Long-Term Implications of Sea Level Rise for Low-Lying Islands

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I wouldn't have been able to do it without any of you.

Abstract

The Major Research Paper (MRP) is a comprehensive literature review of the short and long-term consequences of Sea Level Rise (SLR) on low-lying islands. SLR encroaches on an island's coasts and beaches and is slowly displacing individuals and communities. SLR is intensified by climate change through the process of atmospheric temperature increase. The increasing temperatures cause the oceans to warm and expand in size, while concurrently causing ice on land (in the Arctic North and Antarctica) to melt. Furthermore, as the sea rises, the cascading effects, secondary hazards, and subsequent implications all worsen. The paper explores the dangers of SLR and its relationship with low-lying islands.

The MRP categorizes the hazards of SLR into four categories. The first category explores the primary hazard of SLR and includes the science of which compounds and exacerbates all the other hazards in the other categories. The second category is the secondary hazard which occurs from SLR, which are increasing in frequency and worsening severity. This category explores the relationship between communities and structural measures which mitigate short-term, rapid-onset hazards, at the expense of worsening the consequences of SLR (more floods, more severe hurricanes, etc.). The third category analyzes the cascading effects of the secondary hazards caused by SLR. It specifically explores the relationships between water levels and food/water security, land reclamation processes, and long-term sustainability. The last category is the subsequent consequence of SLR, where all of the repercussions combine, causing forced displacement of habitants. This section explores long term questions of displaced populations and the lack of a new categorization of climate displacee. Throughout the MRP, there are primarily three low-lying islands mentioned: Tuvalu, Kiribati, and the Maldives. Each has a different social dynamic in the country and a different response to SLR.

Preamble - The Shifting Climate

In a 2018 Special Report by the Intergovernmental Panel on Climate Change, there were predictions made for a 1.5°C increase in global temperature by 2100. While 1.5°C may not look like a significant number, many of the consequences are extreme and irreversible. For example, there is added infectivity and broader geographic range for diseases such as malaria and dengue fever; worsened severity of extreme urban heat waves; and smaller farming yields for products such as maize, rice, and wheat in Sub-Saharan Africa, Southeast Asia, Central and South America (IPCC, 2018). However, one of the most threatening attributes of a shifting climate is the rise in sea-levels (IPCC, 2018). The rise in global temperature projects to exacerbate the severity of natural disasters and the frequency in which they occur, ultimately threatening nations and their land. The shift in the climate affects lifeforms on earth including land animals, sea life, and birds, but also increases the stress to critical infrastructures, vulnerable individuals, agriculture sectors, and freshwater deposits. With warming temperatures, oceans and relatively cold areas, such as areas with a high density of ice, will begin to warm which contributes to a shifting climate. Two critical consequences of the warming temperatures come from the ocean, and the North and South Pole. Warmer temperatures make the oceans expand - meaning more water, but it also means melting ice caps and ice shelves. Both are primary factors that contribute to the threat of sea-level rise (SLR). SLR is when the ocean's relative average levels are raised, thus creating higher tides and engulfing more coastal land and beaches. SLR threatens the nature of habitable areas as they increase the average height of the waves, but also produce more floods. Floods are the most significant threat from SLR as it influences the day to day life, food and

freshwater security, and safety of individuals. Overall, SLR is a significant threat to coastlines across the world, especially low-lying islands. Low-lying islands are the islands that are approximately one metre to the ocean, meaning they are especially prone to SLR and floods. This Major Research Project sets out to explore these problems related to SLR and low-lying islands.

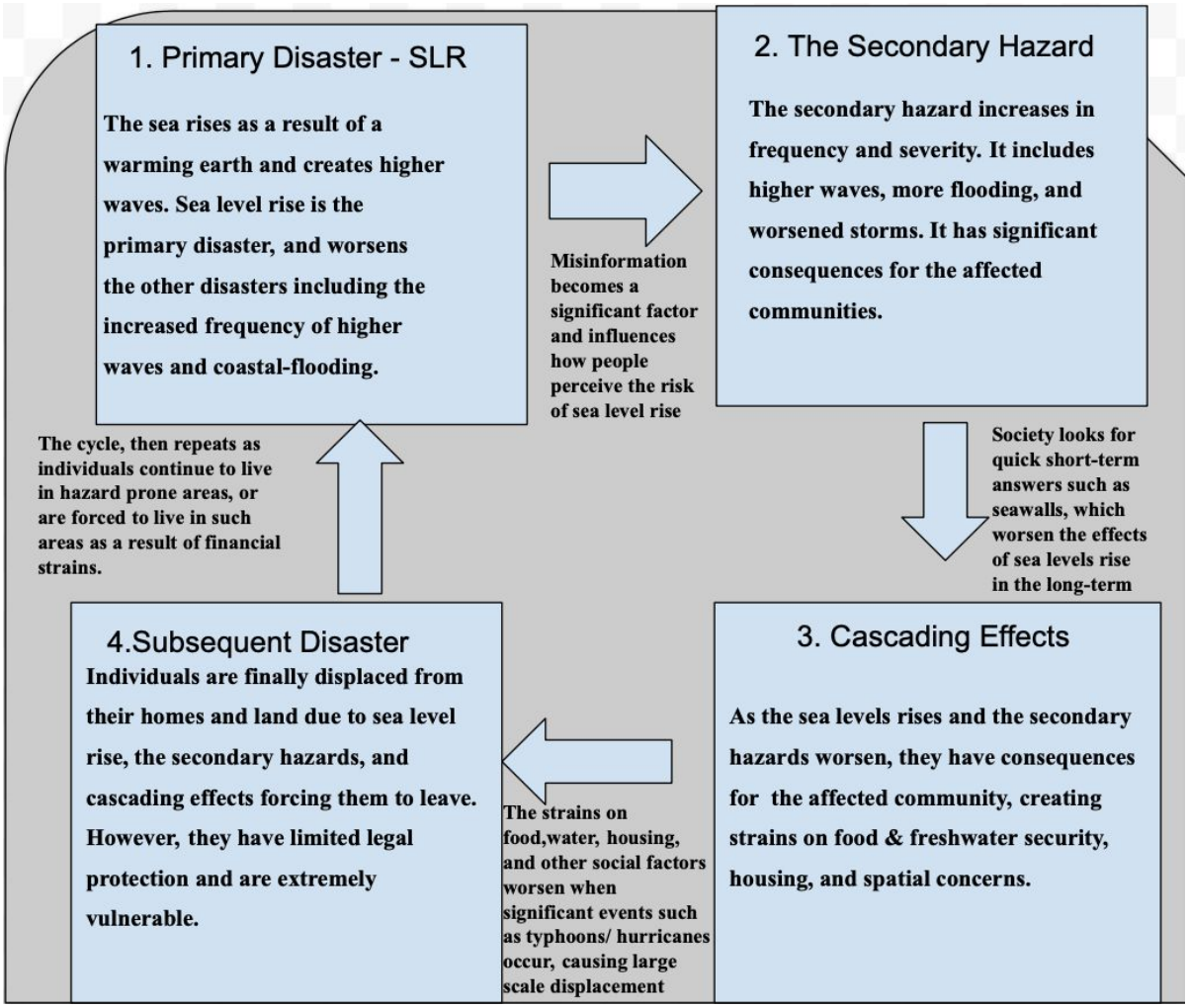

Figure 1: Cycle of Sea Level Rise (SLR) and Major Research Paper (MRP) Flow.

This diagram shows the progression of Sea Level Rise, and helps to understand the flow of the MRP. Chapter One and Two discusses the primary hazard of SLR; Chapter Three is dedicated to discussing the secondary hazards; Chapter Four demonstrates the cascading effects SLR has on

society; and finally, the MRP ends with Chapter Five and the subsequent disaster of displacement.

Figure 1 shows the progression of Sea Level Rise (SLR) through disaster and emergency management terminology in four cycles. (1) The Primary Disaster is Sea Level Rise. As the sea rises, it produces worse secondary hazards which include higher waves, more flooding, and worsened storms. (2) As the secondary hazards occur more often, they have significant consequences for the affected community, which forces the community to develop protections useful for only the short-term. (3) As SLR and secondary hazards worsen, they influence the affected community, having direct consequences on food and housing. These are the cascading effects, which create concerns regarding overpopulation, food security, and vulnerable housing. (4) The subsequent disaster then becomes more prevalent, where individuals are displaced from their homes and land due to SLR, and have limited legal protection.

Themes & Structure

This MRP serves as a guide to gaining an understanding of the practical and theoretical knowledge of the short and long-term effects of SLR and how societies and governments respond to its consequences. In particular, the MRP seeks to explore the long-term implications of SLR through addressing the following themes found in the research process:

1. There are both short-term and long-term implications of SLR which affect low-lying islands.
2. Short-term mitigation decisions are exacerbating long-term issues of SLR.

3. The reliance on technology - such as new equipment and land reclamation processes - profoundly worsens the consequences of SLR.
4. Displacement and relocation are significant challenges currently within the topic of SLR, and they will worsen with time.
5. The legal challenges SLR creates are becoming more complex; there are no guiding framework for those displaced by the climate.

The paper will address the guiding statements identified above through the use of the emergency management literature, defining the primary hazard as Sea Level Rise (SLR). This will be done through an exploration of the implications of SLR on low-lying island nations through an analysis of legal documents, case studies, and literature on climate change and rising sea levels. The order of the paper is especially important, as each Chapter builds upon the previous chapter. In particular, the MRP is divided into four major chapters:

- Chapter One: Introduction to the Long-Term Effects of SLR. In the first chapter, the reader will gain a clear understanding of the hazards, threats, and cascading effects of rising sea levels. The Chapter sets the context in which the MRP must be understood through a discussion on the scale of long-term hazards and demonstrates the importance of cultural dynamics on island nations through examples of the islands of Tuvalu and the Maldives.
- Chapter Two: The Science of SLR. The Second Chapter discusses the scientific complexities of SLR. The sea is rising through warming ocean temperatures and increased ice melting. Scientists cannot with 100% certainty say how much the sea is

going to rise. Confidence levels are the only way to depict SLR projections with some degree of accuracy. The MRP draws upon scientific data from United Nations Climate Change Reports, International Panel for Climate Change, hydrologists, oceanographers, seismologists, geographers, and engineers, which discuss the increase in temperatures and natural hazards, as well as the effects of SLR. The Chapter then discusses the complicated case of Funafuti, Tuvalu which has experienced receding ocean levels on parts of the island instead of rising sea levels. Additionally, tectonic plate shifting contributes to the rise and fall of land, adding another element of complexity of SLR. This Chapter also explains the science of erosion and the increased acidification to coral reefs, both of which are further used in later chapters. The Chapter then illustrates the most likely scientific scenarios of SLR in an effort to clarify the complexities.

- Chapter Three: Rapid-Onset Disasters. The Third Chapter illustrates society's inability to balance current concerns with future problems. Through analysis of rapid-onset disasters including coastal-floods, typhoons, and higher waves, this Chapter demonstrates societies fixation with deterring hazards in the short-term, at the expense of worsening hazards in the future. Specifically, this Chapter uses the science of erosion and critiques the short-term use of sea walls. The case study focuses on the capital city of Malè in the Maldives, which continues to engineer higher sea walls.
- Chapter Four: Food Security, Sustainability, and Spatial Problems. This Chapter explores the cascading effects on the food industry and the sustainability of life on these islands. The Chapter then discusses the unsustainable, recurring processes of land reclamation

which is compounded by overpopulation and urbanization. Then, the case study of Tuvalu, where the government has reclaimed land by filling in a flooding hazard.

- Chapter Five: Environmental Displacement, Climate Refugees and Statelessness. Chapter Five explores the subsequent effects of rising sea levels. Specifically focusing on the significant gap in international protection for 'climate refugees,' then explores the depiction of the sinking island phenomena and the problems of statelessness. Finally, discusses the habitability of low-lying islands for the future.

Methodology

Through a literature review, the use of emergency management literature, and applied cases, the paper positions itself to take a critical approach to the long-term effects of SLR and their effect upon low-lying islands. This MRP synthesizes and analyzes literature to conduct a comprehensive literature review on the complexities of rising sea levels. There are four areas reviewed including disaster and emergency management literature, refugee and migration literature, environmental climate change literature, and climate displacement literature. The MRP also utilizes works published by non-government organizations, government entities, and United Nations reports. It draws upon scientific projections for sea-level rise, legal precedents for statelessness, definitions of displacement, refugees, and migrants.

Chapter One: Introduction to Sea Level Rise

This introduction begins with a section on why Sea Level Rise matters and is followed by a discussion on terminology, which describes the hazards, threats, and cascading effects of rising

sea levels. The Chapter sets the context in which the MRP must be understood through a discussion on the scale of long-term hazards, including its effects on non-low-lying islands, and demonstrates the importance of cultural dynamics on island nations through examples of the islands of Tuvalu and the Maldives.

Why does Sea Level Rise matter?

SLR is an international issue which affects some nations more severely than others. Disasters occur internationally, yet the response differs from one country to the next. Natural hazards shape the way societies interact with their environment. Rising sea level hazards affect a range of nations from large islands, such as Madagascar, to coastal nations, such as Bangladesh, and low-lying islands such as Kiribati. However, the truth of SLR is that it will influence and change every coastline in the world. Projections estimate that environmental hazards including SLR will displace roughly 200 million people living in these coastal areas (Milne *et al*., 2009, p. 1). Many of these people will directly be affected by SLR, as low-lying islands and coastal nations have already seen incremental increases in sea levels. As one of the worst-case scenarios, it is estimated that by 2100, SLR will reach a one-metre increase (Church *et al*., 2013) making many low-lying islands uninhabitable (McAdams, 2012). SLR will destroy numerous sources of freshwater and farmable land while displacing entire coastal communities (De Haen & Hemrich, 2007; McAdams, 2012).

