change on tropical coastal ecosystem services, public health, local economies and livelihood sustainability of small islands: Cumulative impacts and synergies," *Marine Pollution Bulletin* 101, no. 1 (2015/12/15/ 2015), https://doi.org/https://doi.org/10.1016/j.marpolbul.2015.09.018, https://www.sciencedirect.com/science/article/pii/S0025326X15300357.
[530] Eric C Ip and Daisy Cheung, "Mapping the legal foundations of planetary mental health," *Global Mental Health* 9 (2022).
[531] Ip and Cheung, "Mapping the legal foundations of planetary mental health."
[532] Interview H

abuse, as well as illegal ways to generate an economic livelihood. This will further increase gender disparities and gender-based violence, as well as reinforce existing social inequalities.[533] Supporting the implementation of climate-resilient health systems would be a good intervention and ensuring that these health systems are responsive to mental health issues and gender disparities arising from climate change will be crucial.

The ocean has always had larger cultural significance for coastal communities, especially those in the Pacific Islands, as it underpins their livelihoods by providing life, culture, and food.[534] Climate change is already impacting people's livelihoods and generating insecurity.[535] This will undoubtedly get worse, impacting many people's wellbeing, identity, and culture, as well as increasing their economic vulnerability and destroying their livelihoods. As people's legitimate economic opportunities decline, this increases the incentive for people to engage in illicit activities, this could equate to an uptick in piracy as coastal communities lose their access to legitimate economic opportunities.[536] Declining economic opportunities also opens an avenue for transnational organised crime (TNOC) and terrorist groups to take advantage of people's vulnerability through issues such as forced labour, exploitation, human trafficking and migration.[537] In interviews, human trafficking was identified as one of the biggest issues that people thought would be impacted by climate change, as people look for other economic activities and migration pathways.[538]

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[533] Bruce Burson et al., *Pacific Peoples and Climate-Related (Im)mobility: A Synthesis Report on Scale, Patter and Impact, Now and in the Future* (2024), https://www.mfat.govt.nz/assets/Environment/Climate-change/Pacific-Climate-Immobility-Synthesis-Report-30-June-2024.pdf.

[534] Quentin Hanich et al., "Small-scale fisheries under climate change in the Pacific Islands region," *Marine Policy* 88 (2018/02/01/ 2018), https://doi.org/https://doi.org/10.1016/j.marpol.2017.11.011, https://www.sciencedirect.com/science/article/pii/S0308597X17307340.

[535] Dhanasree Jayaram, *Climate-Fragility Risk Brief: South Asia* (adelphi research gGmbH, 2019), https://climate-diplomacy.org/magazine/conflict/climate-fragility-risk-brief-south-asia.

[536] Mazaris and Germond, "Bridging the gap between climate change and maritime security: Towards a comprehensive framework for planning."

[537] Pacific Islands Forum Secretariat, *Regional Transnational Organised Crime Disruption Strategy 2024 - 2028* (2024).

[538] Interview A, B, C, D, G, and K
Pacific Islands Forum Secretariat, *Regional Transnational Organised Crime Disruption Strategy 2024 - 2028*.

The link between TNOC and climate change is well understood in the Pacific sub-region of the Indo-Pacific, with the *Pacific Islands Forum Regional Transnational Organised Crime Disruption Strategy 2024-2028*, explicitly making the link between the two issues.[539]

TNOC while also a symptom of the impacts of climate change, is a good example of a feedback loop, as discussed in the context section, many of the activities undertaken as part of TNOC continue to exacerbate the impacts of climate change, especially those related to IUUF and contribute to increasing environmental degradation.Sea level rise is projected to impact countries across the Indo-Pacific affecting people in low lying SIDS but also millions of people in countries with low lying coastal areas such as Bangladesh, Vietnam, and Indonesia.[540] Sea level rise could cause migration can become a national security issue (and is discussed in Chapter 8), as seen through the Australian-Tuvalu Falepili Union, which includes migration pathways for Tuvaluans to Australia and Australian support for the Tuvalu Coastal Adaptation Project. In return for this, Australia will be given unprecedented influence over Tuvaluan security and sovereignty. This will increase the responsibilities of the Australian Defence Force, as it will need to exert its influence over the Tuvaluan maritime domain and EEZs.

Migration was heavily discussed in interviews as a human security impact stemming from climate change.[541] Migration does not come through very clearly in the NGMA and EIPs for Human security, but it can be viewed as a symptom that stems from impacts such as, loss of land, a lack of food and economic security as well as reduced livelihoods.[542] Illegal migration will contribute to the potential outbreak of conflict, which will increase the workload on navies' resources (this will be covered more in the national security section). Migrating communities also end up having worse health indicators than the communities that they

[539] Anna Powles and Jose Sousa-Santos, "Chapter 13: Climate Crisis, Geopolitical Vulnerability, Transnational Crime and Mitigating Responses," in *Pacific Ocean and Climate Crisis Assessment* (2024).
[540] Aditi Chatterjee, "Non-traditional Maritime Security Threats in the Indian Ocean Region," *Maritime affairs (New Delhi, India)* 10, no. 2 (2014), https://doi.org/10.1080/09733159.2014.972669.
R. S. Aswani, "Non-Traditional maritime security threats in the Indian Ocean Region: Policy alternatives," *Journal of public affairs* 22, no. 2 (2022), https://doi.org/10.1002/pa.2456.
[541] Interview C, D, E, F, G, H, J, and K
[542] Nicholas P. Simpson et al., "Research priorities for climate mobility," *One Earth* 7, no. 4 (2024/04/19/ 2024), https://doi.org/https://doi.org/10.1016/j.oneear.2024.02.002, https://www.sciencedirect.com/science/article/pii/S259033222400085X.
Celia McMichael, "Climatic and environmental change, migration, and health," *Annual Review of Public Health* 44, no. 1 (2023).

end up in.[543] This will amplify existing health outcome inequalities throughout the Indo-Pacific. Investing in interventions that support people to stay in place would require a focus on better health care, food and water security, and legitimate economic opportunities.

Attached to migration is the issue of stowaways. Stowaways cause issues in relation to human rights, but they also have a negative economic impact (and as such relate to economic security) on the ships that they stow away on. This is because these ships then get held up in port when stowaways are found, causing a reduction in productivity and losing sailing days as they sort out the issue of stowaways with the port state.

The cultural and traditional aspects of human life will also be impacted by climate change.[544] Along with the 'Loss of human wellbeing' being the most discussed 'impact' within the NGAM, the interviews conducted during this research served to illustrate the fact that communities would be impacted by climate change and that the cultural and traditional aspects would be affected as they would need to relocate ancestral graves that would be lost to sea level rise.[545] As the central precept of tradition and culture is related to place, people will lose their cultural and traditional ties as they migrate. The loss of culture, tradition and connection to a place has impacts on individuals' mental health, which contributes to the previously mentioned impacts on health inequalities and health security.[546] It was anecdotally referred to in interviews that this impact on mental health causes drinking problems and increases in gender-based violence, as people migrate and lose their connection to their culture, traditions and sense of place.[547]

The interviews also served to illustrate that issues surrounding gender inequality and women, peace and security occur frequently, and are important factors to build into a human understanding of the impacts of climate change.[548] Because climate change impacts are not equally distributed across genders, and as outlined previously, women are already

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[543] McMichael, "Climatic and environmental change, migration, and health."
Celia McMichael, Jon Barnett, and Anthony J McMichael, "An ill wind? Climate change, migration, and health," *Environmental health perspectives* 120, no. 5 (2012).
[544] Scott Allan Orr, Jenny Richards, and Sandra Fatorić, "Climate change and cultural heritage: A systematic literature review (2016–2020)," *The Historic Environment: Policy & Practice* 12, no. 3-4 (2021).
[545] Interview H
[546] Burson et al., *Pacific Peoples and Climate-Related (Im)mobility: A Synthesis Report on Scale, Patter and Impact, Now and in the Future*.
[547] Interview H
[548] Interview H

subjected to worse outcomes and this will be further impacted by climate change.[549] As "women are the linchpin of society" investing in interventions that support beneficial outcomes for women will act to mitigate the negative impacts on society.[550]

Women and youth are particularly vulnerable following disasters and with disasters predicted to increase in frequency and severity, this will mean we will likely see an increase in vulnerability for women and youth.[551] An interesting observation from the interviews was that single women are less able to prepare for disasters and in general, women face a disproportionate burden in the preparation and related stress of disasters. This is especially true in relation to disasters which impact the ability of women to engage in subsistence agriculture which many women have to undertake while their husbands are out fishing or working.

The impacts of climate change on coastal communities, such as 'Loss of human well-being', 'Food insecurity', 'Loss of culture and Identity', 'Economic uncertainty/insecurity', 'Health insecurity', and 'Increase in non-communicable diseases' can impact how family groups interact with each other causing friction within them.[552] At a household level, it can increase occurrences of gender-based violence; on the wider family group it can cause competition for food, water and land, and within this resource competition will become an increasingly serious problem as it impacts, communities and countries.[553] Developing interventions that focus on supporting a healthy natural environment will in turn support better human security outcomes and studies have shown that MPAs can have positive impacts on human wellbeing which bolsters the links between the dimensions of environmental security and

[549] Australian Strategic Policy Institute, *The geopolitics of climate and security in the Indo-Pacific*. "How Pacific Women View Human Security in the Context of Climate-Related Mobility," Regional Office for Asia and the Pacific, accessed 21 June, 2025, https://roasiapacific.iom.int/stories/how-pacific-women-view-human-security-context-climate-related-mobility#:~:text=Women%20living%20in%20the%20Pacific,from%20the%20COVID%2D19%20lockdown.

[550] Interview H

[551] Sarah Brown et al., *Gender and Age Inequality of Disaster Risk: Research Paper*, UNICEF and UN Women (2019).

[552] Jorge Cuartas et al., "Climate Change, Families, and Human Development: Review of the Evidence," *Journal of Cognition and Development* (2025), https://doi.org/10.1080/15248372.2025.2468187, https://doi.org/10.1080/15248372.2025.2468187.

[553] Interview H

human security.[554] The majority of the EIPs tagged as impacting human security have a pathway that is in some way related to environmental factors such as 'Biodiversity loss' and 'changes in coastal ecosystems'. This supports the reconceptualization of maritime security being built on a base of environmental security and further supports the argument for interventions that focus on security the natural environment such as MPAs and other related NbS.

Maladaptation of climate policies and the response to climate impacts is a big issue, especially in the way that the policies introduced to respond to climate change may further infringe upon individual freedoms and choices.

6.5 Conclusion

This chapter has illustrated that within the Indo-Pacific region, in coastal communities peoples' wellbeing and food security will be severely impacted by the effects of climate change, further supporting the need for the sustainable management of fisheries, increasing aquaculture production, and supporting climate-resilient subsistence agriculture.

Within the Indo-Pacific there are countries that will struggle to maintain social cohesion and structures and the impacts of the effects of climate change will add to these stressors especially as they are synergistic, additive, and multiplicative in nature. It will be important to support people to stay in place and promote socially cohesive communities, which includes ensuring that women have representation within decision-making on climate and maritime issues, as well as ensuring that gender inequality is factored into analysis that is done when investigating human security issues. This will help to minimise those migrating both legally and illegally, those engaging in illegal or illegitimate means of generating a

[554] Dana Baker, Nathan J. Bennett, and Natalie C. Ban, "Human well-being outcomes of large-scale marine protected areas," *Marine Policy* 173 (2025/03/01/ 2025), https://doi.org/https://doi.org/10.1016/j.marpol.2024.106579, https://www.sciencedirect.com/science/article/pii/S0308597X24005797.
Zachary J. Cannizzo et al., "Future-proofing the global system of marine protected areas: Integrating climate change into planning and management," *Marine Policy* 171 (2025/01/01/ 2025), https://doi.org/https://doi.org/10.1016/j.marpol.2024.106420, https://www.sciencedirect.com/science/article/pii/S0308597X24004202.

livelihood, promote a mentally healthy society which doesn't delve into alcoholism, or gender-based violence, and overall reduce the impact on the health care system.

Chapter 6 also shows the flow of effects and linkages between environmental security and human security, which situates human security as the next dimension of maritime security and highlights its crucial role in building a secure maritime domain. This came through clearly with human wellbeing and the interrelated issues of losing one's culture and identity, being reoccurring issues that flow on from biodiversity loss. This in turn is supportive of the general widening in scope for security as it looks to incorporate 'non-traditional' issues under a more holistic definition of security. This flow from environmental security to human security can be seen by through the feedback loops concerned with biodiversity loss. This is because biodiversity loss is a preceding factor for a number of the main pathways and receptors in EIP chains that are tagged against human security. Equally, the linkages from human security to economic security are also highlighted in this chapter with issues relating to food security being the most frequently occurring receptor and second most occurring impact within EIP chains tagged against human security.

The next chapter will continue to make the links between environmental and human security and economic security.

Chapter 7: Economic Security

The Indo-Pacific is a maritime super region, and as shown in Chapter 2 its economy is intrinsically intertwined with the ocean and the maritime and coastal ecosystems that it encompasses. Countries within the Indo-Pacific include those with a range of economies ranging from the most advanced and developed, to those that are still developing and heavily dependent on aid.[555] With 60 percent of Asia-Pacific's GDP vulnerable to impacts stemming from biodiversity loss,[556] there is a need to pay attention to the linkages between economic security and environmental security especially in the maritime domain.

The maritime domain is also fundamentally important in the Indo-Pacific, not only because of the critical supply chains that transect it and that around 80 percent of global trade flows through, but also because many fast-growing sectors of its economy are dependent upon it, including transportation, port infrastructure, energy, fisheries, and tourism.[557] Voyer et al. highlighted this fact when they published their 2018 study, indicating that the "Blue Economy and Maritime Security" are "mutually co-dependent" and rely on the "sustainable use and environmental protection as necessary to secure the ongoing availability of the opportunities provided by the oceans."[558]

The focus of this chapter is to outline the current Indo-Pacific context of the economic security dimension of maritime security. This will be achieved by disseminating the findings that were developed through the NGAM process as outlined in Chapter 4 showing the impacts most strongly associated with climate change, such as reducing communities' ability to diversify their livelihoods, reducing tourism especially tourism which is based around the natural environment, and damage to built infrastructure in coastal areas. Finally, it will analyse and discuss these findings in the context of the interviews undertaken, and the

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[555] Catalina Udani and Thomas J. Shattuck, *Economic Security and the Future of the Global Order in the Indo-Pacific*, Perry World House (2023), https://global.upenn.edu/perryworldhouse/economic-security-and-future-global-order-indo-pacific.

[556] Khatri and Howard, "How to address Asia Pacific's biodiversity crisis and encourage nature-positive growth."

[557] "Geo-economic trends and maritime supply chain resilience: What's next for the Indo-Pacific?," Melbourne Aisa Review, 2024, accessed 21 June, 2025, https://melbourneasiareview.edu.au/geo-economic-trends-and-maritime-supply-chain-resilience-whats-next-for-the-indo-pacific/.
Parashar, "Blue Economy in the Indo-Pacific: The Need to Create a Cooperative Framework."

[558] Michelle Voyer et al., "Maritime security and the Blue Economy: intersections and interdependencies in the Indian Ocean," *Journal of the Indian Ocean Region* 14, no. 1 (2018/01/02 2018), https://doi.org/10.1080/19480881.2018.1418155, https://doi.org/10.1080/19480881.2018.1418155.

Indo-Pacific context to identify where the effects of climate change might impact economic security within the maritime domain. Through the analysis of the data collected and the current context of the Indo-Pacific, it will show that the best areas for interventions to increase economic resilience in the region in the face of climate change are to support sustainable fisheries management, increase monitoring of IUUF, support economic diversification, and support climate-resilient supply chains.

7.1 The Economic Security Environment in the Indo-Pacific

The economic security dimension of maritime security is the third level of the maritime security pyramid shown in Chapter 2 following on from the base of environmental security and the second level of human security. The economic security dimension of maritime security is where more 'traditional' aspects of security come into start to be impacted by the effects of climate change, especially within the maritime domain.

Some argue that the economic case for an Indo-Pacific region is absent and the main economic activity that happens to connect the Indo-Pacific is transitory shipping, stating that intra-Indo-Pacific economic interactions are minimal when you start looking beyond previous definitions of the Asia-Pacific.[559] This section, however, will provide further support to the argument that the Indo-Pacific is becoming the economic centre of the globe.[560] This sub-section goes on to talk about some of the key issues to the economic security dimension of maritime security within the Indo-Pacific.

7.1.1 Global Supply Chains

Commercial Shipping

The fact that the vast majority of the countries in the Indo-Pacific have access to a coastline, means that shipping and maritime trade plays a highly significant role in the context of the supply chains within the Indo-Pacific region.[561] However, under a changing climate the

[559] Jeffrey D. Wilson, "Rescaling to the Indo-Pacific: From Economic to Security-Driven Regionalism in Asia," *East Asia* 35, no. 2 (2018/06/01 2018), https://doi.org/10.1007/s12140-018-9285-6, https://doi.org/10.1007/s12140-018-9285-6.
[560] Bharti, Kumari, and Bharti, "Indo-French Comprehensive Bilateral Cooperation: A Roadmap to Indo-Pacific Parks Partnership and Beyond."
[561] Letts, "Maritime security in South East Asia."

shipping industry faces a complex and uneasy future, which will require significant change and adaptation, especially with relation to future fuel sources.[562]

The Indo-Pacific is a global centre for trade with 60 percent of global maritime trade passing through the Indo-Pacific.[563] The sea routes of the Indian and Pacific oceans are increasing in importance.[564] This is because they are crucial to the energy security of many countries within the Indo-Pacific.[565] Concerning global shipping, the Indo-Pacific is home to many strategic choke points that could derail the global economy, the most important of which are the Bal al Mandeb and the Malacca Strait.[566] In 2024, there is currently a crisis in the Red Sea where the Houthis a rebel group backed by Iran are attacking commercial shipping as ships pass through the Bab al-Mandab Strait.[567] The current crisis has become increasingly volatile since the outbreak of Israel's war against Palestine in the Gaza Strip.[568] This geopolitical environment in the Red Sea highlights the vulnerabilities of sea routes that pass through choke points and how this impacts global supply chains when they are disrupted.

Shipping, and to a greater extent IUU fishing, go hand in hand with the trafficking of illicit goods and people.[569] These constitute a significant threat in the Indo-Pacific in and of themselves, but also these activities tend to go hand in hand with terrorist and TNOC groups.[570] This is an example of an issue which cuts across human, economic, and national security.

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[562] Alice Larkin, Tristan Smith, and Paul Wrobel, "Shipping in changing climates," *Marine Policy* 75 (2017/01/01/ 2017), https://doi.org/https://doi.org/10.1016/j.marpol.2016.05.033, https://www.sciencedirect.com/science/article/pii/S0308597X16303207.
[563] "The regional economic order: four scenarios," ANU National Security College, accessed 15 May, 2024, https://futureshub.anu.edu.au/the-regional-economic-order-four-scenarios/.
[564] Bharti, Kumari, and Bharti, "Indo-French Comprehensive Bilateral Cooperation: A Roadmap to Indo-Pacific Parks Partnership and Beyond."
[565] Nicolas, "The regional economic order: four scenarios."
[566] Nicolas, "The regional economic order: four scenarios."
[567] "Who are the Houthis and why are they attacking Red Sea ships?," BBC, 2024, accessed 11 August, 2024, https://www.bbc.com/news/world-middle-east-67614911.
[568] "Who are the Houthis and why are they attacking Red Sea ships?."
[569] Joan P. Mileski, Cassia Bomer Galvao, and Zaida Denise Forester, "Human trafficking in the commercial fishing industry: A multiple case study analysis," *Marine Policy* 116 (2020/06/01/ 2020), https://doi.org/https://doi.org/10.1016/j.marpol.2019.103616, https://www.sciencedirect.com/science/article/pii/S0308597X19300533.
[570] Letts, "Maritime security in South East Asia."

Maritime Infrastructure

Maritime infrastructure including the security and distribution of ports, resource exploration platforms, and submarine telecommunications cables, all form an important part of economic security. Indeed, ports, being coastal in nature, are the lifeblood of many Indo-Pacific nations big or small and within the region, there are nine of the ten busiest ports in the world.[571] Ports are critical to the continued functioning of global supply chains, but the risks to them are yet to be fully considered. Although, it has been estimated that at least 85 percent of global ports are exposed to at least three natural hazards with 32 percent at risk of damage from tropical cyclones and extreme weather events.[572]

Submarine cables account for "Over 95 per cent of international communications and data transfers globally travel through submarine data cables" with many Indo-Pacific countries relying on a singular cable for their internet.[573] Many submarine cables also have choke points which present big vulnerabilities, and many of these follow the same routes as shipping lanes. With the internet underpinning much of the economic activity that is undertaken globally, especially following the rise of cloud computing, ensuring the security of submarine cables is increasingly important.[574] Submarine cables will also be further discussed in the national security section as this is not just an economic security issue.

7.1.2 Ocean Resources (extraction)

Harvesting and extracting resources from the ocean overwhelmingly contributes to the economic security of the Indo-Pacific.

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[571] To Anh Tuan, "Maritime security in the Indo-Pacific: Mixed opportunities and challenges from connectivity strategies," *Responding to the Geopolitics of Connectivity* (2020).
[572] Jasper Verschuur et al., "Multi-hazard risk to global port infrastructure and resulting trade and logistics losses," *Communications Earth & Environment* 4, no. 1 (2023/01/12 2023), https://doi.org/10.1038/s43247-022-00656-7, https://doi.org/10.1038/s43247-022-00656-7.
[573] Samuel Bashfield and Anthony Bergin, *Options for safeguarding undersea critical infrastructure: Australia and Indo-Pacific submarine cables* Australian National University National Security College (2022).
[574] "Securing the backbone: Security challenges to and governance of submarine cables in the Indo-Pacific," Melbourne Asia Review, 2024, accessed 24 April, 2025, https://melbourneasiareview.edu.au/securing-the-backbone-security-challenges-to-and-governance-of-submarine-cables-in-the-indo-pacific/.

Fishing

As noted in Chapter 5, the environmental security of the maritime domain is paramount, and this in particularly relevant when it comes to fishing, as ocean connectivity it crucial to supporting healthy reef fish populations.[575] Also noted in Chapter 6 is the crucial role fisheries play in supporting human security. This is particularly true for the Western Indian Ocean where small-scale fisheries provide " up to 99% of protein intake and around 82% of household income".[576] However, due to climate change fisheries within the Pacific Ocean are changing as "marine species are shifting their distributions generally poleward and into deeper waters, and are shrinking in average body size, causing impacts on fisheries yields, composition and revenues".[577]

Fishing is the largest activity based around extracting wildlife for economic gain and it plays a massive part in the economic security of the Indo-Pacific.[578] Within the Indo-Pacific region, around 120 million people rely on small-scale fisheries as their primary means of economic livelihood.[579] This is especially true in SIDS, like Mauritius where artisanal fisheries are highly important for economic opportunities.[580] In Southeast Asia, some estimates believe that several fisheries have been overfished to the point that they are down to less than 15 percent of their original stock levels.[581] In the Pacific Ocean, the El Niño-Southern Oscillation (ENSO) is already impacting the efficiency of fishery resources, especially those closest to the equator.[582]

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[575] Laura M Warmuth et al., "Environmental change and connectivity drive coral reef fish abundance in the Western Indian Ocean," *ICES Journal of Marine Science* 81, no. 9 (2024), https://doi.org/10.1093/icesjms/fsae125, https://doi.org/10.1093/icesjms/fsae125.
[576] Warmuth et al., "Environmental change and connectivity drive coral reef fish abundance in the Western Indian Ocean."
[577] Paolo Cappa et al., "Climate change undermines seafood micronutrient supply from wild-capture fisheries in Southeast Asia and Pacific Island countries," *Science of The Total Environment* 955 (2024/12/10/ 2024), https://doi.org/https://doi.org/10.1016/j.scitotenv.2024.177024, https://www.sciencedirect.com/science/article/pii/S004896972407181X.
[578] "Fisheries Partnerships," 2020, accessed 19 May, 2024, https://ipdefenseforum.com/2020/01/fisheries-partnerships/.
[579] Parashar, "Blue Economy in the Indo-Pacific: The Need to Create a Cooperative Framework."
[580] Chandani Appadoo et al., "Artisanal fishers in small island developing states and their perception of environmental change: the case study of Mauritius," *Reviews in Fish Biology and Fisheries* 33, no. 3 (2023/09/01 2023), https://doi.org/10.1007/s11160-022-09735-6, https://doi.org/10.1007/s11160-022-09735-6.
[581] Pomeroy, Parks, and Green, "Fisheries Partnerships."
[582] Xiaohan Fang and Ying Zhang, "The impact of climate change and economic development on the catches of small pelagic fisheries," *Marine Policy* 175 (2025/05/01/ 2025),

IUUF is a big issue in maritime security, with global estimates stating that about 20 percent of all fish sold are caught illegally.[583] It comprises many different activities ranging from state-sponsored fishing fleets to TNOC, to individuals fishing for their own livelihoods, with IUUF activities happening across the maritime domain.[584] IUUF accounts for USD 50 billion each year "making it the third most lucrative natural resource crime after timber and mining."[585] In the IUU Fishing Risk Index 2023 update, "Asia was the region with the highest risk, and the West Indian Ocean was the ocean basin of most concern."[586]

IUUF also converges on a national security issue because China has a massive distant-water fishing fleet of about 4,600 vessels which often encroach on other countries' EEZs in search of fish.[587] This will be discussed in the national security section. However, IUUF needs to also be tackled alongside TNOC as IUUF converges with other crimes happening at sea such as human, drug and wildlife trafficking, and forced labour.[588]

Aquaculture

Globally, the demand for and on aquaculture is increasing.[589] The Indo-Pacific is the most important region globally for aquaculture, generating 90 percent of global aquaculture production.[590] Within the Indo-Pacific 20 million people rely on aquaculture as their main

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https://doi.org/https://doi.org/10.1016/j.marpol.2025.106631, https://www.sciencedirect.com/science/article/pii/S0308597X25000466.

[583] "Ocean of Data," 2023, accessed 18 May, 2024, https://ipdefenseforum.com/2023/12/ocean-of-data/.

[584] Lauren Young, Cathy Haenlein, and Grace Evans, *Future Illegal, Unreported and Unregulated Fishing Trends in a Warming World: A Global Horizon Scan*, The Royal United Services Institute (2023).

[585] "In Hot Water: Climate Change, IUU Fishing and Illicit Finance," RUSI, 2023, accessed 18 May, 2024, https://rusi.org/explore-our-research/publications/commentary/hot-water-climate-change-iuu-fishing-and-illicit-finance.

[586] G. Macfadyen and G Hosch, *The Illegal, Unreported and Unregulated Fishing Risk index 2023 Update*, Poseidon Aquatic Resource Management Limited and the Global Initiative Against Transnational Organized Crime (2023).

[587] Indo-Pacific Defense Forum, "Ocean of Data."

[588] Indo-Pacific Defense Forum, "Ocean of Data."

[589] M. Ruckelshaus et al., "Securing ocean benefits for society in the face of climate change," *Marine Policy* 40 (2013/07/01/ 2013), https://doi.org/https://doi.org/10.1016/j.marpol.2013.01.009, https://www.sciencedirect.com/science/article/pii/S0308597X13000183.

[590] "Sustainable Aquaculture = Healthy Food for Asia Pacific," accessed 21 May, 2024, https://www.nature.org/en-us/about-us/where-we-work/asia-pacific/the-pacific-islands/stories-in-the-pacific-islands/aquaculture-in-palau/.

Ibon Galparsoro et al., "Assessment tool addresses implementation challenges of ecosystem-based management principles in marine spatial planning processes," *Communications Earth & Environment* 6, no. 1 (2025/01/28 2025), https://doi.org/10.1038/s43247-024-01975-7, https://doi.org/10.1038/s43247-024-01975-7.

source of economic livelihoods.[591] Aquaculture can support progress towards most of the SDGs and although aquaculture is still a small part of many countries' economic and food security, it has the potential to meaningfully contribute to a country's economic security and Pacific Island countries especially are looking into this.[592] However, aquaculture can present a risk of invasive species, especially where it involves the farming of introduced exotic species.[593]

Deep sea mining

Deep-sea mining (also discussed in Chapter 5: Environmental Security and is an issue that highlights the links between environmental security and economic security) has increasingly garnered attention, especially as the green transition picks up pace and the undersea polymetallic nodules which contain cobalt, nickel, and manganese become valuable sources of these minerals which are critical to things such as electric car batteries.[594] It is thought that much of the deep-sea mining will happen in the Pacific Ocean, in an area called the Clarion-Clipperton Zone, which has one of the biggest clusters of polymetallic nodules.[595] This has led to countries such as China, investing in deep-sea submersibles and unmanned underwater vehicles, which will play an important part in extracting precious metals from the sea floor.[596]

Deep-sea mining has come up against resistance from many countries, some of which are in the Pacific because they are unsure whether this extraction will actually provide benefit to their communities.[597] Others are actively exploring how to engage in deep-sea mining,

[591] Parashar, "Blue Economy in the Indo-Pacific: The Need to Create a Cooperative Framework."
[592] Monal M Lal et al., "An assessment of the aquaculture potential of indigenous freshwater food fish of Fiji, Papua New Guinea, Vanuatu, Solomon Islands, Samoa and Tonga as alternatives to farming of tilapia," *Reviews in Aquaculture* 15, no. 2 (2023).
[593] Lal et al., "An assessment of the aquaculture potential of indigenous freshwater food fish of Fiji, Papua New Guinea, Vanuatu, Solomon Islands, Samoa and Tonga as alternatives to farming of tilapia."
[594] "Why Pacific Island States Are Concerned About Deep-Sea Mining," 2023, accessed 19 May, 2024, https://carnegieendowment.org/posts/2023/11/why-pacific-island-states-are-concerned-about-deep-sea-mining?lang=en.
[595] Prasad and Hardy, "Why Pacific Island States Are Concerned About Deep-Sea Mining."
[596] "Scramble for the Indo-Pacific Seabed," The Diplomat, 2019, accessed 19 May, 2024, https://thediplomat.com/2019/11/scramble-for-the-indo-pacific-seabed/.
[597] Long, "Scramble for the Indo-Pacific Seabed."

which the Cook Islands, Kiribati, Tonga, and Nauru, all sponsoring exploration permits in the Clarion-Clipperton Fracture Zone.[598]

Energy

Energy plays a significant role in the economic security provided by the oceans both in terms of the exploration of fossil fuels, and also in relation to the potential of renewable energy generation. The Asia Pacific "consumes roughly 25% of world oil, 45% of coal and 10% of the natural gas."[599] The region's energy consumption is expected to grow as economic and population growth continues.[600] Of the oil that is consumed in the Asia Pacific it is thought that 80 percent of it comes from the Persian Gulf.[601] As a result, this makes these sea lanes of communication very important to the economic and energy security of the Indo-Pacific.

7.1.3 Tourism

The Indo-Pacific is one of the most abundant regions for tourism and with China's economic rise, it has become a very fruitful enterprise within the region.[602] Tourism plays an important role in many of the economies within the Indo-Pacific, especially those of SIDS which factor tourism as an opportunity for increasing their income.[603] Globally coastal areas attract roughly 50 percent of all international tourists.[604] This makes healthy marine ecosystems crucial to the communities and countries that depend on them, so the

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[598] "Deep sea mining—can it sink the visions in Pacific regionalism?," Griffith Asia Insights, 2022, accessed 19 May, 2024, https://blogs.griffith.edu.au/asiainsights/deep-sea-mining-can-it-sink-the-visions-in-pacific-regionalism/.

[599] "Changes for the Asia Pacific Oil and Gas Segment," Enterprise Risk Management Academy, accessed 29 September, 2023, https://www.erm-academy.org/publication/risk-management-article/changes-asia-pacific-oil-and-gas-segment/; John Connell, *Blue ocean tourism in Asia and the Pacific: Trends and directions before the coronavirus crisis*, ADBI Working Paper Series (2020).

[600] Jeffrey B. Kucharski, *The evolution of energy security in the Indo-Pacific: Why is it important for Canada?*, Macdonald-Laurier Institute (2022), https://macdonaldlaurier.ca/wp-content/uploads/2022/02/Feb2022_Evolution_energy-security_Indo-Pacific_Kucharski_COMMENTARY_FWeb.pdf?mc_cid=82a88f17e7&mc_eid=UNIQID.

[601] Corbett, "Changes for the Asia Pacific Oil and Gas Segment."

[602] Ning An and Jason Dittmer, "The Geopolitics of Tourism in the Indo-Pacific," *Geopolitics* 28, no. 4 (2023/08/08 2023), https://doi.org/10.1080/14650045.2023.2200940, https://doi.org/10.1080/14650045.2023.2200940; Lauren Young and Alfonso Daniels, "In Hot Water: Climate Change, IUU Fishing and Illicit Finance."

[603] Connell, *Blue ocean tourism in Asia and the Pacific: Trends and directions before the coronavirus crisis*.

[604] Secretariat of the Pacific Regional Environment Programme, *Fact Sheet - Pacific Marine and Coastal Tourism* (2022), https://pacific-data.sprep.org/dataset/pacific-marine-and-coastal-tourism.

sustainability and security of these ecosystems is an economic (as well as cultural) priority for countries with coastal ecosystems.[605,]

China understands the influence it can generate through leveraging the outward tourism of its citizens and uses this outward tourism to increase its diplomatic and cultural ties with other countries.[606] It is projected that China's outward trips will surpass its pre-COVID level by 2025.[607]

Cruise ships also play a role in tourism in the maritime domain, and they can provide short-term economic opportunities to land-based communities in areas where cruise ships undertake onshore excursions.[608] While cruise ships have brought about some economic opportunity to areas that were otherwise overlooked, it has in some places put increasing pressure on areas to cope with the influx of tourists.[609] As shown with the outbreak of COVID-19 when some cruise ships struggled to dock and disembark their passengers, cruise ships are an area of concern for maritime security, not to mention their impact on the welfare of seafarers as cruise ships are poorly regulated workplaces and they're generally operated under a flag of convenience.[610]

7.1.4 Illegal Economic Activities

Piracy

Piracy, robbery, and violence at sea, pose a grave threat to all those that use the ocean for economic gain. It is estimated that piracy negatively impacts the global economy, to the tune of up to USD 12 billion a year.[611] Starting in the 1990s there was a steep increase in the occurrence of piracy in Southeast Asia that peaked in 2015 and since then there has been a

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[605] Secretariat of the Pacific Regional Environment Programme, *Fact Sheet - Pacific Marine and Coastal Tourism*.
Connell, *Blue ocean tourism in Asia and the Pacific: Trends and directions before the coronavirus crisis*.
[606] "2023: A vital year for tourism in Asia Pacific," Asia Media Centre, 2023, accessed 19 May, 2024, https://www.asiamediacentre.org.nz/features/2023-a-vital-year-for-tourism-in-asia-pacific/.
[607] Bowerman, "2023: A vital year for tourism in Asia Pacific."
[608] Connell, *Blue ocean tourism in Asia and the Pacific: Trends and directions before the coronavirus crisis*.
[609] Connell, *Blue ocean tourism in Asia and the Pacific: Trends and directions before the coronavirus crisis*.
[610] Connell, *Blue ocean tourism in Asia and the Pacific: Trends and directions before the coronavirus crisis*.
[611] Nitya Labh Darshana M. Baruah, Jessica Greely, *Working Paper: Mapping the Indian Ocean Region* (Carnegie Endowment for International Peace, 2023), https://carnegieendowment.org/files/Baruah_IO_final_6-28.pdf.

general decrease in piracy in Southeast Asia.[612] Most piracy that takes place now in Southeast Asia is limited to petty theft and in recent times, the Singapore Strait has seen an increase in the number of piracy and robbery attempts with 2021 hitting a six-year high, of 49 incidents.[613] There has also been an increase in attacks taking place in the southern part of the South China Sea.[614]

Within the Indo-Pacific, the main occurrence of piracy now is in the Indian Ocean off the east coast of Africa.[615] However, this has also generally seen a decline in piracy attacks, thanks to a multi-country UN-led military response to piracy in the region, to which countries including China and India have both contributed their support.[616]

Smuggling Drugs, Arms, and People

Organised crime and smuggling are growing and diversifying across the Indo-Pacific and the increasing poverty and economic inequality is helping to drive this growth.[617] In particular, the Pacific has seen growth, some of this is due to an increase in the domestic drug market, as well as the deportation policies of Australia and New Zealand which have been deporting members of organised crime networks in those countries to the Pacific, which have started acting as intermediaries between Australia and New Zealand's domestic crime groups and other TNOC groups.[618]

Within the Indo-Pacific, there is also the "Golden Triangle" between Laos, Myanmar, and Thailand. This is the second largest opium-producing region globally and the product from this area is smuggled through many different maritime jurisdictions of the Indo-Pacific to reach its end market.[619] The eastern coast of Africa has become a big transhipment hub for

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[612] "Piracy and armed robbery cases in Singapore Strait hit 6-year high in 2021," The Straits Times, 2022, accessed 14 September, 2023, https://www.straitstimes.com/singapore/piracy-and-armed-robbery-cases-in-singapore-strait-hit-6-year-high-in-2021.
[613] Darshana M. Baruah, *Working Paper: Mapping the Indian Ocean Region*.
Shiying, "Piracy and armed robbery cases in Singapore Strait hit 6-year high in 2021."
[614] Sam Bateman, "Maritime piracy in the Indo-Pacific region – ship vulnerability issues," *Maritime Policy & Management* 37, no. 7 (2010/12/01 2010), https://doi.org/10.1080/03088839.2010.524739, https://doi.org/10.1080/03088839.2010.524739.
[615] Letts, "Maritime security in South East Asia."
[616] Darshana M. Baruah, *Working Paper: Mapping the Indian Ocean Region*.
[617] United Nations Office on Drugs and Crime, *Drivers of Illicit Trafficking in Border Communities in Southeast Asia* (2023).
[618] "Drug trafficking in the Pacific Islands: The impact of transnational crime," Lowy Institute, 2022, accessed 19 May, 2024, https://www.lowyinstitute.org/publications/drug-trafficking-pacific-islands-impact-transnational-crime.
[619] Darshana M. Baruah, *Working Paper: Mapping the Indian Ocean Region*.

traffickers.[620] Trafficking is also increasing in the Pacific with Fiji recording several large drug busts recently.[621] This is largely due to the porous nature of the country's large maritime boundaries and limited law enforcement capabilities.[622]

Closely connected to the smuggling of drugs is the smuggling of small arms and there have been a few instances in the western Indian Ocean where the interception of drugs has also discovered small arms that were being illegally smuggled with them.[623]

Human trafficking in the Indo-Pacific is a dynamic issue with several different forms taking place.[624] This was dealt with in the Human Security section, as it most gravely impacts those who are being trafficked. Additionally, this also goes hand in hand with other kinds of trafficking and maritime crime it is worth noting here, especially as many of those that are victims of forced labour within the Indo-Pacific are found to be engaged by the fishing industry.[625]

7.2 Findings

Figure 7.1 is a visual representation of the NGAM for economic security.

[620] Darshana M. Baruah, *Working Paper: Mapping the Indian Ocean Region*.
[621] Danielle Watson, Jose Luis Sousa-Santos, and Loene Howes, "Transnational and organised crime in Pacific Island countries and territories: Police capacity to respond to the emerging security threat," (2021); "Pacific Islands: Spillover threats from transnational organised crime," The Interpreter, 2024, accessed 19 May, 2024, https://www.lowyinstitute.org/the-interpreter/pacific-islands-spillover-threats-transnational-organised-crime.
[622] Watson, Sousa-Santos, and Howes, "Transnational and organised crime in Pacific Island countries and territories: Police capacity to respond to the emerging security threat."
[623] Darshana M. Baruah, *Working Paper: Mapping the Indian Ocean Region*.
[624] "Human trafficking," accessed 19 May, 2024, https://www.unodc.org/roseap/en/what-we-do/toc/human-trafficking.html.
[625] "New UNODC report examines patterns and prevalence of trafficking in persons in the Pacific Islands," 2023, accessed 19 May, 2024, https://www.unodc.org/roseap/en/pacific/2023/10/trafficking-persons-report-pacific-islands/story.html.

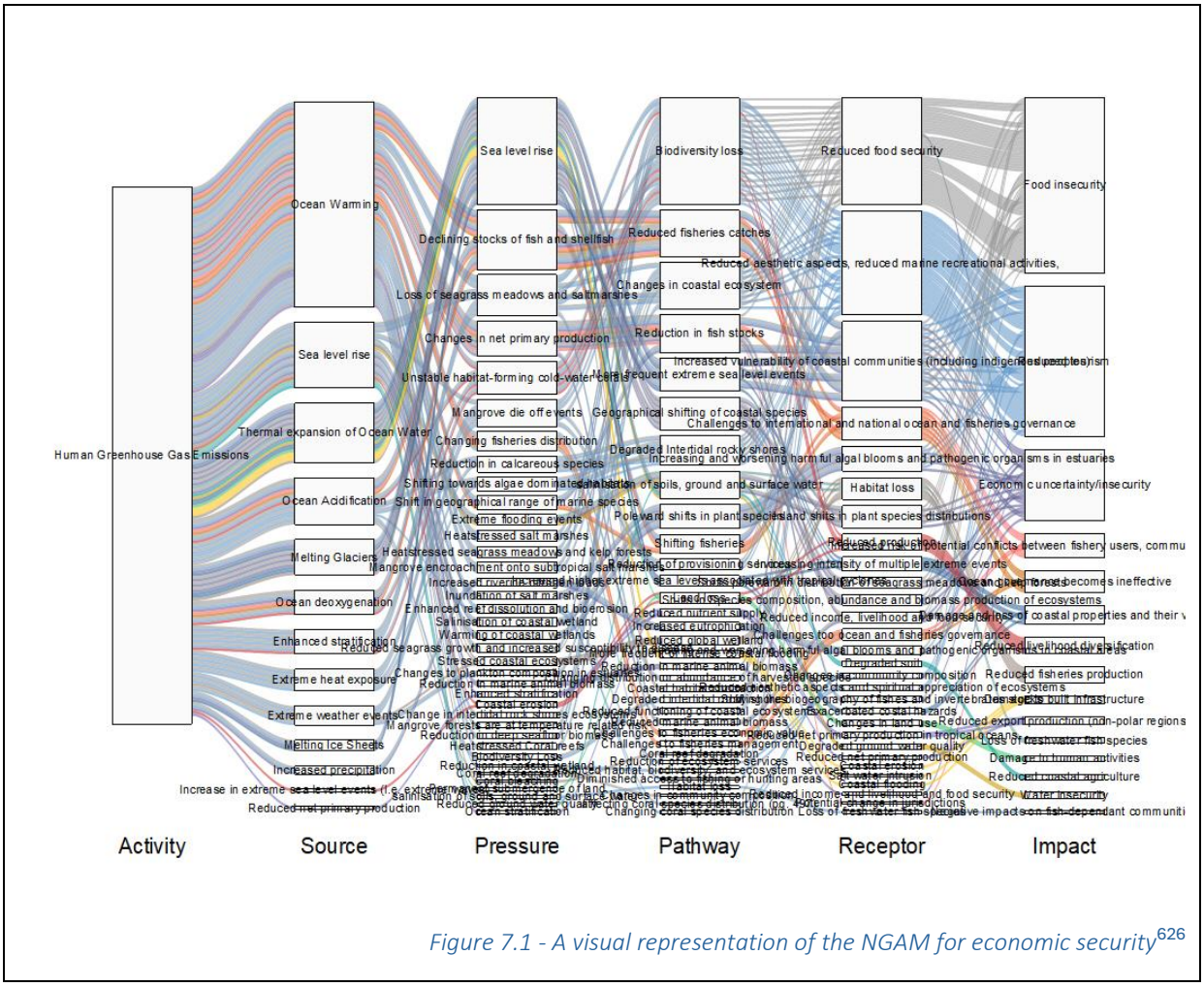

Figure 7.1 - A visual representation of the NGAM for economic security[626]

Table 7.1 shows the Pathways found to occur within EIP chains that are tagged against economic security from the NGAM constructed in Chapter 4. Economic security has 169 different individual EIP chains that flow through 33 different pathways. The most frequently occurring 'pathway' was 'Biodiversity Loss' which was the Pathway for 39 different EIPs. The five 'pathways' that occurred the most accounted for 50 percent of the EIP chains tagged against economic security. Many of the 'pathways' are interrelated with each other; some specific examples are 'Reduced fisheries catches' and 'shifting fisheries' or 'change in coastal ecosystems' and 'reduced global wetland'. Many of these Pathways have an affinity to the natural environment which again shows the underpinning of environmental security to all the other dimensions of maritime security.

As discussed in other chapters, understanding the preceding step in the EIP chain supports the analysis of the flow of the effects of climate change through to their impacts. For

[626] An enlargement of this figure can be found in Annex Thirteen

'pathways' the preceding step is 'pressures 'and the main 'pressures' preceding the 'pathway' of 'Biodiversity loss', are 'Loss of seagrass meadows and saltmarshes', and 'Mangrove die off events'. For the 'pathway' of 'Changes in coastal ecosystem', the main 'pressures' are 'Changes to plankton composition in estuaries', 'Heat stressed Coral reefs', 'Heat stressed salt marshes', 'Heat stressed seagrass meadows and kelp forests', 'Loss of seagrass meadows and saltmarshes', and 'Mangrove encroachment onto subtropical salt marshes'. For the 'pathway' of 'Reduced fisheries catches', the only preceding 'pressure' is 'Declining stocks of fish and shellfish'.

Table 7.1 – Economic security 'pathways

Pathway	Number of occurrences	Frequency of occurrence
Biodiversity loss	39	19.90%
Changes in coastal ecosystem	17	8.67%
Reduced fisheries catches	17	8.67%
Reduction in fish stocks	14	7.14%
Geographical shifting of coastal species	12	6.12%
More frequent extreme sea level events	12	6.12%
Degraded Intertidal rocky shores	11	5.61%
salinisation of soils, ground and surface water	10	5.10%
Poleward shifts in plant species	9	4.59%
Shifting fisheries	7	3.57%
Increased higher extreme sea levels associated with tropical cyclones	4	2.04%
Land loss	4	2.04%
Reduction of provisioning services	4	2.04%
Increased eutrophication	3	1.53%
More frequent or intense coastal flooding	3	1.53%
Reduced global wetland	3	1.53%
Reduced nutrient supply	3	1.53%
Challenges to fisheries economic value	2	1.02%
Challenges to fisheries management	2	1.02%
Changing distribution or abundance of harvested species	2	1.02%
Coastal habitat contraction	2	1.02%
Degraded intertidal rocky shores	2	1.02%
Reduced functioning of coastal ecosystems	2	1.02%
Reduced marine animal biomass	2	1.02%
Reduction in marine animal biomass	2	1.02%
affecting coral species distribution (pg. 497)	1	0.51%
Changes in community composition	1	0.51%
Changing coral species distribution	1	0.51%
Coral reef degradation	1	0.51%

Diminished access to fishing or hunting areas	1	0.51%
Habitat loss	1	0.51%
Reduced habitat, biodiversity, and ecosystem services	1	0.51%
Reduction of ecosystem services	1	0.51%
Grand Total	**196**	**100.00%**

Table 7.2 shows the 'receptors' in EIP chains tagged against economic security, with the most frequently occurring 'receptor' being 'Reduced food security' which occurred 39 times, closely followed by 'Reduced aesthetic aspects, reduced marine recreational activities' which occurred 38 times. These both underscored the third most frequently occurring 'receptor' which was 'Increased vulnerability of coastal communities (including indigenous peoples)' that acknowledged the underlying vulnerability of coastal communities to maritime insecurity. A surprisingly frequent 'receptor for economic security was 'Increasing and worsening harmful algal blooms and pathogenic organisms in estuaries' as well as many 'receptors' that highlighted the liminality of maritime security by showing the impacts of climate change to land-based vulnerabilities such as 'Coastal erosion', 'Degraded soil', and 'Changes in land use'.

For the 'receptor' section of the EIP chain the preceding step is the 'pathway' and for the 'receptor' of 'reduced food security' the preceding pathways are 'Biodiversity loss', 'Changes in coastal ecosystem', and 'Degraded Intertidal rocky shores'. For the 'receptor' of 'Reduced aesthetic aspects, reduced marine recreational activities' the preceding pathways are 'Biodiversity loss', 'Changes in coastal ecosystem', and 'Degraded Intertidal rocky shores'. For the 'receptor' of 'Increased vulnerability of coastal communities (including indigenous peoples)' the pathways are 'More frequent extreme sea level events', 'Reduced fisheries catches', 'Reduction in fish stocks', and 'Shifting fisheries'.