Sea Level Rise (SLR) encroaches on island coasts and beaches, and is slowly displacing individuals and communities. As discussed above, SLR is intensified by climate change through

the process of atmospheric temperatures and warming oceans. As the sea rises, more floods occur near areas that have cities and growing populations. The floods ultimately can ruin infrastructure which supports and allows individuals to reside in coastal areas and on islands. The floods from SLR are more than just common threats, they threaten the very nature of cultures and habitability around the world. Ultimately, SLR threatens the entire world, as coastlines will be altered. SLR threatens to displace up to 670 million without coastal protection and 450 million with coastal protection people by 2100 (Mimura, 2013), of which will be forced to migrate within the same country and across borders. It should be noted that many large metropolises are near the coastline. As indicated in Figure 2, there are notable cities in Asia which will be affected by SLR along with their population. These include:

- Hong Kong, China: 7.4 million residents
- Shanghai, China: 24 million residents
- Dhaka, Bangladesh: 8.9 million residents
- Indonesia, Jakarta: 9.6 million residents
- Tokyo, Japan: 9.2 million residents
- Bangkok, Thailand: 8.2 million residents

Figure 2 Surging Seas map of Asia (map of the Risk Zone Map by Climate Central)

Map of sea levels risen to 5 feet, affecting every coast in Asia - all points indicate areas in the East that face a threatened rise (Climate Central, 2020)

SLR, thus will influence millions of people, changing the environment many live in, especially for those individuals who live on islands. In Figure 2, circles in the Pacific Ocean in areas which look like they have no land (right side of the photo), are low-lying islands which face the significant threat of SLR. Low-lying islands are one metre or lower relative to sea level. This means they are especially prone to SLR. Two low-lying islands which are repeatedly mentioned are the Maldives in the Indian Ocean, and Tuvalu in the Pacific Ocean. For low-lying islands, floods, higher waves, typhoons, and worsening food and freshwater security threaten the long-term habitability of living on each island. Each island and coastline faces a different

situation, as well, the responses and organization of those societies matter. Many cities and individuals will utilize short term measures to prevent the effects of SLR. However, as will be argued in this paper, these measures often trigger long term consequences.

Within each island, consideration on how each community is structured and how wide the gap is between the middle and low income groups needs to be understood. The low-income and poor are the most vulnerable groups primarily due to the fact that they don't have the same infrastructure that protects them. As well, there is a lack of legal protection for individuals in these low-lying islands. To leave, they must consider becoming migrant workers or if they have the income, immigrate. If neither of these options are available, the only protection is from the state in which they then will live as individuals displaced by the climate, and are excluded from consideration for refugee status.

The hazards of SLR have significant implications on the daily lives of residents on low-lying islands. It will influence the long-term habitability and current responses they implement. While worse-case projections are considered, the implications and effects that climate change has on SLR, compound every aspect of the hazard.

Terminology

Two concepts exemplify the short and long-term problems or SLR. (1) Fundamentally, short term decisions are made to mitigate hazards, yet they worsen vulnerability in the long-term (Brym, 2009). (2) Impoverished communities and individuals are disproportionately more affected by disasters (Brym, 2009; Youngman, 2009; Klinenberg, 1999). To gain a better understanding of how each concept influences societies, terminology of the topic is needed.

A disaster refers to a situation where a natural hazard causes damage to humans and their environment. When discussing events such as earthquakes, tsunamis, sea-level rise, and other 'naturally' occurring events, the MRP uses the terms disaster and hazard. When considering the short-term effects of SLR, one has to understand the difference between rapid-onset disasters and slow-onset disasters. Rapid-onset disasters or sudden-onset disasters are hazards and events that cause substantial damage in a short-time frame. Sudden-onset disasters also have a more defined start and end time, ranging from hours to days as they occur with little or no warning (Coppala, 2015). In the context of this paper, coastal-floods, tsunamis, and hurricanes all classify as rapid-onset disasters as they occur in short periods of time. Slow-onset disasters (also known as 'creeping' disasters) are more subtle and occur overtime with no clear start time, yet can cause significant damage. An example of a relevant slow-onset disaster is the main topic for discussion in the MRP - rising sea levels, as it will incrementally cause damage while slowly intensifying year after year. For SLR, it is considered the main disaster in all discussions, and as discussed in Chapter Three, it produces and exacerbates the 'secondary' disaster. A secondary disaster is a separate disaster that is triggered by the main hazard - for example, rising sea levels trigger higher waves that cause coastal-floods (Coppola, 2015). While these changes in the earth's climate are occurring and the shifts in hazards worsen, however, affected governments realize these changes, and are prompted to act. The difficulty with disasters that affect multiple countries is that there are different types of vulnerability, different effects on individual nations, and importantly different responses from each nation.

The term, cascading effects is used to describe when an initial disaster triggers an ensuing hazard, which can be more destructive and disruptive than the initial hazard (Schauwecker *et al*.,

2019). Some examples of cascading effects are the implications that SLR has on food security, specifically when saltwater flooding from the ocean ruins a freshwater deposit on a low-lying island. Lastly, a subsequent effect or hazard is when a disaster or an effect occurs after an initial event. An example would be the displacement of numerous individuals from coastal-flooding. Other terms mentioned in the paper are king tides, low-lying islands, sea walls, land reclamation, which are discussed in-depth and using case studies in their respective chapters.

Understanding the Context of Island Culture and Time for Island Response to SLR

The issue of SLR must be understood in a long-term context, recognizing that the implications will continue to worsen over the next 20 to 50 years. While there are immediate threats, they are managed through short-term mitigation planning instead of long-term planning. Currently, the most significant issue is coastal-flooding which will progressively worsen. SLR has occurred, yet the perceived threat has only actualized for a number of islands. This is the difficulty of a slow-onset disaster such as SLR, as it is difficult to perceive the threat when it happens slowly.

The perception of the threat is critical for response in terms of a slow-onset disaster, and can be problematic as people tend to not respond to risks until the effects of the disaster are experienced. The perception of the hazard was the main focus for a survey conducted in the Maldives by Kelman *et al*. (2019), one interview participant stated “climate change impacts might not happen in my lifetime” (P. 393). While disasters may be a reality, public perception is

vital to making individuals and governments respond in a timely manner. The Maldives will be under threat for the next 20 to 50 years as SLR intensifies, but the difficulty in declaring it is a long-term threat makes individuals somewhat complacent to the threats. With that said, the importance of cultural dynamics and how they influence sea levels must also be understood.

Importance of Culture and Identity for Islands

In his article *On Islanders and Islandness*, Philip Conkling's (2007) quantifies the sense of culture and identity islanders all share. "Islanders from different archipelagoes share a sense of islandness that transcends the particulars of local island culture. Islandness is a metaphysical sensation that derives from the heightened experience that accompanies physical isolation" (p 192). What Conkings infers is that island people share similar traits within their culture, as related to their isolation, something acknowledged amongst different island cultures around the world. The difficulties of living in isolation also fosters mutual respect between island cultures. "Islandness is reinforced by boundaries of often frightening and occasionally impassable bodies of water that amplify a sense of a place that is closer to the natural world because you are in closer proximity to your neighbors" (Conking, 2007, p. 192). Isolation also brings the local community closer together. For islanders around the world, the significant distance to travel to the next body of land cultivates a sense of self-reliance.

Another inherent element of the islander culture includes deeply rooted traditions and practices within the communities. This is evident when analyzing the Faroe Islands (north of Britain), a cluster of islands known for its controversial festival, the 'Grindadráp'. During

Grindadráp, whales are trapped and killed for their meat and blubber, but these parts are not sold, rather they are distributed to local communities to maintain food security (Olsen & Bogadottir, 2017). The festival celebrates their Viking ancestry and is one of their founding traditions which can be traced back to the 8th and 9th century (Olsen & Bogadottir, 2017). Grindadráp is internationally condemned by news outlets (The Guardian, 2015; Lifegate, 2016), yet there is a reluctance to stop the event, as it is a collective proceeding which strengthens collective culture and bonds. The most critical rule is that individuals are not allowed to whale trap and kill alone, as the festival also promotes collective community bonding (Olsen & Bogadottir, 2017) . However, Grindadráp was never practiced for individuals to become well-off compared to their neighbours, and this was established in its traditional rules as the festival became more prevalent in Faroese society. No other known islands are associated with the controversial practice of Grindadráp. Yet, the Faroese's Grindadráp festival demonstrates how a profound cultural event can bring a community and culture together.

The final cultural element of significance is the notion that life is inseparable from the sea and the island. This is evident in the Pacific Islands of Tuvalu, where culture and the island are inseparable from the residents of Tuvalu. When a child is born, their placenta is buried with a coconut. As the coconut tree grows, the individuals who grow up on the islands believe themselves inseparable from the island and their culture. For these individuals, they are literally a part of these islands, as a piece of them is the island (Talia, 2009).

Introduction to Case Studies: Tuvalu, The Maldives, and Kiribati

The MRP primarily explores three nations, Tuvalu and Kiribati in the Pacific Ocean and the Maldives in the Indian Ocean. When analyzing each case, both share similar vulnerabilities in relation to SLR. Specifically, each nation is on the forefront of SLR and the actions and responses taken by each country may set the standards and benchmarks for how other islands respond in the future.

Quick Comparison of Major Case Studies		
Tuvalu	**The Maldives**	**Kiribati**
Capital City: Funafuti	Capital City: Malé	Capital City: South Tarawa
Low population, 11,147	High population, 391,904	Medium population 115,847
9 atoll islands - 4th smallest nation in the world	1,190 coral islands, of which 200 inhabited islands	33 Islands, largely atolls
Great Political Representation - runs a balanced budget	Poor Political Representation - various human rights abuses	Good Political Representation - Prime Minister urging people to leave islands
Located north of New Zealand in the Pacific Ocean	Located south of India in the Indian Ocean	Located in the middle of the Pacific Ocean - East of Hawaii
Highly Educated population with many residents having university degrees and certificates - as a result of number of scholarship programs and access to universities	Compulsory high school education until 17, however, low social mobility.	Compulsory education until the age of 14, post-secondary education increasing.
Collective culture where individuals are tightly bonded with community - don't necessarily aspire for western goals - accumulate weather, buy large houses, etc. Typically called the 'share and care' system.	Significant island culture. Many individuals cannot see themselves living without the ocean.	Culture revolves around the sea and family. Plays a significant role in shaping identity.

Highly Christain population - 97%	Highest percentage of Sunni Muslim residents in the world (100%), as it is the state religion and the law makes it mandatory for citizens to be Muslim	Chritian Population of around 90%

Table 1: Quick Comparison of the Maldives and Tuvalu

Tuvalu

Tuvalu is made up of 101 different islands of which nine atolls are inhabited. Atolls are small islands that form a ring of land around a body of water. The process for the creation of atolls is elaborated upon in Chapter Two. Of the total population of 11,147 nearly 50% reside in the Funafuti atoll- the capital city (CIA Factbook, 2019). The islands are located north of New Zealand as indicated by Figures 4 and 5. Tuvalu is the 4th smallest nation in the world, largely due to it being atoll islands illustrated in Figure 6 (CIA Factbook, 2019).

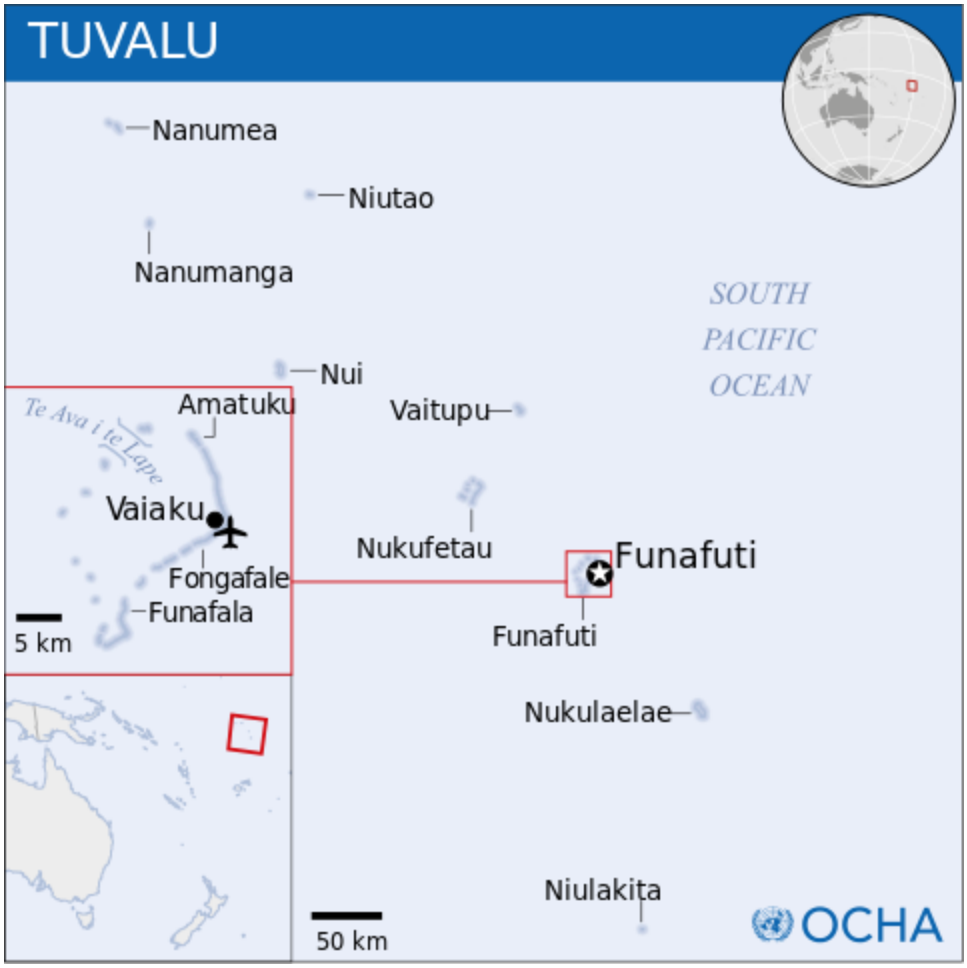
TUVALU
Nanumea
Niutao
Nanumanga
SOUTH
PACIFIC
OCEAN
Nui
Amatuku
Vaitupu
Te Ava i te Lape
Vaiaku
Nukufetau
Funafuti
Fongafale
Funafala
5 km
Funafuti
Nukulaelae
Niulakita
50 km
OCHA

Figure 3: Map of Tuvalu nine habited islands - (OCHA, 2013)

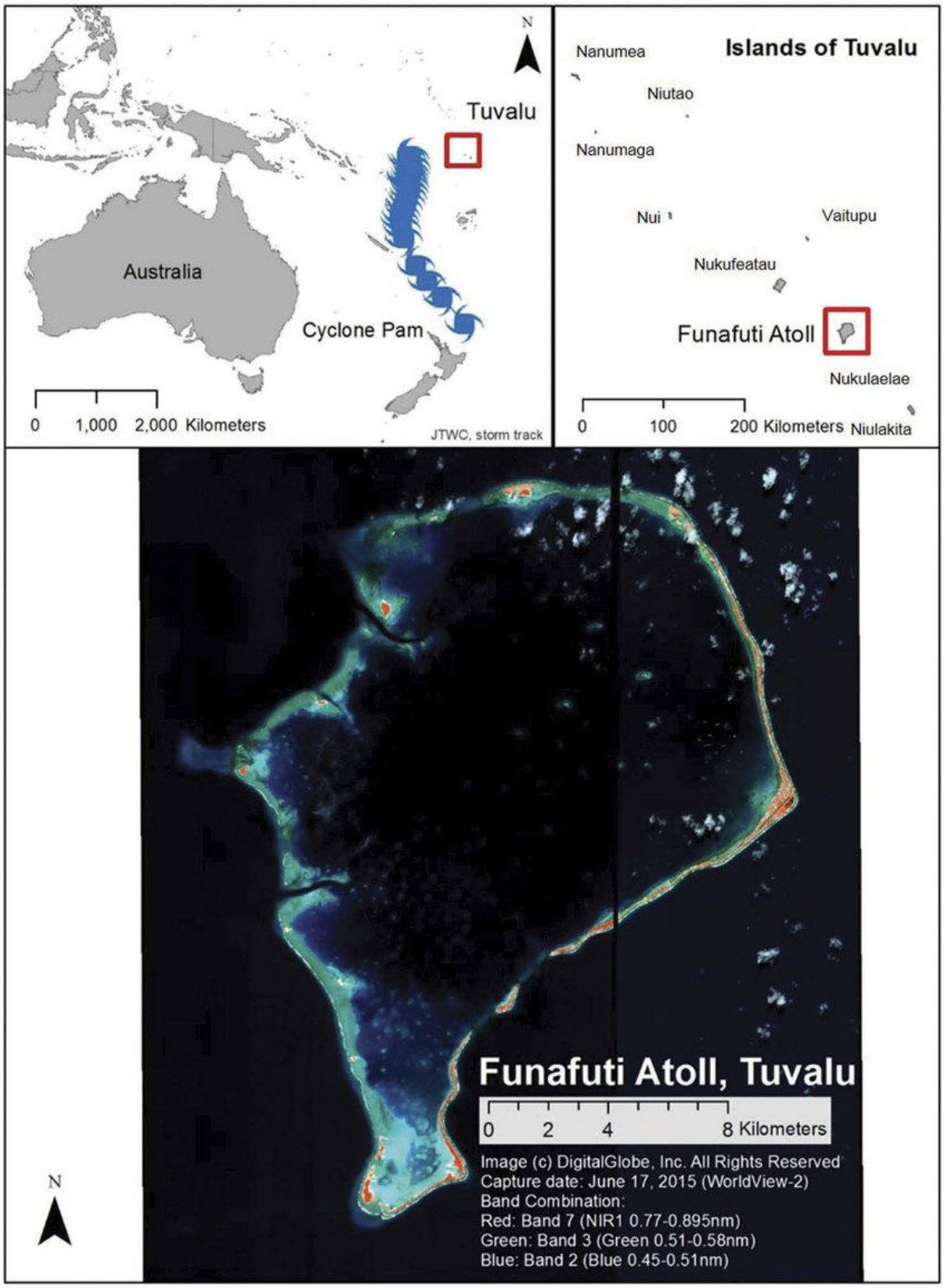
N
Tuvalu
Australia
Cyclone Pam
0 1,000 2,000 Kilometers
JTWC, storm track
Islands of Tuvalu
Nanumea
Niutao
Nanumaga
Nui
Vaitupu
Nukufeatau
Funafuti Atoll
Nukulaelae
0 100 200 Kilometers
Niulakita
Funafuti Atoll, Tuvalu
0 2 4 8 Kilometers
Image (c) DigitalGlobe, Inc. All Rights Reserved
Capture date: June 17, 2015 (WorldView-2)
Band Combination:
Red: Band 7 (NIR1 0.77-0.895nm)
Green: Band 3 (Green 0.51-0.58nm)
Blue: Band 2 (Blue 0.45-0.51nm)
N

Figure 4: Map of where Tuvalu and the Funafuti Atoll is - (Hisabayashi, *et al*, 2017, p. 5)

Figure 5: Photo of Tuvalu's capital - Funafuti (Fiona Goodall, 2018)

In terms of hazards, Tuvalu's islands are mostly atolls and fringing reefs. Almost all of the inhabited islands of Tuvalu are low-lying, meaning they are typically one meter below sea level. As a result of SLR, the islands are becoming more susceptible to coastal-floods, as salt-water intrusion can ruin the freshwater sources (Government of Tuvalu, 2016). However, freshwater caches allow residents to get their water during rainfall. The lagoons and marshes are areas to grow food. However, the marshes also absorb water and pose flood risks during the high tide season (otherwise known as king tides in January to April). Overall, Tuvalu residents are unable to flee or move inland when there are disaster warnings as the islands are so small, as Tuvalu's

total land size is only 26 kilometres. Thus they bear the brunt of disasters and face considerable exposure.

Two significant economic industries of the Tuvalu Islands are fishing and agriculture. In terms of farming, one of the staples of the islands for food is Swamp Taro (Webb, 2007). However, a report in 2006 indicated that some plants have died off due to high tides and rainfall in the growing areas, meaning there is a higher risk of food insecurity (Webb, 2007).

The island is heavily reliant on supplies being shipped from larger countries, importing goods such as food, animals, fuel, and machinery (CIA, 2019). Tuvalu's biggest trade partner is Singapore, where Tuvalu imports up to 33.4% of its goods from Singapore (CIA, 2019). Tuvalu imports 35.6 million dollars worth of goods making it the 215th largest importer out of 221 nations (OEC, 2017). Other than being reliant on supplies and imports from other nations, Tuvalu has a particularly vulnerable resource-based industry. Fishing accounts for 50% of all exports, as the island is heavily dependent on the threatened coral reefs and wildlife population (OEC, 2017). However, Tuvalu has high rates of advanced education at the University of South Pacific (USP), which is highly accessible and affordable (UNESCO, 2020). Tuvalu has a number of scholarship opportunities allowing its residents to be specialized in many occupations. While the population is educated, few employment opportunities mean many individuals have to work as migrant workers. Unemployment rates remain high at 44%, as well 26.3% of the population remains under the poverty line, a number which may heighten due to instability of economics and climate (CIA, 2019).

There is also a traditional share and care system where individuals will assist one another. The system acts as a social safety net in case of any serious economic, food, or social

problems (Talia, 2009). Before the arrival of Europeans and Christianity, the Tuvaluan way of life can be described as the 'share and care' system. It was a free exchange of goods without the expectation in return (Talia, 2009). Traditional food-sharing practices served as a type of social safety net, where food is produced, and distributed to ensure community well-being under challenging conditions (McCubbin et. al, 2017). Therefore, abject poverty is rare or non-existent (Taupo, et. al, 2018). Communal labor or voluntary work provided by members of the community was offered to whosoever needed help and was compulsory to all men and women when announced by the chief (Talia, 2009). Tuvalu has excellent political representation, which creates continuity government to government. The politics also motivates the government to implement and complete several projects that assist residents in farming and risk mitigation. These projects are elaborated in Chapter Four.

Over the past 60 years, the capital - Funafuti, has experienced the highest rate of SLR in the world (Hisabayashi *et al*., 2018). Projections anticipate that before 2100, some of Tuvalu's islands will submerge underwater due to the rise in sea level (IPCC, 2018). However, residents of the islands are more likely to be displaced by the freshwater availability before the islands 'sink' (McAdams, 2010). This rise in sea level has already affected the daily lives of the people as coastal-floods destabilize food (NOAA, 2017; ADB, 2019). If current projections of rising sea levels continue, then entire populations in the Pacific Islands may be displaced or quickly become uninhabitable.

The Maldives

Maldives is a chain of archipelago islands which are made up of 1,190 coral islands, of which 200 inhabited islands, and have 80 islands that have tourist resorts (CIA, 2019). As illustrated in Figure 7, the Maldives is in a prime geographical location for trade and warm temperatures, as the Maldives is south of Sri Lanka and India. The beautiful luxury nation of the Maldives is made up of beaches, celebrity hotels, and island paradises. In recent years it has gained the image of 'nature's sunken garden' or the place to go for 'a true holiday of a lifetime' (Lonely Planet, 2019).

Figure 6: Map of where the Maldives is located (Travel Center Maldives, 2015)

The Maldives has high exposure to tsunamis and coastal flooding, and represents the greatest threat to Maldivian communities (GFDRR, 2019). Tsunamis represent one of the gravest threats, as many islands cannot cope with coastal floods and initial big waves. The

Maldives has many islands under or near one-metre, meaning it is especially prone to floods (Prevention Web, 2014). Critical infrastructures, commercial buildings, and necessities such as schools are often the buildings damaged during the hazards. As illustrated in Figure 8, the Maldives is close to the Indian Fault line, making it prone to the tsunamis triggered by earthquakes. The Maldives has experienced earthquakes and cyclones in the past. However, since the frequency rate is very low, it is considered a low threat (GFDRR, 2019).

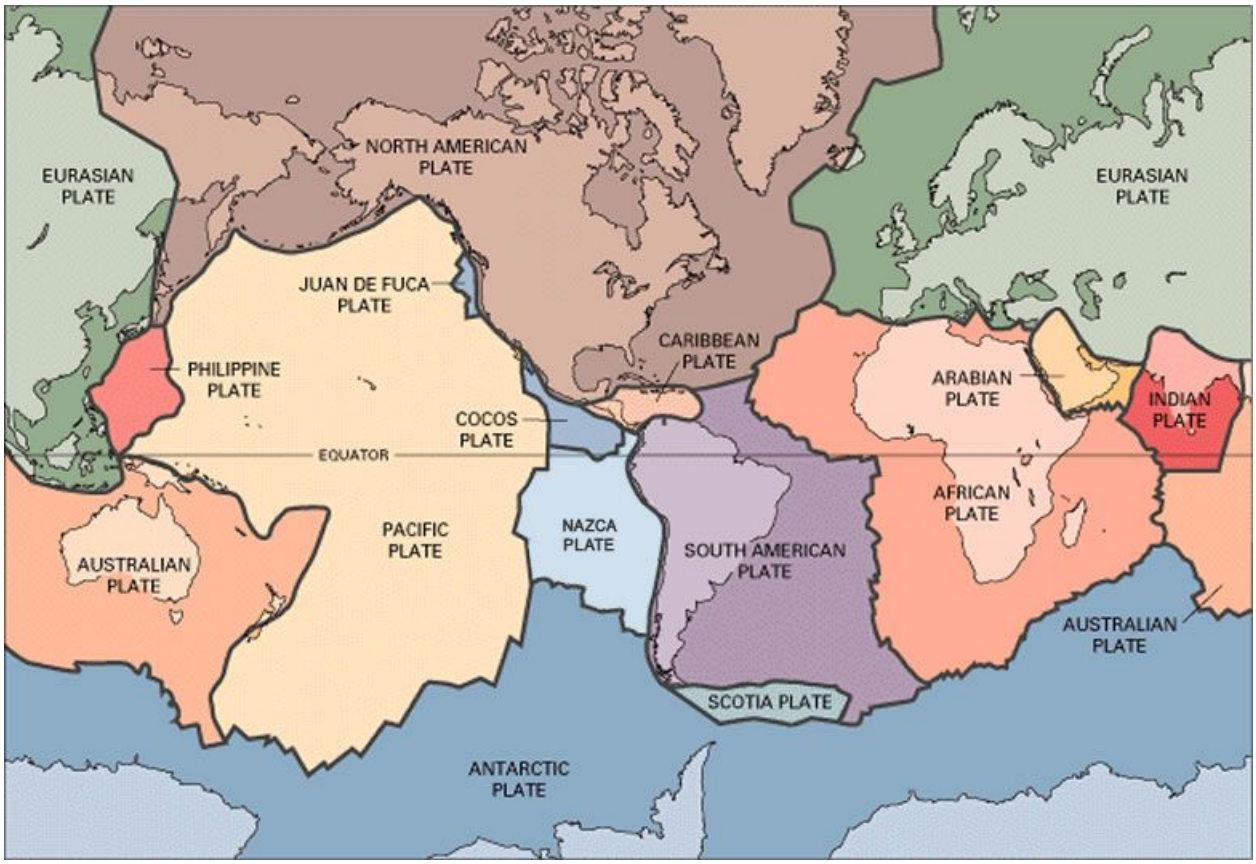

Figure 7: The tectonic plates map, which shows how the Maldives is near three plates - the Indian, African, and Arabian plate. (United States Geological Survey, 2020)

As a result of a large number of inhabited islands, response to disasters can vary due to the time it takes to travel from one island to another. There are more concentrated efforts to implement mitigation, response, and recovery plans in the inhabited urban areas, where approximately 40% of the total population resides. The rest of the population resides in the undeveloped rural islands or resort islands (CIA, 2019). The decentralized populations in the Maldives means greater self-reliance when it comes to preparing for and responding to natural disasters. Due to lack of financial resources on the undeveloped islands, informal equipment such as makeshift sandbags are used as seawalls to mitigate the destructive nature of SLR.

While the disasters produce barriers to rural economic growth, the nation thrives on tourism. Yet, the Maldives feigns a middle-income nation through its strategic deals with Sri Lanka, India, and, most importantly, China. In reality, the dichotomy between rich and poor grows. The Government's inability to represent its people squanders many of these opportunities the local Maldivians could have. These political and social issues are not inseparable. The Maldivian Government is a known human rights violator - oppressing political opposition, preventing free speech, and allowing for gender-based violence and human trafficking to occur (HRW, 2018). The oppressive government also has forced the sale of the resources on islands, such as palm trees, to island resorts in an effort to make them more appealing for tourists. There are few opportunities for upward social mobility and few economic opportunities, which forces many residents to work as migrant workers. These limitations are prevalent in the Maldives as the Maldivian Government only allows its residents to purchase land on the island they were born on and cannot purchase on other islands in the Maldives (Maldives Government, 2002).

China and Maldives have a trade agreement where China has built critical infrastructures such as roads and houses on the Maldives (The Guardian, 2018). In return, the Maldives gives its significant waterway advantage in China's 'Belts and Roads Initiative' or 'String of Pearls, 'where China plans to create a safe shipping way for oil from the Middle East and other products to China. Economically, the Maldives is more independent and has less reliance on imports than Tuvalu does. With that said, it imports 2.1 billion dollars worth of goods a year from areas of proximity, including UAE and India (CIA, 2019).

To conclude, Maldives is especially prone to the implications and cascading effects of rising sea levels, as they are highly decentralized states, with various political and social problems. The economics of the state may be strong, relative to Tuvalu, but the number of people below the poverty line is 15% and this does not illustrate the growing divide between rich and poor (CIA, 2019).

Kiribati

Pronounced Kiri-bas, Kiribati lies west of Hawaii and is one of the most remote and spread out countries in the world. I-Kibraiti (meaning residents of Kiribati) are non-migratory people, unlike other Pacific Island Nations. The total population of Kiribati consists of 111,796 permanent residents (CIA, 2020). However, estimates suggest that only 5,000 people migrate out of country for work, as compared to Tuvalu's 5,000 (CIA, 2020 ; Curtain & Dornan, 2019). This is significant as the total population of Tuvalu is almost 100,000 people less than Kiribati.