Table 7.2 – Economic security 'receptors'

Receptor	Number of occurrences	Frequency of occurrence
Reduced food security	39	19.90%
Reduced aesthetic aspects, reduced marine recreational activities,	38	19.39%
Increased vulnerability of coastal communities (including indigenous peoples)	29	14.80%
Challenges to international and national ocean and fisheries governance	12	6.12%

Increasing and worsening harmful algal blooms and pathogenic organisms in estuaries	9	4.59%
Habitat loss	8	4.08%
Inland shits in plant species distributions	8	4.08%
Reduced production	6	3.06%
Increasing intensity of multiple extreme events	5	2.55%
Challenges too ocean and fisheries governance	4	2.04%
Reduced income, livelihood and food security	4	2.04%
Shifts in Species composition, abundance and biomass production of ecosystems	4	2.04%
Shifts poleward in distribution of seagrass meadows and kelp forests	4	2.04%
Increasing and worsening harmful algal blooms and pathogenic organisms in coastal areas	3	1.53%
Changes in community composition	2	1.02%
Changes in land use	2	1.02%
Degraded ground water quality	2	1.02%
Degraded soil	2	1.02%
Exacerbated costal hazards	2	1.02%
Reduced aesthetic aspects and spiritual appreciation of ecosystems	2	1.02%
Reduced net primary production in tropical oceans	2	1.02%
Shifting the biogeography of fishes and invertebrates stocks	2	1.02%
Coastal erosion	1	0.51%
Coastal flooding	1	0.51%
Loss of freshwater fish species	1	0.51%
Potential change in jurisdictions	1	0.51%
Reduced income and livelihood and food security	1	0.51%
Reduced net primary production	1	0.51%
Salt water intrusion	1	0.51%
Grand Total	**196**	**100.00%**

Table 7.3 shows the impacts associated with economic security in the maritime domain. There are about half the number of 'impacts' (15 different 'impacts'), compared to 'pathways' (33 different 'pathways') and 'receptors' (29 different 'receptors'). This shows that all of the 'pathways' and 'receptors' converge on a concentrated number of impacts. The most frequently occurring 'impact' of which is 'Food insecurity' stems both from ocean-based and land-based receptors and then 'reduced tourism' being the second most frequent impact shows the reliance that coastal communities have on the sector for their economic security. Surprisingly the impact of 'damage to built infrastructure' only appeared three

times and this highlights the binary nature of this EIP analysis, as it can be argued that infrastructure damage could have a greater fiscal impact than food insecurity. In addition, infrastructure also underpins the security of other impacts such as tourism, the value of coastal properties, and it positively contributes to food security.

For the 'impact' section of the EIP chain, the preceding section is the 'receptor'. For the 'impact' of 'Food insecurity' the main receptors were 'Reduced food security', and 'Increased vulnerability of coastal communities (including indigenous peoples)'. For the 'impact' of 'Reduced tourism' the main receptors were 'Reduced aesthetic aspects, reduced marine recreational activities', and 'Increased vulnerability of coastal communities (including indigenous peoples)'. For the 'impact' of 'Economic uncertainty/insecurity' the main receptors were 'Increased vulnerability of coastal communities (including indigenous peoples)', 'Inland shifts in plant species distributions', and 'Increasing and worsening harmful algal blooms and pathogenic organisms in estuaries'.

Table 7.3 – Economic security 'impacts'

Impact	Number of occurrences	Frequency of occurrence
Food insecurity	64	32.65%
Reduced tourism	55	28.06%
Economic uncertainty/insecurity	26	13.27%
Increased risk of potential conflicts between fishery users, communities and authorities	9	4.59%
Ocean governance becomes ineffective	8	4.08%
Damage and loss of coastal properties and their value	7	3.57%
Reduced fisheries production	6	3.06%
Reduced livelihood diversification	6	3.06%
Damage to built infrastructure	3	1.53%
Reduced export production (non-polar regions)	3	1.53%
Damage to human activities	2	1.02%
Loss of freshwater fish species	2	1.02%
Reduced coastal agriculture	2	1.02%
Water insecurity	2	1.02%
Negative impacts on fish-dependant communities	1	0.51%
Grand Total	**196**	**100.00%**

7.3 Feedback Loops

As outlined in Chapter 4, feedback loops are important to fully understanding how the effects of climate change impact the different dimensions of maritime security. Some examples for economic security, where feedback loops could exist are:

- The receptor of 'Inland shifts in plant species distributions' to the pathway 'Changes in coastal ecosystem'.
- The receptor of 'habitat loss' to the pathway 'habitat loss'.
- The receptor of 'coastal erosion' to the pathway 'land loss'.

A visual representation of this can be seen in Figure 7.2.

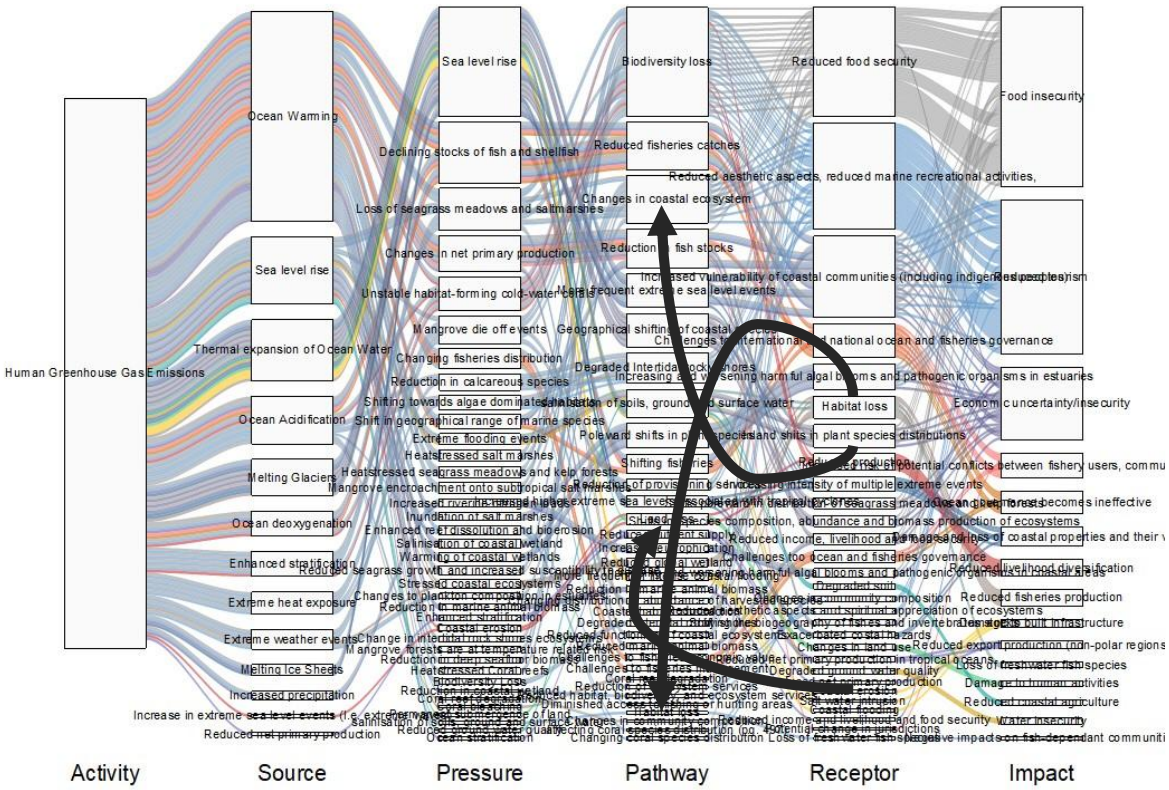

Figure 7.2 – A visual representation of economic security's feedback loops[627]

These feedback loops would serve to exacerbate these issues and then the receptors and impacts that flow on from the pathways that are fed back into. All these feedback loops

[627] An enlargement of this figure can be found in Annex Fourteen

have a link to the natural environment which also reinforces the argument that environmental security provides a foundation for the other aspects of maritime security.

Figure 7.3 shows the feedback loop for the receptor of 'Inland shifts in plant species distributions' exacerbating and multiplying the pathway 'Changes in coastal ecosystem'. As with the feedback loop examples in Chapter 4, 5, and 6, this shows the interconnected nature of maritime security and the EIPs within the NGAM and how this will need to be further taken into account in future research.

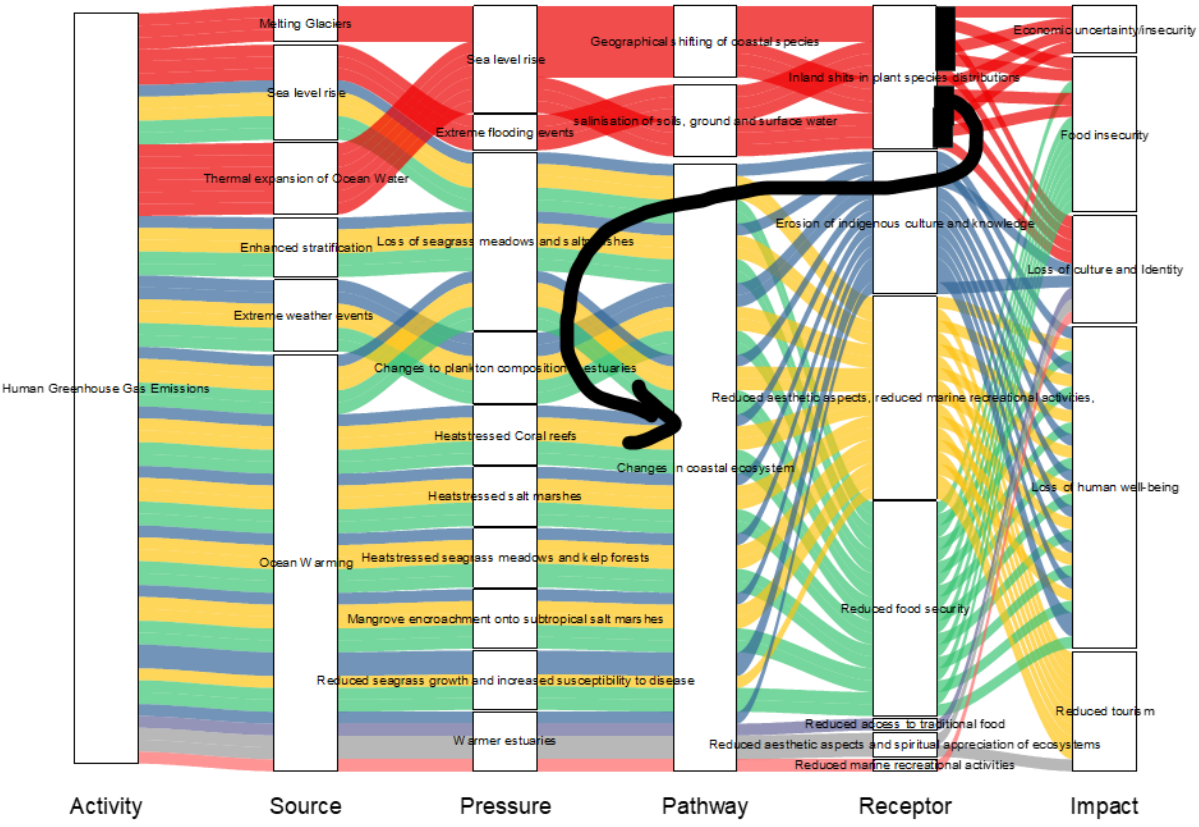

Figure 7.3 – A visualisation of the feedback loop from the receptor 'Inland shifts in plant species distributions'[628]

7.4 Discussion

While the economic valuation associated with the marine and costal ecosystems are calculated in a myriad of ways and vary on the scale of contribution, it is generally recognised that they provide positive economic gains in areas relating to provisioning

[628] An enlargement of this figure can be found in Annex Fifteen

services, cultural services, and recreation and tourism services.[629] So, looking for interventions that could best support the economic security dimension of maritime security within the Indo-Pacific would be protecting 'Biodiversity loss' and moving to nature-positive and nature-based solutions. This also reinforces the point mentioned previously that the dimension of economic security of the Indo-Pacific is dependent on the dimension of environmental security. 'Biodiversity loss' goes on to contribute to three different impacts: 'food insecurity', 'reduced livelihood diversification' and 'reduced tourism'.

Tourism in the Indo-Pacific has largely been fairly accessible and cheap, and as mentioned previously, global coastal areas make up half of all tourist destinations.[630] With 'Reduced tourism' being the second most frequently occurring impact within the NGAM, this means that supporting maritime and coastal biodiversity is imperative to supporting economic security in coastal areas, as can be seen in Figure 7.4, which shows the complex and interconnected nature of nature-based pressures and pathways within the EIPs that impact on tourism. Incentivising sustainable tourism, including supporting the tourism industry to better report on their obligation to look after the natural environment, which could increase the support and understanding of climate solutions and potentially enhance resilience.[631] Supporting sustainable tourism opportunities will support and address issues, including livelihood generation, while protecting the natural environment and the cultural value of ecosystems.[632]

Further supporting Marine Protected Areas (MPAs), as mentioned in Chapter 5 as an intervention to support environmental security, can also support maritime tourism and drive further economic revenue and development.[633] However, the implementation of

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[629] Jose D. Lopez-Rivas and Juan-Camilo Cardenas, "What is the economic value of coastal and marine ecosystem services? A systematic literature review," *Marine Policy* 161 (2024/03/01/ 2024), https://doi.org/https://doi.org/10.1016/j.marpol.2024.106033, https://www.sciencedirect.com/science/article/pii/S0308597X24000319.

[630] Ralf Buckley, "Surf tourism and sustainable development in Indo-Pacific Islands. I. The industry and the islands," *Journal of sustainable tourism* 10, no. 5 (2002).

[631] Peter Tangney et al., "Climate security in the Indo-Pacific: a systematic review of governance challenges for enhancing regional climate resilience," *Climatic Change* 167, no. 3 (2021/08/16 2021), https://doi.org/10.1007/s10584-021-03197-8, https://doi.org/10.1007/s10584-021-03197-8.

[632] Mohammed Shahedul Quader, H.M. Kamrul Hassan, and Tareq Mahbub, "Sustainable Coastal and Marine Tourism in Bangladesh: A Qualitative Evaluation," *Tourism and Hospitality Management* 31, no. 2 (2025).

[633] Reniel B. Cabral et al., "Marine protected areas for dive tourism," *Scientific Reports* 15, no. 1 (2025/02/11 2025), https://doi.org/10.1038/s41598-024-83664-1, https://doi.org/10.1038/s41598-024-83664-1.

MPAs comes with the issue of being able to sustainably manage these areas and govern/enforce the MPAs, as ineffective MPA monitoring has been seen to lead to unsustainable levels of extractive and exploitive behaviours within some Indonesian MPAs.[634] This study will touch on governance and enforcement issues more in Chapter 8, as this can relate to a national security issue and further illustrates the interconnected nature of maritime security dimensions.

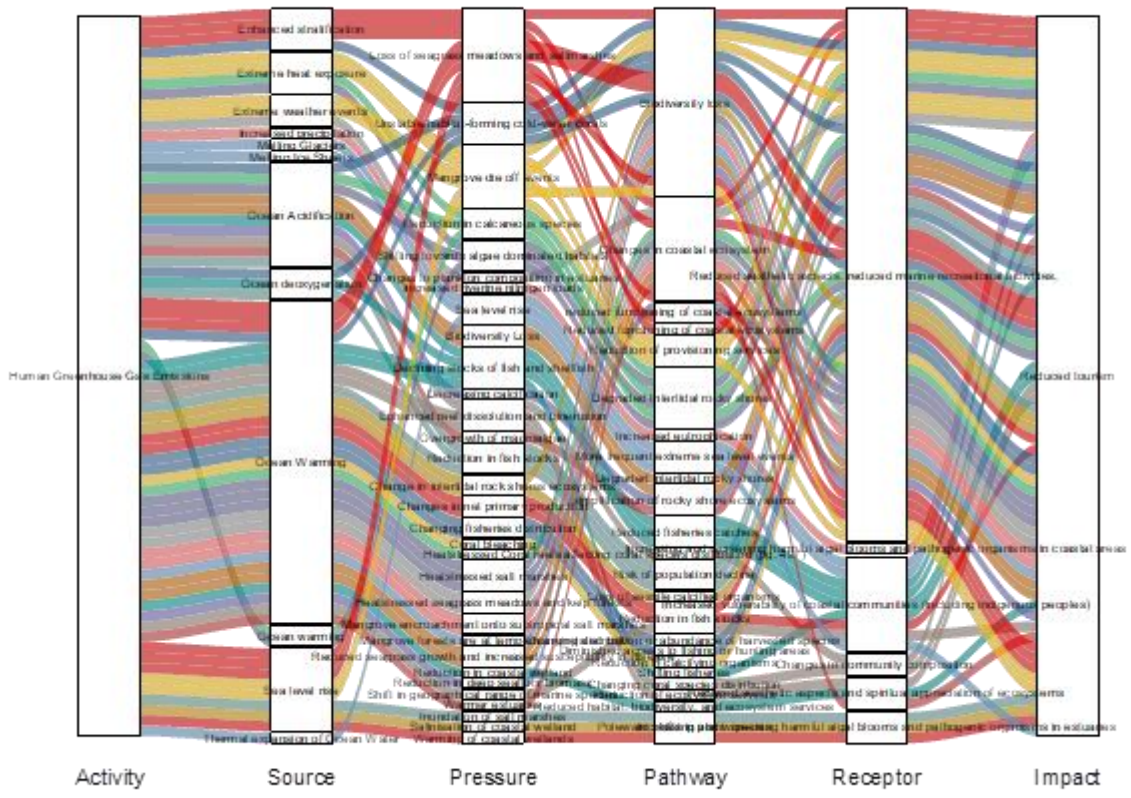

Figure 7.4 – A visualisation of the EIPs that end with the impact ''Reduced tourism''[635]

Shipping was a significant topic of discussion whilst conducting the interviews as one of the main economic generating activities in the maritime domain, especially for the Indo-Pacific.[636] However, shipping doesn't directly feature in the NGAM. Given that the effects of climate change on the Panama Canal are already impacting shipping, this highlights the

[634] Daniela M. Ceccarelli et al., "Emerging marine protected areas of eastern Indonesia: Coral reef trends and priorities for management," *Marine Policy* 141 (2022/07/01/ 2022), https://doi.org/https://doi.org/10.1016/j.marpol.2022.105091, https://www.sciencedirect.com/science/article/pii/S0308597X22001385.
[635] An enlargement of this figure can be found in Annex Sixteen
[636] Interview B, D and E

need for maritime security, as discussed previously, to ensure liminality is adequately accounted for, with future research incorporating wider data to build out NGAMs. The Panama Canal, on the far east side of the Indo-Pacific, has been (at the time of writing in 2024) experiencing sustained periods of below-average rainfall which has limited its operating capacity. While this issue has been driven by the El Niño weather pattern, it is just a taste of what is to come due to the increasing effects of climate change.[637]

The issue of the Panama Canal can also be seen as a feedback loop. This is because it is not just that climate change is impacting the cost of shipping, but while waiting to proceed through the Panama Canal, ships continue to burn fuel and further contribute to GHG emissions. But also, to go around the Panama Canal adds roughly a further 4,000 nm's which is roughly a third longer than going through the Canal, which would increase the GHG emissions of these ships even more.[638] Such feedback loops could also be considered if ships are unable to dock due to bad weather or due to damaged port infrastructure, which is increasingly likely due to climate change.

In the NGAM an indirect 'impact' to shipping could be the 'damage to built infrastructure', which could impact the ability to service ships when in port or even the ability for ships to dock entirely, or 'ocean governance becomes ineffective' or the generic 'economic uncertainty/insecurity'. These latter two in the context of the NGAM's data source (SROCC) relate more to fishing and coastal communities rather than to shipping. However, the impact of climate change on shipping could have major implications in two ways. Firstly, it could impact the operating margins of shipping companies by causing the rerouting of ships due to extreme weather, or damage to the ships themselves.[639] Secondly, the shipping industry is already facing calls to decarbonise, which will also include a cost for both ports and ship owners, as well as need some level of global agreement on the fuel of the future.[640]

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[637] "UN Trade and Development chief visits the Panama Canal ahead of first Global Supply Chain Forum," 2024, accessed 23 May, 2024, https://unctad.org/news/un-trade-and-development-chief-visits-panama-canal-ahead-first-global-supply-chain-forum.
[638] "The challenges of cleaner fuels for shipping supply chains," 2024, accessed 24 April, 2025, https://melbourneasiareview.edu.au/the-challenges-of-cleaner-fuels-for-shipping-supply-chains/.
[639] "The good, the bad and the ugly: Climate change's impact on global shipping routes," AXA XL, 2024, accessed 23 August, 2024, https://axaxl.com/fast-fast-forward/articles/climate-changes-impact-on-global-shipping-routes.
[640] "Decarbonizing shipping: How to speed up the transition and ensure it's fair," 2023, accessed 23 August, 2024, https://unctad.org/news/decarbonizing-shipping-how-speed-transition-and-ensure-its-

In some cases, such as in the Arctic region, climate change might present further opportunities for new trade/shipping routes, which would impact the status quo of shipping within the Indo-Pacific.[641] It was discussed in some interviews that shipping routes opening due to less sea ice in the Arctic, allowing for shipping routes in the high north, is possible.[642] But, it was generally agreed that it was too early to understand how this could impact shipping and that it would be a while before a major re-routing of shipping would occur.[643] This is mostly because of the current nature of global supply chains and that container ships do not go from point A to point B directly but stop off along the way. However, one industry that could potentially be made viable is the transport of resources extracted in the high north by Russia in a one-way fashion, such as any potential LNG or Petroleum where it was being exported directly from Russia to China or other Asian countries.

The need to decarbonise shipping has been agreed upon by the International Maritime Organisation, which aims to reduce greenhouse gas emissions by 20 percent by 2030 and completely phasing them out by 2050.[644] Transitioning away from the current greenhouse gas-emitting fossil fuels as the source of fuel for ships would require a change to land-based infrastructure to store this potential new shipping fuel and also designing new vessels or retrofitting existing vessels to be able to run on a new fuel source.[645] As an intervention, decarbonising shipping would be a great one to invest in, this is because the mitigation of GHG emissions will reduce future security impacts related to climate change, thus supporting action to reduce all of the impacts in the NGAM. All of these issues relating to shipping show the need to develop a long-term strategic vision for the shipping industry,

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fair#:~:text=Estimates%20show%20that%20decarbonizing%20the,would%20affect%20the%20global%20economy.
"INTRODUCTION: Shipping supply chains in Asia are being tested by global crises," Melbourne Asia Review, 2024, accessed 24 April, 2025, https://melbourneasiareview.edu.au/shipping-supply-chains-in-asia-are-being-tested-by-global-crises/.
"Decarbonization of shipping: An ambitious global test bed for green ships sets sail," World Economic Forum, 2024, accessed 23 August, 2024, https://www.weforum.org/agenda/2024/01/decarbonization-of-shipping-an-ambitious-global-test-bed-for-green-ships-sets-sail/.

[641] "How viable is Arctic shipping? Russia is investing in the region," The Economist explains, 2024, accessed 24 April, 2025, https://www.economist.com/the-economist-explains/2024/01/18/how-viable-is-arctic-shipping.

[642] Interview B and E

[643] The Economist, "How viable is Arctic shipping? Russia is investing in the region."

[644] "Shipping is sizing up energy transition opportunities," 2024, accessed 22 May, 2024 https://www.lr.org/en/knowledge/insights-articles/shipping-is-sizing-up-energy-transition-opportunities/.

[645] Lloyd's Register, "Shipping is sizing up energy transition opportunities."

which will guide investment and development of low-carbon fuels and related infrastructure, as well as the implementation of adaptation measures.[646]

While damage to coastal infrastructure did not occur very often as an impact within the NGAM, it was discussed in most interviews. The damage to coastal infrastructure is of increasing importance geostrategically as countries use infrastructure financing to gain influence, so as infrastructure is damaged by the impacts of climate change, such as sea-level rise and extreme weather events, external countries seek to gain influence by supporting these rebuilds or adaptive measures. Increasingly, this has become a priority for Australia, the European Union, Japan, the United Kingdom, and the United States, as they look to counter China's efforts in this area, most of which is funded through the BRI.[647] In the future, the interest in the protection and management of critical maritime infrastructure will be an integral part of maritime security and one that touches on all dimensions of maritime security.[648]

The 'impact' of 'Damage to built infrastructure' can be traced back through receptors of 'coastal erosion', 'coastal flooding' and 'salt water intrusion', to a 'pathway' of 'More frequent and intense coastal flooding' to a 'pressure' of 'sea level rise' caused by a 'source' of 'Thermal expansion of ocean water'. So, in tracing this 'impact' all the way back, a great intervention would be anything that stops the ocean warming, but an alternative intervention would be slowing or protecting against sea level rise. As also discussed in Chapter 5, interventions that support the reduction of both ocean warming and sea level rise include reducing GHG emissions and sequestering carbon dioxide through carbon sinks such as mangrove forests and seagrass sediment.[649] This again shows the underlying foundation that a healthy maritime environment has on all dimensions of maritime security.

Arguably, the most important piece of infrastructure in the maritime domain is ports, playing a pivotal role not just within global supply chains, but also in facilitating interactions

[646] Larkin, Smith, and Wrobel, "Shipping in changing climates."
[647] "Indo-Pacific infrastructure development financing: an agenda for Australia and Europe," Lowy Institute, 2023, accessed 20 May, 2024, https://www.lowyinstitute.org/publications/indo-pacific-infrastructure-development-financing-agenda-australia-europe#heading-7088.
[648] Bueger and Edmunds, "8. New Challenges and a Look to the Future."
[649] IUCN, "Ocean warming."
UNEP, "Why protecting the ocean and wetlands can help fight the climate crisis."

and connections between the ocean and land domains.[650] Many coastal cities' existence is because there was some form of port which allowed it to connect into global or domestic trade routes.[651] Issues such as extreme weather, sea level rise, and sea-surface salinity can all cause damage to port infrastructure.[652] Accordingly, because of the low-lying nature of many ports, they will continue to be exposed to the impacts of climate change, illustrating the underlying concern there should be with the fact that climate change will impact a port's future ability to operate.[653] Ports in the Indian Ocean and Pacific Islands are expected to be extremely vulnerable to the impact of climate change by 2100.[654] However, some ports may benefit from some effects of climate change, with sea level rise potentially allowing ports in shallower waters the ability to accommodate vessels with deeper drafts.[655]

With ports recognising the issue of climate change and the need to adapt to enhance their resilience to the impacts of climate change, there could be a receptive audience to supporting interventions that support the climate adaptation of ports.[656] However, most ports are still at the stage of initial planning.[657] So further analysis into the impacts of climate change on ports could usefully feed into both ports' climate adaptation plans and any future update of the NGAM allowing for a more comprehensive understanding of the impacts on the economic security.

'Food insecurity' is the most frequent impact that is tagged against Economic Security. This highlights a strong link between environmental security, human security and economic security. This is because food insecurity is a major issue that negatively affects public health which results in increasing strain on a country's economic resources to deal with the

[650] Adolf K. Y. Ng et al., "Port Decision Maker Perceptions on the Effectiveness of Climate Adaptation Actions," *Coastal Management* 46, no. 3 (2018/05/04 2018), https://doi.org/10.1080/08920753.2018.1451731, https://doi.org/10.1080/08920753.2018.1451731.
[651] Austin Becker et al., "Implications of climate change for shipping: Ports and supply chains," *Wiley Interdisciplinary Reviews: Climate Change* 9, no. 2 (2018).
[652] Becker et al., "Implications of climate change for shipping: Ports and supply chains."
[653] Regina Asariotis et al., "Climate change and seaports: hazards, impacts and policies and legislation for adaptation," *Anthropocene Coasts* 7, no. 1 (2024/06/18 2024), https://doi.org/10.1007/s44218-024-00047-9, https://doi.org/10.1007/s44218-024-00047-9.
[654] C. Izaguirre et al., "Climate change risk to global port operations," *Nature Climate Change* 11, no. 1 (2021/01/01 2021), https://doi.org/10.1038/s41558-020-00937-z, https://doi.org/10.1038/s41558-020-00937-z.
[655] Becker et al., "Implications of climate change for shipping: Ports and supply chains."
[656] Izaguirre et al., "Climate change risk to global port operations."
[657] Izaguirre et al., "Climate change risk to global port operations."

issue.[658] Fiji already sees the interconnected issues stemming from food insecurity in the maritime domain caused by climate change as a environmental, human, and economic security issue.[659]

As some of the most suitable areas for developing aquaculture are within the Indo-Pacific region, investigating the use of aquaculture both to increase nutritional security and economic security is worthy of investigation.[660] Aquaculture promotes diversification away from fishing and subsistence agriculture and a diverse aquaculture sector improves countries' and communities' food and economic security.[661] However, there must be adequate consideration to ensure that investing in aquaculture does not have adverse impacts and thus becomes a maladaptive intervention, as industrial aquaculture, if not done right, has the potential to have adverse impacts on the environment and increase environmental degradation.[662] As previously mentioned and demonstrated with the carbon capture potential of seagrasses, it is also argued that aquaculture may be able to mitigate climate change, as well as support adaptation.[663] While aquaculture does not feature explicitly in the EIP chains developed for the NGAM, it could be assumed that it would be impacted by receptors such as 'Increasing and worsening harmful algal blooms and pathogenic organisms' in both coastal areas and estuaries, as well as 'shifts poleward in distribution of seagrass meadows and kelp forests' and these would need to be taken into account when investigating aquaculture.[664]

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[658] P. J. Brady et al., "The Relationship between Political, Economic, Social, and Cultural Vulnerability and Food Insecurity among Adults Aged 50 Years and Older," *Nutrients* 13, no. 11 (Oct 29 2021), https://doi.org/10.3390/nu13113896.
[659] Michael O'Keefe and Ilai (Jack) Moceica, "5 Fiji," in *Blue Security in the Indo-Pacific*, ed. Ian Hall, Troy Lee-Brown, and Rebecca Strating (Routledge, 2024).
[660] Rebecca R Gentry et al., "Mapping the global potential for marine aquaculture," *Nature ecology & evolution* 1, no. 9 (2017).
[661] Alexander M. Kaminski et al., "Smallholder aquaculture diversifies livelihoods and diets thus improving food security status: evidence from northern Zambia," *Agriculture & Food Security* 13, no. 1 (2024/01/05 2024), https://doi.org/10.1186/s40066-023-00452-2, https://doi.org/10.1186/s40066-023-00452-2. Cherdsak Virapat, "The Current Challenges of Sustainable Aquaculture in the Asia-Pacific Region and the Measures Recommended," *Asia-Pacific Journal of Rural Development* 32, no. 2 (2022), https://doi.org/10.1177/10185291231193516, https://journals.sagepub.com/doi/abs/10.1177/10185291231193516.
[662] Bennett, Morgera, and Boyd, "The human right to a clean, healthy and sustainable ocean."
[663] "Innovating for equity in nature-based climate solutions in aquaculture food systems in Asia-Pacific (I4E)," accessed 19 May, 2024, https://www.sei.org/projects/i4e/.
[664] Virapat, "The Current Challenges of Sustainable Aquaculture in the Asia-Pacific Region and the Measures Recommended."

Food insecurity also reduces people's productivity and ability to participate in the workforce, as instead of productively contributing to the overall economy, they spend more time and energy securing their food sources.[665] Food insecurity can also stem from an individual's reduced economic security and loss of livelihood, which in turn diminishes their ability to purchase food.[666] Both issues related to food insecurity as an impact on economic security can be traced back to 'receptors' relating to fish and fishing, again demonstrating the link between environmental and economic security.

Supporting the sustainable used and management of fisheries will support and increase the economic benefits these fisheries can provide so aiming an intervention at ensuring the sustainable management of fisheries that supports their long-term sustainability, would be beneficial.[667] This was also discussed in Chapter 6 in relation to how it can support human security, as the sustainable management of fisheries can support individuals' economic security, through increasing their food security.[668] However, when considering interventions relating to the sustainable use and management of fishers, the social and cultural importance of these fisheries must be taken into account, especially because the management of fisheries is crucially important within the Indo-Pacific, given the amount of people that rely on them for both food and economic security.[669] The sustainable management of fisheries should also consider how it will prevent biodiversity loss, as one of the aims of sustainable fisheries management is to balance economic and conservation

[665] Brady et al., "The Relationship between Political, Economic, Social, and Cultural Vulnerability and Food Insecurity among Adults Aged 50 Years and Older."
[666] Adam Drewnowski, "Food insecurity has economic root causes," *Nature Food* 3, no. 8 (2022/08/01 2022), https://doi.org/10.1038/s43016-022-00577-w, https://doi.org/10.1038/s43016-022-00577-w.
[667] Fang and Zhang, "The impact of climate change and economic development on the catches of small pelagic fisheries."
Erika J. Techera, "Supporting blue economy agenda: fisheries, food security and climate change in the Indian Ocean," *Journal of the Indian Ocean Region* 14, no. 1 (2018/01/02 2018), https://doi.org/10.1080/19480881.2017.1420579, https://doi.org/10.1080/19480881.2017.1420579.
[668] Tim McClanahan, Edward H Allison, and Joshua E Cinner, "Managing fisheries for human and food security," *Fish and Fisheries* 16, no. 1 (2015).
Burden and Fujita, "Better fisheries management can help reduce conflict, improve food security, and increase economic productivity in the face of climate change."
[669] Techera, "Supporting blue economy agenda: fisheries, food security and climate change in the Indian Ocean."
"Indo Pacific fish stocks face multiple challenges," Melbourne Asia Review, 2024, accessed 15 August, 2024, https://melbourneasiareview.edu.au/indo-pacific-fish-stocks-face-multiple-challenges/.

issues.[670] Ensuring conservation efforts are adequately taken into account when managing fisheries will further enhance its relevance in providing resilience to climate change as 'biodiversity loss' is the most frequent pathway found in the EIP chains. Calls for effective and collaborative management of fisheries are already being made and advocated for.[671]

In the NGAM for economic security, the EIP chains that have the impact of 'ocean governance become ineffective' can all be traced back to fish-related receptors, pathways and pressures, be it fisheries catches, changes in stock levels, or shifting distribution of fisheries. So, understanding more about how fish move within the Indo-Pacific will be crucial, as it has been estimated that the economic damage to fisheries caused by climate change and global warming of 2°C could be up to USD 41 billion by 2050.[672] The importance of fisheries is felt throughout the Indo-Pacific region but the negative impact of climate change on fisheries will be felt hardest by countries such as Pacific Island SIDS especially as it is estimated that USD 60 million will move out of Pacific EEZs, where fishing revenues can make up at least 30 percent of their GDP and who between now and 2050 could see up to a 17 percent per year reduction in government revenues related to the redistribution of tuna fisheries.[673]

It is widely acknowledged that IUUF also contributes to food insecurity.[674] As climate change impacts people's food insecurity and drives people and communities into IUUF and then

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[670] Ray Hilborn et al., "The trade-off between biodiversity and sustainable fish harvest with area-based management," *ICES Journal of Marine Science* 78, no. 6 (2021).
"Improving the Management of Marine Biodiversity and Fisheries in the Indo-Pacific Region," accessed 25 April, 2025, https://www.tetratech.com/projects/improving-the-management-of-marine-biodiversity-and-fisheries-in-the-indo-pacific-region/.
[671] David Michel, "Fisheries, Food Security, and Climate Change in the Indo-Pacific Region," *Jstor, Washington DC* (2014).
"Fisheries Management," 2019, accessed 25 April, 2025, https://ipdefenseforum.com/2019/07/fisheries-management/.
[672] Michel, "Fisheries, Food Security, and Climate Change in the Indo-Pacific Region."
[673] "US$60 million loss in revenue expected from tuna industry by 2050 due to climate change," 2019, accessed 24 Sepetmber, 2024, https://www.spc.int/updates/blog/2019/07/us60-million-loss-in-revenue-expected-from-tuna-industry-by-2050-due-to.
"14 Pacific Island countries receive a major grant to manage one third of the world's tuna in the face of the climate crisis," 2025, accessed 25 April, 2025, https://www.spc.int/updates/blog/blog-post/2025/02/14-pacific-island-countries-receive-a-major-grant-to-manage-one#:~:text=The%20research%20suggests%20that%20climate,for%20individual%20tuna%2Ddependent%20economies.
[674] Charmaine Misalucha-Willoughby, "12 The Philippines," in *Blue Security in the Indo-Pacific*, ed. Ian Hall, Troy Lee-Brown, and Rebecca Strating (Routledge, 2024).
Mary Mackay, Britta Denise Hardesty, and Chris Wilcox, "The intersection between illegal fishing, crimes at sea, and social well-being," *Frontiers in Marine Science* 7 (2020).

IUUF creates further food insecurity, which can drive more people and communities to engage in IUUF it creates a vicious and multiplicative feedback loop. However, while it is acknowledged that fish stocks can be impacted by IUUF, the reality of IUUF is that there is not enough data, knowledge, or monitoring.[675] IUUF doesn't have a specific impact that it is tied to, but it should be considered alongside the 'impacts' of 'Increased risk of potential conflicts between fishery users, communities and authorities', 'Ocean governance becomes ineffective', 'Reduced fisheries production', 'Damage to human activities', and 'Negative impacts on fish-dependant communities'. This is because IUUF is an economic crime that comes about due to the value of the fish, limited governance, and the small risk of being caught.[676] This means that as ocean governance becomes increasingly ineffective, and conflicts arise between communities and authorities, IUUF and people committing other environmental crimes could potentially take advantage of an already, and increasingly weakening system of maritime governance and enforcement for economic gain.[677] As will be discussed further in the next chapter on national security, enhancing the capabilities of Indo-Pacific countries to monitor, govern and have a credible enforcement threat is a good intervention that supports adaptation to climate change and mitigates some feedback loops.[678]

For both shipping and IUUF, the unclear delineation between vessel, owner, and captain makes understanding who is responsible for a ship complicated and this feeds into ineffective governance.[679] As mentioned above, as ocean governance weakens, and more people's legitimate livelihoods diminish, then there will be an overall increase in ocean-based illegal activities and maritime crimes. The fact that as people's livelihoods are negatively impacted, they will move towards engaging in criminal activities as a way of

[675] Andrew J. Temple et al., "Illegal, unregulated and unreported fishing impacts: A systematic review of evidence and proposed future agenda," *Marine Policy* 139 (2022/05/01/ 2022), https://doi.org/https://doi.org/10.1016/j.marpol.2022.105033, https://www.sciencedirect.com/science/article/pii/S0308597X2200080X.
[676] "Illegal, Unreported and Unregulated Fishing," 2013, accessed 23 May, 2024, https://www.pewtrusts.org/en/research-and-analysis/articles/2013/02/25/illegal-unreported-and-unregulated-fishing-frequently-asked-questions.
[677] Bueger and Edmunds, "5. Blue Crime: Pirates and Ecocriminals."
[678] McCabe, "Environmental drivers of maritime insecurity: governance, enforcement and resilience in the western Indian Ocean."
[679] "Shipping is complex," 2020, accessed 25 April, 2025, https://www.ics-shipping.org/resource/shipping-is-complex-animation/.

supporting themselves and their families.[680] One study in 2024, found that as IUUF declined, occurrences of piracy increased as those that previously engaged in IUUF became involved in piracy.[681] This shows a pattern of people moving from one economic/livelihood opportunity to another given their means and resources. So, while supporting increased governance and enforcement capabilities are a good deterrent-focused intervention, a good pre-emptive intervention would focus on addressing the issue of economic livelihoods before they become criminalised. Such interventions could be things already mentioned, such as the sustainable management of fisheries, MPAs, and diversification into aquaculture.

While this thesis predominantly focuses on the negative impacts of climate change, it does acknowledge that there could be some second order impacts that may be positive for some actors. These second order impacts include factors such as, fish moving out of EEZs which may decrease the amount of IUUF undertaken thus limiting the need for enforcement capabilities. In some interviews, the interviewees extrapolated concepts that discussed about how China sees climate change less as a problem, and more as a benefit and opportunity to be taken advantage of, as the movement of fish presents as a legal economic opportunity.[682] The extent to which China is being seen as taking advantage of the existing ineffectiveness of ocean governance and priming itself to take advantage of a changing climate is the number of growing fishing disputes it has throughout the Info-Pacific.[683] However, China is not the only nation in the Indo-Pacific with a fisheries dispute, as there is already a conflict over fisheries resources between India and Sri Lanka.[684]

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[680] Powles and Sousa-Santos, "Chapter 13: Climate Crisis, Geopolitical Vulnerability, Transnational Crime and Mitigating Responses."

[681] Anup Phayal et al., "All maritime crimes are local: Understanding the causal link between illegal fishing and maritime piracy," *Political Geography* 109 (2024/03/01/ 2024), https://doi.org/https://doi.org/10.1016/j.polgeo.2024.103069, https://www.sciencedirect.com/science/article/pii/S0962629824000180.

[682] Interview I

[683] "Averting China's Fishing Wars," Asia Society, accessed 23 May, 2024, https://asiasociety.org/averting-chinas-fishing-wars#:~:text=Escalating%20fishing%20conflicts%20are%20usually,in%20China's%20worsening%20fishing%20crisis.

[684] "Resolution of the India-Sri Lanka Maritime Border Conflict and Fisheries Dispute," National University of Singapore Institute of South Asian Studies, 2023, accessed 23 May, 2024, https://www.isas.nus.edu.sg/papers/resolution-of-the-india-sri-lanka-maritime-border-conflict-and-fisheries-dispute/#:~:text=The%20fisheries%20dispute%20poses%20serious,and%20the%20lack%20of%20resolution.

As mentioned previously piracy is also expected to grow as people's livelihoods decline and they turn to opportunistic crime. When analysing the SROCC through the EIP methodology to create the NGAM (as done in Chapter 4), there are multiple effects of climate change that are tagged as impacting negatively on livelihoods and economic security. However, within the SROCC the IPCC stops short of describing what the next steps are. This is where the interviews and other grey literature help fill an important gap in understanding the what, and why interventions further up in the EIP chains are so important to safeguarding the economic security of the Indo-Pacific and the coastal communities within the region.

7.4 Conclusion

This chapter has continued to illustrate the links and interconnections between the dimensions of maritime security, and the links between environmental security of the maritime domain and the economic security of coastal communities and countries dependent on it for trade, food, and tourism. This has been demonstrated through the feedback loops that identified a link to the natural environment and many of the preceding steps for the steps of 'receptor' and 'pathway' within the EIP chains tagged as impacting economic security also had links to the natural environment.

It has also shown that there are key links between human security and economic security, especially in relation to food and livelihoods. This reinforces the structure of maritime security outlined in Chapter 2 of it flowing from a base of environmental security to human security, then moving to economic security and then lastly on to national security.

This chapter also highlighted the need to supplement the analysis of the NGAM and the data used to build the database of EIP chains. This was augmented with interviews to ensure a holistic view of the impacts of the effects of climate change. As previously, discussed, the example of shipping being impacted by climate change and the magnitude of the impact that this is already having on global supply chains; however this doesn't come through at all in the SROCC data that is used to create the EIP chains. This means that the underlying quantitative data has a large skew toward the impacts on the natural environment, rather than societal issues.

The next chapter will discuss how the links between the environmental, human, and economic security will interact with national security.

Chapter 8 – National Security

This chapter, through the analysis of the data collected to create the NGAM and situated in the current context of the Indo-Pacific, will illustrate how the effects of climate change impact the resilience of national security within the Indo-Pacific. National security is the final dimension of maritime security used in this study and is where the 'traditional' elements of maritime security are addressed. This chapter will outline the current national security dimension of the Indo-Pacific in the maritime security context. It will then go on to discuss the findings that were developed through the NGAM process as outlined in Chapter 4, showing the impacts that are most strongly associated with climate change such as reduction in fish stocks, challenges to ocean governance, and damage to coastal infrastructure. Finally, it will analyse and discuss these findings in the context of the interviews that were undertaken, and the Indo-Pacific context to identify vulnerabilities and the most effective places for interventions, such as sustainable fisheries management, increased maritime domain awareness, and strengthening coastal infrastructure's resilience to climate impacts.

8.1 The National Security Environment in the Indo-Pacific

National security has traditionally, been focused on issues relating to sovereignty and regional stability and on actors at the state level that are capable of projecting power and force.[685] This chapter will show and contribute to the understanding of how climate change can impact issues relating to national security. As discussed in Chapter 2, the Indo-Pacific is home to the current centre of global geopolitical rivalry.[686] Understanding both how states' national security and the regional security architecture provide a basis for analysing how climate change will impact the region.

As discussed in Chapter 2 the Indo-Pacific is home to several great powers such as China, Japan, India and the United States, as well as an array of middle power states including

[685] Chime Youdon, *Climate resilience reimagined: Integrating concepts of human and ecological security in South Asia*, Clingendael Institute (2025), https://www.planetarysecurityinitiative.org/news/climate-resilience-reimagined-integrating-concepts-human-and-ecological-security-south-asia.
[686] Soumyodeep Deb and Nathan Wilson, "The coming of quad and the balance of power in the Indo-Pacific," *Journal of Indo-Pacific Affairs* 4, no. 9 (2021).

Australia, Indonesia, and South Korea.[687] The Indo-Pacific region is also becoming increasingly crowded and contested as other global powers including France and the United Kingdom are also becoming more active in the region and engage in more maritime security activities.[688] All of these countries have different views on what the Indo-Pacific is and what it should be. Despite the underlying macroeconomic environment, defence spending in Asia has continued to increase, underlying significance that countries are putting on the underlying strategic issues.[689] This all points to the contested geopolitical environment of the Indo-Pacific region.

While the Indian Ocean and the east of the Pacific Ocean become increasingly contested, the same can be said in the South Pacific, however with the only three Pacific Island Countries (Fiji, Papua New Guinea, and Tonga) having formal militaries, there is less capacity. However, the contestation in the Pacific, while it involves the deployment of military assets from countries external to Pacific Island Counties, is mostly focused on external countries securing security deals with Pacific Island Countries, with Australia, China, New Zealand, and the United States the most active in pursuing these deals.[690] This sub-section goes on to talk about some of the key issues to the national security dimension of maritime security within the Indo-Pacific.

8.1.1 Navies within the Indo-Pacific

The main actors in the maritime domain that are concerned with national security are a state's naval forces. The role of navies is multifaceted but is usually argued to fall into three main categories consisting of military, constabulary, and diplomacy. [691]

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[687] "Indo-Pacific Strand," accessed 24 May, 2024, https://www.cfg.polis.cam.ac.uk/research/indo-pacific/.
[688] Andrew Erskine, "The middle power dynamic in the Indo-Pacific: Unpacking how Vietnam and Indonesia can shape regional security and economic issues," *Journal of Indo-Pacific Affairs* 8 (2022). Briffa et al., *Policy Brief: Enhancing maritime security in the Indo-Pacific*
[689] "Chapter Five: Asia," *The Military Balance* 124, no. 1 (2024/12/31 2024), https://doi.org/10.1080/04597222.2024.2298593, https://doi.org/10.1080/04597222.2024.2298593.
[690] "Mapped: the vast network of security deals spanning the Pacific, and what it means," The Guardian, 2024, accessed 26 April, 2025, https://www.theguardian.com/world/article/2024/jul/09/pacific-islands-security-deals-australia-usa-china.
[691] James Goldrick, *Coast Guard-Navy Jointness as a Response to Hybrid Threats*, S. Rajartnam School of International Studies (2017). + Till + Germond 2015.

Military

Of the top 30 navies, according to the World Directory of Modern Military Warships, 14 are based in the Indo-Pacific with two others frequently engaged in the region.[692] Militarily there are navies of different strengths and strategic purposes that operate in the Indo-Pacific: distant blue water navies of France, the United Kingdom, the United States and increasingly, China; Green water navies that are sufficiently able to operate within their economic zones and littoral areas and a limited capacity to operate in a more regional sense such as Australia, India, Indonesia, New Zealand, South Korea, and Thailand; to brown water navies such as Bangladesh, Myanmar, and Vietnam whose operations are limited to operations within their littoral areas.