The challenging geography of the country fosters the islanders' self-reliance, as Kiribati is composed of 33 islands, 32 of which are atolls islands. As well, the overall size of the nation

includes 3.5 million square kilometres of ocean (UNCTAD, 2020). Overall usable living spaces in Kiribati are a growing concern. In the larger cities, increased population growth and urbanization has stressed critical infrastructure similar to the Maldives. This is further elaborated upon in Chapter Five, which explores the displacement of I-Kiribatis.

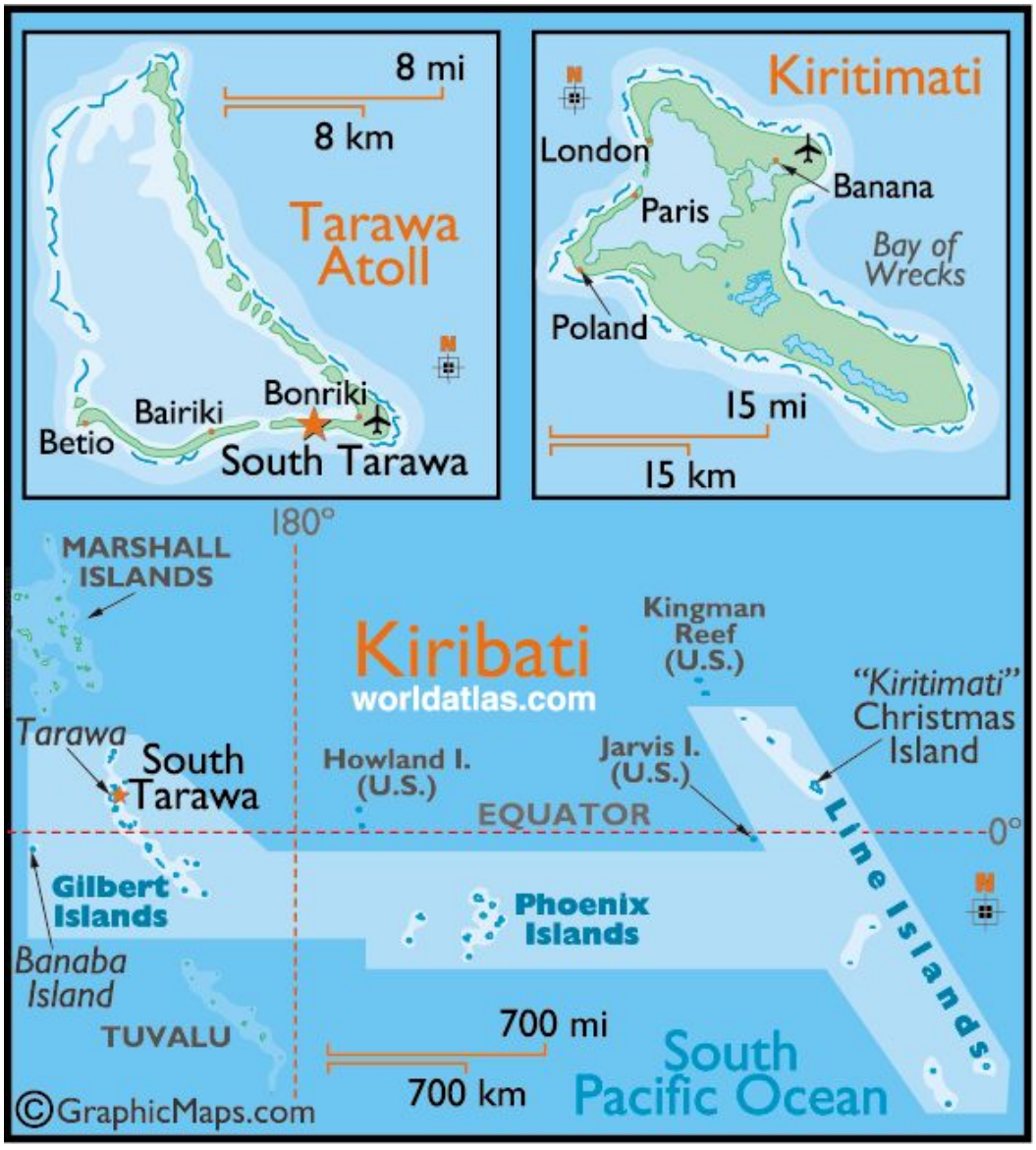

Figure 8: A map of Kiribati is located and the shape of two significant islands

The top left part of the image shows Tarawa Island, which hosts the capital city of South Tarawa, and is where a majority of the population of Kiribati reside. The right side is a map is Christmas Island or Kiritimi, and is a growing tourist destination due to its natural beauty and wildlife reserves (World Atlas, 2020).

With respect to SLR, considerable isolation fosters greater self-reliance but also increases the costs due to the equipment needed to mitigate current disasters. In Kiribati, communication and internet is problematic, with only 14,649 or 13.7% of the country having access to the internet (CIA , 2020). This is due to the cost of supplies, logistics, and distance to get product to Kibriatis' Islands. Kibraiti has a working population of 39,000 people, therefore there is a shortage of specialists and skilled workers which limits technical and overall national development (CIA, 2020). Economic development is notably difficult due to the remoteness of the islands which prevent engagement with international markets (CIA, 2020).

Politicians, environmentalists, and scientists predict disasters to play a significant role in the next 20 years, and the response will determine if the country can be habitable. Similar to Tuvalu, Kiribati politicians do not sit idly by and wait for the disasters to get worse. Re-elected President, Taneti Maamau intends to raise all islands by dredging some areas and raising others with sediment and sand. While this process has consequences (further explained in Chapter Four), it gives the residents of Kiribati hope for the near future (Pala, 2020). Moreover, President Maamau declined all loans from other countries in order to prevent lifetime debt (Pala, 2020). As of 2016, Kiribati has a minimal debt of 40 million US dollars to foreign countries, which ranks 12th lowest in the world (CIA, 2020). In addition, President Maamau took the initiative to

decline assistance from China, who wanted to use one of their islands as a military base (Pala, 2020). This is to say, the near future for Kiribati will be filled with important decisions on raising money and how they respond and adapt to SLR.

Chapter Two: Science of Sea Level Rise (SLR)

Misinformation is becoming a prevalent problem in regard to science. Myths, popular opinions, and non-peer reviewed science articles have worsened the integrity and accuracy of scientific information. As authenticity of information is questioned more, readers must now make a number of considerations when reading a scientific article. Some considerations include: to what extent is the information accurate, whether it comes from a regulated source, and if there are any biases the author has not presented. These considerations are important to consider when researching subjects such as oceanography, atmospheric science, geographical science, and other sciences, as they require large amounts of data to process and understand. For scientific data regarding SLR there is large amounts of misinformation, partially due to the research itself being complex. The information for SLR is difficult to process as there are multiple factors contributing to the rise and fall of sea levels. Moreover, individuals may not be familiar with the information that is relatively new to them. For example, the general population may be unaware

of the difference between global sea levels and relative sea levels and how each affects the areas they reside in.

Thus, this Chapter sets out to clarify the complexities of SLR. This is accomplished through a discussion on misinformation and the case of Tuvalu. Secondly, it will discuss how scientists with the Intergovernmental Panel for Climate Change use confidence and likelihood levels to project how fast ice will melt and how oceans will rise with warming temperatures. The Chapter will then continue on to explore how sea levels are rising through ocean expansion and melting glaciers, and how underwater terrain affects the relative sea level. To conclude, the Chapter will engage in discussion of likely scenarios of SLR.

Background and Misinformation

In a recent 2018 scientific article, it was argued that Tuvalu was not facing the 'sinking' effects of SLR, but rather that some islands were growing in size **(**Kench *et al*, 2018,**)**. In 2018, Australian Member of Parliament Craig Kelly was subjected to controversy for promoting the claims of the article in an attempt to deny climate change. In an audio file posted by *the Guardian*, Member of Parliament (MP) Kelly discussed that the Islands of Tuvalu have actually expanded- citing an article written by Kench *et al*., from 2018 which stated that 74% of the islands experienced expansion of its size; compared to 27% of the other islands which underwent a decreased in size. MP Kelly used these percentages, the argument of shifting global temperatures, and other claims, as the premise for the denial of climate change and the threat of sea level rise for Tuvalu. While his statement is not 100% accurate, the article Kelly referred to is indeed a real and peer reviewed source, inciting further complexity for SLR. It raises serious

questions, such as has SLR has engulfed land on some Tuvalu islands, while other Tuvalu islands are expanding in size?

Ironically, there isn't much of a case for MP Kelly's argument, as Kench *et al*. explain the factors of SLR and beach erosion later on in the article. It seems Kelly only used two sentences: "total land area of the nation has expanded by 73.5 ha (2.9%) since 1971 (in Tuvalu). Notably, eight of nine atolls experienced an increase in land area" (Kench *et al*., 2018, p. 2). While there is an argument to be made for island submergence from RSLs, the Kench article offers insight into the factors of why some islands have increased land. Kench's article is based on several events that occur in Tuvalu.

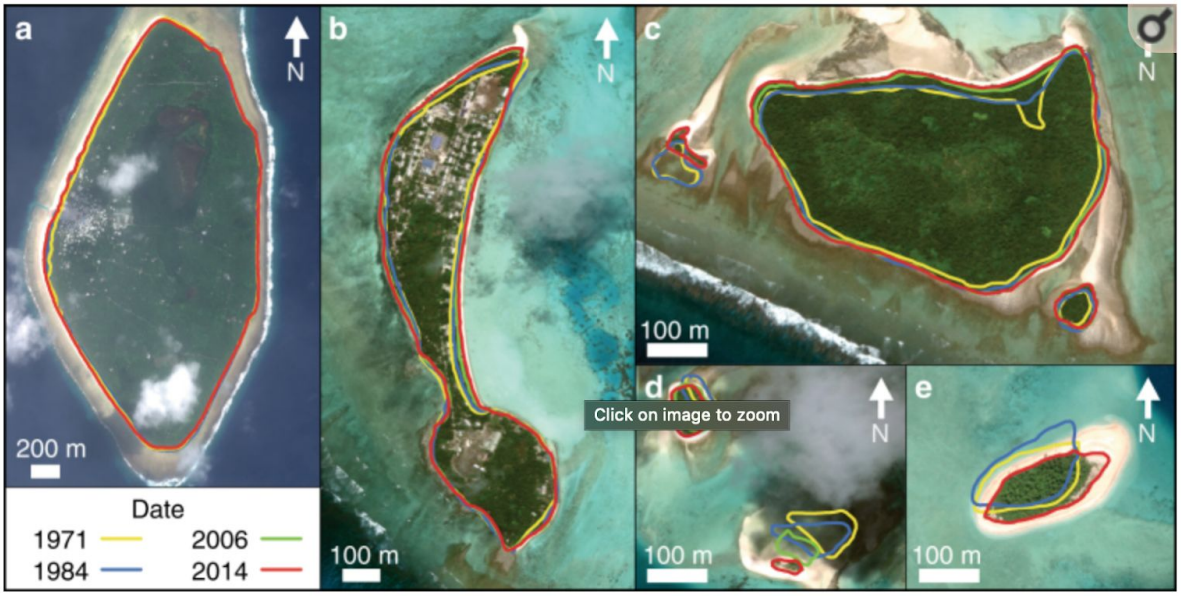

Figure 9: Image of the growing and shrinking shorelines of Tuvalu islands. (image in Kench *et al*, but taken from Images 2017 DigitalGlobe Inc)

Kench *et al.* elaborate on the process and relationship between waves and sediment, and how the natural renewal of beaches was the most compelling argument for the physical changes to the islands in Tuvalu. Kench *et al.* also discuss that the natural cycle of beach replenishment through waves and sediment can mask the effect of SLR, producing complexity when looking at numbers of relative sea levels. Wave and sediment replenishment are extremely important to maintaining the integrity of coastlines and beaches. However, as Tuvalu feels the effects of more typhoons, and larger waves, the sediment is replenished more often. More sediment means more land, except the increase in space isn't really contributing to habitable land, but instead increasing the size of non-habitable beaches.

In fact, the Kench *et al*. article has been subject to discussion and critique by GIS specialists. For example, Hisabayashi *et al*. (2017) conclude that the island has seen a net decrease of 0.35 ha, and not an expansion. Even in the scientific community, consensus regarding SLR is difficult to come to.

Misinformation makes SLR more ambiguous, as demonstrated by Member of Parliament Kelly. Therefore, scientific information must be understood in the context it was researched within. To make blanket statements such as, ‘sea levels are not rising because the island of Tuvalu is expanding’, creates more ambiguity within a topic that is already difficult to understand.

Given this variance of opinion and misinformation, the following sections were created to reduce this ambiguity and create a clear understanding of SLR. To recognize the complexities

and the misinformation surrounding SLR, one must understand the various factors contributing to its rise and fall. One example being the movement of tectonic plates, and how they can raise and lower land for sea levels.

The Science

Local Relative Sea Level Rise & Global Sea Level Rise

The oceans are not flat, but rather are fluctuating and constantly adapting to the underwater terrain and coastlines. This is to say that some underwater terrain is higher than other areas, making some nations more prone to sea level rise than others (NOAA, 2018). Typically, when SLR is discussed in media outlets, it is referred to as global sea level rise. Global sea levels are the most referred to metric when measuring sea level across the world, whereas relative sea levels are not referred to at all. When outlets discuss global sea level rise, they do so in a way that depicts the ocean as a bathtub. And that SLR is just the bathtub getting more water in it due to climate change.

Unfortunately, SLR is not that simple nor is the science of the ocean. In their article, *Eustatic and Relative Sea Level Changes,* Rovere *et al.* (2016) disagree with the notion that the earth's oceans is one giant bathtub. In their article they suggest that the shifting terrain and the internal changes (moving tectonic plates) are both significant factors that influence sea levels. Therefore, the changes in the geography, increased water (from thermal expansion and melting ice), along with shifts in land all contribute to the rise and fall of sea levels around the world. If

we considered the metaphor of earth's oceans as a bathtub, the bathtub would have to be shifting vertically and horizontally similar to earth, to be realistic.

Regional terrain shifts, reducing the accuracy of the metrics received for global sea levels. For this reason, more scientists are switching to local relative sea level as it indicates the water levels in proportion to the land (NOAA - Local Sea Levels, 2019). The relative sea levels give more accurate information for specific regions, thus specifical equipment is required (NOAA - Local Sea Levels, 2019). The equipment to measure sea levels can be relatively expensive as it includes instruments such as tidal gages and space satellites (NOAA - Local Sea Levels, 2019). For the many island nations who use relative sea level equipment, it allows them the ability to plan and prepare for oncoming SLR (Rovere *et al,* 2016).

Why is there Shifting Terrain?

The earth's crust or the outer layer is prone to constant shifting. This is primarily due to the internal processes which force the earth's terrain up and down. These shifts in the core of the earth have molded and shaped the earths, creating the continents and islands in modernity. For example, Tuvalu's islands are primarily known as 'atolls' and 'fringing reefs which have both developed over millions of years. This has occurred through the process of underwater volcanoes which incrementally added height to the tops through millions of years of eruptions. The volcanic eruptions released magma which hardens once it touches the water. After it hardens and cools, it becomes the perfect place for coral reefs to thrive. However, over millions of years, the volcanos rose above the ocean. As the volcanos rose, coral incrementally grew higher until it also rose above the ocean, where it formed small pieces of land. These deposits of coral that rose

above the ocean, died and became sand and sediment, eventually forming into habitable land (KBSLOF, 2015).

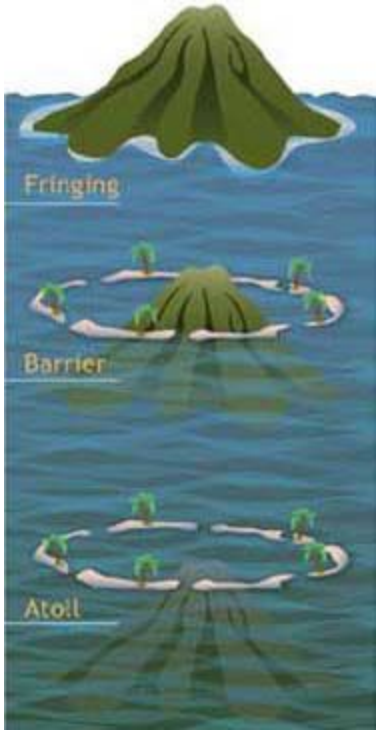

Figure 10: The three characteristics of coral islands - NOAA, 2020

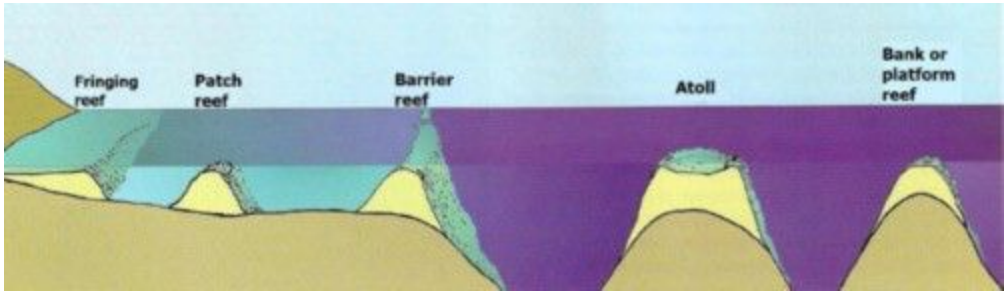

Figure 11: The different types of reefs - (image taken from PMF- IAS, 2019)

As depicted in the three characteristics of coral islands photo (Figures 10 & 11), fringe reefs are the remnants of dormant volcanoes. Eventually, the weight of the dormant volcanoes makes them sink. Barrier reefs, as illustrated in figure 11, are then a result of sunken volcanoes, as they become small islands with land-rings around them (KBSLOF 2015). The rings of sediments are the remains of dead coral. Interestingly, most barrier reefs or former islands have underwater geological formations as shown in the different types of reefs illustration (KBSLOF, 2015). The ring of land acts as a natural barrier between the ocean and the water inside the barrier, which is called a lagoon. After the dormant volcano is completely submerged and the coral has formed a ring of land, it is called an atoll as shown in the three characteristics of coral islands.

The geography of islands are active and constantly shifting due to their weight or the growth of coral. These land masses all have shifting terrain. For example, the Maldives are actually islands created by dormant volcano ranges (Ellis, 2017). In fact, many of the Maldives islands are barrier reefs, meaning they are prone to sinking from the weight of the island over millions of years (Ellis, 2017). And as such, the islands of the Maldives will not sink overnight. However, the main lesson to be learned is that the terrain on earth is not static, and is constantly shifting. These shifts in land are especially evident when exploring the complexities of why sea levels are generally rising.

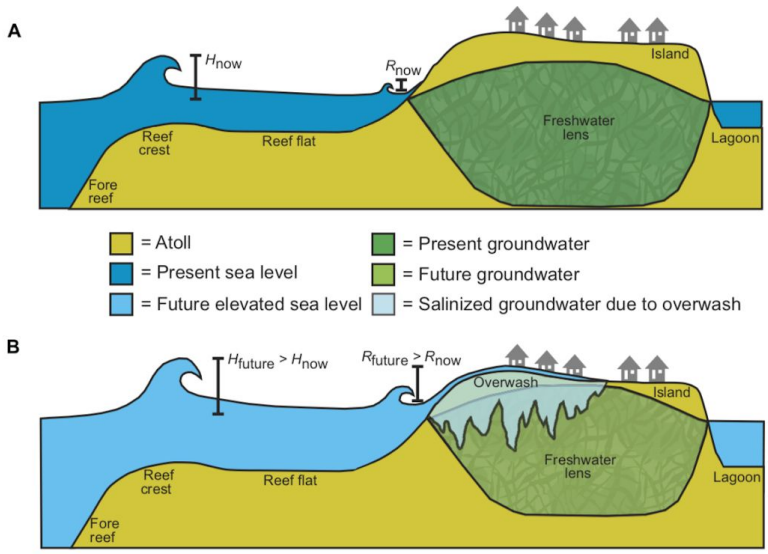

Fig. 1. Conceptual diagram of the influence of SLR on wave heights, wave-driven runup, and flooding and the resulting impact on atoll island groundwater. (**A**) Current sea level. (**B**) Future elevated sea level. SLR will allow for greater wave heights, *H*, and wave-driven runup, *R*, than at present, resulting in frequent overwash that will contaminate the atoll island's freshwater lens. High vertical exaggeration in schematic.

Figure 12: How SLR is influencing islands and freshwater. (Storalizzi, *et al.*, 2018. p. 2)

Benefits of Coral reefs - Acidification and Natural Barriers

For coastal-flooding, specifically on atolls and fringing reef islands, there are natural protective barriers around the islands. The coral act as an ecosystem and also reduce the amount of coastal erosion that occurs on the beaches. Furthermore, the reefs dissipate the oncoming waves for low-lying islands (Quataert *et al*., 2015). Waves that go through reefs first have less energy, ultimately reducing the threat of coastal-flooding (Quataert *et a*l., 2015). While further discussed in Chapter Two and Three, the destruction of coral reefs means there are fewer natural barriers to reduce the waves and flooding onto the new islands. There are two processes that damage reefs, land reclamation practices (discussed in Chapter Three), and ocean acidification. Ocean acidification is when the oceans absorb greenhouse gases, which cause the waters pH

levels to lower (Kelman, 2018). Basically, it changes the ecosystem for coral reefs, preventing many of the reefs from flourishing and causes them to ‘bleach’ (Kelman, 2018)

Coastal Erosion

Furthermore, islands have natural barriers such as coral reefs, beaches, and coastline that mitigates the destruction of hydrological hazards as well as SLR. Without beachfronts and the natural landscape to mitigate and prevent SLR and the secondary hazards, communities and individuals have an increased threat against them. The safety of islands and coastal areas becomes a primary concern once the coastline erodes. As Scholar Bird explains (1996), "Coastal erosion is facilitated by a rising sea level, which brings wave action to progressively higher levels and permits larger waves to reach the coast through deepening near-shore waters” (p 1). The threat of SLR and higher waves becomes more prevalent as both beaches wear down, and the coast undergoes increased rates of erosion. To this point, the exposed coastlines have a higher rate of direct impact from wave hazards such as storm surges, tsunamis, and king tides (Zhang *et al*, 2004). Therefore the threat of coastal erosion is significant as it makes communities and islands more vulnerable to SLR and the secondary hazards. These factors are all discussed in chapter three.

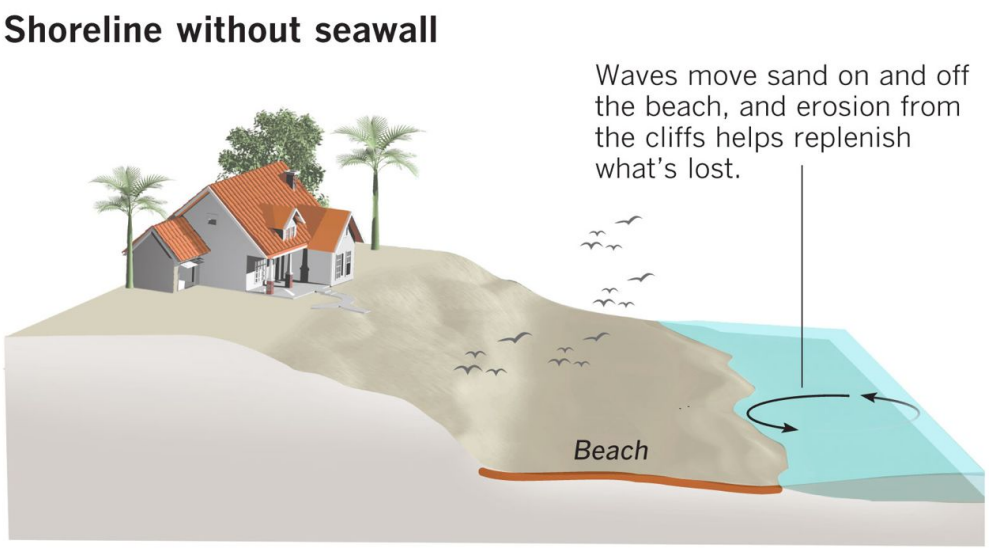

Figure 13:Depiction of a shoreline that doesn't have a seawall - notice there is a natural cycle of replenishment for sediment (Taken from LA times article Xia, 2019)

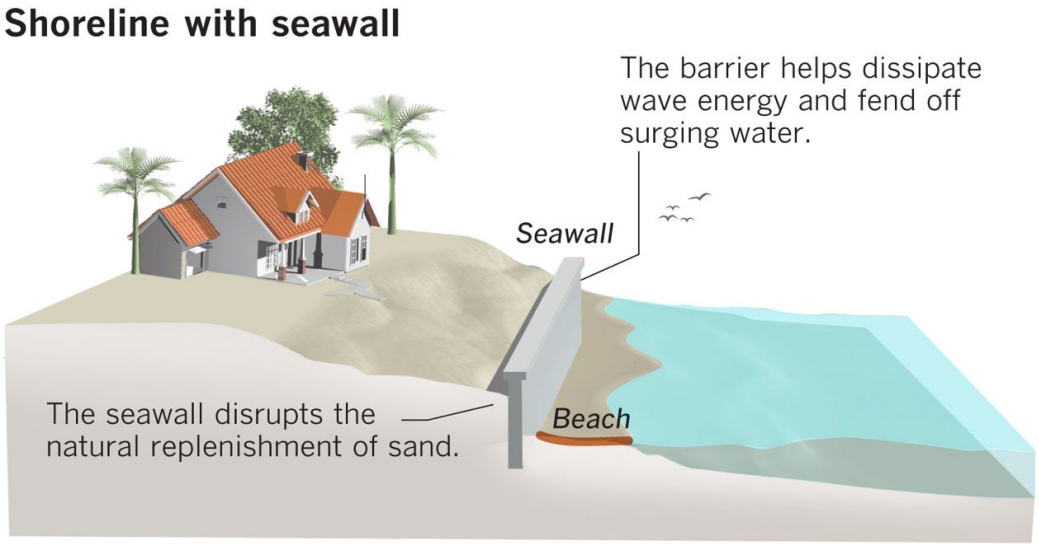

Figure 14: Illustration of shorelines with a seawall, which causes coastal erosion. (Taken from LA times article Xia, 2019)

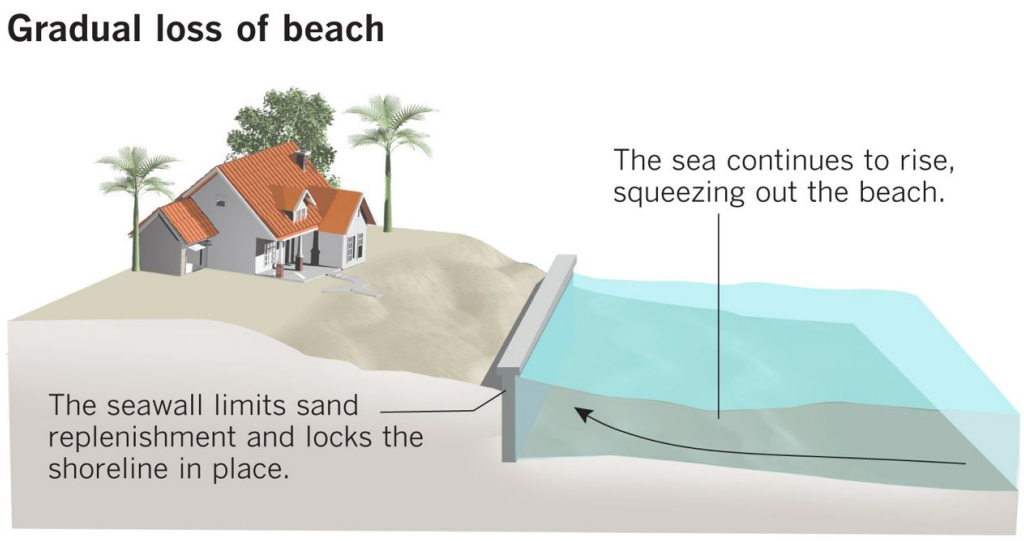

Figure 15: Depiction of what a seawall does to a coast in the long-term. (Taken from LA times article Xia, 2019)

The Complexities of Ice and Heat

In order to understand the science behind SLR, we have to consider the two significant factors that contribute to SLR, ice and heat. To begin, Scholar Andrea Dutton in an online interview explains, that the heat from greenhouse gases is absorbed by the ocean, which causes the ocean to become warmer (Verge Science, 2018). As well, temperatures above the water influence the heat of the ocean, but both cause the ocean to get warmer. These are two significant factors of thermal expansion of the ocean, as interestingly, the warmer waters move towards the surface compared to the cold water which sinks (Verge Science, 2018). Warmer water then

expands upward causing the sea to rise. Over the past 25 years, the increase in temperatures alone has accounted for half of the rise in sea levels (National Geographic, 2019). This has led to a consensus amongst scientists about SLR, with the continued use of greenhouse gases and fossil fuels along with warming global temperatures, global sea levels will continue to rise.