Many western states, including Australia and New Zealand, are reinvesting in their defence forces after COVID-19 contributed to their decline. This occurred through increased attrition rates of personnel due to the type of work they were required to do during COVID-19 and a shift of working patterns amongst the employed.[693] At the same time, there has been a continued under-investment in defence assets and infrastructure.[694]

On the other hand, China has consistently been investing in its navy for at least the last decade and a half and now has the largest navy in the world.[695] China currently is pursuing a strategy of expansion by increasing its capabilities and capacities and advancing and modernising its industry and infrastructure.[696] Across the Indo-Pacific, the Chinese Navy is becoming more commonplace and in Djibouti, in 2017, they established their first permanent base outside of mainland China.[697] China also has one of the most modern and best-equipped coastguards in the world, allowing it to contest and rival the smaller navies of

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[692] "Global Naval Powers Ranking (2024)," World Directory of Modern Military Warships, accessed 25 May, 2024, https://www.wdmmw.org/ranking.php.
[693] "NZDF warns government again it is in dire state," RNZ, 2024, accessed 12 August, 2024, https://www.rnz.co.nz/news/national/512447/nzdf-warns-government-again-it-is-in-dire-state.
[694] Cook, "NZDF warns government again it is in dire state."
[695] "What is most significant in the Pentagon's China military report?," 2023, accessed 24 September, 2024, https://www.reuters.com/world/what-is-most-significant-pentagons-china-military-report-2023-10-21/#:~:text=China%20already%20has%20the%20world's,and%20435%20ships%20by%202030.
[696] Edward Sing Yue Chan, "China's Discourse of Maritime Power: A Thematic Analysis," *Journal of Contemporary China* (2024), https://doi.org/10.1080/10670564.2024.2319064, https://doi.org/10.1080/10670564.2024.2319064.
[697] "China as a Composite Land-Sea Power: A Geostrategic Concept Revisited," The Center for International Maritime Security, 2021, accessed 24 May, 2024, https://cimsec.org/china-as-a-composite-land-sea-power-a-geostrategic-concept-revisited/.

the Indo-Pacific.[698] The very recent boat clash between China and the Philippines in Sabina Shoal in the South China Sea illustrates the tensions existing in the area with China coast guards being blamed for aggressive naval conflicts.[699] Indeed, the Chinese Coast Guard has been expanding its activities in both the East and South China Seas.[700] China is also becoming well versed in grey zone activities which successfully blurs the lines between military and civilian operations.[701]

Other countries including India and Indonesia, both aspire to build their naval capacity and capabilities to increasingly become regional players to ensure regional security and stability.[702] Japan also continues to strengthen its capabilities and is starting to depart from its post-WWII posture of self-defence to being more proactive and assertive, investing in long-range missile and counter-strike capabilities.[703] Following tension with Myanmar in the 2000s, Bangladesh is also aiming to strengthen its navy to ensure it has a green-water navy that is taken seriously.[704]

Submarine warfare capabilities within the Indo-Pacific are also increasing with Australia (through AUKUS as outlined below), Bangladesh, China, India, Indonesia, North Korea, South Korea, and Singapore all on a modernisation and expansion drive.[705]

Constabulary

Navies have always undertaken a constabulary role at sea, but the adoption of UNCLOS has driven the proliferation of navies designed to undertake constabulary functions within a

[698] Chan, "China's Discourse of Maritime Power: A Thematic Analysis."
[699] "Philippines sends replacement ship to Sabina Shoal, vows continued presence," 2024, accessed 24 September, 2024, https://www.reuters.com/world/asia-pacific/philippines-vessel-contested-south-china-sea-shoal-returns-port-2024-09-15/.
[700] Chan, "China's Discourse of Maritime Power: A Thematic Analysis."
[701] Germond, "Maritime power shapes the world order – and is undergoing a sea change."
[702] Kartik Bommakanti, "India and China's Space and Naval Capabilities: A Comparative Analysis," *Observer Research Foundation Occasional Paper* 160 (2018).
Angkasa Dipua et al., "Sea defense strategy the Indonesian navy in dealing with the South China Sea Conflict," *Italienisch* 11, no. 2 (2021).
[703] "Chapter Five: Asia."
[704] "Chapter Five: Asia."
[705] "Chapter Five: Asia."

country's EEZ.[706] In the Indo-Pacific the use of constabulary functions whether from military or non-military agencies has increased over recent years.[707]

One of the connections between economic and national security is the fact that naval forces are, in peacetime, mainly concerned with protecting trade routes and maintaining good order at sea as this keeps the global economy functioning.[708] Protection of trade routes is critical to the national security of many Indo-Pacific states, so ensuring freedom of navigation through the Pacific and Indian oceans is crucial to the ongoing function of these states.[709]

SIDS such as those in the Pacific often struggle with ensuring they have adequate maritime law enforcement capabilities. This arises from issues relating to the lack of infrastructure, the lack of hardware, and the lack of a capable maritime law enforcement staff.[710] To further enhance Maritime Domain Awareness (MDA) for SIDS maritime law enforcement, it is essential to increase capacity and capability, as well as facilitate the vital sharing of information between countries.[711]

Diplomacy

Maritime diplomacy involves using the tools of the state that are usually associated with achieving its militaristic aims (i.e. navies) and instead using them to build influence and reputation.[712] However, the functions that these militaristically focused agencies can undertake during peacetime vary greatly and are a useful way of increasing influence and presence around the world. Such activities could be port visits, support for aid activities, and scientific exchanges. Port visits are a very common and effective way of undertaking

[706] Joseph R Morgan, "Constabulary Navies in the Pacific and Indian Oceans," *Ocean Yearbook Online* 11, no. 1 (1994).
[707] Bama Andika Putra, "Rise of Constabulary Maritime Agencies in Southeast Asia: Vietnam's Paragunboat Diplomacy in the North Natuna Seas," *Social Sciences* 12, no. 4 (2023), https://www.mdpi.com/2076-0760/12/4/241.
[708] Bueger, "What is maritime security?."
[709] "Indo-Pacific allies, partners protect freedom of navigation," 2023, accessed 23 May, 2024, https://ipdefenseforum.com/2023/04/indo-pacific-allies-partners-protect-freedom-of-navigation/.
[710] "A South Pacific Island-led Approach to Regional Maritime Security," Center for International Maritime Security, 2020, accessed 29 May, 2024, https://cimsec.org/a-south-pacific-island-led-approach-to-regional-maritime-security/.
[711] Ginkel, "A South Pacific Island-led Approach to Regional Maritime Security."
[712] Putra, "Rise of Constabulary Maritime Agencies in Southeast Asia: Vietnam's Paragunboat Diplomacy in the North Natuna Seas."

diplomacy and showing goodwill.[713] Navies also very often participate in both Humanitarian Assistance and Disaster Relief, and Search and Rescue activities, both domestically and internationally.

As noted in Chapter 5: Environmental Security navies can capitalise on their experience of undertaking scientific expeditions to build relationships. A good historical example of this are the polar expeditions and hydrographic capabilities in which navies have taken part and serve as good examples of how navies can support diplomatic efforts by supporting activities in these domains.

Navies also participate in multi-lateral exercises which increases interoperability and cooperation between navies, as well as personal and institutional links between different countries.

8.1.2 Non-Military Agencies

In both diplomatic and constabulary functions non-militaristic agencies, such as coast guards, are increasing their profile and engagement, especially in the South China Sea.[714]

Within the Indo-Pacific, the concept of a coast guard has gained prominence, especially in the past twenty years, which has seen significant increases in the capacity of coast guards.[715] This growth has been due to a number of factors such as in response to the growing interests of China, but also because of their utility to address functions that would otherwise be undertaken by a navy, such as domestic maritime constabulary functions (i.e acting against IUUF, protecting against maritime terrorism, and tackling the trafficking of drugs and people).[716]

8.1.3 Tensions and Flashpoints

Strategic competition in the Indo-Pacific has been increasing, and as mentioned in Chapter Two, this is an underlying factor for the re-emergence of the Indo-Pacific terminology. In

[713] P. V. Rao, "Indian Ocean maritime security cooperation: the employment of navies and other maritime forces," *Journal of the Indian Ocean Region* 6, no. 1 (2010/06/01 2010), https://doi.org/10.1080/19480881.2010.489676, https://doi.org/10.1080/19480881.2010.489676.
[714] Putra, "Rise of Constabulary Maritime Agencies in Southeast Asia: Vietnam's Paragunboat Diplomacy in the North Natuna Seas."
[715] Putra, "Rise of Constabulary Maritime Agencies in Southeast Asia: Vietnam's Paragunboat Diplomacy in the North Natuna Seas."
[716] Putra, "Rise of Constabulary Maritime Agencies in Southeast Asia: Vietnam's Paragunboat Diplomacy in the North Natuna Seas."

recent times and especially since the end of the Cold War, the international order has been driven by western dominance, most notably through the unipolarity of the United States. This western dominance has fundamentally been underpinned by the supremacy and control of the ocean.[717]

With the rise of China and its increasing assertiveness and aggression, this strategic competition will continue for the foreseeable future as China has ambitions of leading the global order. Yet the degree to which this will mean the replacement of the current order and institutions is still to be seen.[718] As China continues to push for its ambitions, one of its objectives is to increase its capacity for aggression beyond the first island chain.[719]

India is also growing its presence in Southeast Asia and is seeing growing cultural, trade, and defence ties flowing out of its 'Look East' and the subsequent 'Act East' policies.[720] There have been demonstratable strengthening in ties between India and both Vietnam and Philippines.[721]

South China Sea and the Nine Dash line

The South China Sea is a very prominent flashpoint for tensions within the Indo-Pacific. This is primarily driven by China's nine-dash line, through which it lays claim to most of the South China Sea and also due to China's increasing assertiveness within the areas it claims. Brunei Darussalam, Indonesia, Malaysia, Vietnam and the Philippines are against the nine-dash line and while the disputes have not escalated into state-on-state conflict yet, there are increasing grey zone activities that aim to assert influence and increase presence for China in contested areas.

The nine-dash line outlines the expansive claims that China has been making in the South China Sea.[722] The line has been found to be without a legal foundation by the Permanent Court of Arbitration, which also found that following China's development of Mischief Reef,

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[717] Germond, "Maritime power shapes the world order – and is undergoing a sea change."
[718] Germond, "Maritime power shapes the world order – and is undergoing a sea change."
[719] "Chapter Five: Asia."
[720] "PacNet #16 – India, China, and the Evolving Balance in Southeast Asia," Pacific Forum, 2024, accessed 26 May, 2024, https://pacforum.org/publications/pacnet-16-india-china-and-the-evolving-balance-in-southeast-asia/.
[721] Singh, "PacNet #16 – India, China, and the Evolving Balance in Southeast Asia."
[722] "Science Journals: A New Frontline in the South China Sea Disputes," Asia Maritime Transparency Initiative, 2020, accessed 26 May, 2024, https://amti.csis.org/science-journals-a-new-frontline-in-the-south-china-sea-disputes/.

it unlawfully occupies the island and facilities it has built there as these fall within the Philippines' EEZ.[723] However, of late China has been strengthening its assertiveness towards the Philippines in the South China Sea.[724]

Within the South China Sea, Vietnam has long-running issues with China trying to undertake resource extraction activities within its EEZ; again this happens within the South China Sea in areas that China claims under the nine-dash line. Vietnam takes a different tack to approach these issues with China though trying to resolve these issues privately, as Vietnam is tip-toeing the line between seeing China as a partner for cooperation or a competitor.[725]

Indonesia does have its disputes with China and continues to face efforts from China in the form of attempts to exert influence over Indonesia's EEZ.[726] Indonesia is keen to ensure that the Indo-Pacific is a zone of peace, freedom, neutrality, and prosperity and is pursuing this aim through both the East Asia Summit and the Indian Ocean Rim Association.[727] As an example of good cooperation in the South China Sea, Indonesia and Vietnam have been able to work through their maritime boundary disputes concluding in 2023 after a long-standing issue between the two countries that allows them to present a united front in rejecting China's unilateral nine-dash line claim.[728]

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[723] "The Hague Tribunal's South China Sea Ruling: Empty Provocation or Slow-Burning Influence?," Council of Councils, 2016, https://www.cfr.org/councilofcouncils/global-memos/hague-tribunals-south-china-sea-ruling-empty-provocation-or-slow-burning-influence.

[724] "Understanding China's efforts to bridge the South China Sea and Taiwan Strait disputes," The Interpreter, 2024, accessed 26 May, 2024, https://www.lowyinstitute.org/the-interpreter/understanding-china-s-efforts-bridge-south-china-sea-taiwan-strait-disputes.

[725] "Southeast Asia stymied in South China Sea dispute," East Asia Forum, 2024, accessed 26 May, 2024, https://eastasiaforum.org/2024/03/22/southeast-asia-stymied-in-south-china-sea-dispute/.
Nguyen The Phuong, *The South China Sea Disputes and the Evolution of the Vietnam-China Relationship* The National Bureau of Asian Research (2024).

[726] "Indonesia and the South China Sea," The Royal United Services Institute for Defence and Security Studies, 2016, https://rusi.org/explore-our-research/publications/rusi-newsbrief/indonesia-and-south-china-sea.
"Gauging Indonesia's interests in the South China Sea," East Aisa Forum, 2020, accessed 25 May, 2024, https://eastasiaforum.org/2020/06/26/gauging-indonesias-interests-in-the-south-china-sea/.

[727] Dipua et al., "Sea defense strategy the Indonesian navy in dealing with the South China Sea Conflict."

[728] "What does the Indonesia–Vietnam EEZ Agreement mean for the region," National University of Singapore Centre for International Law, 2023, accessed 25 May, 2024, https://cil.nus.edu.sg/blogs/what-does-the-indonesia-vietnam-eez-agreement-mean-for-the-region/.

Taiwan Strait

Recently it has become obvious that the stability of cross-strait relations has deteriorated.[729] China has always been committed to reunifying Taiwan with mainland China and as such Taiwan remains front and centre of Chinese military thinking and activity as it continues to test the robustness of Taiwan's defences and allies.[730]

Currently, there are multiple questions regarding the robustness of the United States' commitment to defending Taiwan in the face of the Ukraine invasion, with Israel also providing an unnecessary distraction and drawing on policy maker's time. The United States has always used a degree of strategic ambiguity when dealing with the Taiwan issue as it attempts to placate China while providing adequate protection and support for Taiwan.[731]

In early 2024 the United States undertook a naval operation in the Taiwan Strait in response to China's increasing assertiveness and to demonstrate its commitment to Taiwan.[732] But the continued probing by China on the resolve of Taiwan and its allies makes this flashpoint possibly the most dangerous, within the Indo-Pacific.

Increasing Interest in the Pacific

Strategic competition is not limited to large states, as the smaller states have a role to play in geopolitics and strategic competition.[733] The Pacific has become an increasingly contested area with both China and the United States stepping up their engagement in the region in recent years. China has managed to effectively take advantage of the United States' historical lack of focus on the Pacific Island countries to gain influence.[734] China has managed to effectively use its aid, development and diplomacy, to strengthen its ties with

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[729] Nien-chung Chang-Liao and Chi Fang, "The Case for Maintaining Strategic Ambiguity in the Taiwan Strait," *The Washington Quarterly* 44, no. 2 (2021/04/03 2021), https://doi.org/10.1080/0163660X.2021.1932088, https://doi.org/10.1080/0163660X.2021.1932088.
[730] "Chapter Five: Asia."
[731] Chang-Liao and Fang, "The Case for Maintaining Strategic Ambiguity in the Taiwan Strait."
[732] Yi, "Understanding China's efforts to bridge the South China Sea and Taiwan Strait disputes."
[733] Jonathan D. Caverley and Peter Dombrowski, "Too Important to Be Left to the Admirals: The Need to Study Maritime Great-Power Competition," *Security Studies* 29, no. 4 (2020/08/07 2020), https://doi.org/10.1080/09636412.2020.1811448.
[734] "China is making waves in the Pacific," Geopolitical Intelligence Services, 2024, accessed 27 May, 2024, https://www.gisreportsonline.com/r/china-pacific-conflict/.

Pacific Island countries and has managed to sign security deals with at least one Pacific country.[735]

The Pacific holds both military and political importance; for China establishing itself within the Pacific is key to being able to break through the first island chain.

The Red Sea

The Red Sea has a history of being a place of insecurity and uncertainty. The outbreak of the most recent Red Sea crisis has seen a significant impact on shipping and responses by navies.[736] The current crisis is driven by Iranian-backed Houthis targeting merchant vessels from selected states such as the United Kingdom or the United States, this is in response to the current issues going on in Palestine/Gaza, and is a show of solidarity between the Houthis and Hamas.[737]

The Red Sea is in the northwest of the Indo-Pacific region and the current crisis is impacting where states deploy their naval resources, as well as impacting national security. Because of this crisis, many shipping companies have re-routed around Africa adding at least 10 days to their voyage time. Consequently, this is increasing emissions from shipping at a time when shipping is supposed to be working towards a 20 percent reduction in emissions by 2030.[738] With global trade and sea routes being vital to the energy security and economic security of many countries in the Indo-Pacific, the issues in the Red Sea are quickly becoming an issue of national security.

Korean Peninsula

Security on the Korean Peninsula is crucial to ensuring peace and stability not just on the peninsula itself but within the northeast of the Indo-Pacific region.[739] Since 2022 North

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[735] "China's rising power and influence in the Pacific explained in 30 seconds," The Guardian, 2023, accessed 27 May, 2024, https://www.theguardian.com/world/2023/mar/09/chinas-rising-power-and-influence-in-the-pacific-explained-in-30-seconds.
[736] "Red Sea Crisis," The Center for International Maritime Security, accessed 27 May, 2024, https://cimsec.org/red-sea-crisis/.
[737] "China's Calculated Inaction in the Red Sea Crisis," The Center for International Maritime Security, 2024, accessed 27 May, 2024, https://cimsec.org/chinas-calculated-inaction-in-the-red-sea-crisis/.
[738] "Red Sea crisis forces operators to use more container ships, adding to emission concerns," Reuters, 2024, accessed 27 May, 2024, https://www.reuters.com/sustainability/red-sea-crisis-forces-operators-use-more-container-ships-adding-emission-2024-04-10/.
[739] "Korean Peninsula," International Crisis Group, accessed 27 May, 2024, https://www.crisisgroup.org/asia/north-east-asia/korean-peninsula.

Korea has increased its missile testing frequency.[740] As it continues to become a more technically advanced nuclear power, it is unclear if the US will have the resolve to make nuclear retaliation a credible deterrence.[741]

8.1.4 Multilateralism and Rule of Law

UNCLOS

In 1982 most of the world agreed on a comprehensive governance mechanism for the world's oceans, the United Nations Convention on the Law of the Sea (UNCLOS), and this continues to be "the single most important treaty governing maritime norms, rights and responsibilities."[742] UNCLOS set out the basis for the jurisdictions at sea by providing the delineation of different parts of the oceans, including the rights and duties of states within these parts.[743] UNCLOS also outlined the principles and norms that states should follow with the aim of maintaining peace, stability, and order at sea.[744] As mentioned in Chapter 5 UNCLOS also included provisions on the protection and preservation of the marine environment.

UNCLOS at the time was a success story, but as any large and complex convention would, it has thrown up issues that nobody foresaw 40 years ago.[745] It is now coming under pressure from external challenges, not envisaged when UNCLOS was created, such as unmanned and/or autonomous vehicles, and climate change.[746] It is also coming under pressure from China's actions which are aimed at eroding the rule of law, especially within the South China Sea in relation to its nine-dash line.[747] Countries in Southeast Asia believe in the importance of UNCLOS as a way to ensure that all countries abide by the same rules and laws at sea and as a way toward levelling the gaps between great and small powers. To this end, ASEAN and

[740] "Chapter Five: Asia."
[741] "Chapter Five: Asia."
[742] "Cause and effect: The right security architecture for the Indo-Pacific," The Interpreter, 2022, accessed 28 May, 2024, https://www.lowyinstitute.org/the-interpreter/cause-effect-right-security-architecture-indo-pacific.
[743] S. A. M. Bateman, "Solving the "Wicked Problems" of Maritime Security: Are Regional Forums up to the Task?," *Contemporary Southeast Asia* 33, no. 1 (2011), https://doi.org/10.1355/cs34-1a.
[744] Bateman, "Solving the "Wicked Problems" of Maritime Security: Are Regional Forums up to the Task?."
[745] "Sovereignty, Security and Prosperity: Indonesia and the UN Convention on the Law of the Sea," Fulcrum, 2022, accessed 27 May, 2024, https://fulcrum.sg/sovereignty-security-and-prosperity-indonesia-and-the-un-convention-on-the-law-of-the-sea/.
[746] Darmawan, "Sovereignty, Security and Prosperity: Indonesia and the UN Convention on the Law of the Sea."
[747] Storey, "Cause and effect: The right security architecture for the Indo-Pacific."

China are continuing negotiations to develop a binding code of conduct for the South China Sea.[748]

BBNJ

In 2023, states also concluded the negotiations on the United Nations Convention on the Law of the Sea on the conservation and sustainable use of marine biological diversity of areas beyond national jurisdiction (BBNJ).[749] The BBNJ focuses on four areas: marine genetic resources; measures such as area-based management tools; environmental impact assessments; and capacity-building and the transfer of marine technology.[750] How the BBNJ is implemented will be a question that will need to be considered, especially as the enforcement of the BBNJ will be done by flag states.[751]

Increasing Mini-lateralism

As competition has increased in the Indo-Pacific there has been a significant increase in the use of mini-lateral engagements which are becoming a key feature of the geostrategic architecture. Mini-laterals are usually a smaller, more dynamic and less formal arrangement of states.[752] Whereas, multilateral initiatives such as ASEAN, IROA, and the PIF offer a platform for many countries to engage together. Comparatively, mini-laterals such as the Quad and AUKUS offer the opportunity for more directed and focused engagement, such as increased naval interoperability and sustainability between allies. Additionally, mini-laterals

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[748] Storey, "Cause and effect: The right security architecture for the Indo-Pacific."
"What's Behind the New China-ASEAN South China Sea Code of Conduct Talk Guidelines?," Wilson Center 2023, accessed 28 May, 2024, https://www.wilsoncenter.org/blog-post/whats-behind-new-china-asean-south-china-sea-code-conduct-talk-guidelines.

[749] "Marine biodiversity beyond national jurisdiction," New Zealand Foreign Affairs & Trade, accessed 27 May, 2024, https://www.mfat.govt.nz/en/environment/oceans-and-fisheries/marine-biodiversity-beyond-national-jurisdiction.

[750] "United Nations Convention on the Law of the Sea Agreement under the United Nations Convention on the Law of the Sea on the Conservation and Sustainable Use of Marine Biological Diversity of Areas Beyond National Jurisdiction," United Nations Oceans & Law of the Sea 2024, accessed 27 May, 2024, https://www.un.org/Depts/los/bbnj.htm.

[751] Elizabeth Mendenhall and Kahlil Hassanali, "The BBNJ agreement and liability," *Marine Policy* 150 (2023/04/01/ 2023), https://doi.org/https://doi.org/10.1016/j.marpol.2023.105549, https://www.sciencedirect.com/science/article/pii/S0308597X23000763.

[752] Matthew Gray, "The rise of minilateralism, the Indo-Pacific context, and the Arab Gulf states," *Journal of the Indian Ocean Region* 19, no. 1 (2023/01/02 2023), https://doi.org/10.1080/19480881.2023.2261204, https://doi.org/10.1080/19480881.2023.2261204.

provide the ability to be more inclusive and strategic than bilateral engagements without the weaknesses of operating within larger multilateral groupings.[753]

Two of the more prominent mini-laterals in the Indo-Pacific are the Quad and AUKUS. AUKUS started primarily as a platform for sharing the technology needed to increase nuclear-powered submarine capacity and capability in the three AUKUS countries, as well as building interoperability between them.[754] AUKUS has not formally expanded yet, but there is continuing discussion in Canada, Japan, New Zealand, and South Korea on the utility of joining pillar two of AUKUS.[755] AUKUS pillar two is aimed at the joint development and enhancement of technological advancement with the aim of increasing the general (i.e. non-nuclear) capacity, capability, and interoperability of those in the agreement.[756]

The Quad which took two attempts to get going is now positioning itself as the prominent security arrangement within the Indo-Pacific. The Quad features Australia, India, Japan, and the United States and while not an alliance, it provides a way to develop both formal and informal partnerships that focus on limiting China's expansion within the Indo-Pacific.[757] To that extent, the Quad in 2022 announced the implementation of an initiative that will target IUUF in the Indo-Pacific.[758]

Mini-laterals can also be used by middle and small powers such as China, Laos, and Thailand working in a coordinated fashion to counter maritime crime in the Mekong River, with

[753] Troy Lee-Brown, "Asia's Security Triangles: Maritime Minilateralism in the Indo-Pacific," *East Asia* 35, no. 2 (2018/06/01 2018), https://doi.org/10.1007/s12140-018-9290-9, https://doi.org/10.1007/s12140-018-9290-9.
[754] "AUKUS Pillar Two: Advancing the Capabilities of the United States, United Kingdom, and Australia," Center for Strategic and International Studies, 2023, accessed 27 May, 2024, https://www.csis.org/analysis/aukus-pillar-two-advancing-capabilities-united-states-united-kingdom-and-australia.
[755] "South Korea discusses joining part of AUKUS pact with US, UK and Australia," Reuters, 2024, accessed 27 May, 2024, https://www.reuters.com/world/south-korea-confirms-talks-aukus-pact-with-us-uk-australia-2024-05-01/.
[756] Christianson, Monaghan, and Cooke, "AUKUS Pillar Two: Advancing the Capabilities of the United States, United Kingdom, and Australia."
[757] "The Quad eyeing Indo-Pacific security," Geopolitical Intelligence Services, 2024, accessed 25 May, 2024, https://www.gisreportsonline.com/r/quad-indo-pacific-security/.
[758] "'Quad' security group plans system to track illegal fishing by China," Financial Times, 2022, accessed 28 May, 2024, https://www.ft.com/content/4066cc72-119a-48e2-b55c-980c4e3f6c9a.

Indonesia, Malaysia, Singapore, and Thailand working together to tackle piracy and sea robbery in the Malacca Straight.[759]

8.1.5 Sovereignty and Statehood

Much of the contestation in the East and South China Seas concerns sovereignty and the protection of national boundaries and economic resources.[760] Countries such as Bangladesh, China, India, Iran, Malaysia, Myanmar, and Pakistan apply an approach of offshore defence which prohibits foreign militaries from operating within other country's EEZs.[761]

However, this is not the only issue impacting sovereignty and the continued existence of nation-states. Sea level rise is becoming a question of existentialism and continued existence, especially for low-lying SIDS. To this end, the Pacific Island Countries have made a formal declaration in 2021, where they:

> *Proclaim that our maritime zones, as established and notified to the Secretary-General of the United Nations in accordance with the Convention, and the rights and entitlements that flow from them, shall continue to apply, without reduction, notwithstanding any physical changes connected to climate change-related sea-level rise.*[762]

The PIF 2021 declaration was followed by the *2023 Declaration on the Continuity of Statehood and the Protection of Persons in the Face of Climate Change-Related Sea-Level Rise* which they:

> *Declare that the statehood and sovereignty of Members of the Pacific Islands Forum will continue, and the rights and duties inherent thereto will be maintained, notwithstanding the impact of climate change-related sea-level rise.*[763]

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[759] Storey, "Cause and effect: The right security architecture for the Indo-Pacific."
"Piracy and the Pandemic: Maritime Crime in Southeast Asia, 2020-2022," Fulcrum, 2022, accessed 28 May, 2024, https://fulcrum.sg/piracy-and-the-pandemic-maritime-crime-in-southeast-asia-2020-2022/.
[760] Liu Qing, *The Maritime Environment in the Western Pacific*, S. Rajartnam School of International Studies (2017).
[761] Qing, *The Maritime Environment in the Western Pacific*.
[762] Pacific Island Forum, "Declaration on Preserving Maritime Zones in the Face of Climate Change-related Sea-Level Rise," news release, 2021, https://www.forumsec.org/2021/08/11/declaration-on-preserving-maritime-zones-in-the-face-of-climate-change-related-sea-level-rise/.
[763] Pacific Islands Forum, *2023 Declaration on the Continuity of Statehood and the Protection of Persons in the Face of Climate Change-Related Sea-Level Rise*.

How this argument plays out will be interesting to watch. Part of this requires reconceptualising of ocean territory in the same way as land-based territory.

It is not only SIDS that are worried about the impact of rising sea levels on their territory while it is more of an existential question for SIDS, but archipelagic states also such as Indonesia face the complex issue of having to redraw archipelagic baselines that could reduce the sovereign maritime territory and open up areas of high seas between islands.[764]

8.2 Findings

Figure 8.1 is a visual representation of the NGAM for economic security.

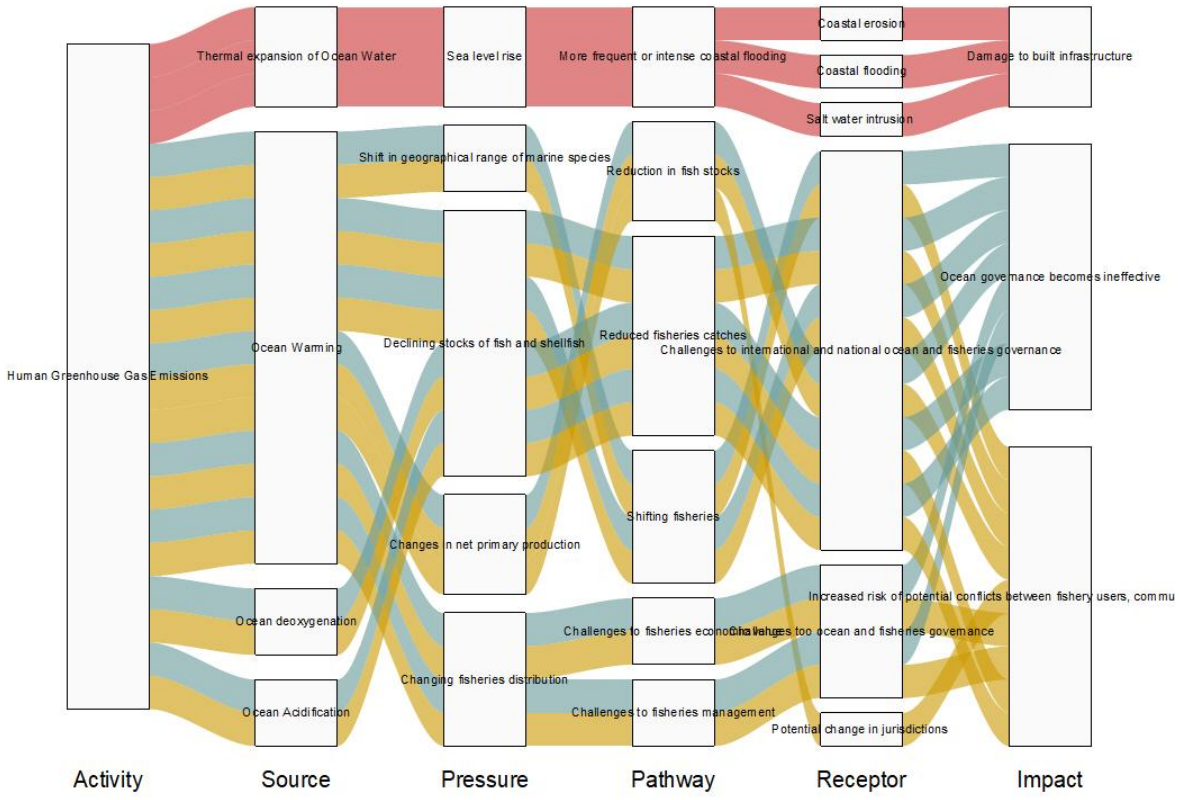

Figure 8.1 – A visual representation of the NGAM for national security[765]

[764] Ria Tri Vinata, Masitha Tismananda Kumala, and Cita Yustisia Serfiyani, "Climate change and reconstruction of Indonesia's geographic basepoints: Reconfiguration of baselines and Indonesian Archipelagic Sea lanes," *Marine Policy* 148 (2023/02/01/ 2023), https://doi.org/https://doi.org/10.1016/j.marpol.2022.105443, https://www.sciencedirect.com/science/article/pii/S0308597X22004900.

[765] An enlargement of this figure can be found in Annex Seventeen

Table 8.1 shows the 'pathways' found during the construction of the NGAM, for EIP chains that are tagged against national security. For national security 20 EIP chains flow through six different 'pathways' the most frequently occurring was 'Reduced fisheries catches' which was the 'pathway' for six different EIP chains. The two most frequently occurring 'pathways' occurred in 50 percent of all the EIP chains. Five out of the six different pathways relate to fish in some way, again showing the linkages between the natural environment and other aspects of maritime security.

As discussed in prior chapters, understanding the preceding step in the EIP chains supports the analysis of the flow of the effects of climate change through to their impacts. For 'pathways', the preceding step is 'pressures'. For the 'pathway' of 'Reduced fisheries catches' the preceding 'pressure' is 'Declining stocks of fish and shellfish'.
For the 'pathway' of 'Shifting fisheries' the preceding 'pressures' are 'Declining stocks of fish and shellfish', and 'Shift in geographical range of marine species'. For the 'pathway' of 'More frequent or intense coastal flooding' the preceding 'pressure' is 'Sea level rise' and for the 'pathway' of 'Reduction in fish stocks' the 'pressure' is 'Changes in net primary production'.

Table 8.1 – National security 'pathways'

Pathway	Number of occurrences	Frequency of occurrences
Reduced fisheries catches	6	30.00%
Shifting fisheries	4	20.00%
More frequent or intense coastal flooding	3	15.00%
Reduction in fish stocks	3	15.00%
Challenges to fisheries economic value	2	10.00%
Challenges to fisheries management	2	10.00%
Grand Total	**20**	**100.00%**

Table 8.2 shows the 'receptors' that occur in the EIP chains tagged against national security with the most frequently occurring 'receptor' being 'Challenges to international and national ocean and fisheries governance' occurring in 80 percent of the EIP chains. The preceding step for 'receptors' is the 'pathway' and for the 'receptor' of 'Challenges to

international and national ocean and fisheries governance' the main 'pathways' are 'Reduced fisheries catches', and 'Shifting fisheries'.

Table 8.2 – National security 'receptors'

Receptor	Number of occurrences	Frequency of occurrences
Challenges to international and national ocean and fisheries governance	16	80.00%
Coastal erosion	1	5.00%
Coastal flooding	1	5.00%
Potential change in jurisdictions	1	5.00%
Salt water intrusion	1	5.00%
Grand Total	**20**	**100.00%**

Table 8.3 shows the 'impacts' associated with National Security. There are only three different 'impacts' that are tagged to national security and as discussed previously, this could be due to methodological and scoping limitations. The three different 'impacts' show three unique ways in which action could be taken to support national security in the Indo-Pacific these are fisheries support and protection, strengthening ocean governance, and protecting critical infrastructure.

The preceding step for 'impact' in the EIP chain is 'receptor'. For the 'impact' of 'Increased risk of potential conflicts between fishery users, communities and authorities' the 'receptors' are 'Challenges to international and national ocean and fisheries governance', and 'Challenges to international and national ocean and fisheries governance'. For the 'impact' of 'Ocean governance becomes ineffective' the 'receptor' is 'Challenges to international and national ocean and fisheries governance'. For the 'impact' of 'Damage to built infrastructure' the 'receptors' are 'Coastal erosion', 'Coastal flooding', and 'Salt water intrusion'.

Table 8.3 – National security 'impacts'

Impact	Number of occurrences	Frequency of occurrences
Increased risk of potential conflicts between fishery users, communities and authorities	9	45.00%
Ocean governance becomes ineffective	8	40.00%
Damage to built infrastructure	3	15.00%
Grand Total	**20**	**100.00%**

8.3 Feedback Loops

For national security there are a couple of feedback loops which could be worth investigating in future studies these are:

- The pathway of 'Shifting fisheries' to the Pressure 'Changing fisheries distribution'; and
- The impact of 'ocean governance becomes ineffective' to the receptor 'challenges to international and national ocean and fisheries governance'.

These feedback loops are related directly and indirectly to the environmental issues of the fish stocks. This continues to highlight the importance of environmental security and the interlinkages between the environment and national security. The above feedback loops will serve to exacerbate these issues and the receptors and impacts that flow on from the pathways that are fed back into. A visual representation of this can be seen in Figure 8.2.

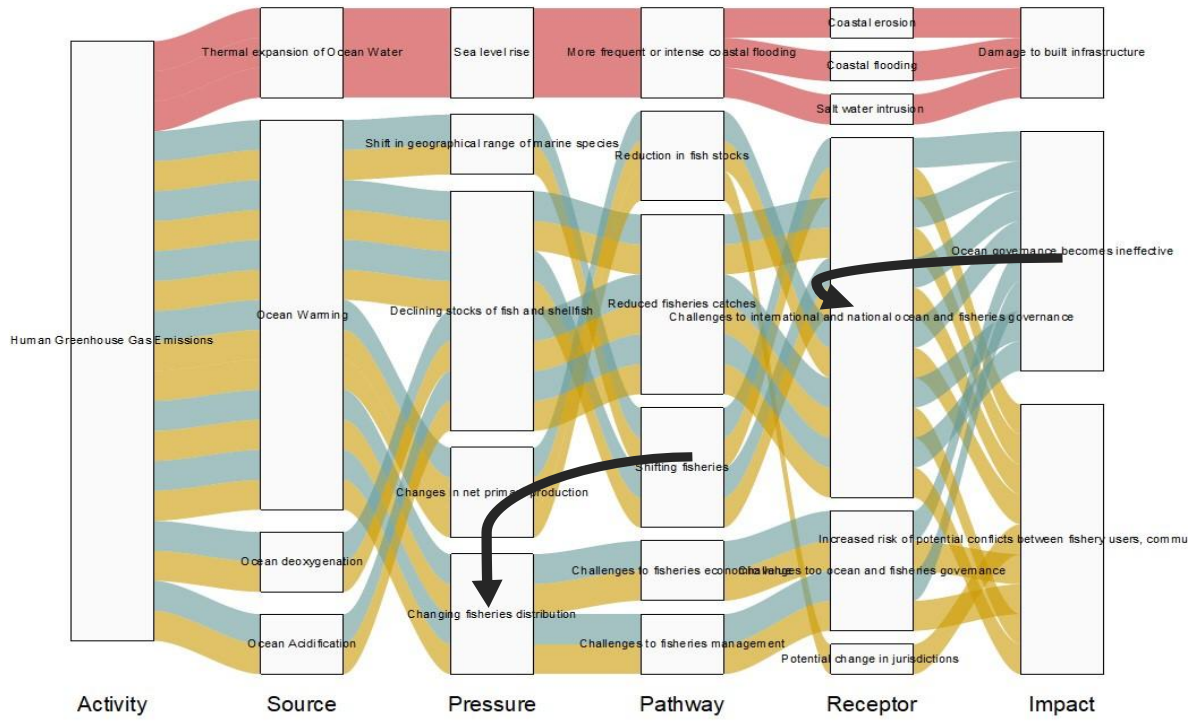

Figure 8.2 – A visual representation of national security's feedback loops[766]

[766] An enlargement of this figure can be found in Annex Eighteen

8.4 Discussion

The negative impacts of climate change will severely impact the national security of a number of countries as it causes direct security implications and exacerbates a number of other issues, such as Humanitarian and Disaster Relief (HADR), disasters at sea, illegal and irregular migration, and IUUF.[767]

As outlined initially in Chapter 2 and further discussed throughout this thesis, the issue of climate change and the impacts it has on security have gained prominence and importance. The various chapters of this thesis have shown the significant implications this has for the maritime security dimensions of environmental, human, and economic security. As chosen by many others, the Indo-Pacific provides a good geographical region to study such intense, transboundary issues as climate change and maritime security.[768] The diversity of its constituents, ranging from continents and sub-continents to the smallest Small Island Developing States (SIDS), and everything in between, makes it very useful in the observation of comparative impacts and solutions.

The dimension of national security has significantly fewer EIPs tagged against it within the NGAM, as discussed in the limitations section of the thesis; this could be due to a bias within the data source (SROCC) towards the impacts on the natural environment. According to the findings from the NGAM of the EIP chains that are tagged against national security, the best interventions that would aim to support the resilience of the national security dimension would be ones that reduced countries vulnerabilities to fisheries conflict, weakened or inefficient governance, and improve the resilience of crucial infrastructure in coastal areas.

Fisheries

For an intervention in relation to 'increased risk of potential conflicts between fishery users, communities and authorities', 'ocean warming' seemed to be the most common source attributed to this. Fisheries conflict has been discussed in the previous chapters on human and economic security, and as an issue that can originate at a sub-national level and lead to interstate conflict it shows the discussion of fisheries conflict in this chapter shows the

[767] Hall, Lee-Brown, and Strating, *Blue Security in the Indo-Pacific*.
[768] Tangney et al., "Climate security in the Indo-Pacific: a systematic review of governance challenges for enhancing regional climate resilience."
Hall, Lee-Brown, and Strating, *Blue Security in the Indo-Pacific*.

multiplicative and synergistic impacts of climate change can culminate in a national security issue as it manifest into interstate conflict and regional instability.[769] Therefore, as discussed in Chapter 7, looking at ways of limiting or reversing ocean warming would be a useful start (as can be seen in figure 8.3); the next would be to understand the actual potential movement of fisheries and ensure robust governance and conflict resolution methods are in place.

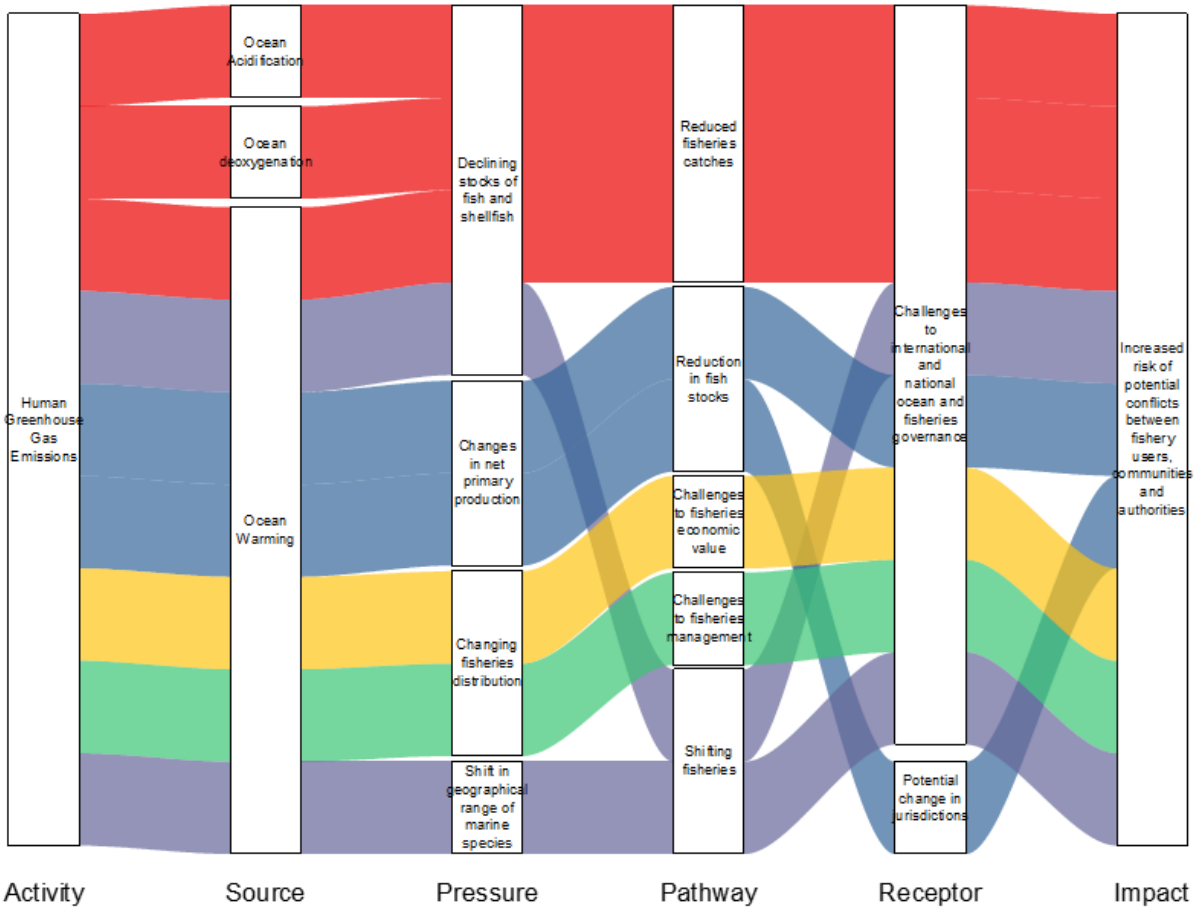

Figure 8.3 – A visualisation of the EIPs ending in the impact 'Increased risk of potential conflicts between fishery users, communities and authorities'[770]

IUUF is a crucial threat to maritime security within the Indo-Pacific, including within the South China Sea,[771] and was also one of the most discussed topics in interviews, as the impacts of fisheries change are accounted for across all sectors of maritime security, not just

[769] Elizabeth Mendenhall et al., "Climate change increases the risk of fisheries conflict," *Marine Policy* 117 (2020/07/01/ 2020), https://doi.org/https://doi.org/10.1016/j.marpol.2020.103954, https://www.sciencedirect.com/science/article/pii/S0308597X19304622.

[770] An enlargement of this figure can be found in Annex Nineteen

[771] Hongzhou Zhang, "Fisheries cooperation in the South China Sea: Evaluating the options," *Marine Policy* 89 (2018/02/01/ 2018), https://doi.org/https://doi.org/10.1016/j.marpol.2017.12.014, https://www.sciencedirect.com/science/article/pii/S0308597X17307145.

military security. This validates the findings of the NGAM and EIP chains, but it also underpins the interconnectedness of maritime security issues. Interventions relating to sustainable fisheries management and governance have been discussed in Chapter 7, and the issue of ocean governance will be discussed below. However, it is crucial to ensure there is an efficient and effective way to ensure fisheries cooperation and conflict resolution in a changing climate.[772]

Fisheries management, an issue related to almost all pressures and pathways that flow on to impact as fisheries conflict as seen in figure 8.3, is transboundary in nature, as with a number of other topics discussed in this thesis, fish have no concept of lines drawn on a map, this further reinforces the usefulness of the super-maritime region of the Indo-Pacific being used for the analysis of this thesis.[773] The fact that fisheries are transboundary in nature elevates this issue to one that has elements of the dimension of national security, as fisheries inevitably get drawn into issues of geo-political economy.[774] Regional Fisheries Management Organisations (RFMOs) are a crucial part of the governance of fisheries, these organisations need to ensure they are responsive to climate change and can support the sustainable management of fisheries by incorporating climate scenarios within their planning and catch limits they set.

China can be a key player in supporting efforts and interventions relating to all aspects of the impacts of the effects of climate change, especially within the Indo-Pacific.[775] However, in interviews with experts, they commented that China still views climate change more as an opportunity than as a problem.[776] This was commented on in relation to IUUF, as the shifting fish stocks from countries' EEZs to the high seas or other countries' EEZs, which may be more favourable to China. This will mean that countries will need to ensure that they

[772] Zhang, "Fisheries cooperation in the South China Sea: Evaluating the options."
[773] Juliano Palacios-Abrantes et al., "The transboundary nature of the world's exploited marine species," *Scientific Reports* 10, no. 1 (2020/10/21 2020), https://doi.org/10.1038/s41598-020-74644-2, https://doi.org/10.1038/s41598-020-74644-2.
[774] Liam Campling et al., "A geopolitical-economy of distant water fisheries access arrangements," *npj Ocean Sustainability* 3, no. 1 (2024/04/29 2024), https://doi.org/10.1038/s44183-024-00060-y, https://doi.org/10.1038/s44183-024-00060-y.
[775] Yen-Chiang Chang et al., "Legal practices and challenges in addressing climate change and its impact on the oceans—A Chinese perspective," *Marine Policy* 111 (2020/01/01/ 2020), https://doi.org/https://doi.org/10.1016/j.marpol.2018.11.018, https://www.sciencedirect.com/science/article/pii/S0308597X18304925.
[776] Interview I

have some sort of credible monitoring and/or constabulary function that can address IUUF as this will put them in a better position when confronting the likes of China on this issue.

An intervention that will support actions towards both impacts of 'Increased risk of potential conflicts between fishery users, communities and authorities' and 'Ocean governance becomes ineffective' is increasing Maritime Domain Awareness capabilities and capacity. Improving a state's MDA and reinforcing this with credible actions is crucial to maritime security and will become increasingly valuable in the face of the impacts of climate change, and as actors use these impacts as opportunities.[777] This is because, as stated by the IMO, MDA is the "effective understanding of anything associated with the maritime domain that could impact security, safety, the economy or the marine environment."[778] With an intervention to support the incorporation of climate impacts into MDA tools, the methodology used within this thesis could be adapted to fit within MDA tools, and this would support states and maritime agencies in identifying further areas for interventions to minimise the impacts of climate change. To support this need to advance MDA capabilities, technology advances such as the increased use of uncrewed vessels that could undertake monitoring tasks could help ease the burden of an intervention.

Another intervention to reduce the impacts of 'Increased risk of potential conflicts between fishery users, communities and authorities' and 'Ocean governance becomes ineffective' is better resourcing states' Coast Guard agencies. When used appropriately, Coast Guards tend to operate in a less provocative manner and are able to assert control and sovereignty in a peaceful way.[779] So developing the capacity and capabilities of a state's Coast Guard will support its overall ability to respond to challenges in an increasingly complex maritime

[777] Marin Chintoan-Uta and Joaquim Ramos Silva, "Global maritime domain awareness: a sustainable development perspective," *WMU Journal of Maritime Affairs* 16, no. 1 (2017/01/01 2017), https://doi.org/10.1007/s13437-016-0109-5, https://doi.org/10.1007/s13437-016-0109-5.
[778] "Maritime Domain Awareness," accessed 26 April, 2025, https://www.imo.org/en/OurWork/Security/Pages/Maritime-Domain-Awareness.aspx.
[779] Douglas Guilfoyle and Edward Sing Yue Chan, "Lawships or warships? Coast guards as agents of (in)stability in the Pacific and South and East China Sea," *Marine Policy* 140 (2022/06/01/ 2022), https://doi.org/https://doi.org/10.1016/j.marpol.2022.105048, https://www.sciencedirect.com/science/article/pii/S0308597X22000951.

environment.[780] Indeed, to this end, ASEAN have set up an ASEAN Coast Guard Forum.[781] Increasing the capacity and capability for Coast Guard agencies is also useful for countries that have navies, as it has the potential to free up naval capacity, and for those that don't, by building maritime enforcement capacity. Mini-lateralism can even provide some support in developing Coast Guard capabilities and capacity, as can be seen with the recent engagement between the Indonesia, Philippines, and Vietnam coast guards.[782]

Ocean Governance

Ocean governance will be affected by a changing climate, and as has been shown throughout the previous chapters ocean governance is a complex issue that engages and relies on a variety of relationships and processes at all levels and is a key aspect of overall global governance.[783] In the NGAM for the dimension of national security the 'impact' of 'ocean governance becomes ineffective' has very similar EIP chains to that of the 'impact' of 'increased risk of potential conflicts between fishery users, communities and authorities', so supporting the interventions to support the mitigation of these impacts as discussed above, is crucial.

A study in 2024 by McClanahan shows that in the western Indian Ocean, there is a broad understanding and acknowledgement of the negative impacts of climate change, but this was not effectively translated into observed actions, especially at the local level.784 The issue of efficient and effective governance is one that is particularly pertinent to SIDS especially those in the Pacific.[785] This is because Pacific SIDS through the vast EEZs have

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[780] "Securing Southeast Asian waters: Formalising the role of the ASEAN Coast Guard Forum," The Interpreter, 2025, accessed 27 April, 2025, https://www.lowyinstitute.org/the-interpreter/securing-southeast-asian-waters-formalising-role-asean-coast-guard-forum.
[781] "ASEAN Coast Guard Forum strengthens cooperation to combat maritime threats," Indo-Pacific Defense Forum, 2023, accessed 25 April, 2025, https://ipdefenseforum.com/2023/06/asean-coast-guard-forum-strengthens-cooperation-to-combat-maritime-threats/.
[782] "Sharing security interests, ASEAN's big three step up cooperation," The Stategist, 2025, accessed 27 April, 2025, https://www.aspistrategist.org.au/sharing-security-interests-aseans-big-three-step-up-cooperation/.
[783] Antonia Zervaki, "Human security and climate change mitigation: The case of ocean governance," *Marine Policy* 98 (2018/12/01/ 2018), https://doi.org/https://doi.org/10.1016/j.marpol.2018.09.026, https://www.sciencedirect.com/science/article/pii/S0308597X18306973.
[784] Tim R. McClanahan, "Perceptions of preparedness to address climate change threats in the western Indian Ocean," *Marine Policy* 162 (2024/04/01/ 2024), https://doi.org/https://doi.org/10.1016/j.marpol.2024.106055, https://www.sciencedirect.com/science/article/pii/S0308597X24000538.
[785] Daniel Mandell, *Legal Challenges in Maritime Governance Cooperation in the Pacific Islands Region*, East-West Center (2025).

rights over an area of ocean that is more than 19 million square kilometres, but lack the capacity to exert credible monitoring, enforcement, and governance over it.[786]
As noted, in the environmental security chapter fish stocks are redistributing and declining due to climate change, as well as a number of other issues such as IUUF as discussed in both the human and economic security chapters. Factors which create feedback loops, such as IUUF, can cause increased climatic changes and the impacts of climate change can drive more people to IUUF as a means of livelihood gathering. It was also noted in the economic security chapter that fisheries can contribute at least 30 percent of some Pacific SIDS.[787] These are all issues that will be felt hard but SIDS in the Indian Ocean as well as many other states through the Indo-Pacific particularly archipelagic countries. So not only is IUUF a national security issue because in many instances governance and enforcement is part of the state and/or military's role, but also because of the cascading and interconnected issue throughout the maritime security dimensions.

While the governance within the Pacific is marked by a lack of capacity, the ocean governance within South East Aisa and particularly the South China Sea is much more contested, due to the close proximity of multiple states with competing maritime claims.[788] Above it was noted that Coast Guards are able to operate in a more peacefully and less provocative manner when used appropriately, however Coast Guards can also be engaged with 'grey-zone' tactics, especially in the South China Sea, East China Sea, and across the Pacific.[789]

The South China Sea is a hot bed for 'grey-zone' tactics, where states seek to blur the lines and obscure the truth, and seek to increase their political influence and presence without escalating the conflict in a way that is directly attributable to them.[790] With the proliferation of 'grey-zone' tactics increases the uncertainty around the role of military forces within the

[786] Mandell, *Legal Challenges in Maritime Governance Cooperation in the Pacific Islands Region*.
[787] The Pacific Community, "14 Pacific Island countries receive a major grant to manage one third of the world's tuna in the face of the climate crisis."
[788] Thu Nguyen Hoang Ang et al., *Assessing Southeast Asia's Maritime Governance Capacity* (2024).
[789]Guilfoyle and Chan, "Lawships or warships? Coast guards as agents of (in)stability in the Pacific and South and East China Sea."
[790] Ang et al., *Assessing Southeast Asia's Maritime Governance Capacity*.
Briffa et al., *Policy Brief: Enhancing maritime security in the Indo-Pacific*

maritime domain, where the division between military forces and law enforcement agencies has not been clear cut.[791]

Conflict in the maritime domain, can undermine economic security and direct attention away from other security issues that require attention such as HADR, TNOC, and irregular migration flows.[792] So in this sense this shows the direct security implications that climate change has but also how climate change acts as a threat multiplier.[793]Maritime boundaries and sovereignty are a big point of tension currently within the Indo-Pacific as was discussed earlier, especially within the South China Sea and Taiwan. However, the South China Sea is not the only place in the Indo-Pacific where there are maritime boundary disputes with disputes in the Andama Sea, Gulf of Thailand, Celebes Sea, Indian Ocean and throughout the Pacific.[794] This means that supporting governance strengthening as well as conflict management and resolution-related interventions is already important without the impacts of climate change. This was supported by a discussion within interviews where a majority of people mentioned that a hot conflict or war was the most pressing security concern for the Indo-Pacific. This again highlights the need for countries, especially middle powers, to invest in their naval capacities in a way that ensures they can act as a credible deterrence, as this will promote more effective maritime cooperation.[795]

While maritime boundaries and sovereignty also weren't found in the NGAM and the analysis of the EIP chains, it was frequently discussed in interviews, especially in relation to

[791] Hall, Lee-Brown, and Strating, *Blue Security in the Indo-Pacific*.
[792] Hall, Lee-Brown, and Strating, *Blue Security in the Indo-Pacific*.
[793] Hall, Lee-Brown, and Strating, *Blue Security in the Indo-Pacific*.
[794] "Introduction: Maritime Boundary Disputes in Southeast Asia," Melbourne Asia Review, 2023, accessed 27 April, 2025, https://melbourneasiareview.edu.au/introduction-maritime-boundary-disputes-in-southeast-asia/.
"Maritime boundary diplomacy in the Gulf of Thailand and the Andaman Sea has been the key to economic prosperity," Melbourne Asia Review, 2023, accessed 27 April, 2025, https://melbourneasiareview.edu.au/maritime-boundary-diplomacy-in-the-gulf-of-thailand-and-the-andaman-sea-has-been-the-key-for-economic-prosperity/.
"Maritime Boundary Disputes in the Celebes Sea," Melbourne Asia Review, 2023, accessed 27 April, 2025, https://melbourneasiareview.edu.au/maritime-boundary-disputes-in-the-celebes-sea/.
"Safeguarding Pacific Island seas starts with indigenous knowledge," The Interpreter, 2021, accessed 27 April, 2025, https://www.lowyinstitute.org/the-interpreter/safeguarding-pacific-island-seas-starts-indigenous-knowledge#:~:text=With%20only%2035%20out%20of,partners%20in%20a%20boundary%20negotiation.
[795] Goldrick, *Coast Guard-Navy Jointness as a Response to Hybrid Threats*.

sea level rise.[796] This theme was mirrored in the context section as well by the recent declarations of Pacific Island countries which have sought to protect both their maritime boundaries and sovereignty with respect to climate change.[797] This point from the Pacific emphasises the need to be even more focused on ensuring that they have credible capabilities to defend and monitor their maritime boundaries. They also need to ensure they do not erode their own sovereignty by undertaking treaties that could reduce their effective sovereignty and force them to rely on a third party for defence and security arrangements. This is something to be aware of especially where the third party might not have a force that can credibly defend another's sovereignty or may have different views of sovereignty, as it will mean that countries will not have their own credible and effective deterrence.

Sea level rise has "more than doubled since the start of the satellite record" and has risen "4.7 mm per year between 2015 and 2024."[798] In the Pacific Ocean the rate of sea level rise is significantly higher than the global average meaning the impacts will be felt worse in the Pacific especially so because of the prevalence of low-lying SIDS within the Pacific.[799] Sea level rise has potential impacts on Indo-Pacific states' maritime boundaries through the erosion of coastline which shifts a countries baseline for measuring their entitlement to maritime areas as set out under UNCLOS.[800] This could exacerbate the issues around non-delineated maritime boundaries as sea level rise and associated coastal erosion leads to loss of land and changing baselines from which draw maritime boundaries from.[801] This links to interventions such as building hard coastal protection or investing in NbS that protect coastlines such as mangrove forests.

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[796] Interview B, E, H, and I,

[797] Forum, "Declaration on Preserving Maritime Zones in the Face of Climate Change-related Sea-Level Rise."
Pacific Islands Forum, *2023 Declaration on the Continuity of Statehood and the Protection of Persons in the Face of Climate Change-Related Sea-Level Rise*.

[798] World Meteorological Organization, "State of the Global Climate 2024."

[799] "Sea levels rising faster in Pacific than elsewhere, says WMO report," 2024, accessed 22 June, 2025, https://www.reuters.com/business/environment/sea-levels-rising-faster-pacific-than-elsewhere-says-wmo-report-2024-08-26/.

[800] Agarwal and Agnihotri, "UNCLOS and climate-induced maritime challenges: Strategic implications for the Indian Ocean Region."

[801] Andreas Østhagen, "Maritime boundary disputes: What are they and why do they matter?," *Marine Policy* 120 (2020/10/01/ 2020), https://doi.org/https://doi.org/10.1016/j.marpol.2020.104118, https://www.sciencedirect.com/science/article/pii/S0308597X20302426.

Sea level rise poses a threat not just to the erosion of sovereignty and statehood, but to the very existence of it especially so for Small Island Developing States.[802] The permanent submergence of islands could, irrespective of the Pacific Islands declarations, lead to conflict over resource competition and continue to intensify increasingly contested geo-political environments.[803]

As referenced to in the context section, mini-laterals, especially within the Indo-Pacific, are increasing. Mini-laterals are small, usually less informal groupings of countries that are focused on critical issues and allow countries to address these issues without necessarily having the same values and agreeing on everything.[804] Using these mini-laterals as an effective way of building consensus on climate change and climate action will be very important, especially where it relates to ocean governance. The Quad is already working towards increased ocean governance through the *Indo-Pacific Partnership for Maritime Domain Awareness* and states among its benefits "Indo-Pacific partners to rapidly detect and respond to a wide range of challenges involving illicit maritime activities such as illegal, unreported and unregulated fishing, climate events, and humanitarian crises."[805] Showing that the Quad is already understanding the role it can play in response to climate change. The Quad has also set up a working group to tackle the impacts of climate change announcing, in 2022, the Quad Climate Change Adaptation and Mitigation Package (Q-CHAMP).[806] The Quad's climate ambitions also extend to working with the Coalition for Disaster Resilient Infrastructure, and working together to "facilitate green shipping corridors by 2025-2030".[807]

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[802] Michalis I. Vousdoukas et al., "Small Island Developing States under threat by rising seas even in a 1.5 °C warming world," *Nature Sustainability* 6, no. 12 (2023/12/01 2023), https://doi.org/10.1038/s41893-023-01230-5, https://doi.org/10.1038/s41893-023-01230-5.
[803] Wenxian Qiu and Jeremy Firestone, "The non-negligible influence of global sea level change on the distribution of maritime zones," *Marine Policy* 122 (2020/12/01/ 2020), https://doi.org/https://doi.org/10.1016/j.marpol.2020.104267, https://www.sciencedirect.com/science/article/pii/S0308597X20309131.
[804] "The Return of Minilateralism: Going Big by Getting Small," National University of Singapore, 2023, accessed 24 August, 2024, https://mei.nus.edu.sg/think_in/the-return-of-minilateralism-going-big-by-getting-small/.
[805] "Indo-Pacific Partnership for Maritime Domain Awareness," Australian Government accessed 24 August, 2024, https://www.pmc.gov.au/resources/quad-leaders-summit-2023/indo-pacific-partnership-maritime-domain-awareness.
[806] "Climate," Quad Leaders' Summit 2023, 2023, accessed 26 April, 2025, https://www.pmc.gov.au/resources/quad-leaders-summit-2023/climate.
[807] Australian Government Department of The Prime Minister and Cabinet, "Climate."

While, as discussed in Chapter 2, AUKUS is based on the technology and capability transfer of nuclear submarines from the USA and UK to Australia. Some argue that in a changing climate it is out of touch with what is needed.[808] However, credible defence posturing and capabilities will be increasingly important in a changing climate. A way to make AUKUS more response to the impacts of climate change would be to introduce a climate change work stream into AUKUS Pillar Two.

Another thing to consider when looking at ocean governance in the current context against the backdrop of a changing climate and increasing tensions and conflict within ocean governance is the attitude of the BRICS grouping (Brazil, Russian, India, China, and South Africa). With four out of the five BRICS countries having access to the Pacific and/or Indian Oceans the BRIC group of countries is well placed to influence Indo-Pacific ocean governance. The BRICS, especially China and India, are dependant on maritime transport flows through the Indo-Pacific, which increases their feeling of vulnerabilities (which were highlighted in Chapter 2).[809] This gives the BRICs an incentive to engage in the governance of the Indo-Pacific to pursue their own objectives, spurred on by the need for continued growth and economic opportunities, especially as the Indo-Pacific increasingly becomes the geopolitical centre for the world.[810] This may increasingly complicate ocean governance issues within the Indo-Pacific.

Infrastructure

For an intervention focused on protecting infrastructure, related EIP chains can be traced all the way back to the 'pressure' of 'sea level rise' and the 'pathway' of 'more frequent or intense coastal flooding'. So, determining interventions that aim to reduce infrastructure vulnerability to flooding would be a good way of strengthening national security. This could be done in through raising the height of wharfs to adapt to sea level rise, building sea walls,

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[808] "Testing the climate for AUKUS," The Interpreter, 2024, accessed 26 April, 2025, https://www.lowyinstitute.org/the-interpreter/testing-climate-aukus.
"The Aukus deal is a crime against the world's climate future. It didn't have to be like this," The Guardian, 2023, accessed 26 April, 2025, https://www.theguardian.com/commentisfree/2023/mar/20/the-aukus-deal-is-a-against-the-worlds-climate-future-it-didnt-have-to-be-like-this.
[809] Juan L. Suárez de Vivero and Juan C. Rodríguez Mateos, "Ocean governance in a competitive world. The BRIC countries as emerging maritime powers—building new geopolitical scenarios," *Marine Policy* 34, no. 5 (2010/09/01/ 2010), https://doi.org/https://doi.org/10.1016/j.marpol.2010.02.002, https://www.sciencedirect.com/science/article/pii/S0308597X10000448.
[810] Suárez de Vivero and Rodríguez Mateos, "Ocean governance in a competitive world. The BRIC countries as emerging maritime powers—building new geopolitical scenarios."

or through NbS, as suggested in the environmental security chapter, including the restoration of mangrove forest and wetlands around ports and military bases, which can mitigate some of the impact from extreme weather events.[811]

Critical infrastructure that is impacted by climate change has a few ways of contributing to the current strategic competition occurring within the Indo-Pacific. Firstly, it can reduce the resources and therefore the capacity and capability of navies which commonly rely on coastal infrastructure which is vulnerable to sea level rise.[812] In this way, this could also impact the functioning of civilian ports which are key to economic and energy security, especially for those countries reliant on importing fossil fuels. Lastly, the vulnerability of coastal infrastructure can be used to gain influence, especially among SIDS who will need support to respond and increase their resilience.

Return on investment is a measure that developed countries use on their aid spend. Using this however, will not support any decisions to be made in favour of SIDS, where the cost of undertaking infrastructure projects is high and the population receiving the benefit is low.[813] However, this is where the calculation of what strategic infrastructure is, comes into play, or the perception of what different countries deem to be of strategic value. Dealing with this trade-off and finding sustainable solutions to these issues will require innovative thinking.

The political economy of climate change support is not limited to infrastructure and how smaller, especially in the Pacific, are becoming increasingly good at trading off other countries' support against each other.[814] This can be seen as part of a larger trend when the geostrategic competition in the Indo-Pacific is heating up and climate support is an attractive avenue of support.

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[811] "Climate adaptation in ports: a global imperative for resilience," Global Center on Adaptation, 2024, accessed 26 April, 2025, https://gca.org/climate-adaptation-in-ports-a-global-imperative-for-resilience/.
[812] "Building Resilience: Indo-Pacific Militaries Adapt, Fortify Against Climate Impacts," Indo-Pacific Defense Forum, 2023, accessed 07 Feburary 2024, https://ipdefenseforum.com/2023/12/building-resilience-2/.
[813] "Cutting Edge: Small Island Developing States: Cultural diversity as a driver of resilience and adaptation," UNESCO, 2022, accessed 1 May, 2025, https://www.unesco.org/en/articles/cutting-edge-small-island-developing-statescultural-diversity-driver-resilience-and-adaptation.
"Small Island Developing States need innovative forms of finance to bridge the devastating 'adaptation gap'," The London School of Economics and Political Science, 2024, accessed 1 May, 2025, https://www.lse.ac.uk/granthaminstitute/news/small-island-developing-states-need-innovative-forms-of-finance-to-bridge-the-devastating-adaptation-gap/.
[814] Keen and Tidwell, *Geopolitics in the Pacific Islands: Playing for advantage*.

Challenges to military infrastructure are noted, not only through critical civilian infrastructure, but also through the development of military bases themselves.[815] Climate change also brings with it the issue of increasingly challenging and harsh environments in which military equipment must work, which could require it to undertake more frequent and severe maintenance or face direct damage from the impacts of climate change.[816]

Other Issues

While only three impacts occurred in EIP chains that were tagged against national security, during the interviews there were other impacts from the effects of climate change that experts thought would impact national security, such as: the decreasing human security generating internal instability (including migration); the direct impact of a changing climate on military personal and resources (warmer climates and larger waves); the impacts of climate increasing the workload of military forces as well as potentially expanding their remit; and also how the political economy of climate change may allow for developing countries to trade off those that help them with their response to climate change.

The impact of climate change as discussed in other chapters in this thesis, will impact environmental, human and economic security. Where these impacts are most harshly felt it was generally agreed in a few interviews that these impacts would flow on to affect national security. The causes of this instability were identified mainly as migration and food insecurity.

Migration also impacts national security in two other ways. Firstly, the trading of migration pathways for climate and/or geostrategic aims, and secondly increased activity by transnational organised crime groups, that engage with Human smuggling, and trafficking and dealing. In 2023 Australia and Tuvalu announced the Falepili Union where migration pathways to Australia were opened up to Tuvaluan citizens in exchange for Australia supporting Tuvalu in their response to climate change and being sighted on any future deals that might impact the security of Tuvalu.[817] In simple terms, trading sovereignty or aspects

[815] Tobias Ide, "Climate change and Australia's national security," *Australian Journal of International Affairs* 77, no. 1 (2023/01/02 2023), https://doi.org/10.1080/10357718.2023.2170978, https://doi.org/10.1080/10357718.2023.2170978.
[816] Ide, "Climate change and Australia's national security."
[817] "Australia-Tuvalu Falepili Union," Tuvalu, Department of Foreign Affairs and Trade, accessed 21 June, 2025, https://www.dfat.gov.au/geo/tuvalu/australia-tuvalu-falepili-union.

thereof for migration. How sustainable this kind of agreement is and how it works in practice is yet to be seen, but realistically this is only a solution (or problem) for those where the population is small enough to be assimilated into a larger country without too much trouble. However, if you look at other countries that may well be facing big migratory movements such as Thailand, Bangladesh, or Indonesia, this seems to be a less realistic way of dealing with the issue and these states will need to be prepared for the national security issues that come from internal migration.

TNOC groups could also find themselves as net beneficiaries of climate change, as greater migration of people leads to increased opportunities to engage in human smuggling and trafficking, as well as all the associated activities that come with it. To deal with TNOC groups, countries will, again, need to ensure that they have adequate constabulary functions to present a credible deterrence through navies or coast guards. Navies and coastguards will also likely be called upon to deal with what is forecast to be an increase in piracy as people's livelihoods especially those in fishing communities, will come under increasing pressure and start diminishing. Ensuring navies have adequate knowledge about environmental and social issues is important to ensure that they can continue to function with maximum influence going forward.

In the interviews, there were also discussions about the direct impact of climate change on military resources, hardware and operational assets such as personnel and ships, and the need for effective and informed decision-making.[818] Issues such as the temperature on the ships which will impact working conditions for sailors as well as potential inefficiencies for ship engines and increasing range of detection for submarines.[819]

HADR, has been touched on in chapters 2, 5 and 6, and was often discussed in interviews as being an increasing issue driven by climate change, and more frequent more intense weather events.[820] However, it is significant to note that HADR did not come through in the analysis of the SROCC data for the NGAM, which could be attributed to the environmental focus of the data used. HADR is often undertaken by militaries both international and

[818] Interview E, F, G, and H
[819] "New study suggests climate change will make submarine warfare more complex," The Strategist, 2023, accessed 28 May, 2024, https://www.aspistrategist.org.au/new-study-suggests-climate-change-will-make-submarine-warfare-more-complex/.
[820] Interview F, G, J and K

domestically, with 343 deployments of military capabilities and assets between June 2022 and August 2024.[821]

As extreme weather events increase in frequency and intensity it can be assumed that the increased responses will divert resources away from more traditional security issues. New Zealand's navy is already at a point where it projects it could not cover concurrent events of a certain magnitude due to the deficiencies in capacity and capability.[822] Add intensifying climate impacts on top of this and it leaves a very vulnerable navy and an exposed country. In using militaries to respond to the impacts of the effects of climate change there needs to be a discussion around whether militaries are best placed to undertake this function or if this detracts from the primary aim of military forces, and whether civilian or quasi-military forces have the capabilities, capacity and assets to undertake this work.[823] While these issues for New Zealand will be felt most in the Pacific, as mentioned in Chapter 2 as India is taking on the role as the security partner of choice in the Indian Ocean, it will also need to understand how its navies will be impacted by increasing calls for HADR assistance.[824]

Climate change is also a threat to the monopoly of force, especially in developing countries, due to an increase in tensions, crime, and conflicts.[825] This, in conjunction with the increased call on military resources, impacts to military hardware and assets, and the changing conditions providing an opening for opportunistic TNOC groups, as well as noted previously, the ability of climate change to impact people's livelihoods, economic security, and cause fisheries conflict. All of this can cause stress on the state's ability to operate efficiently and effectively, both with respect to governance but also enforcement.[826] As this happens, this could provide a vacuum which other actors such as extremists, terrorists, and warlords might seek to exert influence.

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[821] "Military Responses to Climate Hazards (MiRCH) Tracker," Council on Strategic Risk, 2024, accessed 15 August, 2024, https://councilonstrategicrisks.org/ccs/mirch/.
[822] "New Zealand Defence Force tells new minister of high attrition, staff shortages," Radio New Zealand, 2024, accessed 28 May, 2024, https://www.rnz.co.nz/news/national/508181/new-zealand-defence-force-tells-new-minister-of-high-attrition-staff-shortages.
[823] "MiRCH Update: Key Takeaways from Tracking Climate-Related Military Deployments," Council on Strategic Risks, 2024, accessed 12 August, 2024, https://councilonstrategicrisks.org/2024/01/18/mirch-update-key-takeaways-from-tracking-climate-related-military-deployments/.
[824] Agarwal and Agnihotri, "UNCLOS and climate-induced maritime challenges: Strategic implications for the Indian Ocean Region."
[825] Ide, "Climate change and Australia's national security."
[826] Ide, "Climate change and Australia's national security."

As discussed in Chapter 2, where the links between climate change and security are first discussed in detail, climate change has the possibility of causing the physical land mass of a state to disappear due to sea level rise. This issue is particularly relevant to SIDS and in the Pacific, climate change is a well-established part of national security, especially following the PIF Leaders' Boe Declaration in 2018, which states that “climate change remains the single greatest threat to the livelihoods, security and wellbeing of the peoples of the Pacific”

8.5 Conclusion

As shown throughout this chapter and previous chapters, the environmental aspects of maritime security show the underlying need to support the environmental security dimension of maritime security. This is ultimately because of the effects of climate change and the way they interact in a multiplying way, there could quite well become a time when navies are required to respond to concurrent events and are unable to do this. This burden on military forces may be further increased by the increasing tensions related to fisheries management, which was identified as the most frequent impact through the NGAM methodology. They may also be hampered by damage to infrastructure which further complicates future scenarios, at which point it would be the perfect time for an adversary to take advantage and seek to escalate existing tensions and conflict for their own benefit. This could also all happen against the backdrop of rising domestic national security issues such as increased migration and activity by TNOC groups, which could leave countries even more susceptible to challenges from adversaries, especially in countries where inequality is an issue and miss/dis-information could be effectively used. Minimising current conflict and tension in the maritime domain through good ocean and fisheries governance will be necessary, as will increasing infrastructure’s resilience to climate impacts. All of this happening on top of what is already a very complex and contested Indo-Pacific will make for an uncertain future.

This chapter has also shown that military forces are being relied upon to support the response to many different areas in relation to the impacts of the effects of climate change. This may at some point cause them to become less able to address issues, such as maritime crime or respond to HADR requests.

This chapter has also shown that the current contested environment of the Indo-Pacific underscores the need to generally build stability, peace, prosperity, and security, but that it will be tricky to avoid flashpoints especially if the current geostrategic competition continues to increase.

Chapter 9 – Conclusion

As this thesis has shown, the intersection of climate change and maritime security is a crucial global issue and is an especially important issue to grapple with in the context of the Indo-Pacific. This is because the Indo-Pacific is a maritime super-region which is dependent on all levels of maritime security for its prosperity and safety, and because the impacts of climate change will be severely felt throughout the Indo-Pacific. The Indo-Pacific also made a good geographical boundary for this study due to the nature of maritime security and climate change, which are both transnational, cross-jurisdictional, and in a way, global phenomena.

This thesis set out to investigate the impacts that the effects of climate change will have on the maritime security of the Indo-Pacific and has found that the environmental security dimension of maritime security underpins all the other dimensions of maritime security. In undertaking this research, this thesis has also:

- further defined the concepts of maritime security, climate change, and the Indo-Pacific;
- developed an innovative methodology for analysing the full EIP that shows all the steps that the causes of climate change take from the emission of greenhouse gases through to the impact they have on the natural environment and human society;
- used this innovative methodology to analyse data from an IPCC report to develop an NGAM for the impacts of climate change on maritime security; and
- analysed the findings of the NGAM by each dimension of maritime security and in the context of the Indo-Pacific.

Through this investigation and in achieving these four objectives, the study has grappled with three of the most pressing issues the world is currently experiencing (climate change, maritime (in)security, and the geostrategic competition in the Indo-Pacific), and illustrated how all of these issues are likely to interact to generate or exacerbate insecurity.

This concluding chapter will present a summary of the findings presented in previous chapters of this thesis, in a way that shows the complex interconnected nature of the effects and impacts of climate change, that concludes with the finding that the

environmental security dimension of maritime security underpins the rest of the dimensions.

This chapter will then go on to make some recommendations for future actions with can support both future and further research in this area and building on this methodology, but also present recommendations that can support the development of better climate and maritime security policy.

Then this chapter will look at the contributions it has made to the creation of new knowledge and further contributions to the areas of maritime security, the Indo-Pacific, and climate change as a security issue.

Following on this chapter will discuss how this research has developed a unique tool and methodology that can support the use of natural science to support social science and policy responses to the impacts of the effects of climate change.

Penultimately, this chapter discusses how this research could be further developed to increase the utility and analytical capabilities of the methodology and how this could better inform future decision-making.

9.1 Summary of Findings

Climate change is impacting marine systems and maritime security, with researchers and policymakers responding by supporting the mitigation and adaptation to these effects.[827] To support the creation of interventions that mitigate and adapt to the impacts of the effects of climate change, the NGAM developed in Chapter 4 of this thesis and analysed in detail across sectors in Chapters 5 to 8, has created a detailed picture of the major impacts of climate change on maritime security. The analysis of the NGAM throughout these chapters has been crucial to supporting the primary finding of this research, that the environmental dimension of maritime security underpins all other dimensions of maritime security and is crucial to the prosperity, safety and stability of the Indo-Pacific region. It has found this by developing a novel methodological process which supports the analysis of climate change impacts on maritime security and then translating these to the Indo-Pacific region.

[827] Ruckelshaus et al., "Securing ocean benefits for society in the face of climate change."

As demonstrated throughout the thesis, like climate change, maritime security is an issue that is transnational and cross-jurisdictional in nature. These characteristics of transnationality and cross-jurisdictionality mean that determining and understanding the exact nature of maritime security and developing global situations is complex, and implementing interventions to mitigate negative impacts is even more complex. Especially, as addressing challenges with these characteristics requires consensus between actors. One of the overriding elements, discussed extensively in this thesis and highlighted in Chapter 2, is that maritime security carries diverse meanings to different actors, making issues relating to maritime security even more complex. In Chapter 2, this thesis built on the current understanding of maritime security to support an increased understanding of the maritime domain and suggested a new way of framing maritime security issues, as a pyramid with environmental security as the base of the pyramid (shown in Figure 2.5), which supports all other dimensions of maritime security. This new framing of maritime security also supported the development of a structured analytical framework (shown in Figure 2.1), which supports the analysis of the different dimensions of maritime security and considers such complexity.

Chapter 2, through defining the concepts, showed that climate change, maritime security, and the Indo-Pacific are inextricably interlinked issues that will have an impact on the future of global security.[828] It also elaborated on the importance of understanding the complex interactions between climate change and the maritime security of the Indo-Pacific and defined the study's three core concepts: climate change, maritime security, and the Indo-Pacific. In doing so, this chapter demonstrated the process of securitisation that climate change has been through arguing that it is now understood as both an indirect and direct cause of insecurity. The chapter also demonstrated that maritime security is of crucial importance to global security, but lacks a universal definition and, as such, means different things to different actors, which is understandable given the complexity and transnational nature of the issue. To overcome this issue of a maritime security definition, this chapter then outlined the four dimensions of maritime security, but conceptualised them in a new way, which was as layers of a pyramid, with the base of the pyramid being the dimension of

[828]Clayton, *Operationalising the Quad: Maritime security and climate change in the Indo-Pacific*. Mizo, "The Quad, Maritime Security, and Climate Change."

environmental security underpinning all the other dimensions. The chapter then defined the Indo-Pacific as a maritime super-region which different actors use in different ways, although most agree that it is a heavily contested space and is used to frame the current geostrategic competition. Chapter 2 then concluded by bringing these three concepts together showing the linkages between them and their suitability of being analysed together i.e. that climate change will severely impact the maritime domain; that like climate change maritime security is transnational and cross jurisdictional; that maritime security will be severely impacted by the impacts of climate change on the maritime domain; and that because of the cross jurisdictional and transnational nature of climate change and maritime security the Indo-Pacific as a maritime super region makes for great geographical boundaries for this study; as well as because the Indo-Pacific is crucial to maritime security and will be severely impacted by climate change.

Chapter 3 outlined the innovative analytic tool, Non-Geographic Assessment Map (NGAM), that is central to the analysis undertaken in the thesis. It illustrated how this tool has supported the integration of natural sciences into social sciences and security studies. The chapter argued that while CEA frameworks are rarely used for analysis of social issues and even more rarely incorporated into security studies analysis, they are an extremely useful tool that helps develop a fundamental base of interdisciplinary analysis, which can be expanded upon as data and time allow. It also showed that the adaptation of the sub-section of CEAs, called Effect to Impact Pathways, created a methodology which supported the analysis of such complex and interconnected issues through the development of NGAMs. This Chapter then went on to discuss the data used for the NGAM, the SROCC, and talk about why it was chosen and the limitations that using the source provided. Next, the chapter discussed other data sources used in the thesis, namely academic and grey literature and interviews. Finally, Chapter 3 discussed the limitations and constraints of this research, some of which have fed into the section in this chapter on future directions for this research.

Chapter 4 using the EIP methodology to analyse the impacts that the effects of climate change have on maritime security developed a macro-level NGAM (i.e. this showed all of the EIP chains that climate change takes to impacting on all dimensions of maritime security and was not then contextualised by the current state of the Indo-Pacific for any dimensions of

maritime security). Through doing this, it showed the interconnected, synergistic, and multiplicative interactions of the effects of climate change and the impact these have on maritime security. It also justified the argument that the environmental dimension of maritime security underpins all the other dimensions, as it highlighted the importance of protecting ecosystems and halting biodiversity loss. The macro-level NGAM emphasised the importance of the human wellbeing of coastal communities as a way of protecting against maritime insecurity. Chapter 4 also highlighted the importance of understanding feedback loops within and between the EIP chains.

Chapter 5 started by establishing the context of what the environmental security dimension of maritime security currently looks like within the Indo-Pacific. Highlighting issues such as marine pollution, ecosystem changes, and environmental degradation that were already impacting the environmental security of the maritime domain within the Indo-Pacific. Then, through analysing the findings generated through the creation of the NGAM in Chapter 4 for the dimension of environmental security, Chapter 5 showed that biodiversity and marine ecosystems were the most frequently occurring impacts and went on to discuss how interventions based around these issues support the environmental security of the Indo-Pacific. In this context, interventions such as marine protected areas and nature-based solutions were discussed as ways to build increased environmental security within the maritime domain. Chapter 5 also showed that environmental degradation causes instability in the maritime domain and that the dimension of environmental security underpins the rest of maritime security. In this context, interventions, especially where they relate to sustainable fisheries and ocean governance, can also be a driving force for positive cooperation between actors, who are starting to understand that climate change will result in more negative impacts than the current geostrategic competition.

Chapter 6 started by establishing a baseline for the dimension of human security in the Indo-Pacific. Highlighting issues such as human wellbeing, food security, water security, and social cohesion, which are already impacting human security within the Indo-Pacific. It continued to show the many and varied linkages between climate change and maritime security, especially those which were generated from or interconnected with environmental aspects throughout the EIP. The analysis of the NGAM for the human security dimension of maritime security found that in coastal communities, people's wellbeing and food security

will be severely impacted by the effects of climate change, showing how climate change will further exacerbate pre-existing issues for human security. This highlighted the need for interventions aimed at supporting the sustainable management of fisheries, increasing aquaculture production, and supporting climate-resilient subsistence agriculture. Chapter 6 then went on to illustrate how climate change will significantly strain social cohesion, culture and identity, and migration, with impacts disproportionately impacting women. Through the information obtained during the interviews conducted with maritime and climate security experts, it was also brought to light that as people's human security declines, they are more likely to turn to drug and alcohol abuse, as well as illegitimate ways of sustaining their livelihoods. This finding highlighted some of the limitations of the NGAM, especially when relying purely on quantitative data and further showed the range of impacts and complicated nature of the impacts of climate change.

Chapter 7 started by establishing a baseline for the economic security dimension of maritime security within the Indo-Pacific. Highlighting issues such as supply chain vulnerabilities, ocean resources, and tourism as issues that were already of concern under this dimension of maritime security. The chapter went on to reinforce the importance of the maritime domain to economic security and its fragility in the context of being impacted by the effects of climate change. It again further stated the need for sustainable fisheries management due to the number of EIPs within the NGAM that contained or related to issues around fisheries and ecosystem management. This Chapter also highlighted that IUUF (and fishing more generally) was at the intersection of many other criminal activities taking place at sea and that as ocean governance comes under increasing strain from other issues, climate change will place further pressure on governance. This will be especially true as the livelihoods of multiple populations decline and they turn to illegal ways of sustaining their livelihoods. Chapter 7 also showed in the most obvious way the need to guard against maladaptation, especially concerning deep-sea mining. As people turn to this as an alternative source of income and to support the green transition, the adverse impacts and effects of this on the maritime environment need to be considered. Chapter 7 then discussed how efficient and effective interventions that supported maritime security within the Indo-Pacific should be related to supporting the adaptation of port and coastal

infrastructure, the decarbonisation of shipping, revenue and food diversification through aquaculture, and better ocean governance and monitoring.

Chapter 8 started by establishing a baseline for the dimension of national security of the Indo-Pacific. Highlighting issues such as military/navy capabilities, geopolitical tensions, the rule of law, and sovereignty were already issues within the national security dimension of maritime security within the Indo-Pacific. It showed that not all states view climate change through the same lens, as from China's perspective, climate change is currently regarded as an opportunity. The NGAM found that using the data from the SROCC the biggest impact to national security would come from issues relating to fisheries and the chapter then argued that IUUF will increasingly strain ocean governance. This again showed the importance of sustainable fisheries management. The NGMA also found that national security will be impacted by damage to coastal infrastructure and notes that competition over strategic infrastructure is where a lot of geostrategic competition in relation to climate change is currently being played out. In Chapter 8, interviews again highlighted the limitations of quantitative data, as interviewees discussed that climate change-related migration is also showing up as becoming a national security issue, and in some instances, illustrated this point with the example of Tuvalu trading aspects of sovereignty for migration pathways to Australia. Chapter 8 also found that the national security dimension will also be impacted by the increasing fractures in social cohesion, the rise of transnational organised crime, and increasing requests for humanitarian assistance and disaster response. More generally, military forces will be faced with increasing pressure and workload to respond to the security impacts of the effects of climate change; these pressures will be felt acutely by states that are already facing capacity constraints within their armed forces. This chapter highlighted that mini-laterals could act as a way for countries to work on climate change in isolation from their other views and other issues.

9.2 Analytical Contributions and Recommendations

Through the development of a novel methodological approach to investigating and analysing the impacts of climate change and maritime security (outline in Chapter 3 and the benefits of which will be further discusses in section 9.3) the research undertaken in this

thesis has shown that the impacts of the effects of climate change are interconnected, with linkages across all dimensions of maritime security and across the maritime super-region that is the Indo-Pacific. The thesis has also contributed to furthering the understanding of maritime security, providing a framing of the issue that puts environmental concerns and issue at the heart of the issue. As well as this, the thesis has supported the understanding and framing of the Indo-Pacific as a maritime super-region by outlining how the region is viewed by actors and how those actors interact with each other. The thesis also supports the argument for framing climate change as a security issue.

9.2.1 Contribution to the Understanding and Framing of Maritime Security

In Chapter 2, Section 2.2.2, this thesis highlighted the need to develop an overarching framework for supporting different actors to situate themselves relative to each other. The development within section 2.2.2 of the framing of maritime security as a pyramid supports actors to do this, by providing a holistic, cohesive and robust framing. As 'non-traditional' security issues such as climate change become increasingly important to consider, it is increasingly important to support actors and researchers to consider important fundamental and interlinked issues related to maritime security and develop cross-sectoral and interdisciplinary analyses and responses to maritime insecurity.

This thesis contributed to the understanding that maritime security is transnational, cross-jurisdictional, complex, and interconnected (to dimensions of maritime security and some areas of land or coastal-based insecurities). Maritime security will continue to mean different things to different people because most actors work within one or two dimensions rather than across all four dimensions.

The research has brought together recent conceptualisations in a systematic way, and whilst investigating the different models in play, the research has shown how these conceptualisations overlap (see Table 2.1). In turn, this has highlighted the interconnected nature of maritime security. Analysing maritime security through the lens of climate change highlighted the interconnectedness of the four dimensions of maritime security. It also highlighted other attributes of maritime security, such as liminality, interconnectedness, transnational, and cross-jurisdictional.

This thesis, through the development of the NGAM and situating of its findings within the Indo-Pacific context, has illustrated that the interconnectedness of maritime security and its dimensions is an issue that requires global cooperation and coordination, and this justifies using the Indo-Pacific region as the geographic scope for this study. Outlining the interconnectedness of maritime security (and visualised through the figures depicting the EIPs that make up an NGAM) in this thesis has contributed to furthering the understanding of maritime security, and better understanding the interactions of its aspects and dimensions. It has done this by analysing how the effects of climate change impact maritime security, especially in the Indo-Pacific.

In analysing how the effects of climate change impact maritime security, this thesis has shown that a holistic approach to maritime security is underpinned by ensuring a healthy and secure marine environment. In doing this, it has supported the argument for an updated framing of maritime security, to think of it as a pyramid where one level supports the next. It has done this by defining the range of environmental impacts that are encompassed under the environmental dimension of maritime security and the interconnections these impacts have with the other dimensions of maritime security (human, economic, and national). An example of this and the support it provides to thinking of maritime security as a pyramid can be seen in Figure 9.1, which shows how, in this case biodiversity loss as an aspect of environmental security, also contributes to the cultural aspects of human security, aquacultural aspects of economic security, and fisheries aspects of national security. All of these aspects are also interlinked, so cultural aspects rely on environmental and human security, aquacultural aspects interact with environmental, human and economic security, and fisheries aspects interact with all dimensions. In Figure 9.1 conflict is poised at the top of the pyramid, this represents the fragility of peace and security and acknowledges that should layers of the pyramid below disappear, then conflict appears closer and more inevitable.

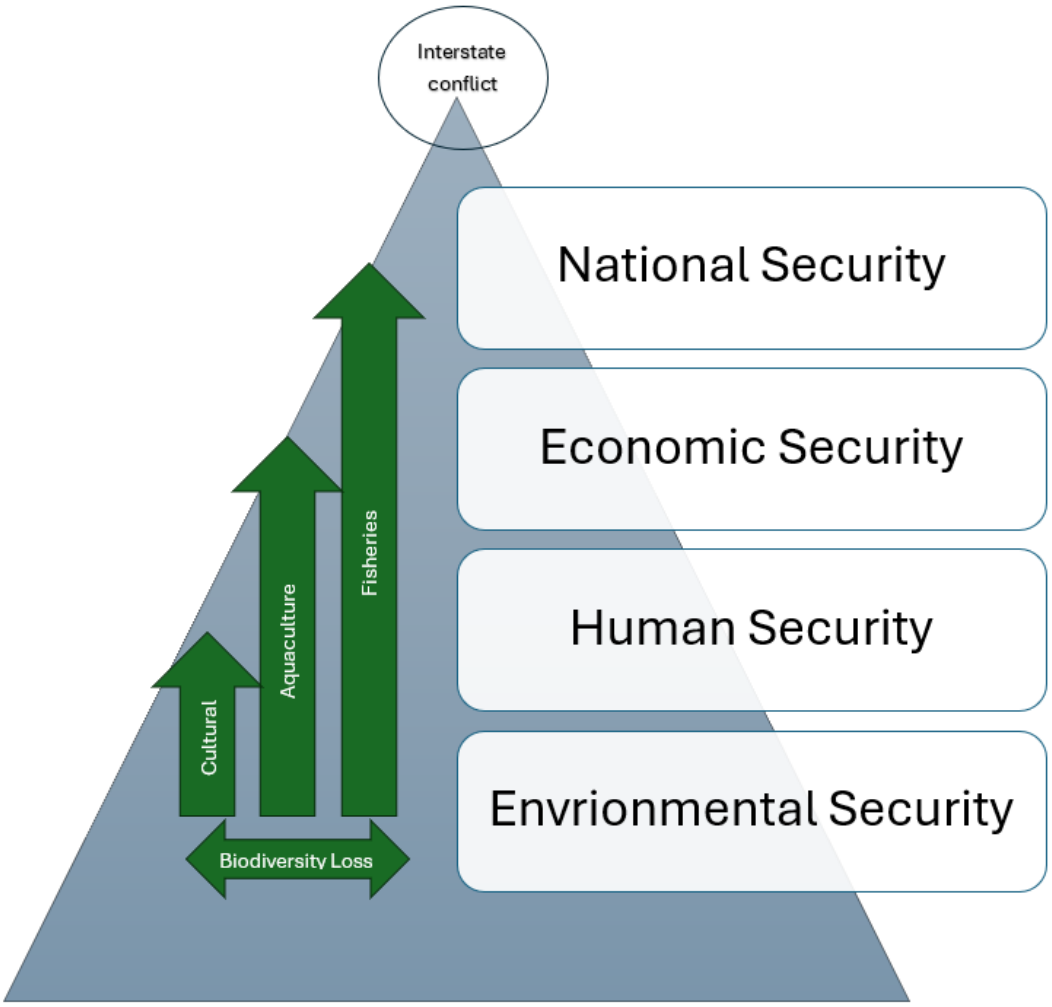

Figure 9.1 – The interconnected nature of the maritime security pyramid

Through this analysis, the thesis has shown how 'non-traditional' security threats can be incorporated into existing debates by using an analytical methodology that incorporates both quantitative and qualitative analysis. The nature of the impacts of the effects of climate change within the maritime domain, as demonstrated throughout this thesis, have indicated the need to approach security issues in the maritime domain in a more holistic way because of the interconnected and expansive nature of maritime security, especially as environmental aspects underpin it.

In breaking down the analysis of maritime security by its four dimensions, across chapters 5 to 8, the analysis has supported the discussion on how each of the four dimensions is constructed and what is considered as impacting or affecting each dimension as well as maritime security as a whole. This thesis, in addition to providing a novel framework to support the analysis of maritime security through the lens of climate change, has provided a

useful and coherent way of formulating the threats and challenges in the maritime domain. The reasoning behind this stems from the fact that, as discussed throughout the thesis, climate change shares similar properties with maritime security, i.e. it is interconnected, cross-jurisdictional, transnational, and has questions about liminality. It has also shown that the dimension of environmental security underpins all the other dimensions of maritime security.

9.2.2 Contribution to the Literature on the Construction of the Indo-Pacific

This thesis has shown that climate change and maritime security benefit from being studied at the level of the maritime super-region. This is because the nature of both issues means that, especially when studying their interactions with a smaller geographical focus area, the full range and complexity of the interactions may not have come through in the analysis. The Indo-Pacific is large enough to support the analysis of transboundary and cross-jurisdictional phenomena that can impact entire regions, such as maritime security and climate change. In undertaking the analysis within this thesis, it had to contend with understanding how the boundaries of the Indo-Pacific are constructed.

In Chapter 2, section 2.2.3, this thesis critically analysed the current efforts and literature that have advance and supported the construction of the Indo-Pacific firstly by grounding the analysis in the theory of how regions are constructed especially maritime regions pointing out that the Indo-Pacific region is constructed by the movement and fluidity of the ocean and the interaction this allows for species, people and goods within and across the oceans of the Indo-Pacific, the cultural ties countries and communities have with the ocean, and the polarity of large actors the act as a similar issue for smaller actors. Chapter 2 also showed that analysing when analysing the Indo-Pacific on has to understanding and analysing maritime security issues as the two are inextricably linked.
Chapter 2 then supported the understanding and construction of the Indo-Pacific by outlining and analysing the different approaches different states take to the Indo-Pacific concept, by showing the varied approaches to the region as a construct. The analysis in Chapter 2 found that the Indo-Pacific is a construct that offers strategic ambiguity as it is a term used by many different actors, but generally means different things to different actors. But in general, the Indo-Pacific refers to the maritime domain contained between the east coast of Africa and the west coast of the United States.

As noted in Chapter 2 and throughout the thesis, the Indo-Pacific is a construct that has, in recent times, been defined by geostrategic competition, and it will continue to be defined by this competition, as it is currently at the centre of the increasing global geostrategic competition. Although the Indo-Pacific can be used in different ways by different actors depending on their aims and goals, as previously stated, its fluid and flexible construct allows actors to use strategic ambiguity when talking about the region to support their aims and goals. The importance of the Indo-Pacific is also cemented in the fact that it is the centre of global trade, which is a crucial aspect of maritime security and many of its dimensions. Analysing how the impacts of climate change will interact with the current increase in strategic competition in the maritime domain of the Indo-Pacific also highlighted the ties and connectivity between the different sub-regions of the Indo-Pacific, not just in relation to trade, but also how their natural environments are interconnected, their shared concerns relating to human wellbeing, and in some instances (especially amongst SIDS which can be found in most sub-regions of the Indo-Pacific) the concerns that climate change may impact their sovereignty and statehood.

Throughout this thesis, the research and analysis of the linkages within the NGAM developed have contributed to the construction and understanding of the Indo-Pacific as it supports a better understanding and analysis of the interactions taking place within the maritime super-region. It does this by showing how climate change and maritime security are inextricably linked and that the effects and impacts are transnational and cross-jurisdictional, which adds another layer of interactions that happen within the Indo-Pacific. This has, in turn, added to the literature and process of constructing the Indo-Pacific, especially as a maritime super-region. As interventions such as MPAs and better ocean and fisheries governance are implemented to minimise the impacts of climate change, this will also reinforce interactions across and within the region, further contributing to the construction of the Indo-Pacific as a maritime super region.

The analysis undertaken in the discussion sections of chapters 5 to 8 highlights issues where there may be similarities or differences in impact or concern about an impact. As a maritime super-complex that is made up of at least four distinct sub-regions, this analysis of the four dimensions of maritime security and how these will be impacted by the effects of climate change has shown how these subregions are interconnected, not just by the impacts of

climate change in the maritime domain, but also by all of the interconnected, transnational, and cross-jurisdictional aspects of maritime security that are considered when analysing the four dimensions of maritime security. Thus, this thesis has made the contributed to the academic discourse and development of the construction of the Indo-Pacific as a region, especially as it relates to the addressing, studying and analysing complex transnational, cross-jurisdictional and interconnected phenomena, such as climate change, maritime security and others beyond the scope of this thesis (e.g. biodiversity loss, pollution, and pandemics).

9.2.3 Contribution to the Framing of Climate Change as a Security Issue

This thesis has contributed to the continued framing of climate change as a security issue. It has done this by both laying out an understanding of how the issue has been framed up to this point and then, through the research and findings, it has shown the extensive, interconnected, and complex impacts climate change has on security. As set out in chapters 1 and 2, the impacts of the effects of climate change are already being observed as creating insecurity. This thesis has built upon this and, through the development of the NGAM and analysis of the findings, has supported the construction of climate change as a security issue in its own right, rather than merely as a 'threat multiplier'. In Chapter 2, section 2.2.1, when discussing the discourse behind climate change as a security threat, it has been shown that climate change is now increasingly viewed as an issue that concerns the survival and continued existence of states, especially SIDS.