However, the increased temperatures are not only the source of an expanding ocean, but also the melting glaciers and ice sheets. As ice around the world continues to melt, scientists have not been able to precisely estimate the amount of SLR it will cause. With ice on land melting across the world, it poses a serious threat to how much water levels will rise. Large ice sheets in Antarctica, Greenland, and glaciers such as in the Himalayan Mountains are beginning to melt at a more rapid pace (Popescu, 2019; Rush , 2019 ; Leahy, 2019).

Another element of confusion is the melting of icebergs in the water already. One may believe that as they melt, the sea will rise. However, since the ice is equal to the weight of the water it holds, the icebergs do not contribute to SLR. It is the ice on land which contributes, as the weight of the water is not in the ocean.

Furthermore, 'Global Warming' also has other significant implications for the rise in sea level, as those same warming temperatures are creating challenges for aquatic life. Giant coral reefs, which are home to hundreds of thousands of sea creatures, are threatened as the increasing temperatures harm ecosystems. For island and coastal nations, which rely on the fishing industry as their way of life, they are threatened and may be unsustainable as the fishing industries rely on coral reefs. Some other industries which are affected include, tourism, fishing and marine life, and overall coral reefs, which provide 375 billion dollars worth of goods and services each year (NOAA, 2017).

The fact that the ocean is warming means there will be an increase in SLR. With warmer waters and more melting ice, SLR will change every coastline in the world.

Worse Case and How Certain is it that the Seas Rise?

As a result of polar ice caps melting, scientists can only make projections. This section is a literature review on why they cannot with 100% accuracy predict how much the sea will rise. The uncertainty of how much sea levels will rise is discussed through Confidence Levels.

While misinformation has occurred for a number of reasons, one example is because climate change is complex and cannot deal in the simplistic - yes and no. Misinformation in the general public is often thought of in a black and white context where individuals question if it will occur compared to if it will not occur. Instead, scientific projections must be understood more in confidence levels, and not in a black and white fashion. This is largely as a result of a scientific process, and it is one of the processes that the Intergovernmental Panel on Climate Change uses. There are two mechanisms to consider for determining confidence levels - agreement and evidence, as illustrated in Table 2. Consider the following figure which illustrates these two factors.

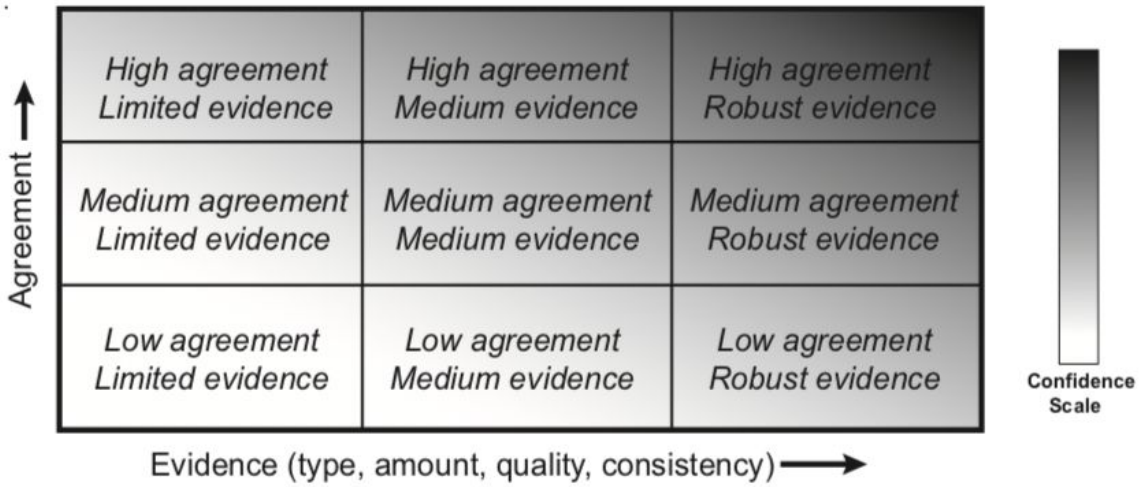

Table 2: (image)/table for measuring confidence levels - (IPCC, 2010)

Or as illustrated in this table:

Medium Confidence	High Confidence	Very High Confidence
Low Confidence	Medium Confidence	High Confidence
Very Low Confidence	Low Confidence	Medium Confidence

Table 3: Table that shows the confidence levels, correlated to Table 2 (IPCC, 2010)

The confidence metrics are critical to understanding for the following section as, for many of the scenarios presented, there is high confidence which usually entails high agreement-medium evidence, or medium agreement-robust evidence. Since these are confidence levels, there is not 100% certainty on anything. This means that the actual scenario which occurs can be better than the projections, or it can be worse.

All scenarios listed below are based on the following line unless specified: "Global warming is *likely* to reach 1.5°C between 2030 and 2052 if it continues to increase at the current

rate. (*high confidence*)" (IPCC, 2018, p. 4). This is the basis for all change in the future for a global average increase in temperature as this is the current trajectory the planet is on for projected scenarios.

Projected Scenarios of shifts in climate and the relation to SLR (taken from multiple authors)			
Authors	Scenario (all are quotations taken from authors work)	Confidence level/ likelihood	Short note on the relation to SLR
IPCC, 2018 Summary for Policymakers Report	*Sea level rise will continue beyond 2100 even if global warming is limited to 1.5°C in the 21st century (p 7)*	High Confidence level	SLR will continue long after 2100, causing more displacement and issues across the globe.
IPCC, 2018 Summary for Policymakers Report (1.5 degrees increase)	Increased "*Marine ice sheet instability in Antarctica and/or irreversible loss of the Greenland ice sheet could result in multi-metre rise in sea level over hundreds to thousands of years*" (p 7)	Medium Confidence levels	Again, SLR within the next 80 years will be substantial, however, it is a long-term threat as it will influence every coastline in the world.
IPCC, 2018 Summary for Policymakers Report	*Increasing warming amplifies the exposure of small islands, low-lying coastal areas and deltas to the risks associated with sea level rise for many human and ecological systems, including increased saltwater intrusion, flooding and damage to infrastructure (p 8)*	High Confidence level	As discussed in Chapter Three and Four, saltwater flooding is one of the most significant threats to food security and to critical infrastructures on islands.
IPCC, 2018 Summary for Policymakers Report	*1.5°C compared to pre-industrial levels, including warming of extreme temperatures in many regions (p 7)*	High Confidence level	Warmer temperatures will increase the temperatures of the ocean, causing more thermal expansion- overall more SLR.
IPCC, 2018 Summary for Policymakers Report	*Increases in frequency, intensity, and/or amount of heavy precipitation in several regions (p 7)*	High Confidence level	Increase in rain also coincides with floods in areas with seawalls. Interestingly, with sea walls it can prevent rain/water from exiting the place it was trying to keep water outside of.

IPCC, 2018 Summary for Policymakers Report	*Heavy precipitation associated with tropical cyclones is projected to be higher at 2°C compared to 1.5°C global warming (p 7)*	Medium confidence	More rain during sudden-onset disasters will increase the odds of floods.
Kench *et a*l. 2018	*Under these higher sea-level projections it is unclear whether islands will continue to maintain their size(p 5)*	Unclear confidence level	The discussion on coastal erosion is explored in Chapter Three, however, erosion is significant as it can increase the severity of SLR
IPCC, 2013 - Report on Sea Level Change	*21st century and beyond, sea level change will have a strong regional pattern, with some places experiencing significant deviations of local and regional sea level change from the global mean change. (p 1140)*	Very likely (high likelihood)	High likelihood that some areas in the world will experience higher relative SLR compared to other nations.
IPCC, 2013 - Report on Sea Level Change	*Annual mean significant wave heights will increase in the Southern Ocean as a result of enhanced wind speeds (p 1141)*	Likely (medium confidence)	The kingwave (described in Chapter Three) and high tide will increase in height causing more coastal floods
AR4 IPCC Climate Report 2007 A1FI	*Increase ranging from 2.2 degree celsius to 6 degrees celsius equating to 0.26 – 0.59M increase in Global Sea Level rise* (p 45)	Highly unlikely unless emissions do not improve and remain consistent	Displace a substantial number of people - unable to retrieve data.
AR4 IPCC Climate Report 2007 A2	*Increase ranging from 2.0 degree celsius to 5.4 degrees celsius equating to 0.23–0.51M increase in Global Sea Level rise* (p 45)	Not likely unless emissions do not improve and remain consistent	"This number will increase to 670 and 450 million people by 2100 for the cases without and with coastal protection, respectively (A2 scenario)." (Mimura , 2013) The A2 projection is based off themes of self-preservation and local identities, increase population (IPCC, 2007)

Schaeffer *et al*. 2012	*Limiting warming to these levels (1.5-2.0) with a probability larger than 50% produces 75–80 cm (0.75M) SLR above the year 2000 by 2100 (p 1)*	Projection based on no change to coastal emission	This scenario by Schaeffer *et al.* projects the minimum number of people would be 670 million if they are left unprotected by structured equipment. (based off Mimura , 2013)

Table 4: Projected Scenarios of shifts in climate and the relation to SLR

Overall, a majority of the projections are worrying for the safety of individuals on coasts and islands. The daily lives of individuals residing on coasts and low-lying islands will be influenced with many of these projections. Through issues of food security, displacement, more severe disasters, individuals will feel the effects of SLR.

Conclusion

There is no way of simplifying complexities of science into headlines, thus the onus falls on scientists, experts, and academics to clearly depict some of the scenarios which are likely. There is complexity in the topic of SLR, as some parts of the ocean are rising whereas others are sinking. The process of SLR is difficult to understand as it is dynamic and constantly changing. However, scientists do conclude that the sea will continue to rise as a result of a warmer climate. Multiple factors will increase the speed and severity of SLR. They include expansion of the ocean through warming temperatures, replenishing sediment processes on coasts, shifting tectonic plates, moving islands and underwater terrain, and the melting of large on land ice sheets in Antarctica, Greenland, and Mountains.

The high confidence levels of the 2018 IPCC report where temperatures will most likely climb to 1.5 degrees, are the most likely scenario to occur. Thus, while there are high confidence levels that the implications of SLR will worsen, as illustrated in the number of scenarios above, the predicted effects will be explored in the next chapter.

Chapter Three: Secondary Hazards of Rising Sea Levels - Rapid-Onset Disasters

Hydrological disasters such as hurricanes/typhoons/cyclones, storm surges, tsunamis, and coastal-floods are potent forces that can appear rapidly and without warning. Sea level rise (SLR) intensifies all of these hydrological or rapid-onset disasters. Not only does SLR increase the severity of these hydrological hazards, but it also amplifies the frequency of many of these disasters. This section discusses several aspects of SLR. In particular, it defines the secondary hazards as hazards that are triggered or worsened by the primary hazard. As explained in Chapter One and Two, the primary disaster in this major research paper is SLR.

This Chapter illustrates societies' inability to balance current concerns with future issues through an analysis of rapid-onset disasters, which are the secondary hazards of SLR. The secondary hazard implications include an increase in the number of floods, higher waves, worsening of cyclones/hurricanes. This chapter demonstrates society's fixation with deterring hazards in the short-term, at the expense of worsening hazards in the future. This is completed by using the science of erosion and critiques the short-term use of seawalls. Afterwards, the paper discusses the Maldives becoming overly reliant on structural mitigation.

The Implication

In emergency management literature, the primary hazard initiates disaster consequences while creating secondary hazards (Copolla, 2015). For example, if an earthquake is the primary

hazard, then a landslide, could be defined as the secondary hazard. As discussed in Chapter Two, rapid-onset hazards are disasters which occur with little to no warning and typically only last hours (Copolla, 2015). Hurricanes/cyclones are typically considered rapid-onset disasters that often trigger displacement in a small amount of time.

Hurricanes / Cyclones / Typhoons

The difference between hurricanes, cyclones, and typhoons is both the geographical location and the rotation of wind currents. In the Northern Hemisphere, wind currents rotate clockwise, whereas, in the Southern Hemisphere, they rotate counterclockwise. The terms Hurricanes / Cyclones / Typhoons are based on geography and are the same event. Hurricanes occur for North, Central, and South Americas, in both the Pacific and American Oceans. Cyclones occur in the South Pacific Ocean and the Indian Ocean affecting southern Islands, Oceania, Africa and Asia. This is illustrated in Figure 16, showing a Red Cross map where areas around the world have different names for the same phenomenon. For simplicity's sake, hurricanes/typhoons/cyclones will be referred to as cyclones as per geographical terminology for the case study countries - Tuvalu and the Maldives.

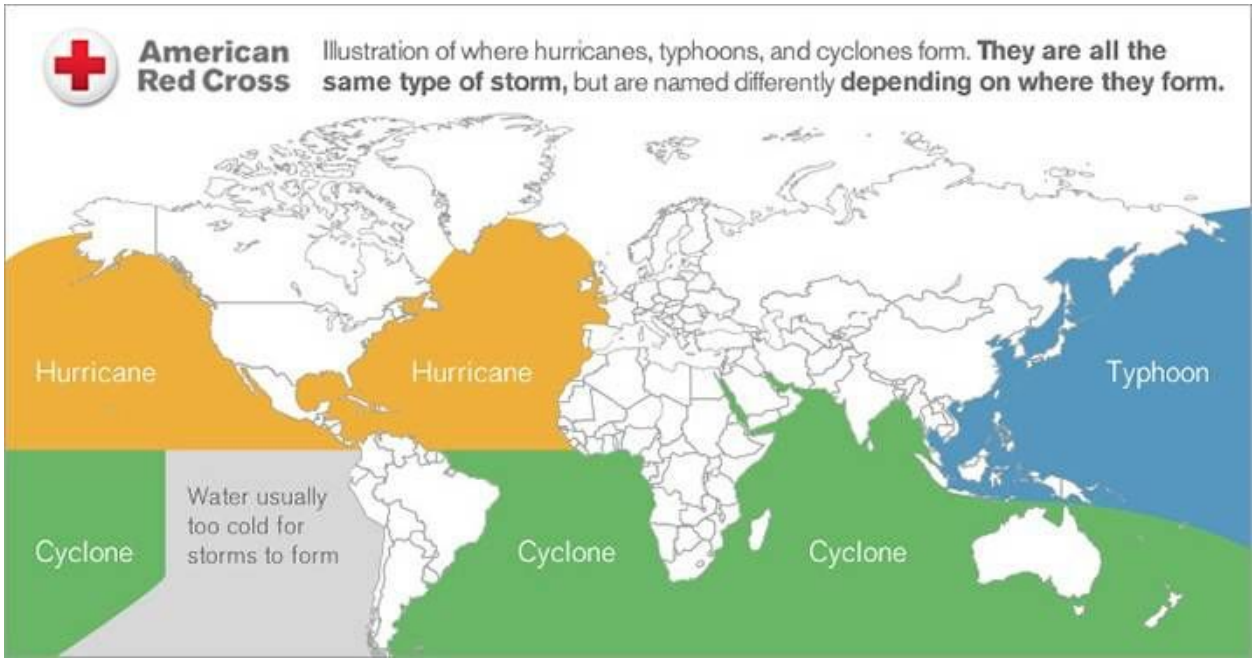

Figure 16: Red Cross map that identifies what each type of storm is called in the region. (American Red Cross, 2020)

In terms of the future of cyclones, there is confidence from scientists that globally, tropical cyclones will decrease in frequency, or remain at the same frequency (IPCC, 2018). However, cyclones are exacerbated by SLR, and as a result of warming ocean temperatures. For example, a 2018 study conducted on hurricanes/cyclones demonstrated that warming ocean temperatures will intensify hurricanes/cyclones in the future (Duan *et a*l., 2018; Knutson, 2010; Knutson, 2019). Moreover, in the future, cyclones are expected to increase rainfall when they occur - which could intensify flooding during such sudden-onset disasters (Knutson *et al.*, 2010; Knutson *et al*. 2019; IPCC, 2018).