This thesis has contributed to the process of climate change has becoming securitised through Chapter 2, which laid out the argument and the route that climate change has followed to be securitised through the use of ‘exceptional measures’ and acceptance of the narrative by actors. This thesis has contributed to framing climate change as an issue in security studies literature by developing an interdisciplinary method for analysis and by using gold-standard scientific data and translating climate change effects to the impacts they have on societies. The widening of security issues and the inclusion of 'non-traditional' security issues such as climate change is occurring, if not already occurred. This is shown throughout this thesis that the environmental dimension of maritime security underpins the other dimensions of maritime security as visualised in Figure 2.5.

This thesis has shown that across the dimensions of maritime security, the effects of climate change can cause insecurity. Analysing this issue through the lens of maritime security and its four different dimensions supports the argument of climate change as a security issue because by the nature of each chapter it focuses on different referent objects within the maritime domain i.e. Chapter 5 focused on the natural environment (natural maritime and costal environments, including ecosystems), Chapter 6 focused on individuals and communities, Chapter 7 focused on the economy and economic aspects including personal livelihoods, Chapter 8 focused on the use of force, statehood and sovereignty as it relates to national security.

Using an NGAM and analysing the EIPs contained within it adds to the literature and construction of climate change as a security issue. It does this, through chapters 4 to 8, as the EIPs trace the effects of climate change through a cause-to-impact chain, using the six steps within the EIP chain to map out the routes of climate change to security, providing demonstrating that climate change does have significant implications on security. This provides legitimacy to the argument that climate change is more than just a 'treat multiplier' but a threat in and of itself.

This thesis has supported the securitisation of climate change by also supporting the widening of the concept of security to incorporate more 'non-traditional' aspects within the security discourse. The expansion of the concept of security can also be seen by the types of issues that are considered to be maritime security issues, and by breaking down the analysis in this thesis by the four dimensions of maritime security, it has highlighted the link between and interconnected nature of human-induced climate change, environmental security and maritime security.

9.3 Methodological Contributions

In chapters 3 and 4 this thesis provides a unique contribution to academic knowledge by continuing the development of a novel methodology developed by the author, as part of the research for this study and first outlined by Brennan and Germond in 2024,[829] and then

[829] Brennan and Germond, "A methodology for analysing the impacts of climate change on maritime security."

expanded upon within this thesis, to build a full NGAM using a large volume of gold-standard data from an IPCC report. In doing so, this thesis has proven the flexibility of CEAs and shown how to create and adapt a CEA that is focused on societal impacts by adapting EIP chains and using these to build an NGAM. It has added an example to the literature of CEAs that are used to analyse environmental effects on societies, rather than societies' effects on the environment.

In further developing the EIP chain methodology, the methodology used in this thesis has provided a way of understanding the full cause-to-effect-to-impact chain in a way that supports the identification of interventions that can address the causes and effects before they become impacts. It has also supported the idea that feedback loops can occur between different stages of the effects of climate change, and between the different impacts of the effects of climate change. It has developed an understanding of the negative and positive impacts of climate change, and how an EIP chain with a seemingly negative impact can also have positive second or third-order impacts. This again shows the complexity of both climate change and maritime security as topics to analyse, and why understanding the full cause and effect chain through the EIP chain methodology is important and valuable.

This thesis has added research and analysis to the discourse on maritime security, climate change (and its links with security), and the Indo-Pacific (as mentioned previously). In doing this, the thesis has contributed to the discussion on how best to understand, analyse, and prepare for the compounding, multiplying, synergistic, and interconnected impacts of climate change that the world will be facing, in addition to an increasingly contested geostrategic environment within the Indo-Pacific.

Through the conceptual framework of this thesis (outlined in Figure 2.1), it also contributes to the furtherment of knowledge as it supports the incorporation of 'natural' or 'traditional' science into social science analysis, especially that of international relations and security studies. Specifically, the main way of doing this is by analysing climate science data, sourced from the SROCC, through the EIP chain process as outlined in Figure 3.2, which seeks to outline and then visualise how climate change impacts environmental and societal issues. It is then overlaid with geostrategic trends, in this case the context of the Indo-Pacific, which grounds the EIP analysis in reality and further integrates 'natural'/'traditional' science and social science and policy making.

Using a methodology that incorporates both natural and social sciences also supports the inclusion of topics under an expanded concept of security. As the EIP chains show the full cause, effect, and impact pathway, it enables people to understand the rationale and logic, in this case, it also supports the argument of climate change being considered a security issue in its own right, while also showing the interconnected, multiplicative, and synergistic links. As well as it highlighting that environmental security is an issue that underpins more 'traditional' aspects of security.

The use of the Delphi approach to undertaking interviews was a useful methodological process for analysing the NGAM, as it supports and supplements the findings of the NGAM. Through the undertaking of interviews, some of the findings generated from the NGAM were validated, and the interviews also increased the connections of environmental science research and social science research/policy making and ensured that the methodology is truly inter-disciplinary.

9.4 Future Research

As shown throughout this thesis, 'Traditional' and 'non-traditional' security issues are occurring with increasing frequency, especially in the maritime domain and these issues are further exacerbated by climate change. This thesis has subsequently shown the benefits of interdisciplinary analysis that can support the expansion of the concept of security, support a holistic approach to maritime security, and support the identification of efficient and effective interventions to minimise the impacts of climate change. This thesis could be further developed in future research by:

- **Expanding the scope and boundaries of the data collection.** As mentioned in the limitations sections, the data source used for this research limits the number of EIPs identified and skews the findings towards those issues found with a high confidence in natural science. Expanding data sources would further support the development and progress of multi-disciplinary analysis. The expanded scope of data and data collection boundaries could include integrating a wider set of data sources into the creation of EIP, including qualitative data found in social science research, as this would again support the multi-disciplinary aspects of this research, as well as help

mitigate some biases in the data sources. It could also include a larger range of quantitative data sources on climate change, or to include data on interconnected issues such as pollution and environmental degradation. This would support a greater quantity of EIP chains with increased granularity and create a better understanding of climate change's impacts, including the interconnectedness and complexity of the interactions, which will lead to a more detailed analysis. Expanding both sets of data sources could be done in several ways: by systematically finding scientific papers, in peer-reviewed journals, that research different aspects of climate change cause, effect, and impact; by training artificial intelligence/computer software to analyse large text depositories; or by using a research team to conduct field research.

- **Adding weightings to the impacts of individual EIP chains**. This would also support a better understanding and more detailed analysis of climate change's impacts. It would especially support the identification of the most severe impacts, allowing policy and decision-makers to develop more efficient and effective interventions. Though a binary study, this thesis has allowed for developing an understanding of the full cause, effect and impact chains and the suggestion of initial interventions.
- **Use complex computer modelling for greater depth of analysis.** This would support increased identification and analysis of the interactions between EIP chains and the feedback loops that occur within the NGAM. This would support the overcoming of one of this research's limitations and support a greater understanding of the severity of impacts.

9.5 Concluding Impressions (The End)

The impact of this research and the unique contribution to the development of new knowledge that it makes should support other researchers and policymakers in decision-making going forward. This thesis, through developing a new analytical methodology and critically analysing the linkages between three important issues, will help focus research and policy in the future and support it to better understand how the natural marine environment is impacted by the effects of climate change, and how the natural marine environment underpins maritime security. This is because, as has been argued throughout

the thesis, the environmental security of dimension provides a foundation for building maritime security as it has interactions across all dimensions of maritime security.

With the Indo-Pacific being the current centre of geostrategic competition and tensions, this thesis supports the need for further and more detailed analysis of how climate change will impact this maritime super-region. The political economy of the climate change response is already alive and well, fuelling an increasingly sharper focus on geostrategic competition, especially in the Pacific. Within the Indo-Pacific, the burden of response will fall unevenly, as the resilience and adaptive capacities of countries within the Indo-Pacific varies. To adequately respond to the challenges presented, countries with means in the Indo-Pacific, notably Australia, China, India, Japan, New Zealand, Singapore, and the United States, will need to pick up their fair share. For those countries that are not in such a position to respond, ensuring that the principles of sustainable and resilient development are followed will support not only their future resilience but will drive their current prosperity forward.

To ensure sustained security across all dimensions of maritime security in a changing climate, will require increased civil-military cooperation especially as bigger powers look to improve ocean governance, maintain their monopoly of military force, sustain their power projection capabilities and aim to ensure that domestic issues do not represent an additional burden to military forces that are already coming under strain in some countries.

Enhanced cooperation between actors is needed to ensure both maritime security and an adequate response to the impacts of climate change within the Indo-Pacific. With the region having a growing number of mini-laterals, there are multiple opportunities to increase efforts relating to these two issues.

Ultimately, the world is going to change, and being prepared for this change requires a level of understanding about climate change and maritime security that we do not currently have. Building cooperation to ensure the security of a healthy maritime environment is essential to minimising the impacts that the effects of climate change will have on the maritime security of the Indo-Pacific.

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Annex One: Interview Question List

Lancaster University

Interview Question list

What is the study about?
This study aims to understand how the effects of climate change are beginning to affect the maritime security of the Indo-Pacific. To do this the study will evaluate literature on maritime security.

Why have I been invited?
I have approached you as you are a prominent expert or practitioner. As you hold valuable experience and insights into either and/or both maritime security and climate change, I would be very grateful if you would agree to take part in this study.

Interview Questions

Q1 – What is your understanding/definition of maritime security?

Q2 – What is your understanding/definition of Climate Change?

Q3 – What is your understanding/definition of the Indo-Pacific?

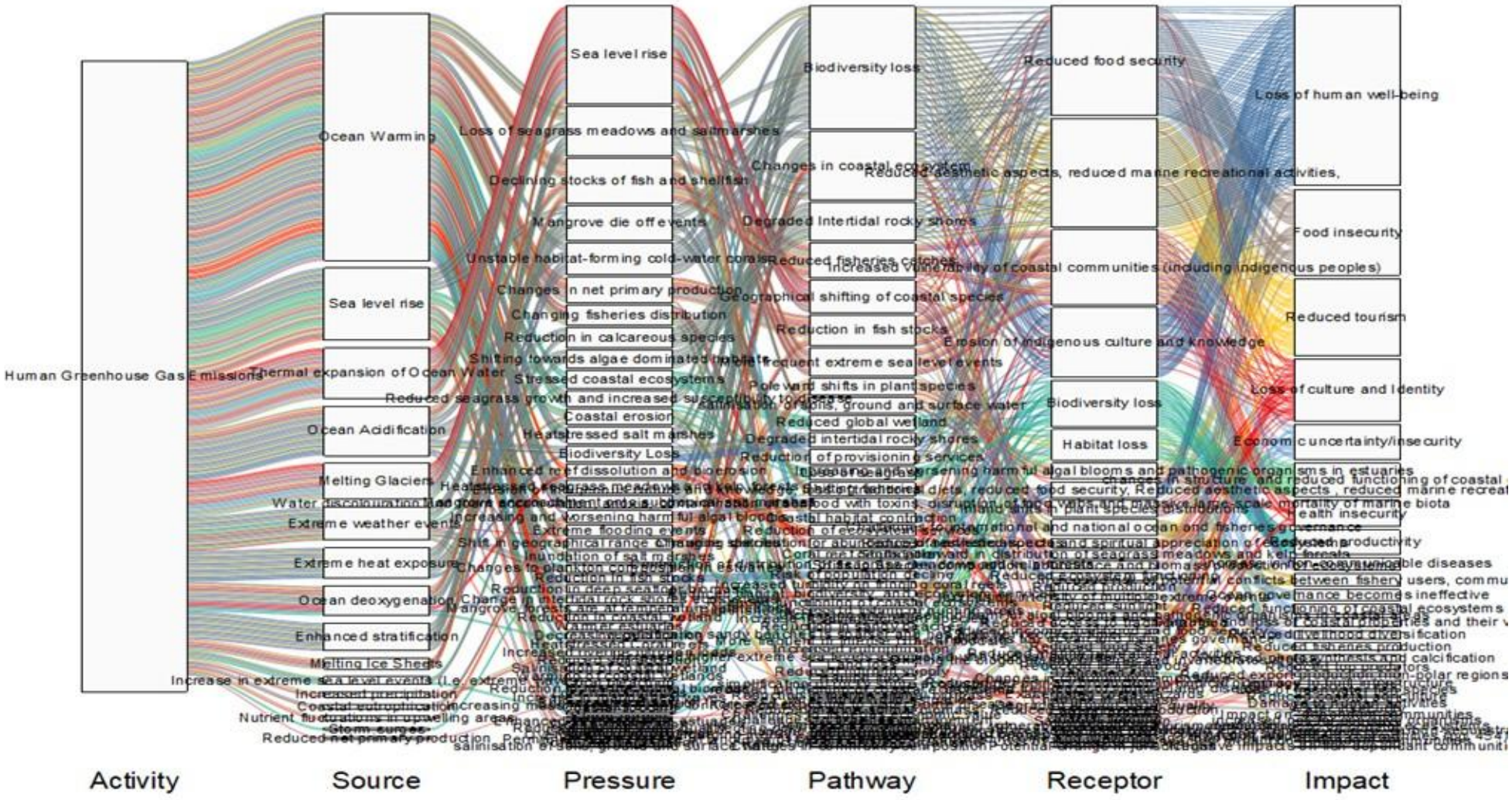
Q4 – Do you think climate change has an impact on maritime security? And if yes how so?

Q5 – Given the provided sanky chart mapping the effects of human greenhouse gas emissions to their impact on maritime security (to be sent separately), how does this chart look to you? Do you think it represents the issues you are currently experiencing?

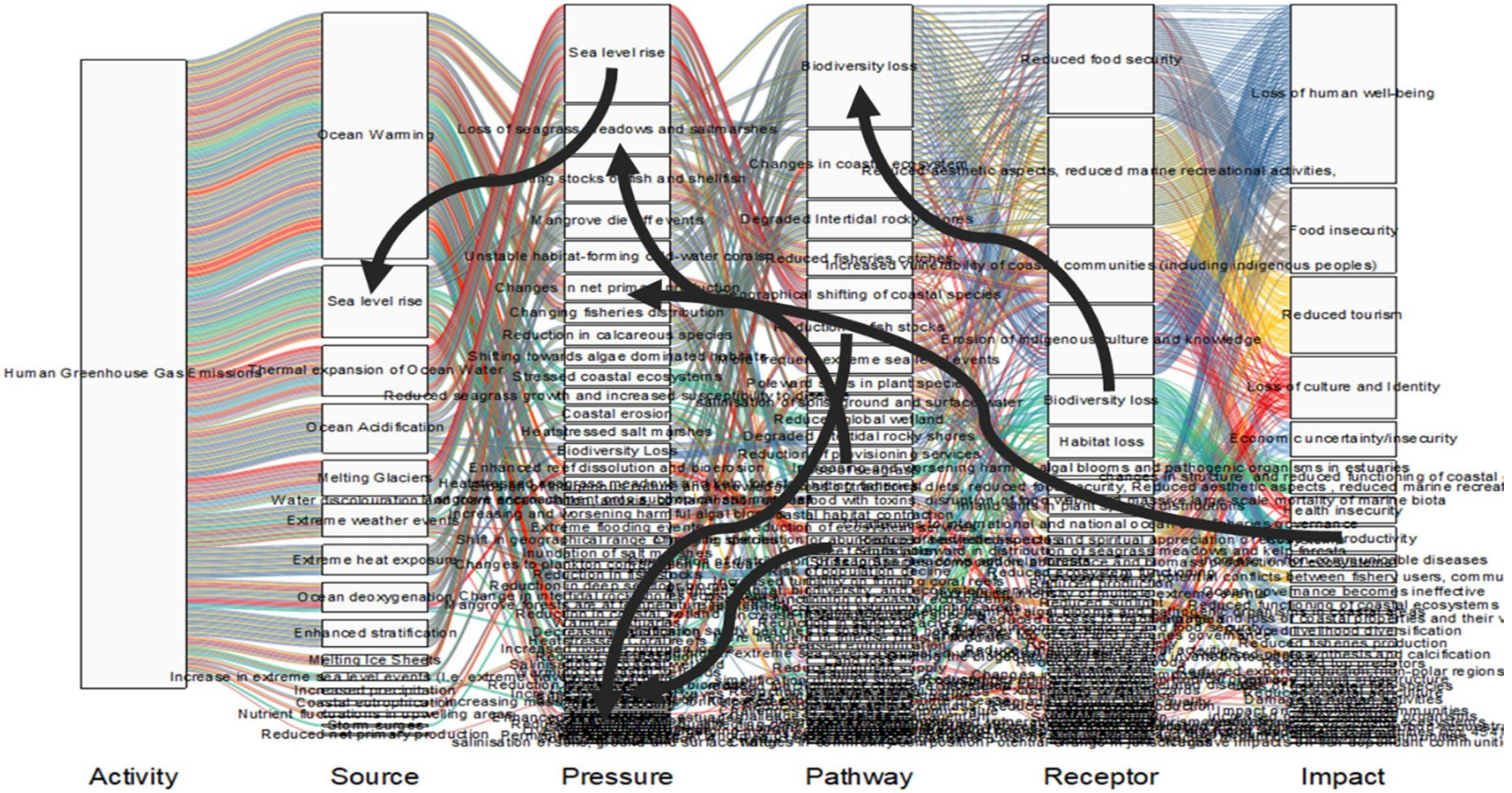
Q6 – In the sanky chart are there any impacts, you think should be present but are not? Are there any other effects of Climate Change are having on maritime security?

Q7 – If I were to ask you these questions again in 5 or 10 years' time do you think your answers would change? And if yes how so?

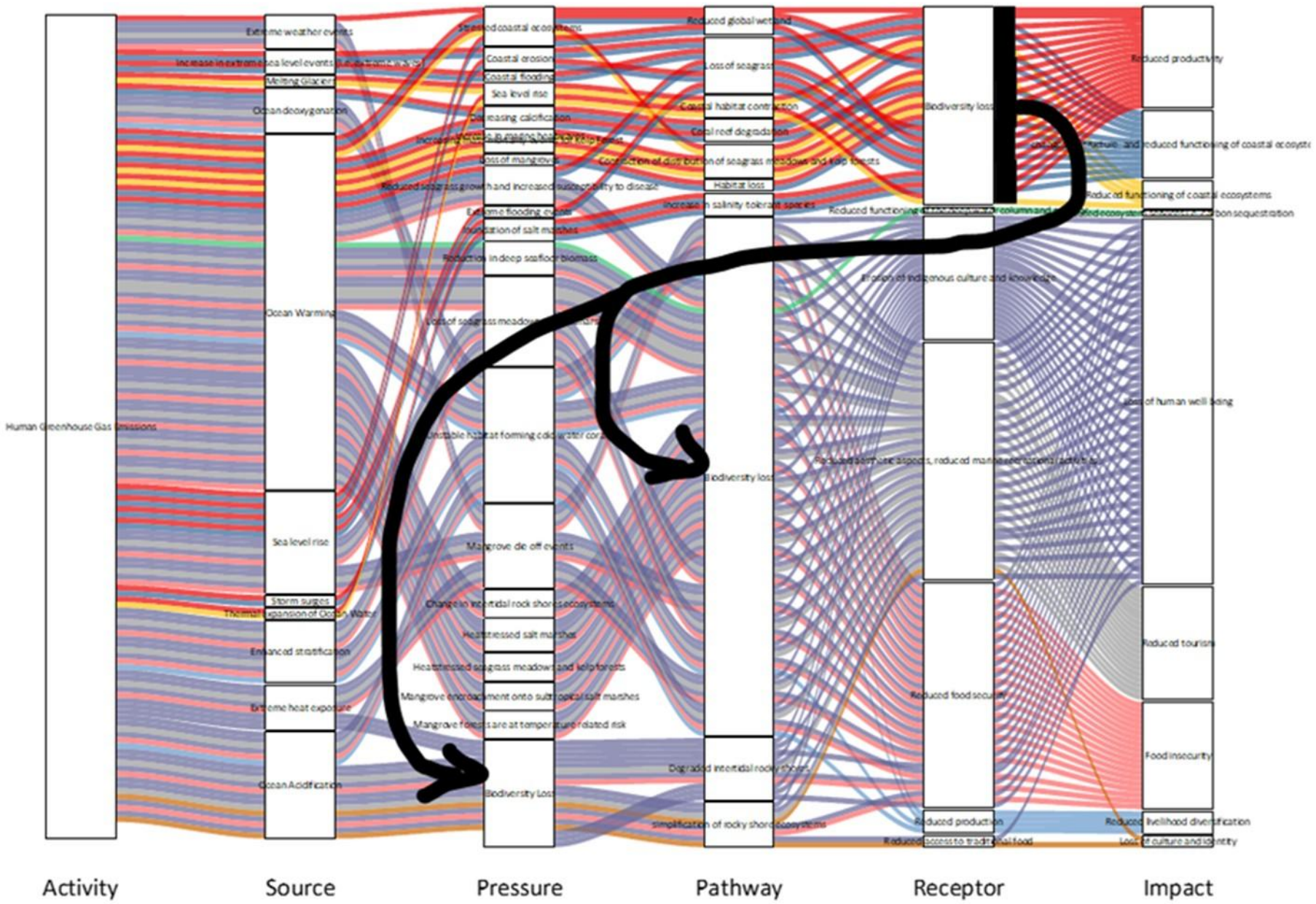
Annex Two: Enlargement of Figure 4.1 – A visualisation of all EIP chains within the NGAM



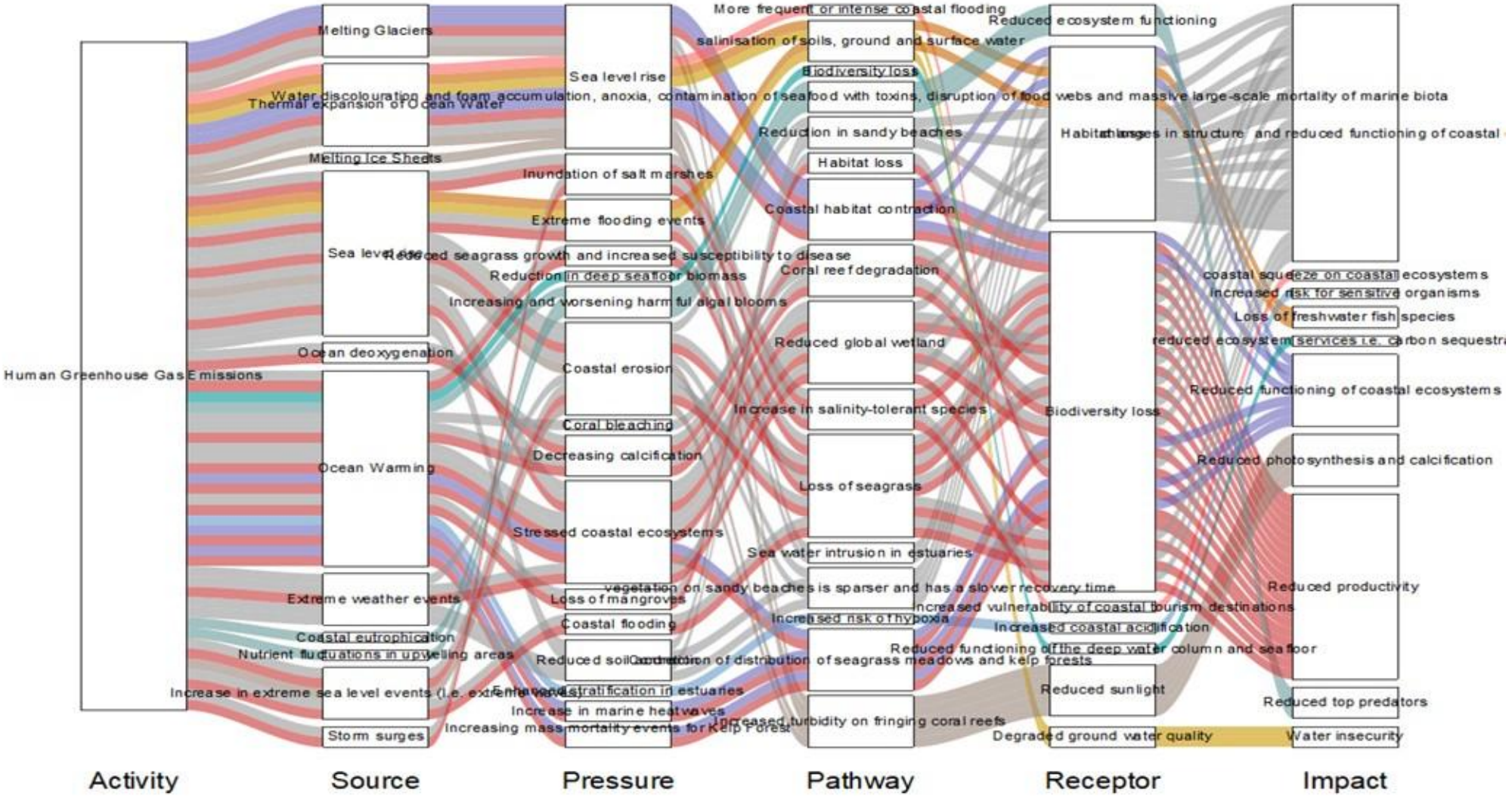
Annex Three: Enlargement of Figure 4.2 - A visual representation of feedback loops within the NGAM



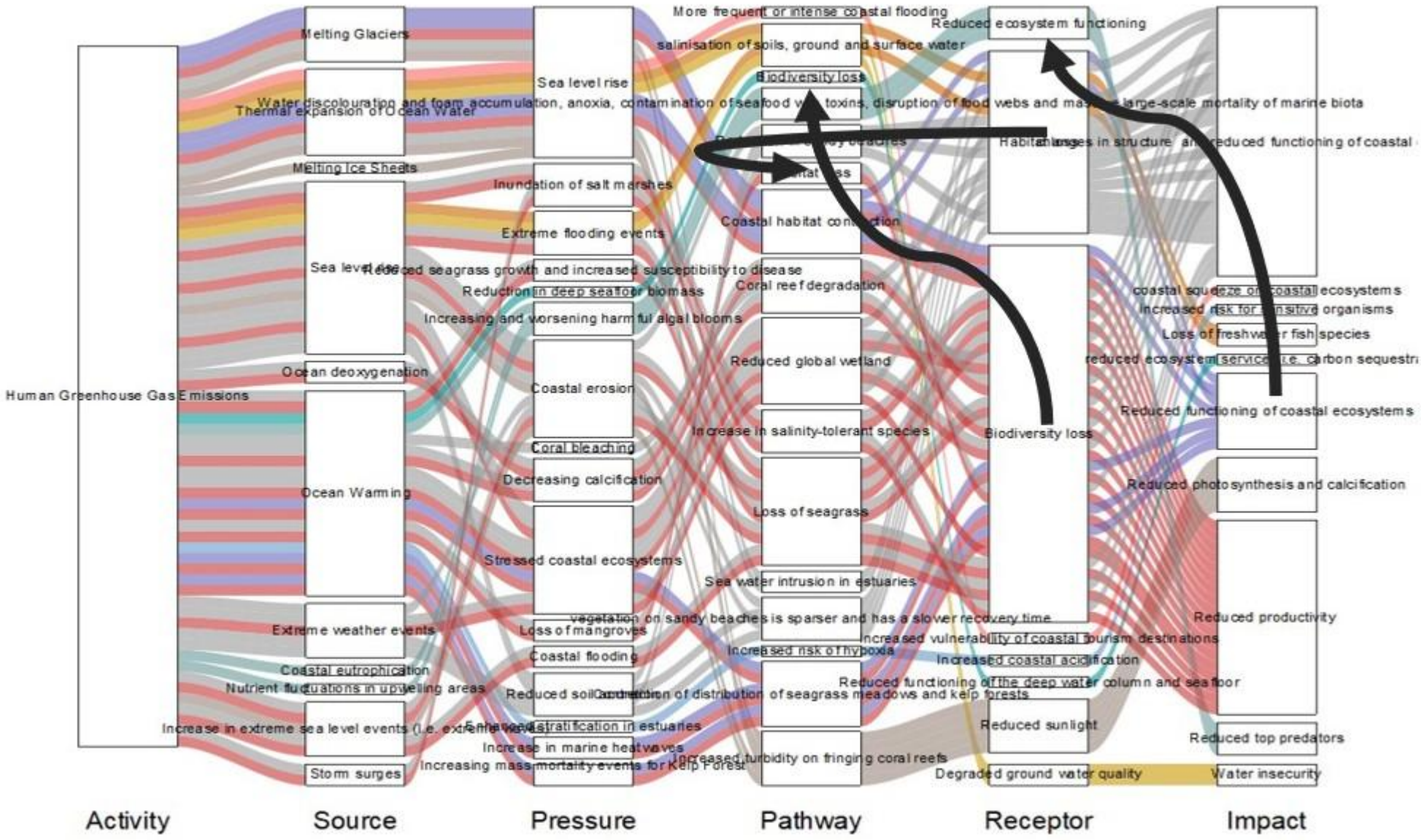
Annex Four: Enlargement of Figure 4.3 – A visual representation of the ‘Biodiversity loss’ feedback loop


Human Greenhouse Gas Emissions
Extreme weather events
Increase in extreme sea level events
Melting Glaciers
Ocean deoxygenation
Ocean Warming
Sea level rise
Storm surges
Thermal expansion of Ocean Water
Enhanced stratification
Extreme heat exposure
Ocean Acidification
Coastal erosion
Coastal flooding
Sea level rise
Loss of mangroves
Extreme flooding events
Reduction of salt marshes
Reduction in deep seafloor biomass
Loss of seagrass meadows
Mangrove die off events
Change in intertidal rock shore ecosystems
Heat stressed salt marshes
Heat stressed seagrass meadows and kelp forests
Mangrove encroachment onto subtropical salt marshes
Mangrove forests are at temperature related risk
Biodiversity Loss
Reduced global wetland
Loss of seagrass
Coastal habitat contraction
Coral reef degradation
Habitat loss
Increase in salinity tolerant species
Biodiversity loss
Degraded intertidal rocky shores
simplification of rocky shore ecosystems
Biodiversity loss
Reduced productivity
Reduced functioning of coastal ecosystems
Reduced food security
Reduced production
Reduced access to traditional food
Reduced productivity
Reduced functioning of coastal ecosystems
Loss of human well being
Reduced tourism
Food insecurity
Reduced livelihood diversification
Loss of culture and identity
Activity
Source
Pressure
Pathway
Receptor
Impact

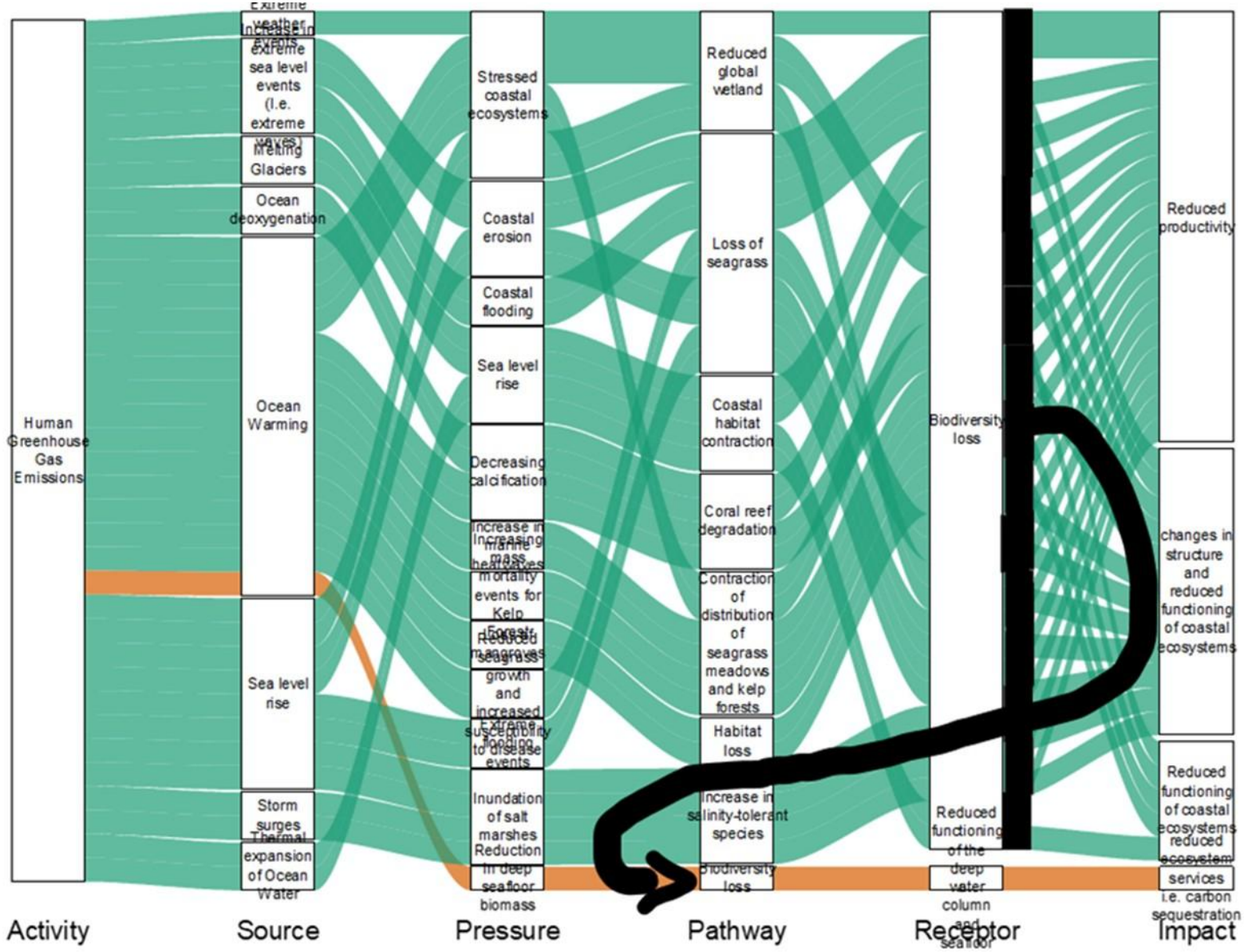
Annex Five: Enlargement of Figure 5.1 – A visual representation of the NGAM for environmental security



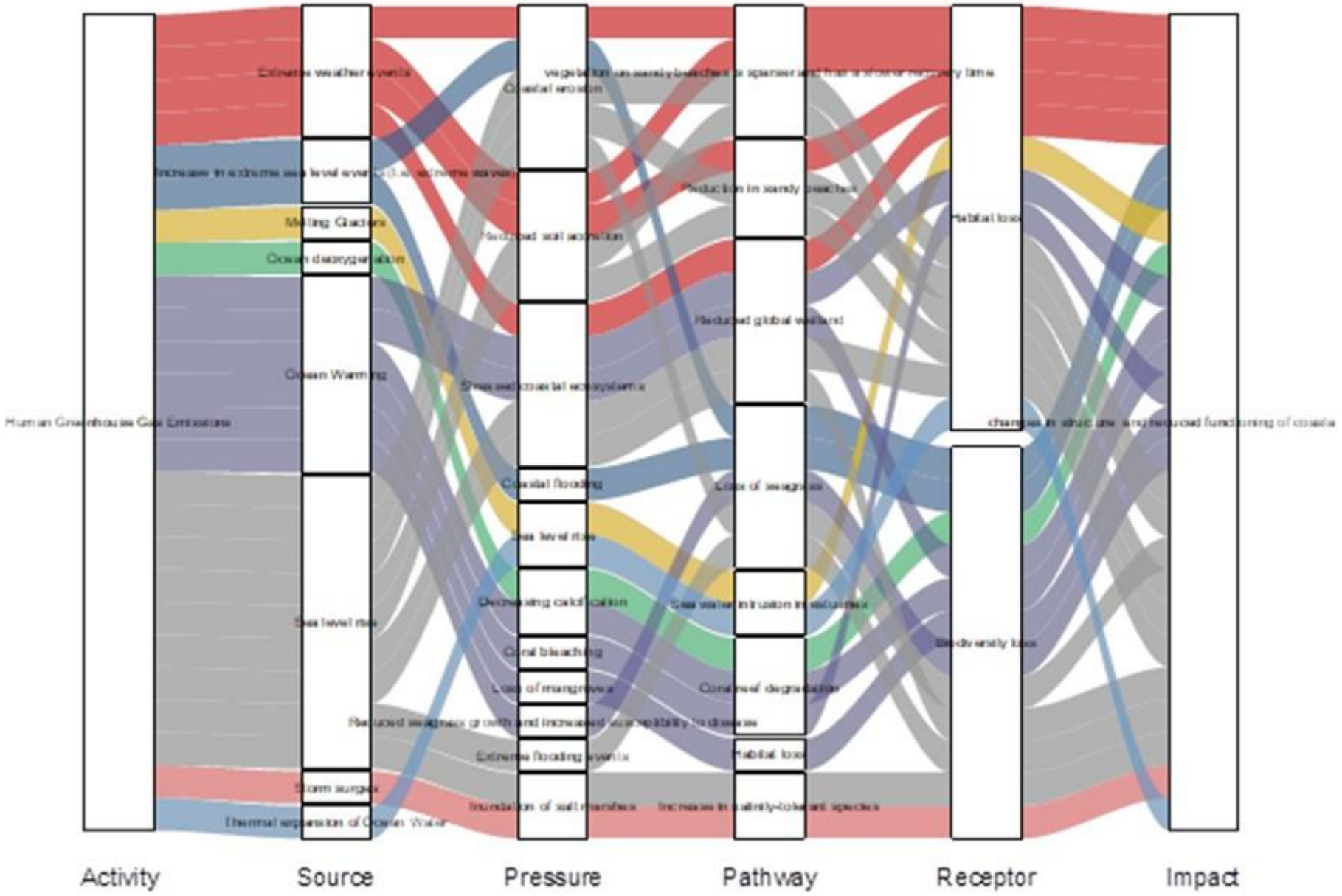
Annex Six: Enlargement of Figure 5.2 - A visual representation environmental security feedback loops



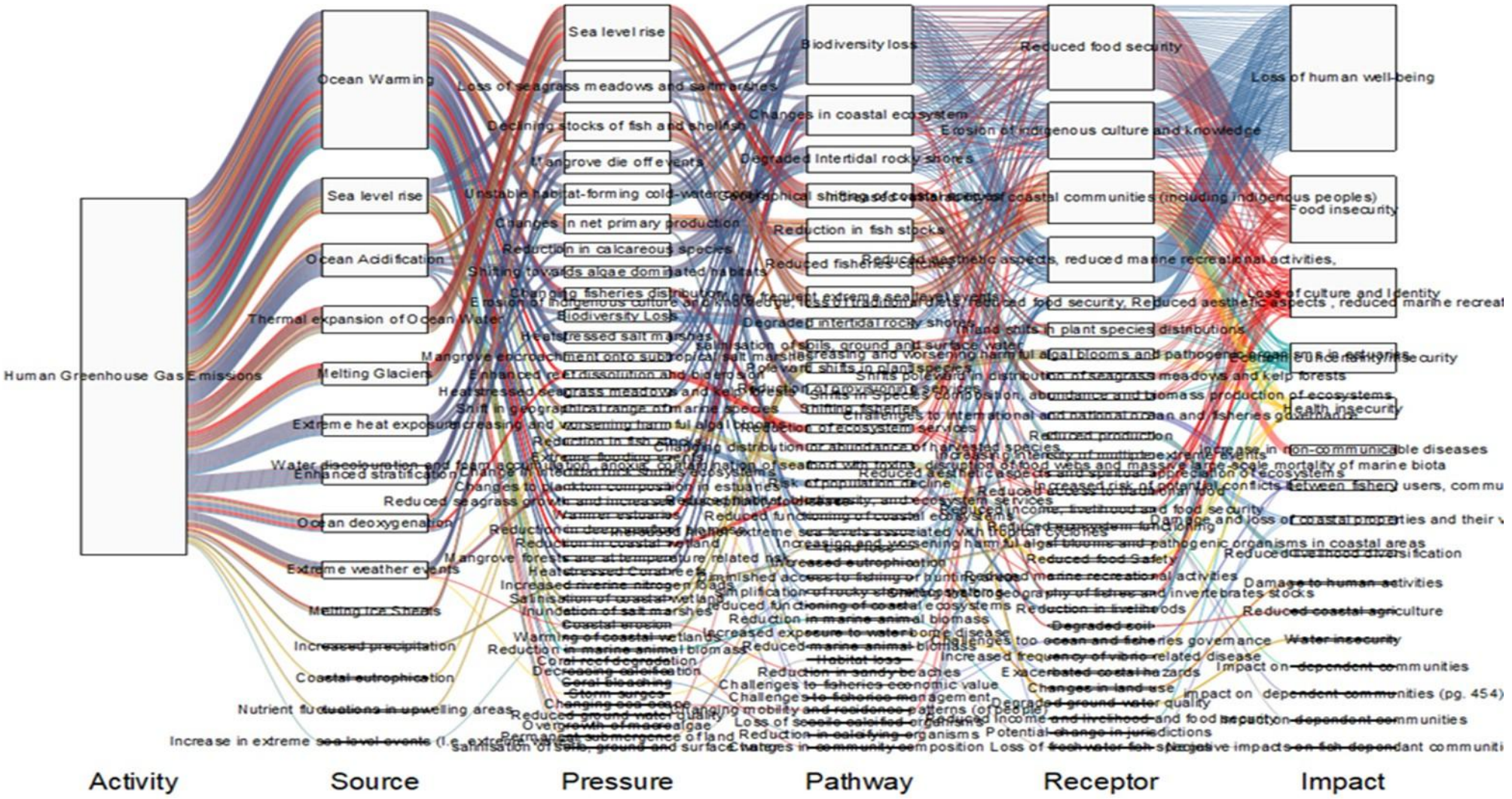
Annex Seven: Enlargement of Figure 5.3 – A visual representation of the biodiversity loss feedback loop as it relates to environmental security dimension of maritime security


Human Greenhouse Gas Emissions
Extreme weather events
Increase in extreme sea level events (i.e. extreme waves)
Melting Glaciers
Ocean deoxygenation
Ocean Warming
Sea level rise
Storm surges
Thermal expansion of Ocean Water
Stressed coastal ecosystems
Coastal erosion
Coastal flooding
Sea level rise
Decreasing calcification
Increase in marine heatwaves
Increasing mass mortality events for Kelp
Forest/ mangroves
Reduced seagrass growth and increased susceptibility to disease
Extreme flooding events
Inundation of salt marshes
Reduction in deep seafloor biomass
Reduced global wetland
Loss of seagrass
Coastal habitat contraction
Coral reef degradation
Contraction of distribution of seagrass meadows and kelp forests
Habitat loss
Increase in salinity-tolerant species
Biodiversity loss
Biodiversity loss
Reduced functioning of the deep water column and seafloor
Reduced productivity
changes in structure and reduced functioning of coastal ecosystems
Reduced functioning of coastal ecosystems
reduced ecosystem services
i.e. carbon sequestration
Activity
Source
Pressure
Pathway
Receptor
Impact

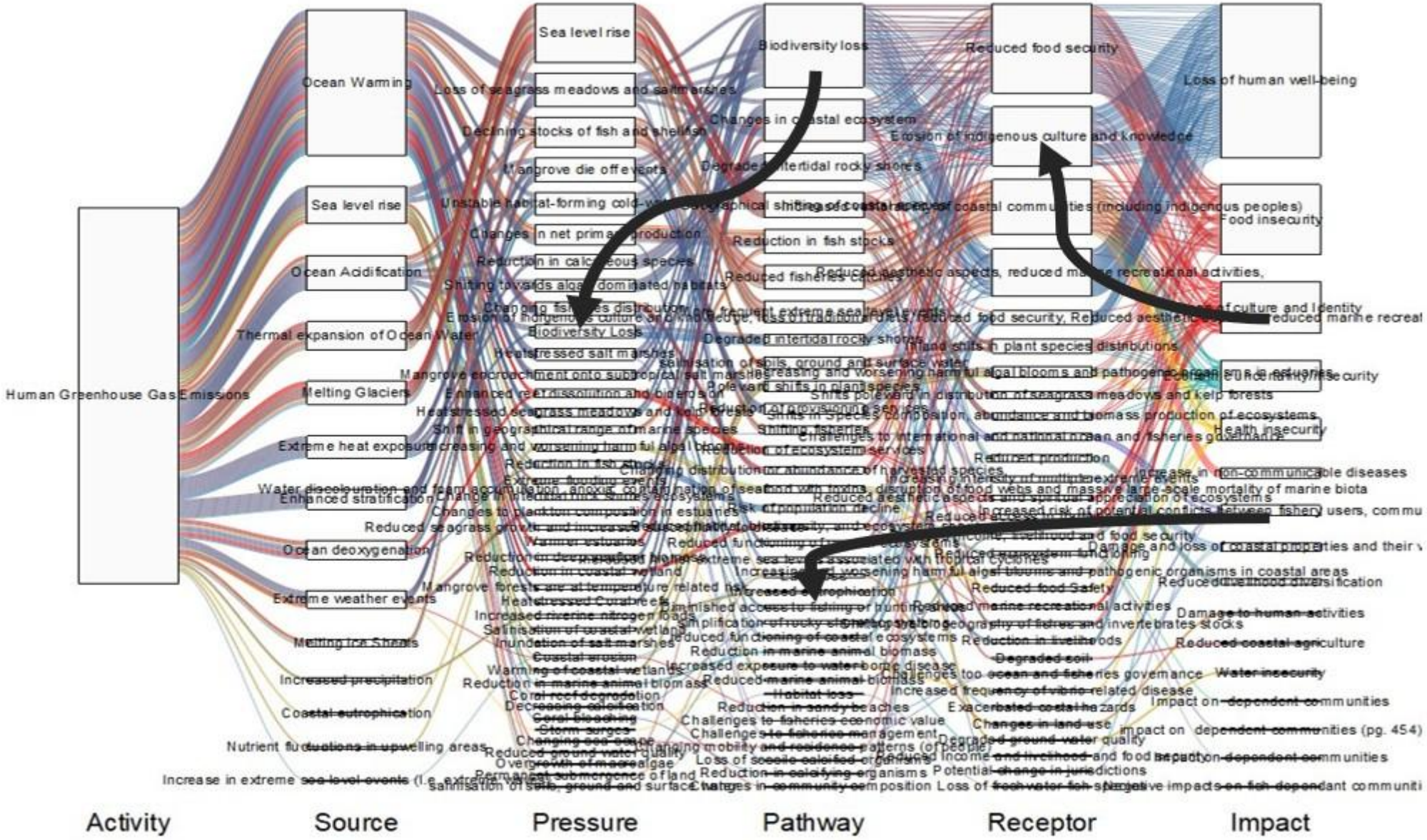
Annex Eight: Enlargement of Figure 5.4 – A visual representation of the EIP chains for the impact ‘changes in structure and reduced functioning of coastal ecosystems’


Human Greenhouse Gas Emissions
Melting Glaciers
Ocean Warming
Sea level rise
Storm surges
Coastal flooding
Sea level rise
Coral bleaching
Habitat loss
Biodiversity loss
Activity
Source
Pressure
Pathway
Receptor
Impact

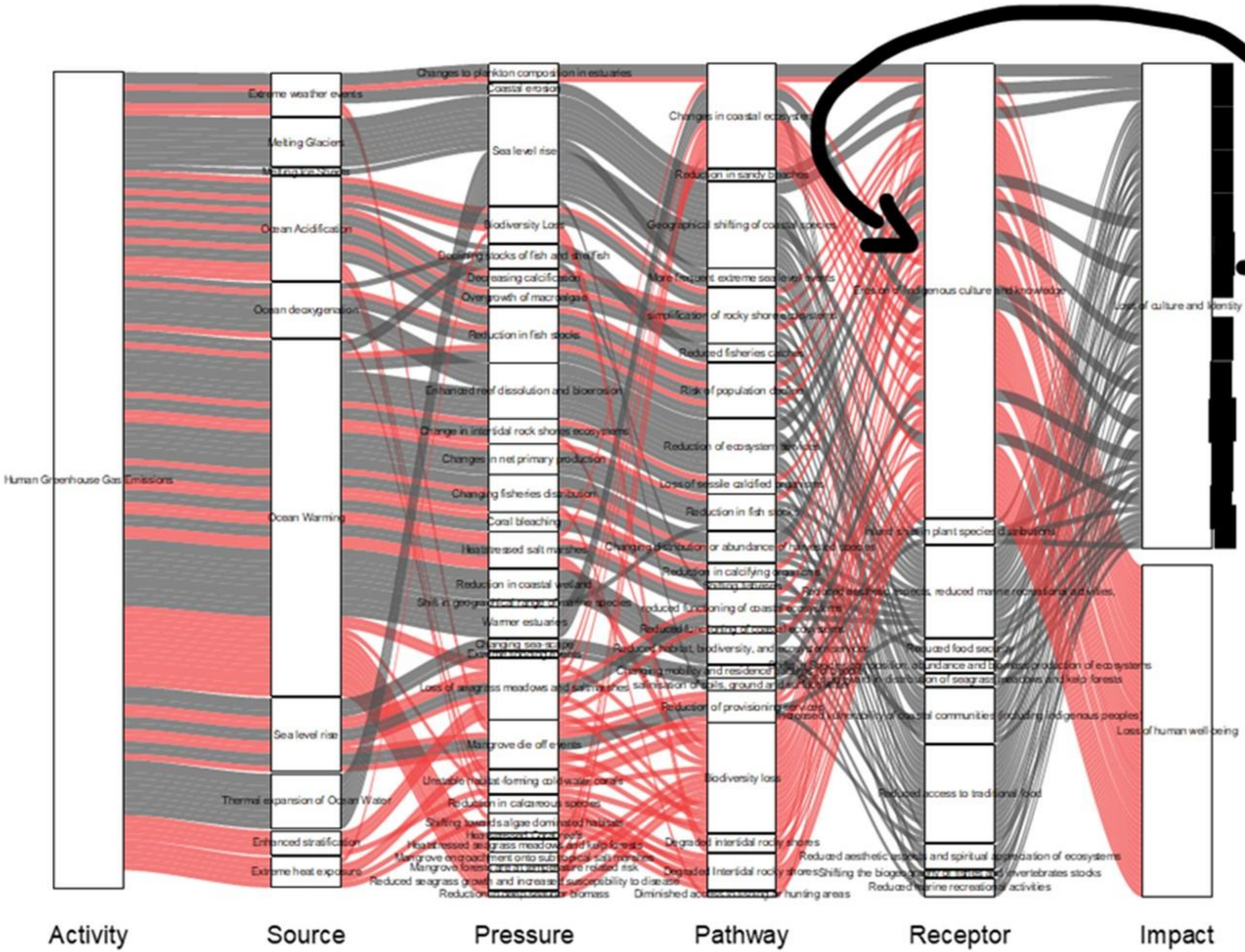
Annex Nine: Enlargement of Figure 6.1 – A visual representation of the NGAM for economic security