Tsunamis, King Tides, and Storm Surges

Tsunamis, king tides, and storm surges are related to the waves of the ocean, but a different phenomenon triggers each. Tsunamis are triggered from displacement in the ocean, from rockslides to volcanic eruptions both occurring underwater. (NOAA, 2018). Tsunamis are the product when water is forced in a downwards motion. Water then fills the void in space, forcing the surrounding water to move in the same direction. This motion then becomes a wave, which accumulates rapidly, causing a wave (NOAA, 2018). Tsunamis are incredibly fast and powerful, and range in their speed anywhere above 200 to 500 miles per hour; however, the level of their destruction increasingly spreads, as they approach the coastline (International Tsunami Information Center, 2019). Tests conducted in the South China Sea concluded that SLR is expected to "increase both the frequency and the intensity of tsunami-induced flooding" (Li *et al.*, 2018, p. 1). The flooding caused by tsunamis is a result of water being at a higher level relative to coasts and islands.

Comparatively, the king tides is a seasonal tidal set of waves and can be described "as merely the highest spring tide" (Lin *et al.*, 2014, p. 212). It is a cycle much larger than a normal wave and is caused primarily by warming waters (similar to cyclones), during the Pacific summer between January and March. However, the king tides are starting to become higher as a result of a warmer ocean, leading to further reaching waves and more severe coastal-flooding (Lin *et al.*, 2014).

In comparison to king tides, storm surges are giant waves that are a consequence from storms, in which the winds from these storms drive the water towards the coast (NOAA, 2019).

Storm surges during the 2015 Cyclone Pam forced the Tuvaluan Red Cross to evacuate the island of Nukufetau, where 300 people were compelled to move for safety (ICRC, 2015). As demonstrated in Figure 17, storm surges can be destructive, and their size can vary; in Tuvalu, during Cyclone Pam, waves ranged from 3 to 5 meters in height (ICRC, 2015). Storm surges will become more destructive as a result of cyclones intensifying and winds becoming stronger.

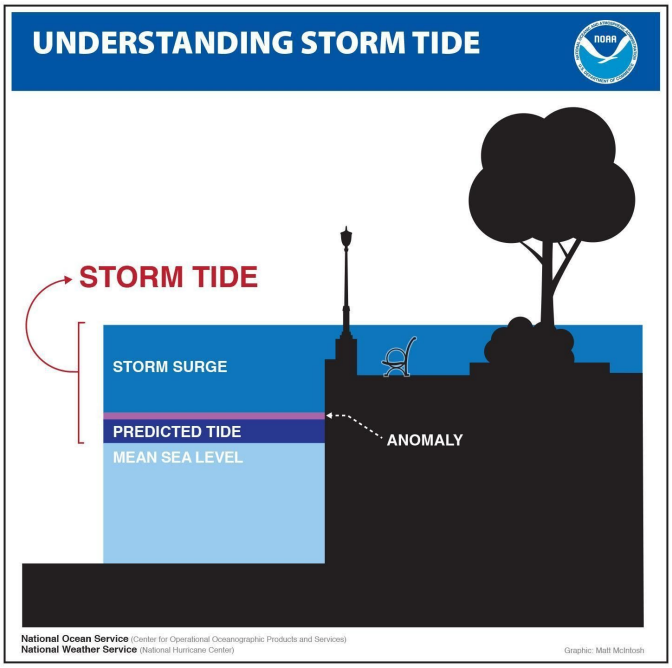

Figure 17: How a storm surge is formed and how SLR makes the surges higher. (NOAA, 2019)

All three wave hazards are worsening in their severity due to an increase in warming waters. Largely, they all contribute to an increase in coastal-flooding.

Coastal-Flooding

With greater severity in sudden-onset disasters and waves, floods are becoming more prevalent and are occurring in places they usually do not. With more floods and saltwater intrusion, comes a threat to habitability. The risk to an island's habitability is discussed in the next chapter, as the threat of floods towards food security is becoming a more serious concern.

However, there is an increased threat of flooding to low lying islands, as the islands are not only exposed to coastal-flooding but also have to manage rainfall, which, on its own may produce floods due to the low-lying islands size. IPCC states that with a warmer climate, the atmosphere will retain more water which increases the intensity of torrential rains, causing more rain in a shorter time (IPCC 2007; IPCC 2018). And more water in shorter periods means greater risk of floods (IPCC, 2007).

However, there are natural protective barriers, coral reefs as explained in Chapter Two, they protect islands against coastal-flooding. The coral reefs triple in their appearance as discussed in Chapter Two, they act as an ecosystem for fish, reduce the amount of coastal erosion that occurs on the beaches, and ultimately reduce the strength of waves.

The most significant problem associated with coastal floods is the increase in frequency of floods from higher relative sea levels. To this point, "[s]ea level rise not only amplifies flood heights but also changes the relation of flood height to flood frequency across locations" (Buchanan, 2017, p. 4). Scholar Buchanan expresses concern over the predictability of floods from RSLs. Since there is uncertainty about the amount of relative sea-level rise (how high the average sea level is), each Island and coastline will experience different levels of exposure and

severity. This is the case for a US Military base on the Kwajalein atoll. In a discussion with a retired high ranking US military official, the individual stated there were many considerations the US military took while creating the US military base on Kwajalein atoll, but there was not a single consideration for SLR and the coastal-floods. The atoll, a low-lying island, will experience severe SLR and more frequent coastal-floods in the near future. Thus, the US Army is faced with a decision to relocate the millions of dollars of military equipment and the entire military base to a different island or remain on the island and build seawalls.

Discussion: Societies Fixation with Short-Term Problems

Structured mitigation can be defined as equipment that lessens or prevents damage from natural disasters (Byrm, 2009 ; Youngman, 2009). Equipment for structured mitigation includes levees, dikes, seawalls, protective buildings, and sandbags.

A growing response around the world to prevent coastal-floods and higher waves is the use of seawalls, which come in many different structures. For rural communities, it could be the use of sandbags stacked up high, compared to Malè, where the concrete walls surround the entire city. Seawalls' primary objective is to protect communities, islands, and coasts from ocean and flood hazards, including high tide waves/king tides, storm surges, tsunamis, and coastal-floods. Seawalls mitigate damage, but ultimately allow communities more opportunities to develop, as many communities build right beside the seawalls.

An LA Times article in July 2019 asked, “Should California become one long wall of concrete against the ocean? Will there still be sandy beaches or surf breaks to cherish in the future, oceanfront homes left to dream about?” (Xia, 2019). The author then discusses

mechanisms to stop the sea from rising, stating the "go to tactic is seawalls." However**,** seawalls only provide temporary relief at the expense of high costs and more significant flooding in the future. However, seawalls contribute to coastal erosion - or the wearing down of natural barriers. Coastal erosion is one of the more significant elements in the discussion of SLR and protection of islands. Dr. Greggs, a scholar at the UC Santa Cruz Institute of Marine Sciences and Ph.D. in Oceanography explains that beaches have a natural cycle and are replenished with the tides as it brings sediment in and fills the beach (cited in Xia, 2019). The construction of seawalls disrupts and prevents the natural processes of beach replenishment. Beaches have a natural replenishment system where they draw sediment from higher up on the beach, but with the construction of sea walls, this process is disrupted. This inevitably results in the loss of beaches, and it coincides with the rise of sea levels (Krause, 1988), making seawalls a short-term option as they just delay the disaster.

Seawalls delay the issues, as they mitigate the damage created by hydrological hazards as discussed in the science chapter. They act to buy time as they reduce the beachfront, yet implementing seawalls is a costly mechanism, but effectively reduces short-term hazards of flooding and storm surges/tsunamis by keeping water out and reducing its effect with concrete walls. Through increasing the severity and frequency of SLR, seawalls eventually must be lifted or they risk being ineffective. The costs are higher over time as they are implemented, primarily as a result of the constant maintenance needed to keep seawalls functional. The long-term consideration can be summarized into four points:

1) Higher waves and increasing SLR requires seawalls to be lifted in order to be effective. The maintenance and raising of seawalls require the original materials in which the

seawalls were built with. This was the case of the African Islands of Comoros, a Small Developing Island States (SDIS) off the coast of East Africa near Madagascar as shown in Figure 18 . In a Betzold & Mohamed (2016) study, they concluded that in Comoros many residents asked for their seawalls to be lifted, but the government was unable to assist and one could speculate that it was a result of high finances costs. In Comoros, it is an island nation with low political and financial capacity, and the nation has to rely on donair aid to fund its implementation and maintenance of seawalls (Betzold & Mohamed, 2016).

Figure 18: Map of where Comoros is located - (taken from Countryreports.org. 2020)

The seawalls around villages in Comoros are primarily a mix of sand and concrete. Sand is one of the most common items in informal seawalls, as it is used in some seawalls, are sandbags. However, the problem with using sand in seawalls, is it is often taken from a local

beach contributing to beach and coastal erosion. Seawalls, as in the case of Comoros and others, mainly require maintenance as a result of the need for concrete meaning residents wait long periods of time, due to the lack of technical expertise needed to fix the walls (Betzold & Mohamed, 2016).

2. Seawalls and structured equipment lull communities into a false sense of security over time. Seawalls must be constructed properly or they increase the vulnerability of the community over time. The increase in vulnerability comes from coastal erosion and SLR as the hydrological hazards are worsening. However, residents may assume there that their seawalls will be effective against the hazards, yet as illustrated in the Betzold & Mohamed study, the lack of technical knowledge resulted in poor designs and construction of seawalls. Meaning many locals with limited formal knowledge were the ones who build and maintain the products. As the seawalls are not properly built, they increase vulnerability. As well, lack of regular repairs expose the seawalls and become highly susceptible to the SLR and floods.

This is also the case in the Maldives, as it appears the individuals who rely on the structured equipment may have false confidence in these structures. This is especially evident when individuals create and maintain the structured equipment themselves, as illustrated in a Maldivian Government report by Dr. Shaigs (2011) stating that "Failure of hard structures is generally seen as a fault with workmanship. However, in reality, most failures are equally related to poor design" (p. 40). Thus, while many believe the structures will keep them safe, their improper care makes them ineffective and vulnerable.

3) Concrete seawalls sink when the ground is not supported. Ironically, this is the case of the rebuilt levees of New Orleans. After Hurricane Katrina in 2005, the US Government

commissioned a revamping of the New Orleans levees. Figure 19 illustrates the damage the broken down levees had on New Orleans. The project was undertaken in 2005 and completed in 2018, but the costs were estimated to be around 14 Billion (US Army Corp of Engineers, 2019). However, a new study by the US Army Corp of Engineers demonstrates that the levees are 'sinking' and require future lifts. The primary cause is that New Orleans' soil is characterized as weak, and SLR is exacerbating this process (US Army Corp of Engineers, 2019). The US Army Corp (2019) also believes that by 2023 (5 years after its completion in 2018), the levees are not guaranteed to protect against the one hundred year flood.

It is worthwhile to consider that a 14-billion-dollar seawall/levee does not provide maximum protection against SLR and the hazards. Now consider that one of the best engineer groups in the world with a significant budget cannot provide maximum protection. Can small island states with low capacities - then expect seawalls in small islands to protect them against SLR in the future.

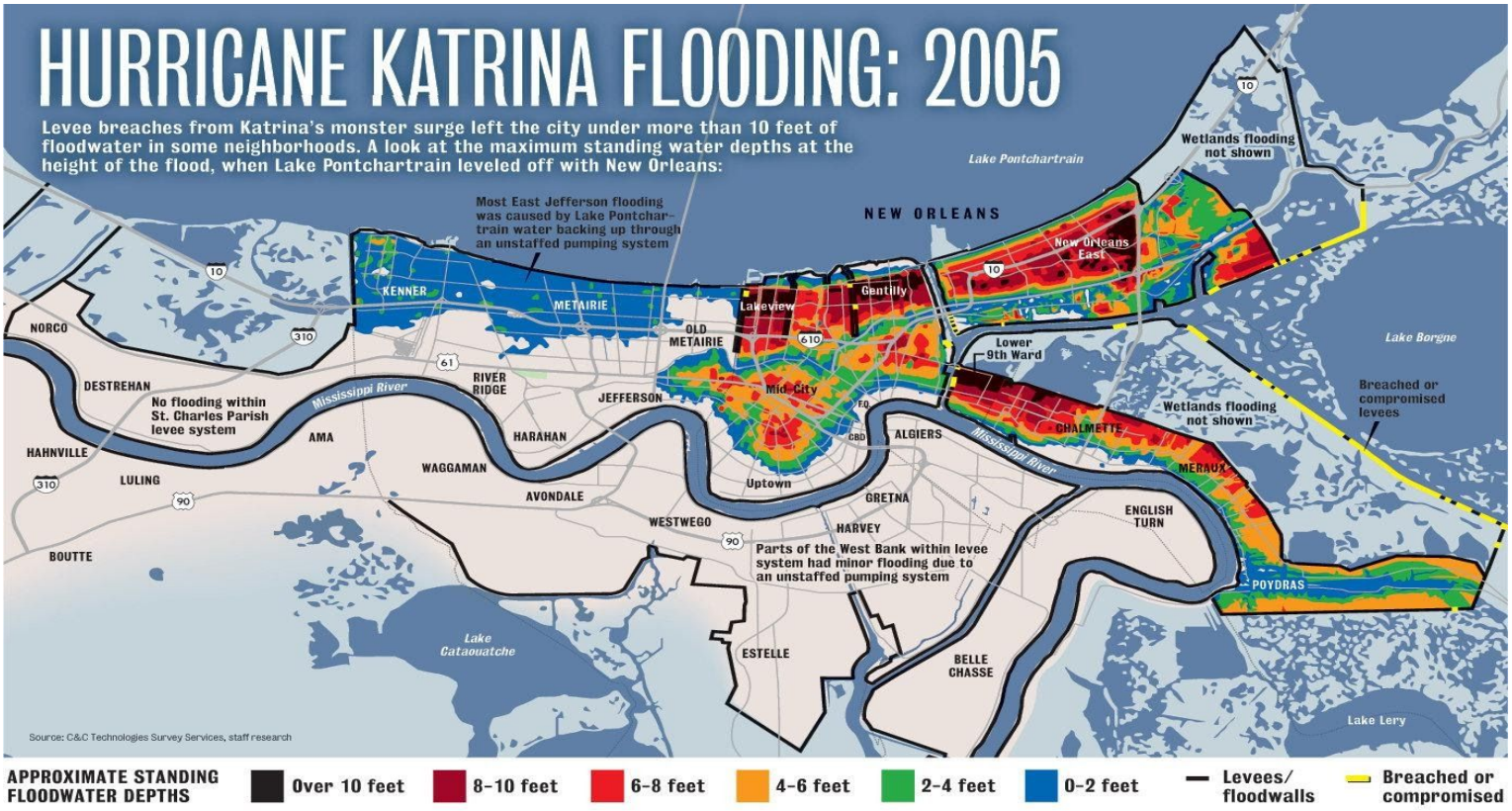

Figure 19: A map of Hurricane Katrina Flooding 2005 - notice the yellow lines on the right and the black lines near the top. (Taken from NOLA website - Swenson 2013)

4) When seawalls are implemented on islands and coastlines, water becomes trapped on the backside of the wall (Kamphuis, 2010). Seawalls must have some form of drainage and these systems tend to cost a significant amount of money. This causes floods, but can worsen the structural integrity of the walls and make them unstable (Kamphuis, 2010). Therefore, considerations must be made for drainage and pipelines - to move the water from behind the wall and back into the sea. However, Kamphuis states this is one of the common problems, and it occurs as a result of water levels getting higher (2010).