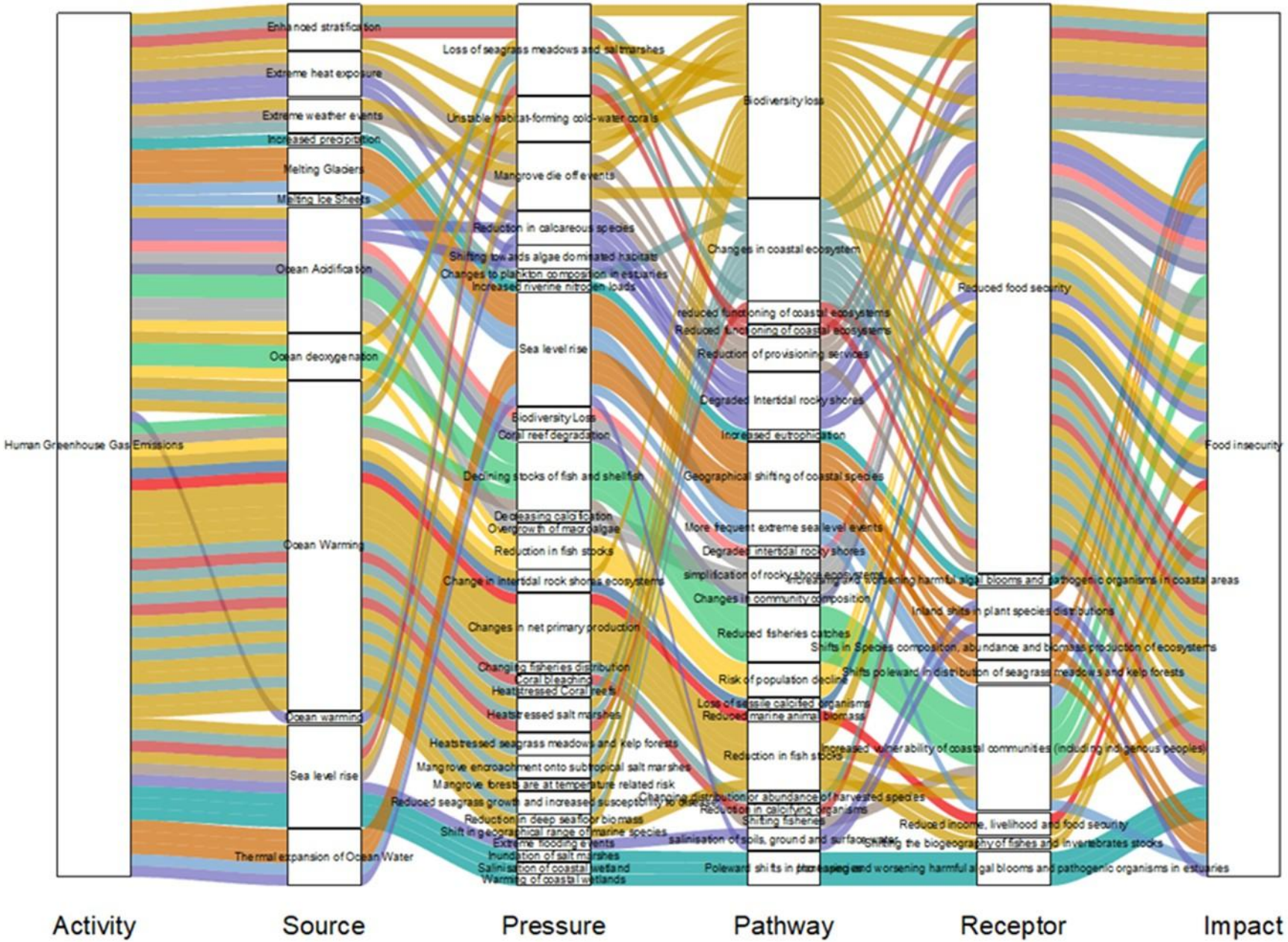
Annex Ten: Enlargement of Figure 6.2 – A visual representation of human security's feedback loops



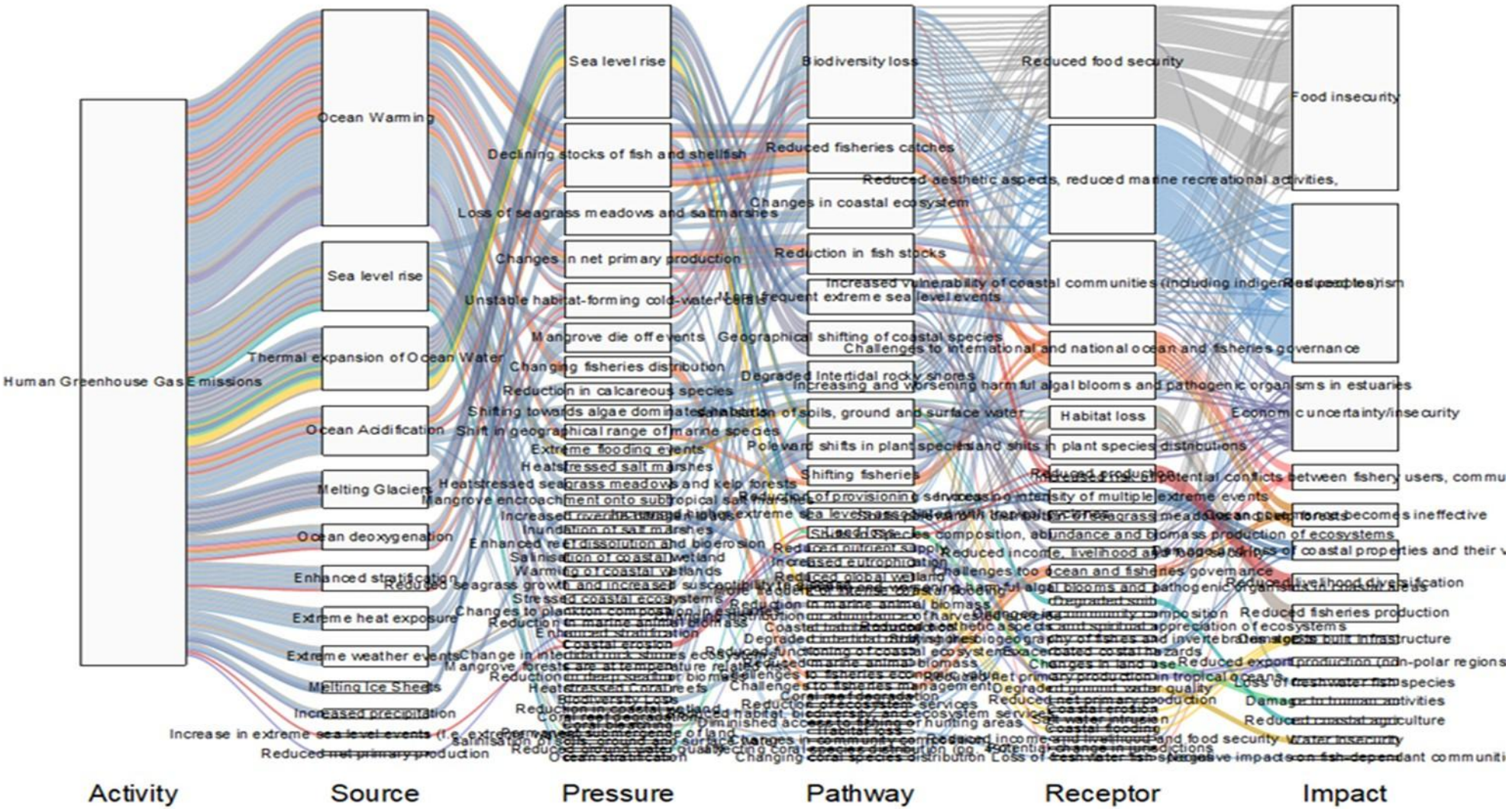
Annex Eleven: Enlargement of Figure 6.3 – A visualisation of the feedback loop of 'Loss of culture and Identity'


Human Greenhouse Gas Emissions
Extreme weather events
Melting Glaciers
Ocean Acidification
Ocean deoxygenation
Ocean Warming
Sea level rise
Thermal expansion of Ocean Water
Enhanced stratification
Extreme heat exposure
Changes to plankton composition in estuaries
Coastal erosion
Sea level rise
Biodiversity Loss
Declining stocks of fish and shellfish
Decreasing calcification
Overgrowth of macroalgae
Reduction in fish stocks
Enhanced reef dissolution and bioerosion
Change in intertidal rock shores ecosystems
Changes in net primary production
Changing fisheries distribution
Coral bleaching
Heat stressed salt marshes
Reduction in coastal wetland
Warmer estuaries
Loss of seagrass meadows and salt marshes
Mangrove die off events
Reduction in calcareous species
Changes in coastal ecosystems
Reduction in sandy beaches
Geographical shifting of coastal species
More frequent extreme sea level events
Simplification of rocky shore ecosystems
Reduced fisheries catches
Risk of population decline
Reduction of ecosystem services
Loss of sessile calcified organisms
Reduction in fish stocks
Reduction in calcifying organisms
Reduction of provisioning services
Biodiversity loss
Degraded intertidal rocky shores
Degraded Intertidal rocky shores
Erosion of indigenous culture and knowledge
Reduced food security
Increased vulnerability of coastal communities (including indigenous peoples)
Reduced access to traditional food
Reduced marine recreational activities
Loss of culture and identity
Loss of human well-being
Activity
Source
Pressure
Pathway
Receptor
Impact

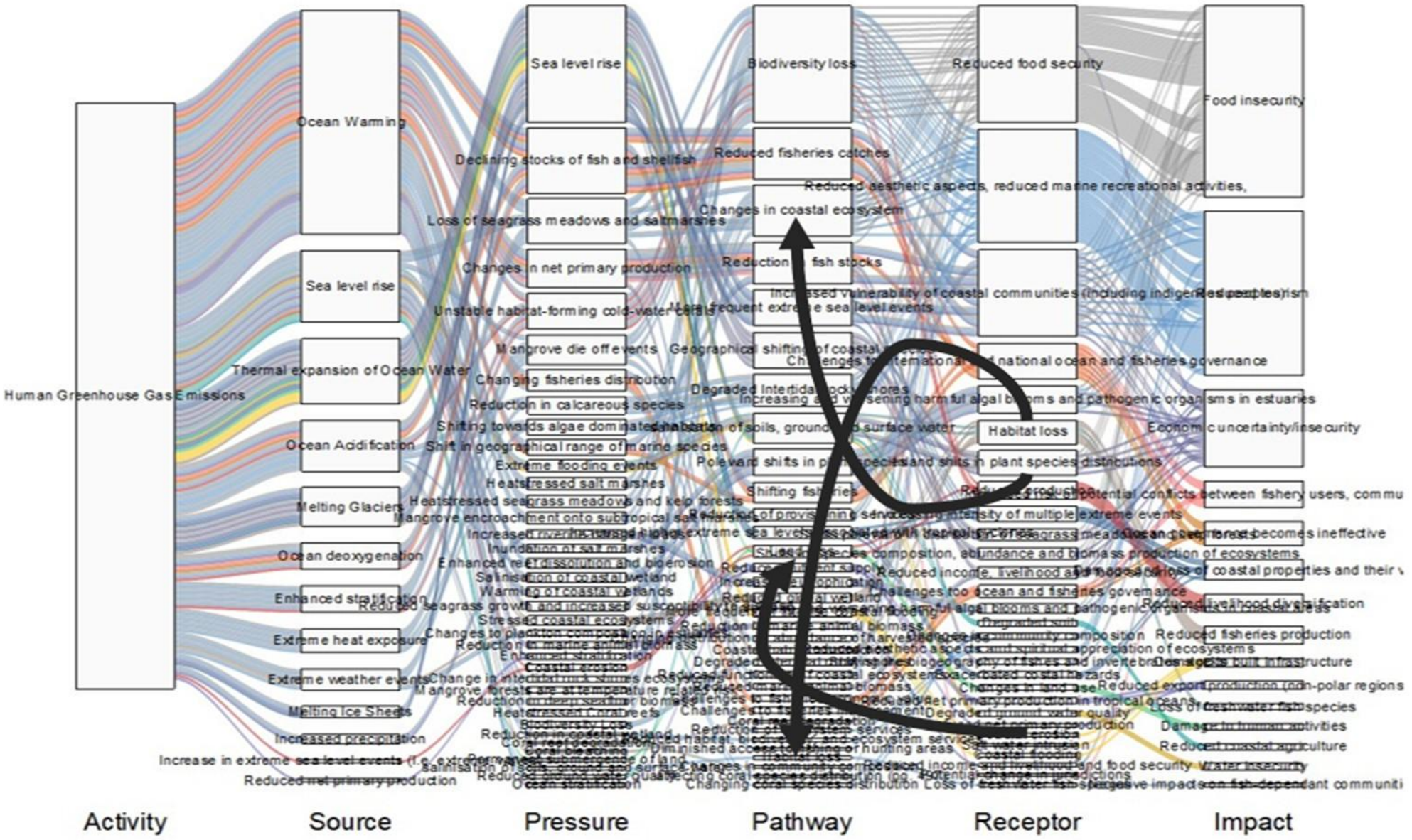
Annex Twelve: Enlargement of Figure 6.4 – A visualisation of the impact ‘Food insecurity’


Human Greenhouse Gas Emissions
Enhanced stratification
Extreme heat exposure
Extreme weather events
Increased precipitation
Melting Glaciers
Melting Ice Sheets
Ocean Acidification
Ocean deoxygenation
Ocean Warming
Ocean warming
Sea level rise
Thermal expansion of Ocean Water
Loss of seagrass meadows and salt marshes
Unstable habitat-forming cold-water corals
Mangrove die off events
Reduction in calcareous species
Shifting towards algae dominated habitats
Changes to plankton composition in estuaries
Increased riverine nitrogen loads
Sea level rise
Biodiversity Loss
Coral reef degradation
Declining stocks of fish and shellfish
Decreasing calcification
Overgrowth of macroalgae
Reduction in fish stocks
Change in intertidal rock shore ecosystems
Changes in net primary production
Changing fisheries distribution
Coral bleaching
Heat stressed Coral reefs
Heat stressed salt marshes
Heat stressed seagrass meadows and kelp forests
Mangrove encroachment onto subtropical salt marshes
Mangrove forests are at temperature related risk
Reduced seagrass growth and increased susceptibility to disease
Reduction in deep sea fish biomass
Shift in geographical range of marine species
Extreme flooding events
Inundation of salt marshes
Salinisation of coastal wetland
Warming of coastal wetlands
Biodiversity loss
Changes in coastal ecosystem
reduced functioning of coastal ecosystems
Reduced functioning of coastal ecosystems
Reduction of provisioning services
Degraded Intertidal rocky shores
Increased eutrophication
Geographical shifting of coastal species
More frequent extreme sea level events
Degraded intertidal rocky shores
simplification of rocky shore ecosystems
Changes in community composition
Reduced fisheries catches
Risk of population decline
Loss of sessile calcified organisms
Reduced marine animal biomass
Reduction in fish stocks
Change in distribution or abundance of harvested species
Reduction in calcifying organisms
Shifting fisheries
salinisation of soils, ground and surface water
Poleward shifts in the ranges
Reduced food security
Increasing harmful algal blooms and pathogenic organisms in coastal areas
Inland shifts in plant species distributions
Shifts in Species composition, abundance and biomass production of ecosystems
Shifts poleward in distribution of seagrass meadows and kelp forests
Increased vulnerability of coastal communities (including indigenous peoples)
Reduced income, livelihood and food security
Shifting the biogeography of fishes and invertebrates stocks
Increasing and worsening harmful algal blooms and pathogenic organisms in estuaries
Food insecurity
Activity
Source
Pressure
Pathway
Receptor
Impact

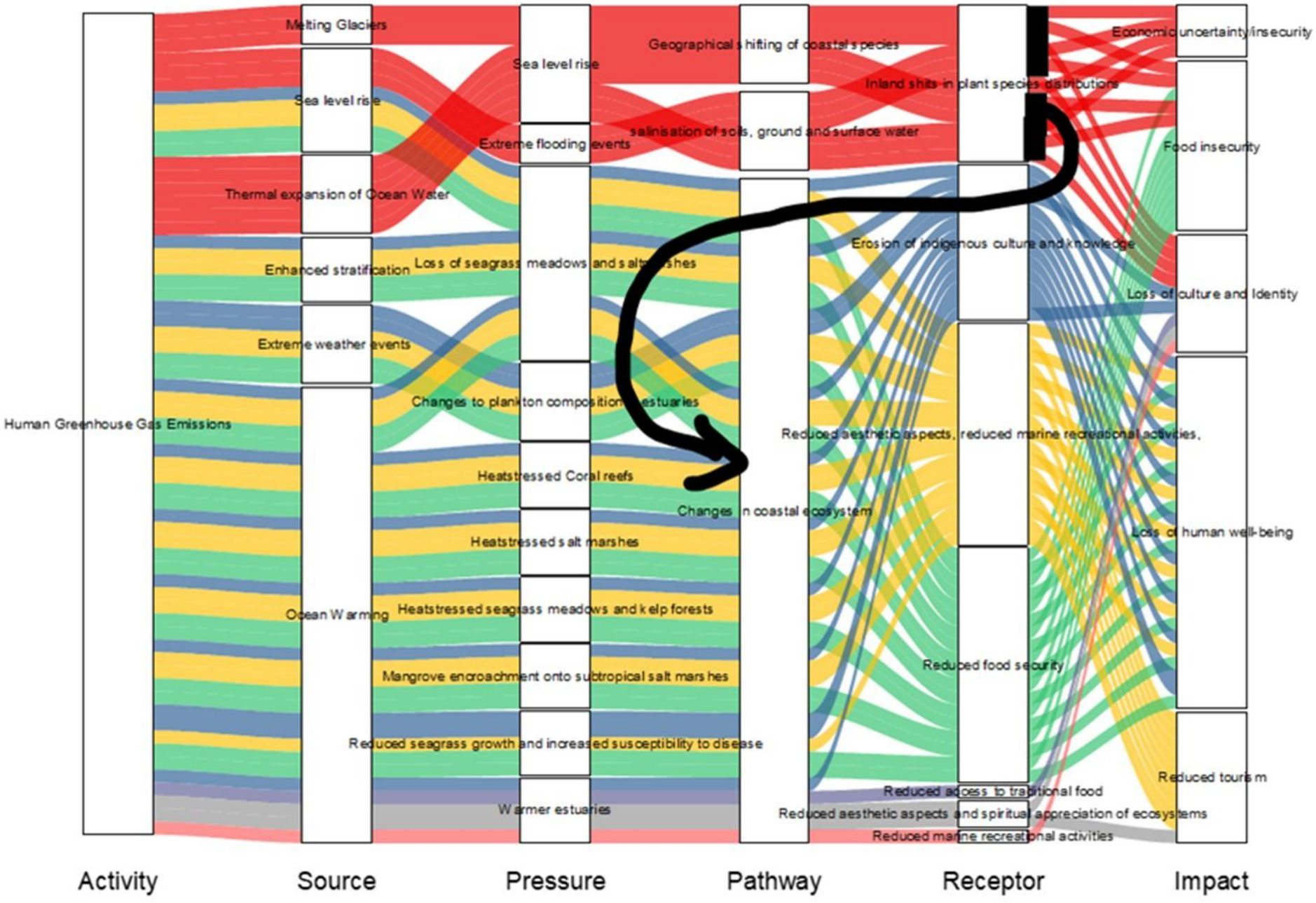
Annex Thirteen: Enlargement of Figure 7.1 - A visual representation of the NGAM for economic security



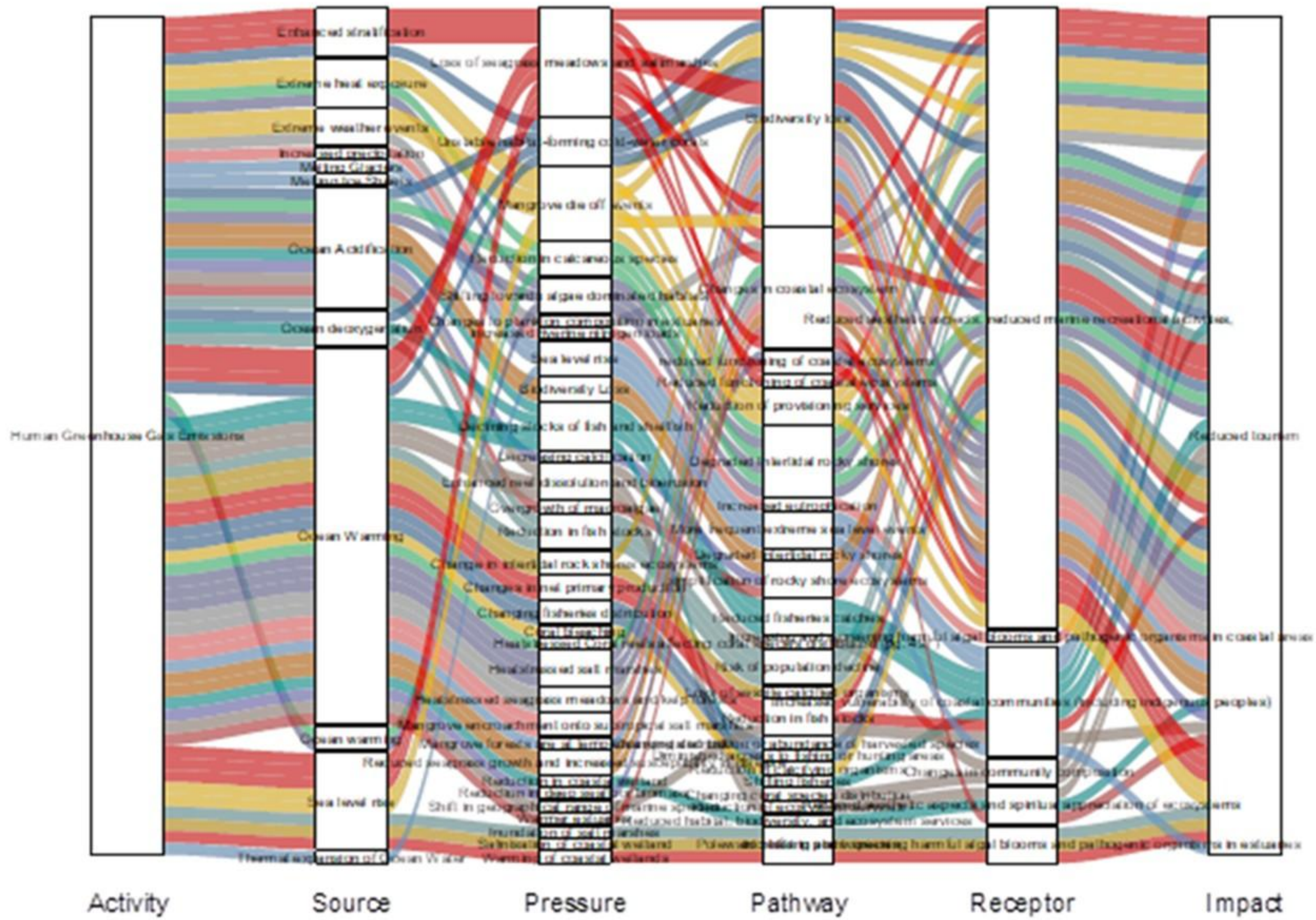
Annex Fourteen: Enlargement of Figure 7.2 – A visual representation of economic security's feedback loops



Annex Fifteen: Enlargement of Figure 7.3 – A visualisation of the feedback loop from the receptor ‘Inland shifts in plant species distributions’

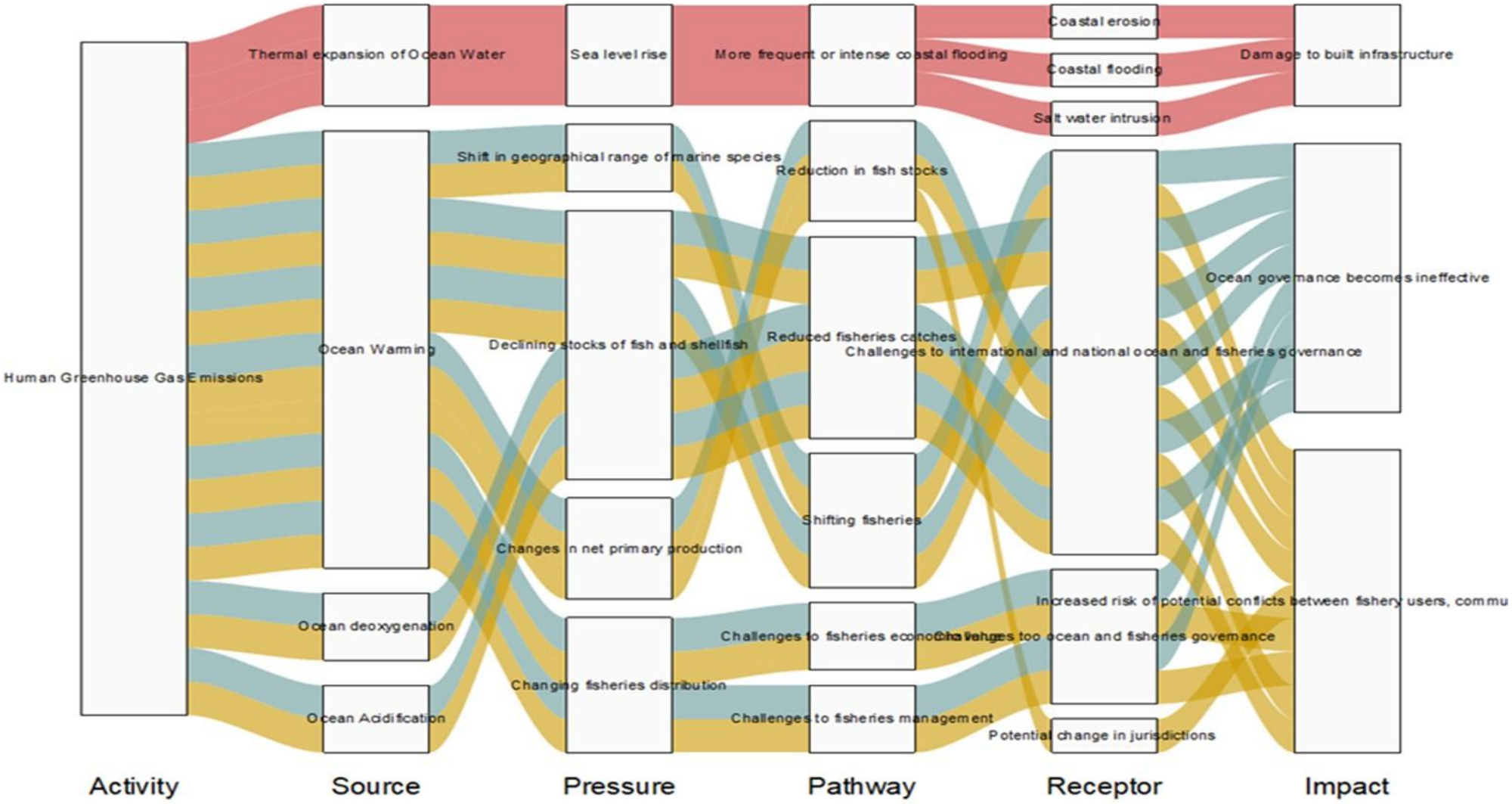

Human Greenhouse Gas Emissions
Melting Glaciers
Sea level rise
Thermal expansion of Ocean Water
Enhanced stratification
Extreme weather events
Ocean Warming
Sea level rise
Extreme flooding events
Loss of seagrass meadows and salt marshes
Changes to plankton composition, estuaries
Heatstressed Coral reefs
Heatstressed salt marshes
Heatstressed seagrass meadows and kelp forests
Mangrove encroachment onto subtropical salt marshes
Reduced seagrass growth and increased susceptibility to disease
Warmer estuaries
Geographical shifting of coastal species
salinisation of soils, ground and surface water
Changes in coastal ecosystem
Inland shifts in plant species distributions
Erosion of indigenous culture and knowledge
Reduced aesthetic aspects, reduced marine recreational activities,
Reduced food security
Reduced access to traditional food
Reduced aesthetic aspects and spiritual appreciation of ecosystems
Reduced marine recreational activities
Economic uncertainty/insecurity
Food insecurity
Loss of culture and Identity
Loss of human well-being
Reduced tourism
Activity
Source
Pressure
Pathway
Receptor
Impact

Annex Sixteen: Enlargement of Figure 7.4 – A visualisation of the EIPs the end with the impact ‘‘Reduced tourism’

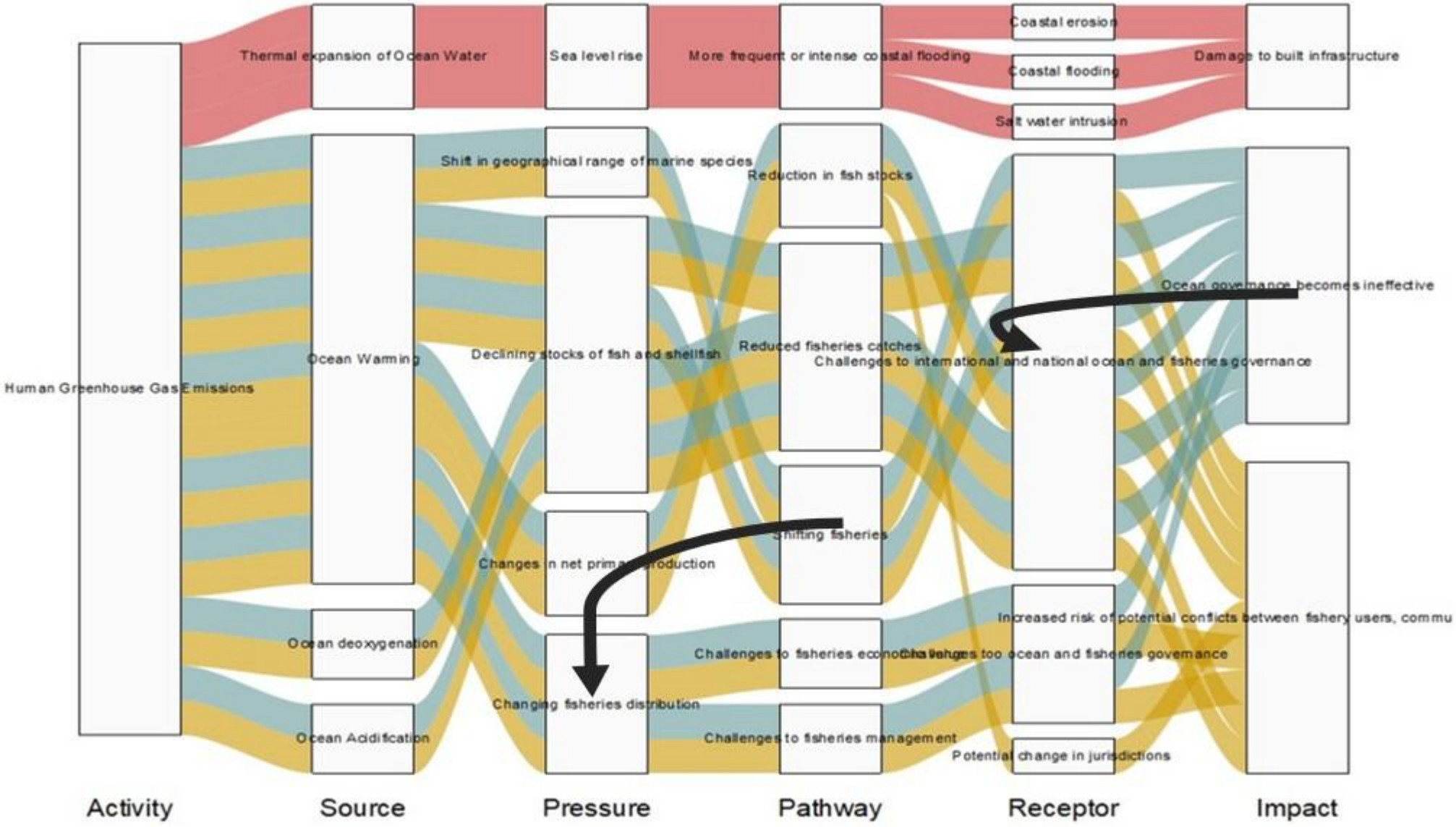


Human Greenhouse Gas Emissions
Enhanced stratification
Extreme heat exposure
Extreme weather events
Ocean Acidification
Ocean Warming
Sea level rise
Mangrove die off events
Sea level rise
Biodiversity Loss
Biodiversity loss
Reduced tourism
Activity
Source
Pressure
Pathway
Receptor
Impact

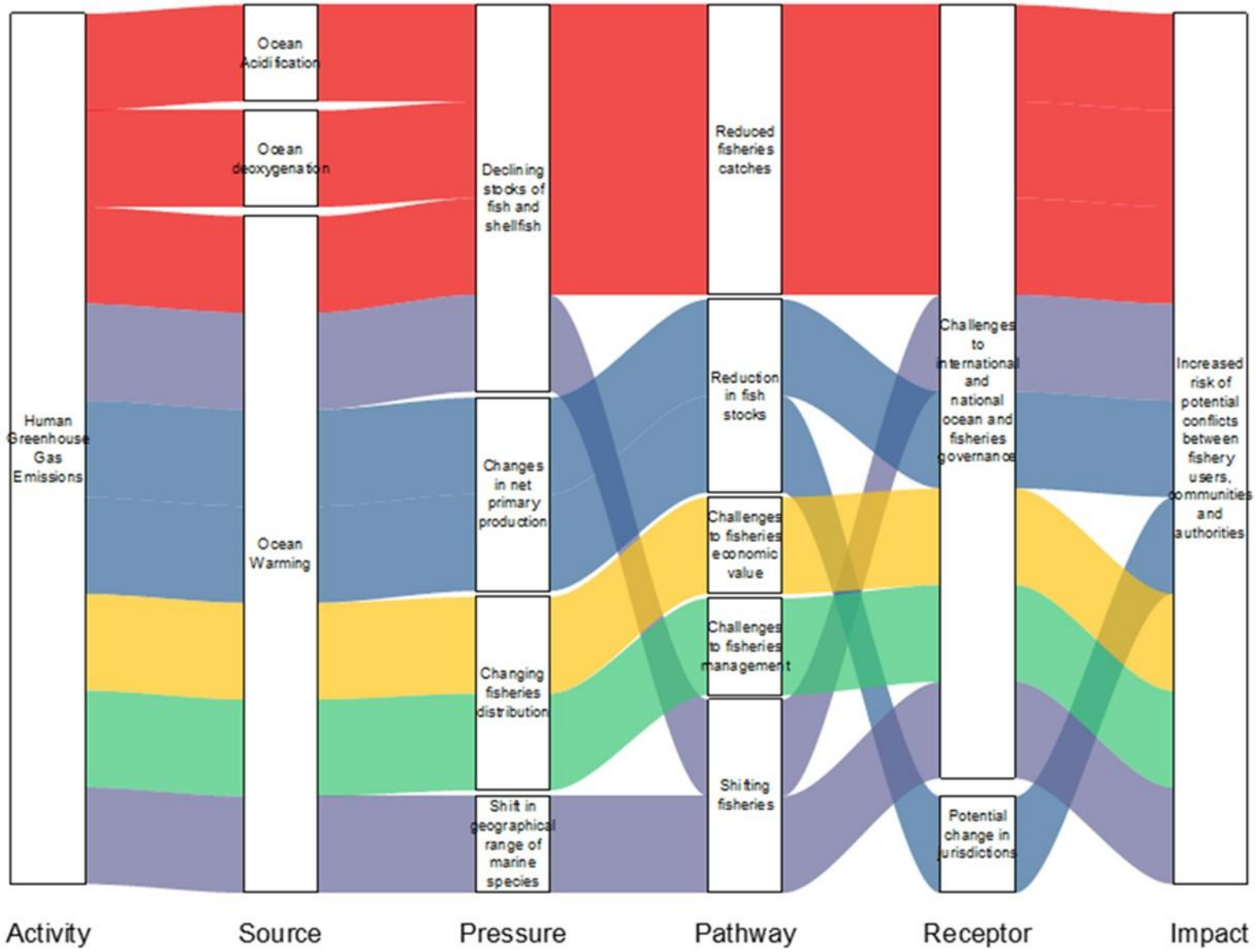
Annex Seventeen: Enlargement of Figure 8.1 – A visual representation of the NGAM for national security



Annex Eighteen: Enlargement of Figure 8.2 – A visual representation of national security's feedback loops



Annex Nineteen: Enlargement of Figure 8.3 – A visualisation of the EIPs ending in the impact ‘Increased risk of potential conflicts between fishery users, communities and authorities’


Human Greenhouse Gas Emissions
Ocean Acidification
Ocean deoxygenation
Ocean Warming
Declining stocks of fish and shellfish
Changes in net primary production
Changing fisheries distribution
Shift in geographical range of marine species
Reduced fisheries catches
Reduction in fish stocks
Challenges to fisheries economic value
Challenges to fisheries management
Shifting fisheries
Challenges to international and national ocean and fisheries governance
Potential change in jurisdictions
Increased risk of potential conflicts between fishery users, communities and authorities
Activity
Source
Pressure
Pathway
Receptor
Impact

Annex Twenty: Full database of Effect to Impact Pathways

Activity	Source	Pressure	Pathway	Receptor	Impact	Environmental	Human	Economic	National
Human Greenhouse Gas Emissions	Coastal eutrophication	Increasing and worsening harmful algal blooms	Water discolouration and foam accumulation, anoxia, contamination of seafood with toxins, disruption of food webs and massive large-scale mortality of marine biota	Reduced ecosystem functioning	Impact on dependent communities		1		
Human Greenhouse Gas Emissions	Coastal eutrophication	Increasing and worsening harmful algal blooms	Water discolouration and foam accumulation, anoxia, contamination of seafood with toxins, disruption of food webs and massive large-scale mortality of marine biota	Reduced ecosystem functioning	Reduced top predators	1			
Human Greenhouse Gas Emissions	Coastal eutrophication	Increasing and worsening harmful algal blooms	Water discolouration and foam accumulation, anoxia, contamination of seafood with toxins, disruption of food webs and massive large-scale mortality of marine biota	Reduced food Safety	Health insecurity		1		
Human Greenhouse Gas Emissions	Enhanced stratification	Loss of seagrass meadows and saltmarshes	Biodiversity loss	Erosion of indigenous culture and knowledge	Loss of human well-being		1		
Human Greenhouse Gas Emissions	Enhanced stratification	Loss of seagrass meadows and saltmarshes	Biodiversity loss	Reduced aesthetic aspects, reduced marine recreational activities,	Loss of human well-being		1		
Human Greenhouse Gas Emissions	Enhanced stratification	Loss of seagrass meadows and saltmarshes	Biodiversity loss	Reduced aesthetic aspects, reduced marine recreational activities,	Reduced tourism			1	
Human Greenhouse Gas Emissions	Enhanced stratification	Loss of seagrass meadows and saltmarshes	Biodiversity loss	Reduced food security	Food insecurity		1	1	
Human Greenhouse Gas Emissions	Enhanced stratification	Loss of seagrass meadows and saltmarshes	Biodiversity loss	Reduced food security	Loss of human well-being		1		
Human Greenhouse Gas Emissions	Enhanced stratification	Loss of seagrass meadows and saltmarshes	Changes in coastal ecosystem	Erosion of indigenous culture and knowledge	Loss of human well-being		1		

Human Greenhouse Gas Emissions	Enhanced stratification	Loss of seagrass meadows and saltmarshes	Changes in coastal ecosystem	Reduced aesthetic aspects, reduced marine recreational activities,	Loss of human well-being		1		
Human Greenhouse Gas Emissions	Enhanced stratification	Loss of seagrass meadows and saltmarshes	Changes in coastal ecosystem	Reduced aesthetic aspects, reduced marine recreational activities,	Reduced tourism			1	
Human Greenhouse Gas Emissions	Enhanced stratification	Loss of seagrass meadows and saltmarshes	Changes in coastal ecosystem	Reduced food security	Food insecurity		1	1	
Human Greenhouse Gas Emissions	Enhanced stratification	Loss of seagrass meadows and saltmarshes	Changes in coastal ecosystem	Reduced food security	Loss of human well-being		1		
Human Greenhouse Gas Emissions	Enhanced stratification	Loss of seagrass meadows and saltmarshes	Reduced functioning of coastal ecosystems	Erosion of indigenous culture and knowledge	Loss of human well-being		1		
Human Greenhouse Gas Emissions	Enhanced stratification	Loss of seagrass meadows and saltmarshes	Reduced functioning of coastal ecosystems	Reduced aesthetic aspects, reduced marine recreational activities,	Loss of human well-being		1		
Human Greenhouse Gas Emissions	Enhanced stratification	Loss of seagrass meadows and saltmarshes	Reduced functioning of coastal ecosystems	Reduced aesthetic aspects, reduced marine recreational activities,	Reduced tourism			1	
Human Greenhouse Gas Emissions	Enhanced stratification	Loss of seagrass meadows and saltmarshes	Reduced functioning of coastal ecosystems	Reduced food security	Food insecurity		1	1	
Human Greenhouse Gas Emissions	Enhanced stratification	Loss of seagrass meadows and saltmarshes	Reduced functioning of coastal ecosystems	Reduced food security	Loss of human well-being		1		
Human Greenhouse Gas Emissions	Enhanced stratification	Unstable habitat-forming cold-water corals	Biodiversity loss	Erosion of indigenous culture and knowledge	Loss of human well-being		1		
Human Greenhouse Gas Emissions	Enhanced stratification	Unstable habitat-forming cold-water corals	Biodiversity loss	Reduced aesthetic aspects, reduced marine recreational activities,	Loss of human well-being		1		
Human Greenhouse Gas Emissions	Enhanced stratification	Unstable habitat-forming cold-water corals	Biodiversity loss	Reduced aesthetic aspects, reduced marine recreational activities,	Reduced tourism			1	
Human Greenhouse Gas Emissions	Enhanced stratification	Unstable habitat-forming cold-water corals	Biodiversity loss	Reduced food security	Food insecurity		1	1	
Human Greenhouse Gas Emissions	Enhanced stratification	Unstable habitat-forming cold-water corals	Biodiversity loss	Reduced food security	Loss of human well-being		1		

Human Greenhouse Gas Emissions	Enhanced stratification	Unstable habitat-forming cold-water corals	Biodiversity loss	Reduced production	Reduced livelihood diversification		1	1	
Human Greenhouse Gas Emissions	Extreme heat exposure	Biodiversity Loss	Degraded intertidal rocky shores	Erosion of indigenous culture and knowledge	Loss of human well-being		1		
Human Greenhouse Gas Emissions	Extreme heat exposure	Biodiversity Loss	Degraded intertidal rocky shores	Reduced aesthetic aspects, reduced marine recreational activities,	Loss of human well-being		1		
Human Greenhouse Gas Emissions	Extreme heat exposure	Biodiversity Loss	Degraded intertidal rocky shores	Reduced food security	Loss of human well-being		1		
Human Greenhouse Gas Emissions	Extreme heat exposure	Mangrove die off events	Biodiversity loss	Erosion of indigenous culture and knowledge	Loss of human well-being		1		
Human Greenhouse Gas Emissions	Extreme heat exposure	Mangrove die off events	Biodiversity loss	Reduced aesthetic aspects, reduced marine recreational activities,	Loss of human well-being		1		
Human Greenhouse Gas Emissions	Extreme heat exposure	Mangrove die off events	Biodiversity loss	Reduced aesthetic aspects, reduced marine recreational activities,	Reduced tourism			1	
Human Greenhouse Gas Emissions	Extreme heat exposure	Mangrove die off events	Biodiversity loss	Reduced food security	Food insecurity		1	1	
Human Greenhouse Gas Emissions	Extreme heat exposure	Mangrove die off events	Biodiversity loss	Reduced food security	Loss of human well-being		1		
Human Greenhouse Gas Emissions	Extreme heat exposure	Mangrove die off events	Reduction of provisioning services	Erosion of indigenous culture and knowledge	Loss of human well-being		1		
Human Greenhouse Gas Emissions	Extreme heat exposure	Mangrove die off events	Reduction of provisioning services	Reduced aesthetic aspects, reduced marine recreational activities,	Loss of human well-being		1		
Human Greenhouse Gas Emissions	Extreme heat exposure	Mangrove die off events	Reduction of provisioning services	Reduced aesthetic aspects, reduced marine recreational activities,	Reduced tourism			1	
Human Greenhouse Gas Emissions	Extreme heat exposure	Mangrove die off events	Reduction of provisioning services	Reduced food security	Food insecurity		1	1	
Human Greenhouse Gas Emissions	Extreme heat exposure	Mangrove die off events	Reduction of provisioning services	Reduced food security	Loss of human well-being		1		
Human Greenhouse Gas Emissions	Extreme heat exposure	Reduction in calcareous species	Degraded Intertidal rocky shores	Erosion of indigenous culture and knowledge	Loss of human well-being		1		
Human Greenhouse Gas Emissions	Extreme heat exposure	Reduction in calcareous species	Degraded Intertidal rocky shores	Reduced aesthetic aspects, reduced marine recreational activities,	Loss of human well-being		1		

Human Greenhouse Gas Emissions	Extreme heat exposure	Reduction in calcareous species	Degraded Intertidal rocky shores	Reduced aesthetic aspects, reduced marine recreational activities,	Reduced tourism			1	
Human Greenhouse Gas Emissions	Extreme heat exposure	Reduction in calcareous species	Degraded Intertidal rocky shores	Reduced food security	Food insecurity		1	1	
Human Greenhouse Gas Emissions	Extreme heat exposure	Reduction in calcareous species	Degraded Intertidal rocky shores	Reduced food security	Loss of human well-being		1		
Human Greenhouse Gas Emissions	Extreme heat exposure	Shifting towards algae dominated habitats	Degraded Intertidal rocky shores	Erosion of indigenous culture and knowledge	Loss of human well-being		1		
Human Greenhouse Gas Emissions	Extreme heat exposure	Shifting towards algae dominated habitats	Degraded Intertidal rocky shores	Reduced aesthetic aspects, reduced marine recreational activities,	Loss of human well-being		1		
Human Greenhouse Gas Emissions	Extreme heat exposure	Shifting towards algae dominated habitats	Degraded Intertidal rocky shores	Reduced aesthetic aspects, reduced marine recreational activities,	Reduced tourism			1	
Human Greenhouse Gas Emissions	Extreme heat exposure	Shifting towards algae dominated habitats	Degraded Intertidal rocky shores	Reduced food security	Food insecurity		1	1	
Human Greenhouse Gas Emissions	Extreme heat exposure	Shifting towards algae dominated habitats	Degraded Intertidal rocky shores	Reduced food security	Loss of human well-being		1		
Human Greenhouse Gas Emissions	Extreme weather events	Changes to plankton composition in estuaries	Changes in coastal ecosystem	Erosion of indigenous culture and knowledge	Loss of culture and Identity		1		
Human Greenhouse Gas Emissions	Extreme weather events	Changes to plankton composition in estuaries	Changes in coastal ecosystem	Erosion of indigenous culture and knowledge	Loss of human well-being				
Human Greenhouse Gas Emissions	Extreme weather events	Changes to plankton composition in estuaries	Changes in coastal ecosystem	Reduced aesthetic aspects, reduced marine recreational activities,	Loss of human well-being		1		
Human Greenhouse Gas Emissions	Extreme weather events	Changes to plankton composition in estuaries	Changes in coastal ecosystem	Reduced aesthetic aspects, reduced marine recreational activities,	Reduced tourism			1	
Human Greenhouse Gas Emissions	Extreme weather events	Changes to plankton composition in estuaries	Changes in coastal ecosystem	Reduced food security	Food insecurity		1	1	
Human Greenhouse Gas Emissions	Extreme weather events	Changes to plankton composition in estuaries	Changes in coastal ecosystem	Reduced food security	Loss of human well-being		1		
Human Greenhouse Gas Emissions	Extreme weather events	Coastal erosion	Reduction in sandy beaches	Erosion of indigenous culture and knowledge	Loss of culture and Identity		1		
Human Greenhouse Gas Emissions	Extreme weather events	Coastal erosion	vegetation on sandy beaches is sparser and	Habitat loss	changes in structure and reduced functioning of coastal ecosystems	1			

			has a slower recovery time						
Human Greenhouse Gas Emissions	Extreme weather events	Extreme flooding events	Increased exposure to water borne disease	Increased frequency of vibrio-related disease	Health insecurity		1		
Human Greenhouse Gas Emissions	Extreme weather events	Mangrove die off events	Biodiversity loss	Erosion of indigenous culture and knowledge	Loss of human well-being		1		
Human Greenhouse Gas Emissions	Extreme weather events	Mangrove die off events	Biodiversity loss	Reduced aesthetic aspects, reduced marine recreational activities,	Loss of human well-being		1		
Human Greenhouse Gas Emissions	Extreme weather events	Mangrove die off events	Biodiversity loss	Reduced aesthetic aspects, reduced marine recreational activities,	Reduced tourism			1	
Human Greenhouse Gas Emissions	Extreme weather events	Mangrove die off events	Biodiversity loss	Reduced food security	Food insecurity		1	1	
Human Greenhouse Gas Emissions	Extreme weather events	Mangrove die off events	Biodiversity loss	Reduced food security	Loss of human well-being		1		
Human Greenhouse Gas Emissions	Extreme weather events	Mangrove die off events	Reduction of provisioning services	Erosion of indigenous culture and knowledge	Loss of human well-being		1		
Human Greenhouse Gas Emissions	Extreme weather events	Mangrove die off events	Reduction of provisioning services	Reduced aesthetic aspects, reduced marine recreational activities,	Loss of human well-being		1		
Human Greenhouse Gas Emissions	Extreme weather events	Mangrove die off events	Reduction of provisioning services	Reduced aesthetic aspects, reduced marine recreational activities,	Reduced tourism			1	
Human Greenhouse Gas Emissions	Extreme weather events	Mangrove die off events	Reduction of provisioning services	Reduced food security	Food insecurity		1	1	
Human Greenhouse Gas Emissions	Extreme weather events	Mangrove die off events	Reduction of provisioning services	Reduced food security	Loss of human well-being		1		
Human Greenhouse Gas Emissions	Extreme weather events	Reduced soil accretion	Reduction in sandy beaches	Habitat loss	changes in structure and reduced functioning of coastal ecosystems	1			
Human Greenhouse Gas Emissions	Extreme weather events	Reduced soil accretion	vegetation on sandy beaches is sparser and has a slower recovery time	Habitat loss	changes in structure and reduced functioning of coastal ecosystems	1			
Human Greenhouse Gas Emissions	Extreme weather events	Storm surges	Increased exposure to water borne disease	Increased frequency of vibrio-related disease	Health insecurity		1		

Human Greenhouse Gas Emissions	Extreme weather events	Stressed coastal ecosystems	Reduced global wetland	Biodiversity loss	Reduced productivity	1			
Human Greenhouse Gas Emissions	Extreme weather events	Stressed coastal ecosystems	Reduced global wetland	Habitat loss	changes in structure and reduced functioning of coastal ecosystems	1			
Human Greenhouse Gas Emissions	Extreme weather events	Stressed coastal ecosystems	Reduced global wetland	Habitat loss	Reduced fisheries production			1	
Human Greenhouse Gas Emissions	Increase in extreme sea level events (I.e. extreme waves)	Coastal erosion	Increased turbidity on fringing coral reefs	Reduced sunlight	Reduced photosynthesis and calcification	1			
Human Greenhouse Gas Emissions	Increase in extreme sea level events (I.e. extreme waves)	Coastal erosion	Land loss	Reduced production	Reduced livelihood diversification		1	1	
Human Greenhouse Gas Emissions	Increase in extreme sea level events (I.e. extreme waves)	Coastal erosion	Loss of seagrass	Biodiversity loss	changes in structure and reduced functioning of coastal ecosystems	1			
Human Greenhouse Gas Emissions	Increase in extreme sea level events (I.e. extreme waves)	Coastal erosion	Loss of seagrass	Biodiversity loss	Reduced productivity	1			
Human Greenhouse Gas Emissions	Increase in extreme sea level events (I.e. extreme waves)	Coastal flooding	Loss of seagrass	Biodiversity loss	changes in structure and reduced functioning of coastal ecosystems	1			
Human Greenhouse Gas Emissions	Increase in extreme sea level events (I.e. extreme waves)	Coastal flooding	Loss of seagrass	Biodiversity loss	Reduced productivity	1			
Human Greenhouse Gas Emissions	Increased precipitation	Increased riverine nitrogen loads	Increased eutrophication	Increasing and worsening harmful algal blooms and pathogenic organisms in coastal areas	Economic uncertainty/insecurity		1	1	
Human Greenhouse Gas Emissions	Increased precipitation	Increased riverine nitrogen loads	Increased eutrophication	Increasing and worsening harmful algal blooms and pathogenic organisms in coastal areas	Food insecurity		1	1	
Human Greenhouse Gas Emissions	Increased precipitation	Increased riverine nitrogen loads	Increased eutrophication	Increasing and worsening harmful algal blooms and pathogenic organisms in coastal areas	Health insecurity		1		
Human Greenhouse Gas Emissions	Increased precipitation	Increased riverine nitrogen loads	Increased eutrophication	Increasing and worsening harmful algal blooms and pathogenic organisms in coastal areas	Reduced tourism			1	
Human Greenhouse Gas Emissions	Melting Glaciers	Sea level rise	Coastal habitat contraction	Biodiversity loss	Reduced functioning of coastal ecosystems	1			

Human Greenhouse Gas Emissions	Melting Glaciers	Sea level rise	Coastal habitat contraction	Biodiversity loss	Reduced productivity	1			
Human Greenhouse Gas Emissions	Melting Glaciers	Sea level rise	Coastal habitat contraction	Habitat loss	Reduced fisheries production			1	
Human Greenhouse Gas Emissions	Melting Glaciers	Sea level rise	Coastal habitat contraction	Habitat loss	Reduced functioning of coastal ecosystems	1			
Human Greenhouse Gas Emissions	Melting Glaciers	Sea level rise	Geographical shifting of coastal species	Erosion of indigenous culture and knowledge	Loss of culture and Identity		1		
Human Greenhouse Gas Emissions	Melting Glaciers	Sea level rise	Geographical shifting of coastal species	Inland shits in plant species distributions	Economic uncertainty/insecurity		1	1	
Human Greenhouse Gas Emissions	Melting Glaciers	Sea level rise	Geographical shifting of coastal species	Inland shits in plant species distributions	Food insecurity		1	1	
Human Greenhouse Gas Emissions	Melting Glaciers	Sea level rise	Geographical shifting of coastal species	Inland shits in plant species distributions	Loss of culture and Identity		1		
Human Greenhouse Gas Emissions	Melting Glaciers	Sea level rise	Geographical shifting of coastal species	Reduced aesthetic aspects, reduced marine recreational activities,	Loss of culture and Identity		1		
Human Greenhouse Gas Emissions	Melting Glaciers	Sea level rise	Geographical shifting of coastal species	Reduced food security	Loss of culture and Identity		1		
Human Greenhouse Gas Emissions	Melting Glaciers	Sea level rise	Geographical shifting of coastal species	Shifts in Species composition, abundance and biomass production of ecosystems	Economic uncertainty/insecurity		1	1	
Human Greenhouse Gas Emissions	Melting Glaciers	Sea level rise	Geographical shifting of coastal species	Shifts in Species composition, abundance and biomass production of ecosystems	Food insecurity		1	1	
Human Greenhouse Gas Emissions	Melting Glaciers	Sea level rise	Geographical shifting of coastal species	Shifts in Species composition, abundance and biomass production of ecosystems	Loss of culture and Identity		1		
Human Greenhouse Gas Emissions	Melting Glaciers	Sea level rise	Geographical shifting of coastal species	Shifts poleward in distribution of seagrass meadows and kelp forests	Economic uncertainty/insecurity		1	1	
Human Greenhouse Gas Emissions	Melting Glaciers	Sea level rise	Geographical shifting of coastal species	Shifts poleward in distribution of seagrass meadows and kelp forests	Food insecurity		1	1	
Human Greenhouse Gas Emissions	Melting Glaciers	Sea level rise	Geographical shifting of coastal species	Shifts poleward in distribution of seagrass meadows and kelp forests	Loss of culture and Identity		1		

Human Greenhouse Gas Emissions	Melting Glaciers	Sea level rise	Increased higher extreme sea levels associated with tropical cyclones	Exacerbated costal hazards	Damage and loss of coastal properties and their value		1	1	
Human Greenhouse Gas Emissions	Melting Glaciers	Sea level rise	Increased higher extreme sea levels associated with tropical cyclones	Increasing intensity of multiple extreme events	Damage and loss of coastal properties and their value		1	1	
Human Greenhouse Gas Emissions	Melting Glaciers	Sea level rise	Increased turbidity on fringing coral reefs	Reduced sunlight	Reduced photosynthesis and calcification	1			
Human Greenhouse Gas Emissions	Melting Glaciers	Sea level rise	More frequent extreme sea level events	Increased vulnerability of coastal communities (including indigenous peoples)	Economic uncertainty/insecurity		1	1	
Human Greenhouse Gas Emissions	Melting Glaciers	Sea level rise	More frequent extreme sea level events	Increased vulnerability of coastal communities (including indigenous peoples)	Food insecurity		1	1	
Human Greenhouse Gas Emissions	Melting Glaciers	Sea level rise	More frequent extreme sea level events	Increased vulnerability of coastal communities (including indigenous peoples)	Health insecurity		1		
Human Greenhouse Gas Emissions	Melting Glaciers	Sea level rise	More frequent extreme sea level events	Increased vulnerability of coastal communities (including indigenous peoples)	Increase in non-communicable diseases		1		
Human Greenhouse Gas Emissions	Melting Glaciers	Sea level rise	More frequent extreme sea level events	Increased vulnerability of coastal communities (including indigenous peoples)	Loss of culture and Identity		1		
Human Greenhouse Gas Emissions	Melting Glaciers	Sea level rise	More frequent extreme sea level events	Increased vulnerability of coastal communities (including indigenous peoples)	Reduced tourism			1	
Human Greenhouse Gas Emissions	Melting Glaciers	Sea level rise	More frequent extreme sea level events	Increasing intensity of multiple extreme events	Damage and loss of coastal properties and their value		1	1	
Human Greenhouse Gas Emissions	Melting Glaciers	Sea level rise	Sea water intrusion in estuaries	Habitat loss	changes in structure and reduced functioning of coastal ecosystems	1			
Human Greenhouse Gas Emissions	Melting Ice Sheets	Sea level rise	Increased turbidity on fringing coral reefs	Reduced sunlight	Reduced photosynthesis and calcification	1			
Human Greenhouse Gas Emissions	Melting Ice Sheets	Sea level rise	More frequent extreme sea level events	Increased vulnerability of coastal communities (including indigenous peoples)	Economic uncertainty/insecurity		1	1	
Human Greenhouse Gas Emissions	Melting Ice Sheets	Sea level rise	More frequent extreme sea level events	Increased vulnerability of coastal communities	Food insecurity		1	1	

				(including indigenous peoples)					
Human Greenhouse Gas Emissions	Melting Ice Sheets	Sea level rise	More frequent extreme sea level events	Increased vulnerability of coastal communities (including indigenous peoples)	Health insecurity		1		
Human Greenhouse Gas Emissions	Melting Ice Sheets	Sea level rise	More frequent extreme sea level events	Increased vulnerability of coastal communities (including indigenous peoples)	Increase in non-communicable diseases		1		
Human Greenhouse Gas Emissions	Melting Ice Sheets	Sea level rise	More frequent extreme sea level events	Increased vulnerability of coastal communities (including indigenous peoples)	Loss of culture and Identity		1		
Human Greenhouse Gas Emissions	Melting Ice Sheets	Sea level rise	More frequent extreme sea level events	Increased vulnerability of coastal communities (including indigenous peoples)	Reduced tourism			1	
Human Greenhouse Gas Emissions	Melting Ice Sheets	Sea level rise	More frequent extreme sea level events	Increasing intensity of multiple extreme events	Damage and loss of coastal properties and their value		1	1	
Human Greenhouse Gas Emissions	Nutrient fluctuations in upwelling areas	Increasing and worsening harmful algal blooms	Water discolouration and foam accumulation, anoxia, contamination of seafood with toxins, disruption of food webs and massive large-scale mortality of marine biota	Reduced ecosystem functioning	Impact on dependent communities		1		
Human Greenhouse Gas Emissions	Nutrient fluctuations in upwelling areas	Increasing and worsening harmful algal blooms	Water discolouration and foam accumulation, anoxia, contamination of seafood with toxins, disruption of food webs and massive large-scale mortality of marine biota	Reduced ecosystem functioning	Reduced top predators	1			
Human Greenhouse Gas Emissions	Nutrient fluctuations in upwelling areas	Increasing and worsening harmful algal blooms	Water discolouration and foam accumulation, anoxia, contamination of seafood with toxins, disruption of food webs and massive large-scale mortality of marine biota	Reduced food Safety	Health insecurity		1		
Human Greenhouse Gas Emissions	Ocean Acidification	Biodiversity Loss	Degraded intertidal rocky shores	Erosion of indigenous culture and knowledge	Loss of human well-being		1		
Human Greenhouse Gas Emissions	Ocean Acidification	Biodiversity Loss	Degraded intertidal rocky shores	Reduced aesthetic aspects, reduced marine recreational activities,	Loss of human well-being		1		

Human Greenhouse Gas Emissions	Ocean Acidification	Biodiversity Loss	Degraded intertidal rocky shores	Reduced aesthetic aspects, reduced marine recreational activities,	Reduced tourism			1	
Human Greenhouse Gas Emissions	Ocean Acidification	Biodiversity Loss	Degraded intertidal rocky shores	Reduced food security	Food insecurity		1	1	
Human Greenhouse Gas Emissions	Ocean Acidification	Biodiversity Loss	Degraded intertidal rocky shores	Reduced food security	Loss of human well-being		1		
Human Greenhouse Gas Emissions	Ocean Acidification	Biodiversity Loss	simplification of rocky shore ecosystems	Erosion of indigenous culture and knowledge	Loss of human well-being				
Human Greenhouse Gas Emissions	Ocean Acidification	Biodiversity Loss	simplification of rocky shore ecosystems	Reduced access to traditional food	Loss of culture and Identity		1		
Human Greenhouse Gas Emissions	Ocean Acidification	Biodiversity Loss	simplification of rocky shore ecosystems	Reduced access to traditional food	Loss of human well-being		1		
Human Greenhouse Gas Emissions	Ocean Acidification	Biodiversity Loss	simplification of rocky shore ecosystems	Reduced aesthetic aspects, reduced marine recreational activities,	Loss of culture and Identity		1		
Human Greenhouse Gas Emissions	Ocean Acidification	Biodiversity Loss	simplification of rocky shore ecosystems	Reduced aesthetic aspects, reduced marine recreational activities,	Loss of human well-being		1		
Human Greenhouse Gas Emissions	Ocean Acidification	Biodiversity Loss	simplification of rocky shore ecosystems	Reduced aesthetic aspects, reduced marine recreational activities,	Reduced tourism			1	
Human Greenhouse Gas Emissions	Ocean Acidification	Biodiversity Loss	simplification of rocky shore ecosystems	Reduced food security	Food insecurity		1	1	
Human Greenhouse Gas Emissions	Ocean Acidification	Biodiversity Loss	simplification of rocky shore ecosystems	Reduced food security	Loss of human well-being		1		
Human Greenhouse Gas Emissions	Ocean Acidification	Coral reef degradation	Changes in community composition	Reduced food security	Food insecurity		1	1	
Human Greenhouse Gas Emissions	Ocean Acidification	Declining stocks of fish and shellfish	Reduced fisheries catches	Challenges to international and national ocean and fisheries governance	Increased risk of potential conflicts between fishery users, communities and authorities		1	1	1
Human Greenhouse Gas Emissions	Ocean Acidification	Declining stocks of fish and shellfish	Reduced fisheries catches	Challenges to international and national ocean and fisheries governance	Ocean governance becomes ineffective			1	1
Human Greenhouse Gas Emissions	Ocean Acidification	Declining stocks of fish and shellfish	Reduced fisheries catches	Increased vulnerability of coastal communities (including indigenous peoples)	Economic uncertainty/insecurity		1	1	

Human Greenhouse Gas Emissions	Ocean Acidification	Declining stocks of fish and shellfish	Reduced fisheries catches	Increased vulnerability of coastal communities (including indigenous peoples)	Food insecurity		1	1	
Human Greenhouse Gas Emissions	Ocean Acidification	Declining stocks of fish and shellfish	Reduced fisheries catches	Increased vulnerability of coastal communities (including indigenous peoples)	Food insecurity		1	1	
Human Greenhouse Gas Emissions	Ocean Acidification	Declining stocks of fish and shellfish	Reduced fisheries catches	Increased vulnerability of coastal communities (including indigenous peoples)	Health insecurity		1		
Human Greenhouse Gas Emissions	Ocean Acidification	Declining stocks of fish and shellfish	Reduced fisheries catches	Increased vulnerability of coastal communities (including indigenous peoples)	Increase in non-communicable diseases		1		
Human Greenhouse Gas Emissions	Ocean Acidification	Declining stocks of fish and shellfish	Reduced fisheries catches	Increased vulnerability of coastal communities (including indigenous peoples)	Loss of culture and Identity		1		
Human Greenhouse Gas Emissions	Ocean Acidification	Declining stocks of fish and shellfish	Reduced fisheries catches	Increased vulnerability of coastal communities (including indigenous peoples)	Reduced tourism			1	
Human Greenhouse Gas Emissions	Ocean Acidification	Decreasing calcification	simplification of rocky shore ecosystems	Erosion of indigenous culture and knowledge	Loss of human well-being				
Human Greenhouse Gas Emissions	Ocean Acidification	Decreasing calcification	simplification of rocky shore ecosystems	Reduced access to traditional food	Loss of culture and Identity		1		
Human Greenhouse Gas Emissions	Ocean Acidification	Decreasing calcification	simplification of rocky shore ecosystems	Reduced access to traditional food	Loss of human well-being		1		
Human Greenhouse Gas Emissions	Ocean Acidification	Decreasing calcification	simplification of rocky shore ecosystems	Reduced aesthetic aspects, reduced marine recreational activities,	Loss of culture and Identity		1		
Human Greenhouse Gas Emissions	Ocean Acidification	Decreasing calcification	simplification of rocky shore ecosystems	Reduced aesthetic aspects, reduced marine recreational activities,	Loss of human well-being		1		
Human Greenhouse Gas Emissions	Ocean Acidification	Decreasing calcification	simplification of rocky shore ecosystems	Reduced aesthetic aspects, reduced marine recreational activities,	Reduced tourism			1	
Human Greenhouse Gas Emissions	Ocean Acidification	Decreasing calcification	simplification of rocky shore ecosystems	Reduced food security	Food insecurity		1	1	
Human Greenhouse Gas Emissions	Ocean Acidification	Decreasing calcification	simplification of rocky shore ecosystems	Reduced food security	Loss of human well-being		1		

Human Greenhouse Gas Emissions	Ocean Acidification	Enhanced reef dissolution and bioerosion	affecting coral species distribution (pg. 497)	Changes in community composition	Reduced tourism			1	
Human Greenhouse Gas Emissions	Ocean Acidification	Overgrowth of macroalgae	simplification of rocky shore ecosystems	Erosion of indigenous culture and knowledge	Loss of human well-being				
Human Greenhouse Gas Emissions	Ocean Acidification	Overgrowth of macroalgae	simplification of rocky shore ecosystems	Reduced access to traditional food	Loss of culture and Identity		1		
Human Greenhouse Gas Emissions	Ocean Acidification	Overgrowth of macroalgae	simplification of rocky shore ecosystems	Reduced access to traditional food	Loss of human well-being		1		
Human Greenhouse Gas Emissions	Ocean Acidification	Overgrowth of macroalgae	simplification of rocky shore ecosystems	Reduced aesthetic aspects, reduced marine recreational activities,	Loss of culture and Identity		1		
Human Greenhouse Gas Emissions	Ocean Acidification	Overgrowth of macroalgae	simplification of rocky shore ecosystems	Reduced aesthetic aspects, reduced marine recreational activities,	Loss of human well-being		1		
Human Greenhouse Gas Emissions	Ocean Acidification	Overgrowth of macroalgae	simplification of rocky shore ecosystems	Reduced aesthetic aspects, reduced marine recreational activities,	Reduced tourism			1	
Human Greenhouse Gas Emissions	Ocean Acidification	Overgrowth of macroalgae	simplification of rocky shore ecosystems	Reduced food security	Food insecurity		1	1	
Human Greenhouse Gas Emissions	Ocean Acidification	Overgrowth of macroalgae	simplification of rocky shore ecosystems	Reduced food security	Loss of human well-being		1		
Human Greenhouse Gas Emissions	Ocean Acidification	Reduction in calcareous species	Degraded Intertidal rocky shores	Erosion of indigenous culture and knowledge	Loss of human well-being		1		
Human Greenhouse Gas Emissions	Ocean Acidification	Reduction in calcareous species	Degraded Intertidal rocky shores	Reduced aesthetic aspects, reduced marine recreational activities,	Loss of human well-being		1		
Human Greenhouse Gas Emissions	Ocean Acidification	Reduction in calcareous species	Degraded Intertidal rocky shores	Reduced aesthetic aspects, reduced marine recreational activities,	Reduced tourism			1	
Human Greenhouse Gas Emissions	Ocean Acidification	Reduction in calcareous species	Degraded Intertidal rocky shores	Reduced food security	Food insecurity		1	1	
Human Greenhouse Gas Emissions	Ocean Acidification	Reduction in calcareous species	Degraded Intertidal rocky shores	Reduced food security	Loss of human well-being		1		
Human Greenhouse Gas Emissions	Ocean Acidification	Reduction in fish stocks	Risk of population decline	Erosion of indigenous culture and knowledge	Loss of human well-being				
Human Greenhouse Gas Emissions	Ocean Acidification	Reduction in fish stocks	Risk of population decline	Reduced access to traditional food	Loss of culture and Identity		1		

Human Greenhouse Gas Emissions	Ocean Acidification	Reduction in fish stocks	Risk of population decline	Reduced access to traditional food	Loss of human well-being		1		
Human Greenhouse Gas Emissions	Ocean Acidification	Reduction in fish stocks	Risk of population decline	Reduced aesthetic aspects, reduced marine recreational activities,	Loss of culture and Identity		1		
Human Greenhouse Gas Emissions	Ocean Acidification	Reduction in fish stocks	Risk of population decline	Reduced aesthetic aspects, reduced marine recreational activities,	Loss of human well-being		1		
Human Greenhouse Gas Emissions	Ocean Acidification	Reduction in fish stocks	Risk of population decline	Reduced aesthetic aspects, reduced marine recreational activities,	Reduced tourism			1	
Human Greenhouse Gas Emissions	Ocean Acidification	Reduction in fish stocks	Risk of population decline	Reduced food security	Food insecurity		1	1	
Human Greenhouse Gas Emissions	Ocean Acidification	Reduction in fish stocks	Risk of population decline	Reduced food security	Loss of human well-being		1		
Human Greenhouse Gas Emissions	Ocean Acidification	Reduction in fish stocks	Risk of population decline	Reduction in livelihoods	Loss of human well-being		1		
Human Greenhouse Gas Emissions	Ocean Acidification	Shifting towards algae dominated habitats	Degraded Intertidal rocky shores	Erosion of indigenous culture and knowledge	Loss of human well-being		1		
Human Greenhouse Gas Emissions	Ocean Acidification	Shifting towards algae dominated habitats	Degraded Intertidal rocky shores	Reduced aesthetic aspects, reduced marine recreational activities,	Loss of human well-being		1		
Human Greenhouse Gas Emissions	Ocean Acidification	Shifting towards algae dominated habitats	Degraded Intertidal rocky shores	Reduced aesthetic aspects, reduced marine recreational activities,	Reduced tourism			1	
Human Greenhouse Gas Emissions	Ocean Acidification	Shifting towards algae dominated habitats	Degraded Intertidal rocky shores	Reduced food security	Food insecurity		1	1	
Human Greenhouse Gas Emissions	Ocean Acidification	Shifting towards algae dominated habitats	Degraded Intertidal rocky shores	Reduced food security	Loss of human well-being		1		
Human Greenhouse Gas Emissions	Ocean Acidification	Unstable habitat-forming cold-water corals	Biodiversity loss	Erosion of indigenous culture and knowledge	Loss of human well-being		1		
Human Greenhouse Gas Emissions	Ocean Acidification	Unstable habitat-forming cold-water corals	Biodiversity loss	Reduced aesthetic aspects, reduced marine recreational activities,	Loss of human well-being		1		
Human Greenhouse Gas Emissions	Ocean Acidification	Unstable habitat-forming cold-water corals	Biodiversity loss	Reduced aesthetic aspects, reduced marine recreational activities,	Reduced tourism			1	
Human Greenhouse Gas Emissions	Ocean Acidification	Unstable habitat-forming cold-water corals	Biodiversity loss	Reduced food security	Food insecurity		1	1	

Human Greenhouse Gas Emissions	Ocean Acidification	Unstable habitat-forming cold-water corals	Biodiversity loss	Reduced food security	Loss of human well-being		1		
Human Greenhouse Gas Emissions	Ocean Acidification	Unstable habitat-forming cold-water corals	Biodiversity loss	Reduced production	Reduced livelihood diversification		1	1	
Human Greenhouse Gas Emissions	Ocean deoxygenation	Declining stocks of fish and shellfish	Reduced fisheries catches	Challenges to international and national ocean and fisheries governance	Increased risk of potential conflicts between fishery users, communities and authorities		1	1	1
Human Greenhouse Gas Emissions	Ocean deoxygenation	Declining stocks of fish and shellfish	Reduced fisheries catches	Challenges to international and national ocean and fisheries governance	Ocean governance becomes ineffective			1	1
Human Greenhouse Gas Emissions	Ocean deoxygenation	Declining stocks of fish and shellfish	Reduced fisheries catches	Increased vulnerability of coastal communities (including indigenous peoples)	Economic uncertainty/insecurity		1	1	
Human Greenhouse Gas Emissions	Ocean deoxygenation	Declining stocks of fish and shellfish	Reduced fisheries catches	Increased vulnerability of coastal communities (including indigenous peoples)	Food insecurity		1	1	
Human Greenhouse Gas Emissions	Ocean deoxygenation	Declining stocks of fish and shellfish	Reduced fisheries catches	Increased vulnerability of coastal communities (including indigenous peoples)	Food insecurity		1	1	
Human Greenhouse Gas Emissions	Ocean deoxygenation	Declining stocks of fish and shellfish	Reduced fisheries catches	Increased vulnerability of coastal communities (including indigenous peoples)	Health insecurity		1		
Human Greenhouse Gas Emissions	Ocean deoxygenation	Declining stocks of fish and shellfish	Reduced fisheries catches	Increased vulnerability of coastal communities (including indigenous peoples)	Increase in non-communicable diseases		1		
Human Greenhouse Gas Emissions	Ocean deoxygenation	Declining stocks of fish and shellfish	Reduced fisheries catches	Increased vulnerability of coastal communities (including indigenous peoples)	Loss of culture and Identity		1		
Human Greenhouse Gas Emissions	Ocean deoxygenation	Declining stocks of fish and shellfish	Reduced fisheries catches	Increased vulnerability of coastal communities (including indigenous peoples)	Reduced tourism			1	
Human Greenhouse Gas Emissions	Ocean deoxygenation	Decreasing calcification	Coral reef degradation	Biodiversity loss	changes in structure and reduced functioning of coastal ecosystems	1			
Human Greenhouse Gas Emissions	Ocean deoxygenation	Decreasing calcification	Coral reef degradation	Biodiversity loss	Reduced productivity	1			

Human Greenhouse Gas Emissions	Ocean deoxygenation	Enhanced reef dissolution and bioerosion	Reduction of ecosystem services	Erosion of indigenous culture and knowledge	Loss of culture and Identity		1		
Human Greenhouse Gas Emissions	Ocean deoxygenation	Enhanced reef dissolution and bioerosion	Reduction of ecosystem services	Reduced access to traditional food	Loss of culture and Identity		1		
Human Greenhouse Gas Emissions	Ocean deoxygenation	Enhanced reef dissolution and bioerosion	Reduction of ecosystem services	Reduced aesthetic aspects and spiritual appreciation of ecosystems	Loss of culture and Identity		1		
Human Greenhouse Gas Emissions	Ocean deoxygenation	Reduction in fish stocks	Risk of population decline	Erosion of indigenous culture and knowledge	Loss of human well-being				
Human Greenhouse Gas Emissions	Ocean deoxygenation	Reduction in fish stocks	Risk of population decline	Reduced access to traditional food	Loss of culture and Identity		1		
Human Greenhouse Gas Emissions	Ocean deoxygenation	Reduction in fish stocks	Risk of population decline	Reduced access to traditional food	Loss of human well-being		1		
Human Greenhouse Gas Emissions	Ocean deoxygenation	Reduction in fish stocks	Risk of population decline	Reduced aesthetic aspects, reduced marine recreational activities,	Loss of culture and Identity		1		
Human Greenhouse Gas Emissions	Ocean deoxygenation	Reduction in fish stocks	Risk of population decline	Reduced aesthetic aspects, reduced marine recreational activities,	Loss of human well-being		1		
Human Greenhouse Gas Emissions	Ocean deoxygenation	Reduction in fish stocks	Risk of population decline	Reduced aesthetic aspects, reduced marine recreational activities,	Reduced tourism			1	
Human Greenhouse Gas Emissions	Ocean deoxygenation	Reduction in fish stocks	Risk of population decline	Reduced food security	Food insecurity		1	1	
Human Greenhouse Gas Emissions	Ocean deoxygenation	Reduction in fish stocks	Risk of population decline	Reduced food security	Loss of human well-being		1		
Human Greenhouse Gas Emissions	Ocean deoxygenation	Reduction in fish stocks	Risk of population decline	Reduction in livelihoods	Loss of human well-being		1		
Human Greenhouse Gas Emissions	Ocean deoxygenation	Unstable habitat-forming cold-water corals	Biodiversity loss	Erosion of indigenous culture and knowledge	Loss of human well-being		1		
Human Greenhouse Gas Emissions	Ocean deoxygenation	Unstable habitat-forming cold-water corals	Biodiversity loss	Reduced aesthetic aspects, reduced marine recreational activities,	Loss of human well-being		1		
Human Greenhouse Gas Emissions	Ocean deoxygenation	Unstable habitat-forming cold-water corals	Biodiversity loss	Reduced aesthetic aspects, reduced marine recreational activities,	Reduced tourism			1	

Human Greenhouse Gas Emissions	Ocean deoxygenation	Unstable habitat-forming cold-water corals	Biodiversity loss	Reduced food security	Food insecurity			1	
Human Greenhouse Gas Emissions	Ocean deoxygenation	Unstable habitat-forming cold-water corals	Biodiversity loss	Reduced food security	Loss of human well-being		1		
Human Greenhouse Gas Emissions	Ocean deoxygenation	Unstable habitat-forming cold-water corals	Biodiversity loss	Reduced production	Reduced livelihood diversification		1	1	
Human Greenhouse Gas Emissions	Ocean warming	Biodiversity Loss	Degraded intertidal rocky shores	Erosion of indigenous culture and knowledge	Loss of human well-being		1		
Human Greenhouse Gas Emissions	Ocean warming	Biodiversity Loss	Degraded intertidal rocky shores	Reduced aesthetic aspects, reduced marine recreational activities,	Loss of human well-being		1		
Human Greenhouse Gas Emissions	Ocean warming	Biodiversity Loss	Degraded intertidal rocky shores	Reduced food security	Loss of human well-being		1		
Human Greenhouse Gas Emissions	Ocean Warming	Change in intertidal rock shores ecosystems	Biodiversity loss	Erosion of indigenous culture and knowledge	Loss of human well-being		1		
Human Greenhouse Gas Emissions	Ocean Warming	Change in intertidal rock shores ecosystems	Biodiversity loss	Reduced aesthetic aspects, reduced marine recreational activities,	Loss of human well-being		1		
Human Greenhouse Gas Emissions	Ocean Warming	Change in intertidal rock shores ecosystems	Biodiversity loss	Reduced aesthetic aspects, reduced marine recreational activities,	Reduced tourism			1	
Human Greenhouse Gas Emissions	Ocean Warming	Change in intertidal rock shores ecosystems	Biodiversity loss	Reduced food security	Food insecurity		1	1	
Human Greenhouse Gas Emissions	Ocean Warming	Change in intertidal rock shores ecosystems	Biodiversity loss	Reduced food security	Loss of human well-being		1		
Human Greenhouse Gas Emissions	Ocean Warming	Change in intertidal rock shores ecosystems	Loss of sessile calcified organisms	Erosion of indigenous culture and knowledge	Loss of human well-being				
Human Greenhouse Gas Emissions	Ocean Warming	Change in intertidal rock shores ecosystems	Loss of sessile calcified organisms	Reduced access to traditional food	Loss of culture and Identity		1		
Human Greenhouse Gas Emissions	Ocean Warming	Change in intertidal rock shores ecosystems	Loss of sessile calcified organisms	Reduced access to traditional food	Loss of human well-being		1		
Human Greenhouse Gas Emissions	Ocean Warming	Change in intertidal rock shores ecosystems	Loss of sessile calcified organisms	Reduced aesthetic aspects, reduced marine recreational activities,	Loss of culture and Identity		1		
Human Greenhouse Gas Emissions	Ocean Warming	Change in intertidal rock shores ecosystems	Loss of sessile calcified organisms	Reduced aesthetic aspects, reduced marine recreational activities,	Loss of human well-being		1		

Human Greenhouse Gas Emissions	Ocean Warming	Change in intertidal rock shores ecosystems	Loss of sessile calcified organisms	Reduced aesthetic aspects, reduced marine recreational activities,	Reduced tourism			1	
Human Greenhouse Gas Emissions	Ocean Warming	Change in intertidal rock shores ecosystems	Loss of sessile calcified organisms	Reduced food security	Food insecurity		1	1	
Human Greenhouse Gas Emissions	Ocean Warming	Change in intertidal rock shores ecosystems	Loss of sessile calcified organisms	Reduced food security	Loss of human well-being		1		
Human Greenhouse Gas Emissions	Ocean Warming	Changes in net primary production	Reduced marine animal biomass	Reduced income, livelihood and food security	Economic uncertainty/insecurity		1	1	
Human Greenhouse Gas Emissions	Ocean Warming	Changes in net primary production	Reduced marine animal biomass	Reduced income, livelihood and food security	Food insecurity		1	1	
Human Greenhouse Gas Emissions	Ocean Warming	Changes in net primary production	Reduction in fish stocks	Challenges to international and national ocean and fisheries governance	Increased risk of potential conflicts between fishery users, communities and authorities		1	1	1
Human Greenhouse Gas Emissions	Ocean Warming	Changes in net primary production	Reduction in fish stocks	Challenges to international and national ocean and fisheries governance	Ocean governance becomes ineffective			1	1
Human Greenhouse Gas Emissions	Ocean Warming	Changes in net primary production	Reduction in fish stocks	Erosion of indigenous culture and knowledge	Loss of human well-being				
Human Greenhouse Gas Emissions	Ocean Warming	Changes in net primary production	Reduction in fish stocks	Increased vulnerability of coastal communities (including indigenous peoples)	Economic uncertainty/insecurity		1	1	
Human Greenhouse Gas Emissions	Ocean Warming	Changes in net primary production	Reduction in fish stocks	Increased vulnerability of coastal communities (including indigenous peoples)	Food insecurity		1	1	
Human Greenhouse Gas Emissions	Ocean Warming	Changes in net primary production	Reduction in fish stocks	Increased vulnerability of coastal communities (including indigenous peoples)	Health insecurity		1		
Human Greenhouse Gas Emissions	Ocean Warming	Changes in net primary production	Reduction in fish stocks	Increased vulnerability of coastal communities (including indigenous peoples)	Increase in non-communicable diseases		1		
Human Greenhouse Gas Emissions	Ocean Warming	Changes in net primary production	Reduction in fish stocks	Increased vulnerability of coastal communities (including indigenous peoples)	Loss of culture and Identity		1		
Human Greenhouse Gas Emissions	Ocean Warming	Changes in net primary production	Reduction in fish stocks	Increased vulnerability of coastal communities	Reduced tourism			1	

				(including indigenous peoples)					
Human Greenhouse Gas Emissions	Ocean Warming	Changes in net primary production	Reduction in fish stocks	Potential change in jurisdictions	Increased risk of potential conflicts between fishery users, communities and authorities		1	1	1
Human Greenhouse Gas Emissions	Ocean Warming	Changes in net primary production	Reduction in fish stocks	Reduced access to traditional food	Loss of culture and Identity		1		
Human Greenhouse Gas Emissions	Ocean Warming	Changes in net primary production	Reduction in fish stocks	Reduced access to traditional food	Loss of human well-being		1		
Human Greenhouse Gas Emissions	Ocean Warming	Changes in net primary production	Reduction in fish stocks	Reduced aesthetic aspects, reduced marine recreational activities,	Loss of culture and Identity		1		
Human Greenhouse Gas Emissions	Ocean Warming	Changes in net primary production	Reduction in fish stocks	Reduced aesthetic aspects, reduced marine recreational activities,	Loss of human well-being		1		
Human Greenhouse Gas Emissions	Ocean Warming	Changes in net primary production	Reduction in fish stocks	Reduced aesthetic aspects, reduced marine recreational activities,	Reduced tourism			1	
Human Greenhouse Gas Emissions	Ocean Warming	Changes in net primary production	Reduction in fish stocks	Reduced food security	Food insecurity		1	1	
Human Greenhouse Gas Emissions	Ocean Warming	Changes in net primary production	Reduction in fish stocks	Reduced food security	Food insecurity		1	1	
Human Greenhouse Gas Emissions	Ocean Warming	Changes in net primary production	Reduction in fish stocks	Reduced food security	Health insecurity		1		
Human Greenhouse Gas Emissions	Ocean Warming	Changes in net primary production	Reduction in fish stocks	Reduced food security	Loss of human well-being		1		
Human Greenhouse Gas Emissions	Ocean Warming	Changes in net primary production	Reduction in fish stocks	Reduced income, livelihood and food security	Economic uncertainty/insecurity		1	1	
Human Greenhouse Gas Emissions	Ocean Warming	Changes in net primary production	Reduction in fish stocks	Reduced income, livelihood and food security	Food insecurity		1	1	
Human Greenhouse Gas Emissions	Ocean Warming	Changes in net primary production	Reduction in fish stocks	Shifting the biogeography of fishes and invertebrates stocks	Economic uncertainty/insecurity		1	1	
Human Greenhouse Gas Emissions	Ocean Warming	Changes in net primary production	Reduction in fish stocks	Shifting the biogeography of fishes and invertebrates stocks	Food insecurity		1	1	

Human Greenhouse Gas Emissions	Ocean Warming	Changes in net primary production	Reduction in fish stocks	Shifting the biogeography of fishes and invertebrates stocks	Loss of culture and Identity		1		
Human Greenhouse Gas Emissions	Ocean Warming	Changing fisheries distribution	Challenges to fisheries economic value	Challenges to international and national ocean and fisheries governance	Increased risk of potential conflicts between fishery users, communities and authorities		1	1	1
Human Greenhouse Gas Emissions	Ocean Warming	Changing fisheries distribution	Challenges to fisheries economic value	Challenges to international and national ocean and fisheries governance	Ocean governance becomes ineffective			1	1
Human Greenhouse Gas Emissions	Ocean Warming	Changing fisheries distribution	Challenges to fisheries management	Challenges to international and national ocean and fisheries governance	Increased risk of potential conflicts between fishery users, communities and authorities		1	1	1
Human Greenhouse Gas Emissions	Ocean Warming	Changing fisheries distribution	Challenges to fisheries management	Challenges to international and national ocean and fisheries governance	Ocean governance becomes ineffective			1	1
Human Greenhouse Gas Emissions	Ocean Warming	Changing fisheries distribution	Changing distribution or abundance of harvested species	Erosion of indigenous culture and knowledge	Loss of culture and Identity		1		
Human Greenhouse Gas Emissions	Ocean Warming	Changing fisheries distribution	Changing distribution or abundance of harvested species	Erosion of indigenous culture and knowledge	Loss of human well-being		1		
Human Greenhouse Gas Emissions	Ocean Warming	Changing fisheries distribution	Changing distribution or abundance of harvested species	Reduced aesthetic aspects, reduced marine recreational activities,	Loss of culture and Identity		1		
Human Greenhouse Gas Emissions	Ocean Warming	Changing fisheries distribution	Changing distribution or abundance of harvested species	Reduced aesthetic aspects, reduced marine recreational activities,	Loss of human well-being		1		
Human Greenhouse Gas Emissions	Ocean Warming	Changing fisheries distribution	Changing distribution or abundance of harvested species	Reduced aesthetic aspects, reduced marine recreational activities,	Reduced tourism			1	
Human Greenhouse Gas Emissions	Ocean Warming	Changing fisheries distribution	Changing distribution or abundance of harvested species	Reduced food security	Food insecurity		1	1	
Human Greenhouse Gas Emissions	Ocean Warming	Changing fisheries distribution	Changing distribution or abundance of harvested species	Reduced food security	Loss of culture and Identity		1		
Human Greenhouse Gas Emissions	Ocean Warming	Changing fisheries distribution	Diminished access to fishing or hunting areas	Erosion of indigenous culture and knowledge	Loss of human well-being		1		
Human Greenhouse Gas Emissions	Ocean Warming	Changing fisheries distribution	Diminished access to fishing or hunting areas	Reduced aesthetic aspects, reduced marine recreational activities,	Loss of human well-being		1		
Human Greenhouse Gas Emissions	Ocean Warming	Changing fisheries distribution	Diminished access to fishing or hunting areas	Reduced aesthetic aspects, reduced marine recreational activities,	Reduced tourism			1	

Human Greenhouse Gas Emissions	Ocean Warming	Changing fisheries distribution	Diminished access to fishing or hunting areas	Reduced food security	Loss of human well-being		1		
Human Greenhouse Gas Emissions	Ocean Warming	Coral bleaching	Coral reef degradation	Habitat loss	changes in structure and reduced functioning of coastal ecosystems	1			
Human Greenhouse Gas Emissions	Ocean Warming	Coral bleaching	Coral reef degradation	Habitat loss	Reduced fisheries production			1	
Human Greenhouse Gas Emissions	Ocean Warming	Coral bleaching	Reduction in calcifying organisms	Erosion of indigenous culture and knowledge	Loss of human well-being				
Human Greenhouse Gas Emissions	Ocean Warming	Coral bleaching	Reduction in calcifying organisms	Reduced access to traditional food	Loss of culture and Identity		1		
Human Greenhouse Gas Emissions	Ocean Warming	Coral bleaching	Reduction in calcifying organisms	Reduced access to traditional food	Loss of human well-being		1		
Human Greenhouse Gas Emissions	Ocean Warming	Coral bleaching	Reduction in calcifying organisms	Reduced aesthetic aspects, reduced marine recreational activities,	Loss of culture and Identity		1		
Human Greenhouse Gas Emissions	Ocean Warming	Coral bleaching	Reduction in calcifying organisms	Reduced aesthetic aspects, reduced marine recreational activities,	Loss of human well-being		1		
Human Greenhouse Gas Emissions	Ocean Warming	Coral bleaching	Reduction in calcifying organisms	Reduced aesthetic aspects, reduced marine recreational activities,	Reduced tourism			1	
Human Greenhouse Gas Emissions	Ocean Warming	Coral bleaching	Reduction in calcifying organisms	Reduced food security	Food insecurity		1	1	
Human Greenhouse Gas Emissions	Ocean Warming	Coral bleaching	Reduction in calcifying organisms	Reduced food security	Loss of human well-being		1		
Human Greenhouse Gas Emissions	Ocean Warming	Declining stocks of fish and shellfish	Reduced fisheries catches	Challenges to international and national ocean and fisheries governance	Increased risk of potential conflicts between fishery users, communities and authorities		1	1	1

Human Greenhouse Gas Emissions	Ocean Warming	Declining stocks of fish and shellfish	Reduced fisheries catches	Challenges to international and national ocean and fisheries governance	Ocean governance becomes ineffective			1	1
Human Greenhouse Gas Emissions	Ocean Warming	Declining stocks of fish and shellfish	Reduced fisheries catches	Increased vulnerability of coastal communities (including indigenous peoples)	Economic uncertainty/insecurity		1	1	
Human Greenhouse Gas Emissions	Ocean Warming	Declining stocks of fish and shellfish	Reduced fisheries catches	Increased vulnerability of coastal communities (including indigenous peoples)	Food insecurity		1	1	
Human Greenhouse Gas Emissions	Ocean Warming	Declining stocks of fish and shellfish	Reduced fisheries catches	Increased vulnerability of coastal communities (including indigenous peoples)	Health insecurity		1		
Human Greenhouse Gas Emissions	Ocean Warming	Declining stocks of fish and shellfish	Reduced fisheries catches	Increased vulnerability of coastal communities (including indigenous peoples)	Increase in non-communicable diseases		1		
Human Greenhouse Gas Emissions	Ocean Warming	Declining stocks of fish and shellfish	Reduced fisheries catches	Increased vulnerability of coastal communities (including indigenous peoples)	Loss of culture and Identity		1		
Human Greenhouse Gas Emissions	Ocean Warming	Declining stocks of fish and shellfish	Reduced fisheries catches	Increased vulnerability of coastal communities (including indigenous peoples)	Reduced tourism			1	
Human Greenhouse Gas Emissions	Ocean Warming	Declining stocks of fish and shellfish	Shifting fisheries	Challenges to international and national ocean and fisheries governance	Increased risk of potential conflicts between fishery users, communities and authorities		1	1	1
Human Greenhouse Gas Emissions	Ocean Warming	Declining stocks of fish and shellfish	Shifting fisheries	Challenges to international and national ocean and fisheries governance	Ocean governance becomes ineffective			1	1
Human Greenhouse Gas Emissions	Ocean Warming	Declining stocks of fish and shellfish	Shifting fisheries	Increased vulnerability of coastal communities (including indigenous peoples)	Economic uncertainty/insecurity		1	1	
Human Greenhouse Gas Emissions	Ocean Warming	Declining stocks of fish and shellfish	Shifting fisheries	Increased vulnerability of coastal communities (including indigenous peoples)	Food insecurity		1	1	
Human Greenhouse Gas Emissions	Ocean Warming	Declining stocks of fish and shellfish	Shifting fisheries	Increased vulnerability of coastal communities (including indigenous peoples)	Health insecurity		1		

Human Greenhouse Gas Emissions	Ocean Warming	Declining stocks of fish and shellfish	Shifting fisheries	Increased vulnerability of coastal communities (including indigenous peoples)	Increase in non-communicable diseases		1		
Human Greenhouse Gas Emissions	Ocean Warming	Declining stocks of fish and shellfish	Shifting fisheries	Increased vulnerability of coastal communities (including indigenous peoples)	Loss of culture and Identity		1		
Human Greenhouse Gas Emissions	Ocean Warming	Declining stocks of fish and shellfish	Shifting fisheries	Increased vulnerability of coastal communities (including indigenous peoples)	Reduced tourism			1	
Human Greenhouse Gas Emissions	Ocean Warming	Decreasing calcification	Coral reef degradation	Biodiversity loss	changes in structure and reduced functioning of coastal ecosystems	1			
Human Greenhouse Gas Emissions	Ocean Warming	Decreasing calcification	Coral reef degradation	Biodiversity loss	Reduced productivity	1			
Human Greenhouse Gas Emissions	Ocean Warming	Enhanced reef dissolution and bioerosion	Changing coral species distribution	Changes in community composition	Reduced tourism			1	
Human Greenhouse Gas Emissions	Ocean Warming	Enhanced reef dissolution and bioerosion	Reduction of ecosystem services	Erosion of indigenous culture and knowledge	Loss of culture and Identity		1		
Human Greenhouse Gas Emissions	Ocean Warming	Enhanced reef dissolution and bioerosion	Reduction of ecosystem services	Reduced access to traditional food	Loss of culture and Identity		1		
Human Greenhouse Gas Emissions	Ocean Warming	Enhanced reef dissolution and bioerosion	Reduction of ecosystem services	Reduced aesthetic aspects and spiritual appreciation of ecosystems	Loss of culture and Identity		1		
Human Greenhouse Gas Emissions	Ocean Warming	Enhanced reef dissolution and bioerosion	Reduction of ecosystem services	Reduced aesthetic aspects and spiritual appreciation of ecosystems	Reduced tourism			1	
Human Greenhouse Gas Emissions	Ocean Warming	Enhanced reef dissolution and bioerosion	Reduction of ecosystem services	Reduced marine recreational activities	Loss of culture and Identity		1		
Human Greenhouse Gas Emissions	Ocean Warming	Enhanced stratification	Reduced nutrient supply	Reduced net primary production in tropical oceans	Reduced export production (non-polar regions)			1	
Human Greenhouse Gas Emissions	Ocean Warming	Enhanced stratification in estuaries	Increased risk of hypoxia	Increased coastal acidification	increased risk for sensitive organisms	1			
Human Greenhouse Gas Emissions	Ocean Warming	Heatstressed Coral reefs	Changes in coastal ecosystem	Erosion of indigenous culture and knowledge	Loss of human well-being		1		

Human Greenhouse Gas Emissions	Ocean Warming	Heatstressed Coral reefs	Changes in coastal ecosystem	Reduced aesthetic aspects, reduced marine recreational activities,	Loss of human well-being		1		
Human Greenhouse Gas Emissions	Ocean Warming	Heatstressed Coral reefs	Changes in coastal ecosystem	Reduced aesthetic aspects, reduced marine recreational activities,	Reduced tourism			1	
Human Greenhouse Gas Emissions	Ocean Warming	Heatstressed Coral reefs	Changes in coastal ecosystem	Reduced food security	Food insecurity		1	1	
Human Greenhouse Gas Emissions	Ocean Warming	Heatstressed Coral reefs	Changes in coastal ecosystem	Reduced food security	Loss of human well-being		1		
Human Greenhouse Gas Emissions	Ocean Warming	Heatstressed salt marshes	Biodiversity loss	Erosion of indigenous culture and knowledge	Loss of human well-being		1		
Human Greenhouse Gas Emissions	Ocean Warming	Heatstressed salt marshes	Biodiversity loss	Erosion of indigenous culture and knowledge	Loss of human well-being		1		
Human Greenhouse Gas Emissions	Ocean Warming	Heatstressed salt marshes	Biodiversity loss	Reduced aesthetic aspects, reduced marine recreational activities,	Loss of human well-being		1		
Human Greenhouse Gas Emissions	Ocean Warming	Heatstressed salt marshes	Biodiversity loss	Reduced aesthetic aspects, reduced marine recreational activities,	Reduced tourism			1	
Human Greenhouse Gas Emissions	Ocean Warming	Heatstressed salt marshes	Biodiversity loss	Reduced food security	Food insecurity		1	1	
Human Greenhouse Gas Emissions	Ocean Warming	Heatstressed salt marshes	Biodiversity loss	Reduced food security	Loss of human well-being		1		
Human Greenhouse Gas Emissions	Ocean Warming	Heatstressed salt marshes	Changes in coastal ecosystem	Erosion of indigenous culture and knowledge	Loss of human well-being		1		
Human Greenhouse Gas Emissions	Ocean Warming	Heatstressed salt marshes	Changes in coastal ecosystem	Reduced aesthetic aspects, reduced marine recreational activities,	Loss of human well-being		1		
Human Greenhouse Gas Emissions	Ocean Warming	Heatstressed salt marshes	Changes in coastal ecosystem	Reduced aesthetic aspects, reduced marine recreational activities,	Reduced tourism			1	
Human Greenhouse Gas Emissions	Ocean Warming	Heatstressed salt marshes	Changes in coastal ecosystem	Reduced food security	Food insecurity		1	1	
Human Greenhouse Gas Emissions	Ocean Warming	Heatstressed salt marshes	Changes in coastal ecosystem	Reduced food security	Loss of human well-being		1		
Human Greenhouse Gas Emissions	Ocean Warming	Heatstressed salt marshes	reduced functioning of coastal ecosystems	Erosion of indigenous culture and knowledge	Loss of human well-being				

Human Greenhouse Gas Emissions	Ocean Warming	Heatstressed salt marshes	reduced functioning of coastal ecosystems	Reduced access to traditional food	Loss of culture and Identity		1		
Human Greenhouse Gas Emissions	Ocean Warming	Heatstressed salt marshes	reduced functioning of coastal ecosystems	Reduced access to traditional food	Loss of human well-being		1		
Human Greenhouse Gas Emissions	Ocean Warming	Heatstressed salt marshes	reduced functioning of coastal ecosystems	Reduced aesthetic aspects, reduced marine recreational activities,	Loss of culture and Identity		1		
Human Greenhouse Gas Emissions	Ocean Warming	Heatstressed salt marshes	reduced functioning of coastal ecosystems	Reduced aesthetic aspects, reduced marine recreational activities,	Loss of human well-being		1		
Human Greenhouse Gas Emissions	Ocean Warming	Heatstressed salt marshes	reduced functioning of coastal ecosystems	Reduced aesthetic aspects, reduced marine recreational activities,	Reduced tourism			1	
Human Greenhouse Gas Emissions	Ocean Warming	Heatstressed salt marshes	reduced functioning of coastal ecosystems	Reduced food security	Food insecurity		1	1	
Human Greenhouse Gas Emissions	Ocean Warming	Heatstressed salt marshes	reduced functioning of coastal ecosystems	Reduced food security	Loss of human well-being		1		
Human Greenhouse Gas Emissions	Ocean Warming	Heatstressed seagrass meadows and kelp forests	Biodiversity loss	Erosion of indigenous culture and knowledge	Loss of human well-being		1		
Human Greenhouse Gas Emissions	Ocean Warming	Heatstressed seagrass meadows and kelp forests	Biodiversity loss	Reduced aesthetic aspects, reduced marine recreational activities,	Loss of human well-being		1		
Human Greenhouse Gas Emissions	Ocean Warming	Heatstressed seagrass meadows and kelp forests	Biodiversity loss	Reduced aesthetic aspects, reduced marine recreational activities,	Reduced tourism			1	
Human Greenhouse Gas Emissions	Ocean Warming	Heatstressed seagrass meadows and kelp forests	Biodiversity loss	Reduced food security	Food insecurity		1	1	
Human Greenhouse Gas Emissions	Ocean Warming	Heatstressed seagrass meadows and kelp forests	Biodiversity loss	Reduced food security	Loss of human well-being		1		
Human Greenhouse Gas Emissions	Ocean Warming	Heatstressed seagrass meadows and kelp forests	Changes in coastal ecosystem	Erosion of indigenous culture and knowledge	Loss of human well-being		1		
Human Greenhouse Gas Emissions	Ocean Warming	Heatstressed seagrass meadows and kelp forests	Changes in coastal ecosystem	Reduced aesthetic aspects, reduced marine recreational activities,	Loss of human well-being		1		
Human Greenhouse Gas Emissions	Ocean Warming	Heatstressed seagrass meadows and kelp forests	Changes in coastal ecosystem	Reduced aesthetic aspects, reduced marine recreational activities,	Reduced tourism			1	
Human Greenhouse Gas Emissions	Ocean Warming	Heatstressed seagrass meadows and kelp forests	Changes in coastal ecosystem	Reduced food security	Food insecurity			1	

Human Greenhouse Gas Emissions	Ocean Warming	Heatstressed seagrass meadows and kelp forests	Changes in coastal ecosystem	Reduced food security	Loss of human well-being		1		
Human Greenhouse Gas Emissions	Ocean Warming	Increase in marine heatwaves	Contraction of distribution of seagrass meadows and kelp forests	Biodiversity loss	Reduced functioning of coastal ecosystems	1			
Human Greenhouse Gas Emissions	Ocean Warming	Increase in marine heatwaves	Contraction of distribution of seagrass meadows and kelp forests	Biodiversity loss	Reduced productivity	1			
Human Greenhouse Gas Emissions	Ocean Warming	Increasing and worsening harmful algal blooms	Water discolouration and foam accumulation, anoxia, contamination of seafood with toxins, disruption of food webs and massive large-scale mortality of marine biota	Reduced ecosystem functioning	Impact on dependent communities		1		
Human Greenhouse Gas Emissions	Ocean Warming	Increasing and worsening harmful algal blooms	Water discolouration and foam accumulation, anoxia, contamination of seafood with toxins, disruption of food webs and massive large-scale mortality of marine biota	Reduced ecosystem functioning	Reduced top predators	1			
Human Greenhouse Gas Emissions	Ocean Warming	Increasing and worsening harmful algal blooms	Water discolouration and foam accumulation, anoxia, contamination of seafood with toxins, disruption of food webs and massive large-scale mortality of marine biota	Reduced food Safety	Health insecurity		1		
Human Greenhouse Gas Emissions	Ocean Warming	Increasing mass mortality events for Kelp Forest	Contraction of distribution of seagrass meadows and kelp forests	Biodiversity loss	Reduced functioning of coastal ecosystems	1			
Human Greenhouse Gas Emissions	Ocean Warming	Increasing mass mortality events for Kelp Forest	Contraction of distribution of seagrass meadows and kelp forests	Biodiversity loss	Reduced productivity	1			
Human Greenhouse Gas Emissions	Ocean Warming	Loss of mangroves	Habitat loss	Biodiversity loss	changes in structure and reduced functioning of coastal ecosystems	1			
Human Greenhouse Gas Emissions	Ocean Warming	Loss of mangroves	Habitat loss	Biodiversity loss	Reduced productivity	1			
Human Greenhouse Gas Emissions	Ocean Warming	Loss of seagrass meadows and saltmarshes	Biodiversity loss	Erosion of indigenous culture and knowledge	Loss of human well-being		1		
Human Greenhouse Gas Emissions	Ocean Warming	Loss of seagrass meadows and saltmarshes	Biodiversity loss	Reduced aesthetic aspects, reduced marine recreational activities,	Loss of human well-being		1		

Human Greenhouse Gas Emissions	Ocean Warming	Loss of seagrass meadows and saltmarshes	Biodiversity loss	Reduced aesthetic aspects, reduced marine recreational activities,	Reduced tourism			1	
Human Greenhouse Gas Emissions	Ocean Warming	Loss of seagrass meadows and saltmarshes	Biodiversity loss	Reduced aesthetic aspects, reduced marine recreational activities,	Reduced tourism			1	
Human Greenhouse Gas Emissions	Ocean Warming	Loss of seagrass meadows and saltmarshes	Biodiversity loss	Reduced food security	Food insecurity		1	1	
Human Greenhouse Gas Emissions	Ocean Warming	Loss of seagrass meadows and saltmarshes	Biodiversity loss	Reduced food security	Loss of human well-being		1		
Human Greenhouse Gas Emissions	Ocean Warming	Loss of seagrass meadows and saltmarshes	Changes in coastal ecosystem	Erosion of indigenous culture and knowledge	Loss of human well-being		1		
Human Greenhouse Gas Emissions	Ocean Warming	Loss of seagrass meadows and saltmarshes	Changes in coastal ecosystem	Reduced aesthetic aspects, reduced marine recreational activities,	Loss of human well-being		1		
Human Greenhouse Gas Emissions	Ocean Warming	Loss of seagrass meadows and saltmarshes	Changes in coastal ecosystem	Reduced aesthetic aspects, reduced marine recreational activities,	Reduced tourism			1	
Human Greenhouse Gas Emissions	Ocean Warming	Loss of seagrass meadows and saltmarshes	Changes in coastal ecosystem	Reduced food security	Food insecurity		1	1	
Human Greenhouse Gas Emissions	Ocean Warming	Loss of seagrass meadows and saltmarshes	Changes in coastal ecosystem	Reduced food security	Loss of human well-being		1		
Human Greenhouse Gas Emissions	Ocean Warming	Mangrove encroachment onto subtropical salt marshes	Biodiversity loss	Erosion of indigenous culture and knowledge	Loss of human well-being		1		
Human Greenhouse Gas Emissions	Ocean Warming	Mangrove encroachment onto subtropical salt marshes	Biodiversity loss	Reduced aesthetic aspects, reduced marine recreational activities,	Loss of human well-being		1		
Human Greenhouse Gas Emissions	Ocean Warming	Mangrove encroachment onto subtropical salt marshes	Biodiversity loss	Reduced aesthetic aspects, reduced marine recreational activities,	Reduced tourism			1	
Human Greenhouse Gas Emissions	Ocean Warming	Mangrove encroachment onto subtropical salt marshes	Biodiversity loss	Reduced food security	Food insecurity		1	1	
Human Greenhouse Gas Emissions	Ocean Warming	Mangrove encroachment onto subtropical salt marshes	Biodiversity loss	Reduced food security	Loss of human well-being		1		
Human Greenhouse Gas Emissions	Ocean Warming	Mangrove encroachment onto subtropical salt marshes	Changes in coastal ecosystem	Erosion of indigenous culture and knowledge	Loss of human well-being		1		
Human Greenhouse Gas Emissions	Ocean Warming	Mangrove encroachment onto subtropical salt marshes	Changes in coastal ecosystem	Reduced aesthetic aspects, reduced marine recreational activities,	Loss of human well-being		1		

Human Greenhouse Gas Emissions	Ocean Warming	Mangrove encroachment onto subtropical salt marshes	Changes in coastal ecosystem	Reduced aesthetic aspects, reduced marine recreational activities,	Reduced tourism			1	
Human Greenhouse Gas Emissions	Ocean Warming	Mangrove encroachment onto subtropical salt marshes	Changes in coastal ecosystem	Reduced food security	Food insecurity		1	1	
Human Greenhouse Gas Emissions	Ocean Warming	Mangrove encroachment onto subtropical salt marshes	Changes in coastal ecosystem	Reduced food security	Loss of human well-being		1		
Human Greenhouse Gas Emissions	Ocean Warming	Mangrove forests are at temperature related risk	Biodiversity loss	Erosion of indigenous culture and knowledge	Loss of human well-being		1		
Human Greenhouse Gas Emissions	Ocean Warming	Mangrove forests are at temperature related risk	Biodiversity loss	Reduced aesthetic aspects, reduced marine recreational activities,	Loss of human well-being		1		
Human Greenhouse Gas Emissions	Ocean Warming	Mangrove forests are at temperature related risk	Biodiversity loss	Reduced aesthetic aspects, reduced marine recreational activities,	Reduced tourism			1	
Human Greenhouse Gas Emissions	Ocean Warming	Mangrove forests are at temperature related risk	Biodiversity loss	Reduced food security	Food insecurity		1	1	
Human Greenhouse Gas Emissions	Ocean Warming	Mangrove forests are at temperature related risk	Biodiversity loss	Reduced food security	Loss of human well-being		1		
Human Greenhouse Gas Emissions	Ocean Warming	Ocean stratification	Reduced nutrient supply	Reduced net primary production	Reduced export production (non-polar regions)			1	
Human Greenhouse Gas Emissions	Ocean Warming	Reduced seagrass growth and increased susceptibility to disease	Biodiversity loss	Erosion of indigenous culture and knowledge	Loss of human well-being		1		
Human Greenhouse Gas Emissions	Ocean Warming	Reduced seagrass growth and increased susceptibility to disease	Biodiversity loss	Reduced aesthetic aspects, reduced marine recreational activities,	Loss of human well-being		1		
Human Greenhouse Gas Emissions	Ocean Warming	Reduced seagrass growth and increased susceptibility to disease	Biodiversity loss	Reduced aesthetic aspects, reduced marine recreational activities,	Reduced tourism			1	
Human Greenhouse Gas Emissions	Ocean Warming	Reduced seagrass growth and increased susceptibility to disease	Biodiversity loss	Reduced food security	Food insecurity			1	
Human Greenhouse Gas Emissions	Ocean Warming	Reduced seagrass growth and increased susceptibility to disease	Biodiversity loss	Reduced food security	Loss of human well-being		1		
Human Greenhouse Gas Emissions	Ocean Warming	Reduced seagrass growth and increased susceptibility to disease	Changes in coastal ecosystem	Erosion of indigenous culture and knowledge	Loss of human well-being		1		
Human Greenhouse Gas Emissions	Ocean Warming	Reduced seagrass growth and increased susceptibility to disease	Changes in coastal ecosystem	Erosion of indigenous culture and knowledge	Loss of human well-being				

Human Greenhouse Gas Emissions	Ocean Warming	Reduced seagrass growth and increased susceptibility to disease	Changes in coastal ecosystem	Reduced aesthetic aspects, reduced marine recreational activities,	Reduced tourism				
Human Greenhouse Gas Emissions	Ocean Warming	Reduced seagrass growth and increased susceptibility to disease	Changes in coastal ecosystem	Reduced food security	Food insecurity			1	
Human Greenhouse Gas Emissions	Ocean Warming	Reduced seagrass growth and increased susceptibility to disease	Changes in coastal ecosystem	Reduced food security	Loss of human well-being				
Human Greenhouse Gas Emissions	Ocean Warming	Reduced seagrass growth and increased susceptibility to disease	Loss of seagrass	Biodiversity loss	changes in structure and reduced functioning of coastal ecosystems	1			
Human Greenhouse Gas Emissions	Ocean Warming	Reduced seagrass growth and increased susceptibility to disease	Loss of seagrass	Biodiversity loss	Reduced productivity	1			
Human Greenhouse Gas Emissions	Ocean warming	Reduction in calcareous species	Degraded Intertidal rocky shores	Erosion of indigenous culture and knowledge	Loss of human well-being		1		
Human Greenhouse Gas Emissions	Ocean warming	Reduction in calcareous species	Degraded Intertidal rocky shores	Reduced aesthetic aspects, reduced marine recreational activities,	Loss of human well-being		1		
Human Greenhouse Gas Emissions	Ocean warming	Reduction in calcareous species	Degraded Intertidal rocky shores	Reduced aesthetic aspects, reduced marine recreational activities,	Reduced tourism			1	
Human Greenhouse Gas Emissions	Ocean warming	Reduction in calcareous species	Degraded Intertidal rocky shores	Reduced food security	Food insecurity		1	1	
Human Greenhouse Gas Emissions	Ocean warming	Reduction in calcareous species	Degraded Intertidal rocky shores	Reduced food security	Loss of human well-being		1		
Human Greenhouse Gas Emissions	Ocean Warming	Reduction in coastal wetland	Reduced habitat, biodiversity, and ecosystem services	Erosion of indigenous culture and knowledge	Loss of culture and Identity		1		
Human Greenhouse Gas Emissions	Ocean Warming	Reduction in coastal wetland	Reduced habitat, biodiversity, and ecosystem services	Reduced access to traditional food	Loss of culture and Identity		1		
Human Greenhouse Gas Emissions	Ocean Warming	Reduction in coastal wetland	Reduced habitat, biodiversity, and ecosystem services	Reduced aesthetic aspects and spiritual appreciation of ecosystems	Loss of culture and Identity		1		
Human Greenhouse Gas Emissions	Ocean Warming	Reduction in coastal wetland	Reduced habitat, biodiversity, and ecosystem services	Reduced aesthetic aspects and spiritual appreciation of ecosystems	Reduced tourism			1	
Human Greenhouse Gas Emissions	Ocean Warming	Reduction in coastal wetland	Reduced habitat, biodiversity, and ecosystem services	Reduced marine recreational activities	Loss of culture and Identity		1		

Human Greenhouse Gas Emissions	Ocean Warming	Reduction in deep seafloor biomass	Biodiversity loss	Erosion of indigenous culture and knowledge	Loss of human well-being		1		
Human Greenhouse Gas Emissions	Ocean Warming	Reduction in deep seafloor biomass	Biodiversity loss	Reduced aesthetic aspects, reduced marine recreational activities,	Loss of human well-being		1		
Human Greenhouse Gas Emissions	Ocean Warming	Reduction in deep seafloor biomass	Biodiversity loss	Reduced aesthetic aspects, reduced marine recreational activities,	Reduced tourism			1	
Human Greenhouse Gas Emissions	Ocean Warming	Reduction in deep seafloor biomass	Biodiversity loss	Reduced food security	Food insecurity		1	1	
Human Greenhouse Gas Emissions	Ocean Warming	Reduction in deep seafloor biomass	Biodiversity loss	Reduced food security	Loss of human well-being		1		
Human Greenhouse Gas Emissions	Ocean Warming	Reduction in deep seafloor biomass	Biodiversity loss	Reduced functioning of the deep water column and seafloor	reduced ecosystem services i.e. carbon sequestration	1			
Human Greenhouse Gas Emissions	Ocean Warming	Reduction in fish stocks	Risk of population decline	Erosion of indigenous culture and knowledge	Loss of human well-being				
Human Greenhouse Gas Emissions	Ocean Warming	Reduction in fish stocks	Risk of population decline	Reduced access to traditional food	Loss of culture and Identity		1		
Human Greenhouse Gas Emissions	Ocean Warming	Reduction in fish stocks	Risk of population decline	Reduced access to traditional food	Loss of human well-being		1		
Human Greenhouse Gas Emissions	Ocean Warming	Reduction in fish stocks	Risk of population decline	Reduced aesthetic aspects, reduced marine recreational activities,	Loss of culture and Identity		1		
Human Greenhouse Gas Emissions	Ocean Warming	Reduction in fish stocks	Risk of population decline	Reduced aesthetic aspects, reduced marine recreational activities,	Loss of human well-being		1		
Human Greenhouse Gas Emissions	Ocean Warming	Reduction in fish stocks	Risk of population decline	Reduced aesthetic aspects, reduced marine recreational activities,	Reduced tourism			1	
Human Greenhouse Gas Emissions	Ocean Warming	Reduction in fish stocks	Risk of population decline	Reduced food security	Food insecurity		1	1	
Human Greenhouse Gas Emissions	Ocean Warming	Reduction in fish stocks	Risk of population decline	Reduced food security	Loss of human well-being		1		
Human Greenhouse Gas Emissions	Ocean Warming	Reduction in fish stocks	Risk of population decline	Reduction in livelihoods	Loss of human well-being		1		

Human Greenhouse Gas Emissions	Ocean Warming	Reduction in marine animal biomass	Reduction in marine animal biomass	Reduced food security	Economic uncertainty/insecurity		1	1	
Human Greenhouse Gas Emissions	Ocean Warming	Reduction in marine animal biomass	Reduction in marine animal biomass	Reduced income and livelihood and food security	Economic uncertainty/insecurity		1	1	
Human Greenhouse Gas Emissions	Ocean Warming	Shift in geographical range of marine species	Reduction in fish stocks	Increased vulnerability of coastal communities (including indigenous peoples)	Economic uncertainty/insecurity		1	1	
Human Greenhouse Gas Emissions	Ocean Warming	Shift in geographical range of marine species	Reduction in fish stocks	Increased vulnerability of coastal communities (including indigenous peoples)	Food insecurity		1	1	
Human Greenhouse Gas Emissions	Ocean Warming	Shift in geographical range of marine species	Reduction in fish stocks	Increased vulnerability of coastal communities (including indigenous peoples)	Health insecurity		1		
Human Greenhouse Gas Emissions	Ocean Warming	Shift in geographical range of marine species	Reduction in fish stocks	Increased vulnerability of coastal communities (including indigenous peoples)	Increase in non-communicable diseases		1		
Human Greenhouse Gas Emissions	Ocean Warming	Shift in geographical range of marine species	Reduction in fish stocks	Increased vulnerability of coastal communities (including indigenous peoples)	Loss of culture and Identity		1		
Human Greenhouse Gas Emissions	Ocean Warming	Shift in geographical range of marine species	Reduction in fish stocks	Increased vulnerability of coastal communities (including indigenous peoples)	Reduced tourism			1	
Human Greenhouse Gas Emissions	Ocean Warming	Shift in geographical range of marine species	Shifting fisheries	Challenges to international and national ocean and fisheries governance	Increased risk of potential conflicts between fishery users, communities and authorities		1	1	1
Human Greenhouse Gas Emissions	Ocean Warming	Shift in geographical range of marine species	Shifting fisheries	Challenges to international and national ocean and fisheries governance	Ocean governance becomes ineffective			1	1
Human Greenhouse Gas Emissions	Ocean warming	Shifting towards algae dominated habitats	Degraded Intertidal rocky shores	Erosion of indigenous culture and knowledge	Loss of human well-being		1		
Human Greenhouse Gas Emissions	Ocean warming	Shifting towards algae dominated habitats	Degraded Intertidal rocky shores	Reduced aesthetic aspects, reduced marine recreational activities,	Loss of human well-being		1		
Human Greenhouse Gas Emissions	Ocean warming	Shifting towards algae dominated habitats	Degraded Intertidal rocky shores	Reduced aesthetic aspects, reduced marine recreational activities,	Reduced tourism			1	

Human Greenhouse Gas Emissions	Ocean warming	Shifting towards algae dominated habitats	Degraded Intertidal rocky shores	Reduced food security	Loss of human well-being		1		
Human Greenhouse Gas Emissions	Ocean Warming	Stressed coastal ecosystems	Contraction of distribution of seagrass meadows and kelp forests	Biodiversity loss	Reduced functioning of coastal ecosystems	1			
Human Greenhouse Gas Emissions	Ocean Warming	Stressed coastal ecosystems	Contraction of distribution of seagrass meadows and kelp forests	Biodiversity loss	Reduced productivity	1			
Human Greenhouse Gas Emissions	Ocean Warming	Stressed coastal ecosystems	Reduced global wetland	Biodiversity loss	changes in structure and reduced functioning of coastal ecosystems	1			
Human Greenhouse Gas Emissions	Ocean Warming	Stressed coastal ecosystems	Reduced global wetland	Biodiversity loss	Reduced productivity	1			
Human Greenhouse Gas Emissions	Ocean Warming	Stressed coastal ecosystems	Reduced global wetland	Habitat loss	changes in structure and reduced functioning of coastal ecosystems	1			
Human Greenhouse Gas Emissions	Ocean Warming	Stressed coastal ecosystems	Reduced global wetland	Habitat loss	Reduced fisheries production			1	
Human Greenhouse Gas Emissions	Ocean Warming	Unstable habitat-forming cold-water corals	Biodiversity loss	Erosion of indigenous culture and knowledge	Loss of human well-being		1		
Human Greenhouse Gas Emissions	Ocean Warming	Unstable habitat-forming cold-water corals	Biodiversity loss	Reduced aesthetic aspects, reduced marine recreational activities,	Loss of human well-being		1		
Human Greenhouse Gas Emissions	Ocean Warming	Unstable habitat-forming cold-water corals	Biodiversity loss	Reduced aesthetic aspects, reduced marine recreational activities,	Reduced tourism			1	
Human Greenhouse Gas Emissions	Ocean Warming	Unstable habitat-forming cold-water corals	Biodiversity loss	Reduced food security	Food insecurity		1	1	
Human Greenhouse Gas Emissions	Ocean Warming	Unstable habitat-forming cold-water corals	Biodiversity loss	Reduced food security	Loss of human well-being		1		
Human Greenhouse Gas Emissions	Ocean Warming	Unstable habitat-forming cold-water corals	Biodiversity loss	Reduced production	Reduced livelihood diversification		1	1	
Human Greenhouse Gas Emissions	Ocean Warming	Warmer estuaries	Changes in coastal ecosystem	Erosion of indigenous culture and knowledge	Loss of culture and Identity		1		
Human Greenhouse Gas Emissions	Ocean Warming	Warmer estuaries	Changes in coastal ecosystem	Reduced access to traditional food	Loss of culture and Identity		1		
Human Greenhouse Gas Emissions	Ocean Warming	Warmer estuaries	Changes in coastal ecosystem	Reduced aesthetic aspects and spiritual	Loss of culture and Identity		1		

				appreciation of ecosystems					
Human Greenhouse Gas Emissions	Ocean Warming	Warmer estuaries	Changes in coastal ecosystem	Reduced aesthetic aspects and spiritual appreciation of ecosystems	Reduced tourism				
Human Greenhouse Gas Emissions	Ocean Warming	Warmer estuaries	Changes in coastal ecosystem	Reduced marine recreational activities	Loss of culture and Identity		1		
Human Greenhouse Gas Emissions	Reduced net primary production	Enhanced stratification	Reduced nutrient supply	Reduced net primary production in tropical oceans	Reduced export production (non-polar regions)			1	
Human Greenhouse Gas Emissions	Sea level rise	Changing sea-scape	Changing mobility and residence patterns (of people)	Erosion of indigenous culture and knowledge	Loss of culture and Identity		1		
Human Greenhouse Gas Emissions	Sea level rise	Coastal erosion	Increased turbidity on fringing coral reefs	Reduced sunlight	Reduced photosynthesis and calcification	1			
Human Greenhouse Gas Emissions	Sea level rise	Coastal erosion	Land loss	Reduced production	Reduced livelihood diversification		1	1	
Human Greenhouse Gas Emissions	Sea level rise	Coastal erosion	Loss of seagrass	Biodiversity loss	changes in structure and reduced functioning of coastal ecosystems	1			
Human Greenhouse Gas Emissions	Sea level rise	Coastal erosion	Loss of seagrass	Biodiversity loss	Reduced productivity	1			
Human Greenhouse Gas Emissions	Sea level rise	Coastal erosion	Reduction in sandy beaches	Habitat loss	changes in structure and reduced functioning of coastal ecosystems	1			
Human Greenhouse Gas Emissions	Sea level rise	Coastal erosion	vegetation on sandy beaches is sparser and has a slower recovery time	Habitat loss	changes in structure and reduced functioning of coastal ecosystems	1			
Human Greenhouse Gas Emissions	Sea level rise	Extreme flooding events	Loss of seagrass	Biodiversity loss	changes in structure and reduced functioning of coastal ecosystems	1			
Human Greenhouse Gas Emissions	Sea level rise	Extreme flooding events	Loss of seagrass	Biodiversity loss	Reduced productivity	1			
Human Greenhouse Gas Emissions	Sea level rise	Extreme flooding events	salinisation of soils, ground and surface water	Degraded ground water quality	Water insecurity	1	1	1	

Human Greenhouse Gas Emissions	Sea level rise	Extreme flooding events	salinisation of soils, ground and surface water	Habitat loss	Loss of freshwater fish species	1		1	
Human Greenhouse Gas Emissions	Sea level rise	Extreme flooding events	salinisation of soils, ground and surface water	Inland shits in plant species distributions	Economic uncertainty/insecurity		1	1	
Human Greenhouse Gas Emissions	Sea level rise	Extreme flooding events	salinisation of soils, ground and surface water	Inland shits in plant species distributions	Food insecurity		1	1	
Human Greenhouse Gas Emissions	Sea level rise	Extreme flooding events	salinisation of soils, ground and surface water	Inland shits in plant species distributions	Loss of culture and Identity		1		
Human Greenhouse Gas Emissions	Sea level rise	Inundation of salt marshes	Increase in salinity-tolerant species	Biodiversity loss	changes in structure and reduced functioning of coastal ecosystems	1			
Human Greenhouse Gas Emissions	Sea level rise	Inundation of salt marshes	Increase in salinity-tolerant species	Biodiversity loss	Reduced productivity	1			
Human Greenhouse Gas Emissions	Sea level rise	Inundation of salt marshes	Poleward shifts in plant species	Increasing and worsening harmful algal blooms and pathogenic organisms in estuaries	Economic uncertainty/insecurity		1	1	
Human Greenhouse Gas Emissions	Sea level rise	Inundation of salt marshes	Poleward shifts in plant species	Increasing and worsening harmful algal blooms and pathogenic organisms in estuaries	Food insecurity		1	1	
Human Greenhouse Gas Emissions	Sea level rise	Inundation of salt marshes	Poleward shifts in plant species	Increasing and worsening harmful algal blooms and pathogenic organisms in estuaries	Health insecurity		1		
Human Greenhouse Gas Emissions	Sea level rise	Inundation of salt marshes	Poleward shifts in plant species	Increasing and worsening harmful algal blooms and pathogenic organisms in estuaries	Reduced tourism			1	
Human Greenhouse Gas Emissions	Sea level rise	Loss of seagrass meadows and saltmarshes	Biodiversity loss	Erosion of indigenous culture and knowledge	Loss of human well-being		1		
Human Greenhouse Gas Emissions	Sea level rise	Loss of seagrass meadows and saltmarshes	Biodiversity loss	Reduced aesthetic aspects, reduced marine recreational activities,	Loss of human well-being		1		
Human Greenhouse Gas Emissions	Sea level rise	Loss of seagrass meadows and saltmarshes	Biodiversity loss	Reduced aesthetic aspects, reduced marine recreational activities,	Reduced tourism			1	
Human Greenhouse Gas Emissions	Sea level rise	Loss of seagrass meadows and saltmarshes	Biodiversity loss	Reduced food security	Food insecurity		1	1	

Human Greenhouse Gas Emissions	Sea level rise	Loss of seagrass meadows and saltmarshes	Biodiversity loss	Reduced food security	Loss of human well-being		1		
Human Greenhouse Gas Emissions	Sea level rise	Loss of seagrass meadows and saltmarshes	Changes in coastal ecosystem	Erosion of indigenous culture and knowledge	Loss of human well-being		1		
Human Greenhouse Gas Emissions	Sea level rise	Loss of seagrass meadows and saltmarshes	Changes in coastal ecosystem	Reduced aesthetic aspects, reduced marine recreational activities,	Loss of human well-being		1		
Human Greenhouse Gas Emissions	Sea level rise	Loss of seagrass meadows and saltmarshes	Changes in coastal ecosystem	Reduced aesthetic aspects, reduced marine recreational activities,	Reduced tourism			1	
Human Greenhouse Gas Emissions	Sea level rise	Loss of seagrass meadows and saltmarshes	Changes in coastal ecosystem	Reduced food security	Food insecurity		1	1	
Human Greenhouse Gas Emissions	Sea level rise	Loss of seagrass meadows and saltmarshes	Changes in coastal ecosystem	Reduced food security	Loss of human well-being		1		
Human Greenhouse Gas Emissions	Sea level rise	Loss of seagrass meadows and saltmarshes	reduced functioning of coastal ecosystems	Erosion of indigenous culture and knowledge	Loss of human well-being				
Human Greenhouse Gas Emissions	Sea level rise	Loss of seagrass meadows and saltmarshes	reduced functioning of coastal ecosystems	Reduced access to traditional food	Loss of culture and Identity		1		
Human Greenhouse Gas Emissions	Sea level rise	Loss of seagrass meadows and saltmarshes	reduced functioning of coastal ecosystems	Reduced access to traditional food	Loss of human well-being		1		
Human Greenhouse Gas Emissions	Sea level rise	Loss of seagrass meadows and saltmarshes	reduced functioning of coastal ecosystems	Reduced aesthetic aspects, reduced marine recreational activities,	Loss of culture and Identity		1		
Human Greenhouse Gas Emissions	Sea level rise	Loss of seagrass meadows and saltmarshes	reduced functioning of coastal ecosystems	Reduced aesthetic aspects, reduced marine recreational activities,	Loss of human well-being		1		
Human Greenhouse Gas Emissions	Sea level rise	Loss of seagrass meadows and saltmarshes	reduced functioning of coastal ecosystems	Reduced aesthetic aspects, reduced marine recreational activities,	Reduced tourism			1	
Human Greenhouse Gas Emissions	Sea level rise	Loss of seagrass meadows and saltmarshes	reduced functioning of coastal ecosystems	Reduced food security	Food insecurity		1	1	
Human Greenhouse Gas Emissions	Sea level rise	Loss of seagrass meadows and saltmarshes	reduced functioning of coastal ecosystems	Reduced food security	Loss of human well-being		1		
Human Greenhouse Gas Emissions	Sea level rise	Mangrove die off events	Biodiversity loss	Erosion of indigenous culture and knowledge	Loss of human well-being		1		
Human Greenhouse Gas Emissions	Sea level rise	Mangrove die off events	Biodiversity loss	Reduced aesthetic aspects, reduced marine recreational activities,	Loss of human well-being		1		

Human Greenhouse Gas Emissions	Sea level rise	Mangrove die off events	Biodiversity loss	Reduced aesthetic aspects, reduced marine recreational activities,	Reduced tourism			1	
Human Greenhouse Gas Emissions	Sea level rise	Mangrove die off events	Biodiversity loss	Reduced food security	Food insecurity		1	1	
Human Greenhouse Gas Emissions	Sea level rise	Mangrove die off events	Biodiversity loss	Reduced food security	Loss of human well-being		1		
Human Greenhouse Gas Emissions	Sea level rise	Mangrove die off events	Reduction of provisioning services	Erosion of indigenous culture and knowledge	Loss of human well-being				
Human Greenhouse Gas Emissions	Sea level rise	Mangrove die off events	Reduction of provisioning services	Reduced access to traditional food	Loss of culture and Identity		1		
Human Greenhouse Gas Emissions	Sea level rise	Mangrove die off events	Reduction of provisioning services	Reduced access to traditional food	Loss of human well-being		1		
Human Greenhouse Gas Emissions	Sea level rise	Mangrove die off events	Reduction of provisioning services	Reduced aesthetic aspects, reduced marine recreational activities,	Loss of culture and Identity		1		
Human Greenhouse Gas Emissions	Sea level rise	Mangrove die off events	Reduction of provisioning services	Reduced aesthetic aspects, reduced marine recreational activities,	Loss of human well-being		1		
Human Greenhouse Gas Emissions	Sea level rise	Mangrove die off events	Reduction of provisioning services	Reduced aesthetic aspects, reduced marine recreational activities,	Reduced tourism			1	
Human Greenhouse Gas Emissions	Sea level rise	Mangrove die off events	Reduction of provisioning services	Reduced food security	Food insecurity		1	1	
Human Greenhouse Gas Emissions	Sea level rise	Mangrove die off events	Reduction of provisioning services	Reduced food security	Loss of human well-being		1		
Human Greenhouse Gas Emissions	Sea level rise	Permanent submergence of land	Land loss	Changes in land use	Damage to human activities		1	1	
Human Greenhouse Gas Emissions	Sea level rise	Reduced ground water quality	salinisation of soils, ground and surface water	Degraded soil	Reduced coastal agriculture		1	1	
Human Greenhouse Gas Emissions	Sea level rise	Reduced soil accretion	Reduction in sandy beaches	Habitat loss	changes in structure and reduced functioning of coastal ecosystems	1			
Human Greenhouse Gas Emissions	Sea level rise	Reduced soil accretion	vegetation on sandy beaches is sparser and has a slower recovery time	Habitat loss	changes in structure and reduced functioning of coastal ecosystems	1			

Human Greenhouse Gas Emissions	Sea level rise	Salinisation of coastal wetland	Poleward shifts in plant species	Increasing and worsening harmful algal blooms and pathogenic organisms in estuaries	Economic uncertainty/insecurity		1	1	
Human Greenhouse Gas Emissions	Sea level rise	Salinisation of coastal wetland	Poleward shifts in plant species	Increasing and worsening harmful algal blooms and pathogenic organisms in estuaries	Food insecurity		1	1	
Human Greenhouse Gas Emissions	Sea level rise	Salinisation of coastal wetland	Poleward shifts in plant species	Increasing and worsening harmful algal blooms and pathogenic organisms in estuaries	Health insecurity		1		
Human Greenhouse Gas Emissions	Sea level rise	Salinisation of coastal wetland	Poleward shifts in plant species	Increasing and worsening harmful algal blooms and pathogenic organisms in estuaries	Reduced tourism			1	
Human Greenhouse Gas Emissions	Sea level rise	salinisation of soils, ground and surface water	Habitat loss	Loss of freshwater fish species	Negative impacts on fish-dependant communities		1	1	
Human Greenhouse Gas Emissions	Sea level rise	Stressed coastal ecosystems	Reduced global wetland	Biodiversity loss	changes in structure and reduced functioning of coastal ecosystems	1			
Human Greenhouse Gas Emissions	Sea level rise	Stressed coastal ecosystems	Reduced global wetland	Biodiversity loss	Reduced productivity	1			
Human Greenhouse Gas Emissions	Sea level rise	Stressed coastal ecosystems	Reduced global wetland	Habitat loss	changes in structure and reduced functioning of coastal ecosystems	1			
Human Greenhouse Gas Emissions	Sea level rise	Stressed coastal ecosystems	Reduced global wetland	Habitat loss	Reduced fisheries production			1	
Human Greenhouse Gas Emissions	Sea level rise	Warming of coastal wetlands	Poleward shifts in plant species	Increasing and worsening harmful algal blooms and pathogenic organisms in estuaries	Economic uncertainty/insecurity		1	1	
Human Greenhouse Gas Emissions	Sea level rise	Warming of coastal wetlands	Poleward shifts in plant species	Increasing and worsening harmful algal blooms and pathogenic organisms in estuaries	Food insecurity		1	1	
Human Greenhouse Gas Emissions	Sea level rise	Warming of coastal wetlands	Poleward shifts in plant species	Increasing and worsening harmful algal blooms and pathogenic organisms in estuaries	Health insecurity		1		
Human Greenhouse Gas Emissions	Sea level rise	Warming of coastal wetlands	Poleward shifts in plant species	Increasing and worsening harmful algal blooms and pathogenic organisms in estuaries	Reduced tourism			1	

Human Greenhouse Gas Emissions	Storm surges	Inundation of salt marshes	Increase in salinity-tolerant species	Biodiversity loss	changes in structure and reduced functioning of coastal ecosystems	1			
Human Greenhouse Gas Emissions	Storm surges	Inundation of salt marshes	Increase in salinity-tolerant species	Biodiversity loss	Reduced productivity	1			
Human Greenhouse Gas Emissions	Thermal expansion of Ocean Water	Sea level rise	Coastal habitat contraction	Biodiversity loss	Reduced functioning of coastal ecosystems	1			
Human Greenhouse Gas Emissions	Thermal expansion of Ocean Water	Sea level rise	Coastal habitat contraction	Biodiversity loss	Reduced productivity	1			
Human Greenhouse Gas Emissions	Thermal expansion of Ocean Water	Sea level rise	Coastal habitat contraction	Habitat loss	Reduced fisheries production			1	
Human Greenhouse Gas Emissions	Thermal expansion of Ocean Water	Sea level rise	Coastal habitat contraction	Habitat loss	Reduced functioning of coastal ecosystems	1			
Human Greenhouse Gas Emissions	Thermal expansion of Ocean Water	Sea level rise	Geographical shifting of coastal species	Erosion of indigenous culture and knowledge	Loss of culture and Identity		1		
Human Greenhouse Gas Emissions	Thermal expansion of Ocean Water	Sea level rise	Geographical shifting of coastal species	Inland shits in plant species distributions	Economic uncertainty/insecurity		1	1	
Human Greenhouse Gas Emissions	Thermal expansion of Ocean Water	Sea level rise	Geographical shifting of coastal species	Inland shits in plant species distributions	Food insecurity		1	1	
Human Greenhouse Gas Emissions	Thermal expansion of Ocean Water	Sea level rise	Geographical shifting of coastal species	Inland shits in plant species distributions	Loss of culture and Identity		1		
Human Greenhouse Gas Emissions	Thermal expansion of Ocean Water	Sea level rise	Geographical shifting of coastal species	Reduced aesthetic aspects, reduced marine recreational activities,	Loss of culture and Identity				
Human Greenhouse Gas Emissions	Thermal expansion of Ocean Water	Sea level rise	Geographical shifting of coastal species	Reduced food security	Loss of culture and Identity				
Human Greenhouse Gas Emissions	Thermal expansion of Ocean Water	Sea level rise	Geographical shifting of coastal species	Shifts in Species composition, abundance and biomass production of ecosystems	Economic uncertainty/insecurity		1	1	
Human Greenhouse Gas Emissions	Thermal expansion of Ocean Water	Sea level rise	Geographical shifting of coastal species	Shifts in Species composition, abundance and biomass production of ecosystems	Food insecurity		1	1	

Human Greenhouse Gas Emissions	Thermal expansion of Ocean Water	Sea level rise	Geographical shifting of coastal species	Shifts in Species composition, abundance and biomass production of ecosystems	Loss of culture and Identity		1		
Human Greenhouse Gas Emissions	Thermal expansion of Ocean Water	Sea level rise	Geographical shifting of coastal species	Shifts poleward in distribution of seagrass meadows and kelp forests	Economic uncertainty/insecurity		1	1	
Human Greenhouse Gas Emissions	Thermal expansion of Ocean Water	Sea level rise	Geographical shifting of coastal species	Shifts poleward in distribution of seagrass meadows and kelp forests	Food insecurity		1	1	
Human Greenhouse Gas Emissions	Thermal expansion of Ocean Water	Sea level rise	Geographical shifting of coastal species	Shifts poleward in distribution of seagrass meadows and kelp forests	Loss of culture and Identity		1		
Human Greenhouse Gas Emissions	Thermal expansion of Ocean Water	Sea level rise	Increased higher extreme sea levels associated with tropical cyclones	Exacerbated costal hazards	Damage and loss of coastal properties and their value		1	1	
Human Greenhouse Gas Emissions	Thermal expansion of Ocean Water	Sea level rise	Increased higher extreme sea levels associated with tropical cyclones	Increasing intensity of multiple extreme events	Damage and loss of coastal properties and their value		1	1	
Human Greenhouse Gas Emissions	Thermal expansion of Ocean Water	Sea level rise	Increased turbidity on fringing coral reefs	Reduced sunlight	Reduced photosynthesis and calcification	1			
Human Greenhouse Gas Emissions	Thermal expansion of Ocean Water	Sea level rise	Land loss	Changes in land use	Damage to human activities		1	1	
Human Greenhouse Gas Emissions	Thermal expansion of Ocean Water	Sea level rise	More frequent extreme sea level events	Increased vulnerability of coastal communities (including indigenous peoples)	Economic uncertainty/insecurity		1	1	
Human Greenhouse Gas Emissions	Thermal expansion of Ocean Water	Sea level rise	More frequent extreme sea level events	Increased vulnerability of coastal communities (including indigenous peoples)	Food insecurity		1	1	
Human Greenhouse Gas Emissions	Thermal expansion of Ocean Water	Sea level rise	More frequent extreme sea level events	Increased vulnerability of coastal communities (including indigenous peoples)	Health insecurity		1		
Human Greenhouse Gas Emissions	Thermal expansion of Ocean Water	Sea level rise	More frequent extreme sea level events	Increased vulnerability of coastal communities (including indigenous peoples)	Increase in non-communicable diseases		1		
Human Greenhouse Gas Emissions	Thermal expansion of Ocean Water	Sea level rise	More frequent extreme sea level events	Increased vulnerability of coastal communities (including indigenous peoples)	Loss of culture and Identity		1		
Human Greenhouse Gas Emissions	Thermal expansion of Ocean Water	Sea level rise	More frequent extreme sea level events	Increased vulnerability of coastal communities (including indigenous peoples)	Reduced tourism			1	

Human Greenhouse Gas Emissions	Thermal expansion of Ocean Water	Sea level rise	More frequent extreme sea level events	Increasing intensity of multiple extreme events	Damage and loss of coastal properties and their value		1	1	
Human Greenhouse Gas Emissions	Thermal expansion of Ocean Water	Sea level rise	More frequent or intense coastal flooding	Coastal erosion	Damage to built infrastructure			1	1
Human Greenhouse Gas Emissions	Thermal expansion of Ocean Water	Sea level rise	More frequent or intense coastal flooding	Coastal flooding	Damage to built infrastructure			1	1
Human Greenhouse Gas Emissions	Thermal expansion of Ocean Water	Sea level rise	More frequent or intense coastal flooding	Increased vulnerability of coastal tourism destinations	coastal squeeze on coastal ecosystems	1			
Human Greenhouse Gas Emissions	Thermal expansion of Ocean Water	Sea level rise	More frequent or intense coastal flooding	Salt water intrusion	Damage to built infrastructure			1	1
Human Greenhouse Gas Emissions	Thermal expansion of Ocean Water	Sea level rise	salinisation of soils, ground and surface water	Degraded ground water quality	Water insecurity	1	1	1	
Human Greenhouse Gas Emissions	Thermal expansion of Ocean Water	Sea level rise	salinisation of soils, ground and surface water	Degraded soil	Reduced coastal agriculture		1	1	
Human Greenhouse Gas Emissions	Thermal expansion of Ocean Water	Sea level rise	salinisation of soils, ground and surface water	Habitat loss	Loss of freshwater fish species	1		1	
Human Greenhouse Gas Emissions	Thermal expansion of Ocean Water	Sea level rise	salinisation of soils, ground and surface water	Inland shits in plant species distributions	Economic uncertainty/insecurity		1	1	
Human Greenhouse Gas Emissions	Thermal expansion of Ocean Water	Sea level rise	salinisation of soils, ground and surface water	Inland shits in plant species distributions	Food insecurity		1	1	
Human Greenhouse Gas Emissions	Thermal expansion of Ocean Water	Sea level rise	salinisation of soils, ground and surface water	Inland shits in plant species distributions	Loss of culture and Identity		1		
Human Greenhouse Gas Emissions	Thermal expansion of Ocean Water	Sea level rise	Sea water intrusion in estuaries	Habitat loss	changes in structure and reduced functioning of coastal ecosystems	1			

List of Abbreviations

ASEAN – Association of Southeast Asian Nations

BBNJ – The United Nations Convention on the Law of the Sea on the conservation and sustainable use of marine biological diversity of areas beyond national jurisdiction

BRI – Belt and Road Initiative

CEA - Cumulative Effect Assessment

CO2 – Carbon Dioxide

EEZ – Exclusive Economic Zone

EIP – Effect to Impact Pathway

ENSO – El Niño-Southern Oscillation

EU – European Union

FOIP – Free and Open Indo-Pacific

GDP – Gross Domestic Product

GHGs – Greenhouse Gasses

GMF – Global Maritime Fulcrum

HADR – Humanitarian Assistance and Disaster Relief

IOR – Indian Ocean Region

IPCC – Intergovernmental Panel on Climate Change

ISA – International Seabed Authority

IUUF – Illegal Unregulated and unreported fishing

MDA – Maritime Domain Awareness

MPAs – Marine Protected Areas

NGAM – Non-Geographic Assessment Map

NDCs – Non-Communicable Diseases

RFMOs – Regional Fisheries Management Organisations

RSC – Regional Security Complex

SIDS – Small Island Developing States

SLOCs – Sea Lanes of Communication

SROCC - Special Report on the Ocean and Cryosphere in a Changing Climate

TNOC – Transnational Organised Crime

UNCLOS – United Nations Convention on the Law of the Sea

UNFCCC – United Nations Framework Convention on Climate Change's