To summarize, seawalls must be constructed and maintained with expertise as inadequate structures only provide a false protection. Moreover, the continuous maintenance and the initial implementation requires a large financial commitment. In the short-term they are costly, but in the long-term they represent continued maintenance. This adds to the overall expenses which includes costs of expertise, repairs, and lifting the walls. All four considerations of seawalls represent a significant financial burden in the long-term.

The all encompassing costs of seawalls provide short-term and temporary protection against SLR and floods, but at a high cost. To summarize, the long-term consequences of building seawalls, creates erosion, and results in increased vulnerability.

Applied Case Study - The Maldives

As explained in Chapter One, the Maldives experiences cyclones and significant coastal-floods, however the islands are also exposed to tsunamis as it is in proximity to a fault line that produces underwater earthquakes. The Maldives has some available capital for implementing and maintaining projects, yet this is not the case for rural islands, but only urban centers. For example, as a result of past disasters, "[t]he entire perimeter of the capital Male is now protected by seawalls" (Esteban *et al,* 2019, p. 8). In Malé, they have the capacity to purchase and maintain seawalls which provide short-term safety. The equipment used to prevent hydrological floods from occurring has been effective since 2011 (for Male, the capital of the Maldives - Figures 20 and 21), although it appears the Maldives residents and business owners have become reliant on them as a result of their current effectiveness. As well, more seawalls are

being purchased, installed, and maintained on smaller islands, mainly by tourist resorts (Schultz, 2017).

Figures 20 and 21 are called the “Great Wall of Malé” (Esteban *et al*, 2019, p. 18)

Figure 20: Photo of the Maldives and sea revetment using tetrapods as the mitigation equipment

Figure 21: Photo of the Maldives and using rock revetment as the mitigation equipment

Many rural islands have opted to use soft structures (sandbags, light seawalls, etc), but found the equipment requires continued funding to maintain. Yet, they do not have the resources to continuously fund the maintenance for the equipment, making them useless. The financial costs reflect a dichotomy between the wealthy and the middle-class residents in the Maldives. Not every island in the Maldives has the capital to implement a seawall, nor the capacity to maintain it. However, since there are more people and infrastructures (government buildings) on Malè, they are more likely to get attention and continual government funding.

How is Reliance on Structured Equipment Manifested?

The use of seawalls and other structural mitigation increases complacency and gives a false sense of security. A 2019 research survey conducted in the Maldives by Kelman *et al.* illustrates interesting findings about optics of climate change and SLR. The survey states:

> Perceptions of impacts from neither climate change nor environmental change were especially highlighted as a reason to move internally or overseas, temporarily or permanently… Interviewee #109 believes that climate change impacts 'might not happen in my life time'; #37 expressed, 'It's very long time in future'; and #64 stated, 'Our generation will survive; don't know about the future (p. 292- 293).

Therefore, individuals are okay with using short-term equipment as they know it will be efficient in their lifetime. As seawalls are effective short-term therefore, they receive funding and become the 'go-to' structure to mitigate hydrological and rapid-onset hazards. Communities are able to demonstrate short term cost-benefit analysis that the equipment works effectively. However, little consideration is given for long-term effectiveness of the wall.

If there are a lack of hazards, the population grows complacent and the perception of a threat diminishes. Once there are less perceived threats, then there is inherently lower attention given to structures, which ultimately leads to greater vulnerability. This perpetuated cycle is one of the sole reasons disaster managers and societies should not be reliant upon structured mitigation, as they only delay the hazards. To summarize the concerns about overreliance on structured mitigations, Youngman (2009) states mitigations are "helping to diminish risk in the short term, while actually making things worse in the long term" (p. 187).

In reality these structures cost significant amounts of money to reduce vulnerability in the short-term, but the evidence proves that seawalls increase the speed coastal erosion occurs, and therefore increase vulnerability in the long-term.

Moreover, in the survey conducted by Betzold & Mohamed (2016), individuals on Comoros were satisfied using short-term options such as seawalls because they know they are effective in the short-term. However, they also realize there are other innovations which could be better, yet the choices are unproven and may not be worth implementing. Communities are more likely to opt for a solution which is proven, and not for a new innovation (Betzold & Mohamed, 2016). Financial considerations are made in this situation, as societies will choose effective measures which work in the short-term instead of a new innovation which could cost more, and may not work.

Conclusion

There is evidence that SLR and its secondary disasters are increasing in severity and frequency. Thus, exposure to floods, hurricanes, and higher waves, island nations will experience greater strain, forcing them to prepare, adapt, and find capacities to cope. However, many communities opt for short-term answers to long-term problems creating increased costs and increased future vulnerability. The Maldives' reliance on structured equipment to reinforce seawalls comes at great costs, as seawalls erode the landscape and increase the severity of coastal-flooding.

Long-term consideration must be made to find new innovations to reduce the destructiveness of SLR and the secondary hazards. If no innovations are found, communities will be caught in a perpetuated cycle of structured equipment with false sense of security.

Chapter Four: Cascading Effects on Social Aspects of Low-Lying Islands

As discussed in the previous Chapter, with increased severity of the secondary hazards of sea level rise (SLR), societies may only have the capacity to focus on short-term hazards, and will neglect possible long-term solutions. Short-term and long-term reactions to SLR include land reclamation practices, where nations and companies move terrain (sand, concrete, clay, silt, etc.) onto beach fronts and reefs, to create habitable land. However, as discussed in this chapter, cascading effects from secondary hazards of SLR result in three social implications: 1) urbanization, which further compounds spatial issues; 2) insecure sources of food such as fish, agriculture, and more imported food, and 3) poor housing locations systems. These effects combine to create significant concerns and vulnerability for individuals and families residing in vulnerable areas, as illustrated by the case study of Tuvalu and Cyclone Pam.

This Chapter illustrates that low-income families and individuals are disproportionately affected by disasters. Specifically, the Chapter analyzes the spatial concerns of overpopulation and urbanization on low-lying islands, ineffective and poor use of land reclamation or artificial islands, and severe food insecurity.

Background Factors

A cascading effect is caused by an initial event which then triggers the ensuing ramifications from the hazard, which can be more destructive and disruptive than the initial hazard (Schauwecker *et al.,* 2019). SLR is the initial hazard which has worsened the severity of secondary hazards discussed in Chapter Three, which include coastal-flooding, king-tides, storm

surges and cyclones. The direct cascading effects - food insecurity- are directly influenced by the secondary hazards. However, it must be noted that overpopulation and land reclamation processes compound the consequences of food and water security and housing issues. Land reclamation is the creation of artificial land, which reduces overpopulation in urban centers. However, it is a costly process and population oftentimes outgrow the available space. Overpopulation follows, as individuals move to urban centers looking for economic opportunity. When more land is needed for individuals to reside on, the high-risk areas are typically developed at lower prices (Brym, 2009; Youngman, 2009). Therefore, urbanization and land reclamation are responses to cascading effects, and by themselves compound the problems of food security and housing.

Spatial Concerns, Overpopulation, & Urbanization

Over the span of 70 years, urbanization and overpopulation have subtly influenced low-lying islands. This is apparent in Table 5, which lists the population of low-lying islands referred to in this paper.

Table of increased populations for select low-lying islands over 70 years (UN, 2019)			
	1950 Population	1990 population	2020 population
Kiribati	33,000	72,000	119,000
Tuvalu	5,000	9,000	12,000
Maldives	74,000	223,000	541,000

Table 5: Population increase over 70 years (UN, 2019)

Table of population density for select low-lying islands over 70 years (UN, 2019)				
Country	Country size*	1950 Population Density : Individuals per square KM	1990 Population Density : Individuals per square KM	2020 Population Density : Individuals per square KM
Kiribati	811 KM^2	40.8	89.4	147.5
Tuvalu	25.9 KM^2	155.9	297.0	393.1
Maldives	297.8 KM^2	245.7	743.9	1,801.8

Table 6: Population density for low-lying islands over 70 years. (UN, 2019)

Both tables show significant growth in populations across four different low-lying islands. People urbanize for a variety of factors, but if we consider Tuvalu over the last few decades, the capital island of Funafuti has seen an influx of migrants from the outer atolls in search of jobs, better health facilities, and educational opportunities (Locke, 2009; Bedford & Bedford, 2010; Taupo *et al*, 2018). The Pacific Island's exposed land is becoming less viable, and forces those who cannot immigrate internationally, instead to urbanize to the closest large city, which increases pressure on already weak labour markets (McAdams, 2012). Larger cities typically have more jobs and better resources, however the increase in exponential population growth has a secondary effect - less usable land where land is already sparse. Table 6 shows the growing concern of population density which has exponentially grown. Interestingly, what both tables don't show is the spatial use of the land. Some of the land isn't habitable, but is actually just

beaches and swamps. To this point, when there is more usable land, societies can use the extra land for agricultural purposes. Therefore, an understanding of the population density will be more important for food security.

While population density does show some good statistics, it does not account for truly habitable land - like living on a beach compared to stable and habitable land. As well, there is no distinction made between disaster high-risk land (such as living in a flood plain) and low-risk land. In cases where land is scarce, people live and continue to develop on high-risk land which has greater vulnerability. Risk can inherently be mitigated through proper land use planning, however, the land is often sold and resided upon by individuals with less financial capacity - oftentimes the relatively poor. The natural disasters which occur upon these low-lying islands can expose the dichotomy divide in socio-economic situations. This is echoed when scholar Klinnenberg (1999) states, "environmental events are revealers of social conditions that are less visible but nonetheless present in everyday life" (p. 242). The divisions in race, age, and wealth can produce circumstances where individuals have more exposure to disasters, as they cannot afford to live in one area. This was the case after Cyclone Pam in 2015 (further analyzed in this chapter) for some Tuvalu residents, as illustrated by Noy and Taupo (2016) where they found that roughly 50% of respondents in a survey stated they ,"lack(ed) the financial resources" to relocate from cyclone prone areas (p. 30). Ultimately the lesson is that overpopulation entails more families and individuals living in hazardous areas. As well, with higher costs for reclaiming land, there will be less places for poor individuals. High-risk areas are often cheaper to maintain and to purchase, meaning low-income populations have higher vulnerability when it comes to

exposure to disasters. Overpopulation produces spatial concerns, such as use of land which has high exposure and also reduces the amount of land used for agriculture and water purposes.

This is the case for residents of Tuvalu, many individuals migrate to urban centers for jobs, health, and education, however, they are causing social and environmental problems. These come in the forms of more insecure water supplies and inferior critical infrastructures (Milan *et al*, 2016). For individuals who have migrated to South Tarawa (the capital) in Kiribati, tensions have risen as a result of the lack of land (UNCCPR, 2020). This has become increasingly evident as the population in South Tarawa experienced significant growth from 1,641 in 1941 to 50,000 in 2010 (UNCCPR, 2020). The effects of urbanization are also felt in Malè where there is a significant problem of rapid growth disrupting critical infrastructures such as freshwater, sewage and sanitation, and waste disposal (Kelman, 2019). Therefore, it is fair to say that all low-lying islands are struggling with overpopulation and land allocation for housing or agriculture, and freshwater reservoirs capacity (McCubbin *et al*, 2017).

Overall, for Pacific Islands, the population and population density is becoming a greater threat and current projections over the next 30 years show an expected increase in population to exceed 18 million, from a high of 10 million in 2010 (Hugo & Bedford 2012). These problems associated with overpopulation continue to appear on smaller islands that are 1 to 2 KMS wide, and these issues continue to worsen as the population increases. With an increasing population and more urbanization, it has forced land-use planners to find methods of increasing their space. One of the methods is using land reclamation, which is especially prevalent in China.

Reclamation / Artificial Islands as the Short-term Answer

The short-term destructiveness of SLR and its secondary hazards has influenced where societies develop and expand. Increased habitable land has a number of benefits such as commercial development, real estate and housing. Subsequently, there are two primary issues associated with living in disaster-prone and low-lying islands: overpopulation and poor land-use planning. Overpopulation is and will continue to compound issues as RSLs continue. Secondly, by living within the hazard-prone areas, people are creating risk for themselves. For example, if a city develops in an area where there are yearly tsunamis versus if they developed in an area away from the hazard. This is to say, there is a significant risk in living on these artificial islands as more individuals residing in these vulnerable areas can amplify risk. Land reclamation is typically used as an alternative to building more habitable and usable land in a city.

Through engineering techniques, along with advancing technology, nations can create artificial islands and reclaimed land. Artificial islands range in their composition, from sand to concrete, and there are a variety of nations who have built artificial islands and use them. The most prominent example of an artificially built island, is China. They built the artificial islands to gain strategic advantage of trade routes in the South China Sea. Interestingly, the land reclamation processes in China have used a variety of materials, including silt (clay), sand, and concrete (Wu *et al.*, 2018). To start they cover coral reefs with sand, which in turn killed the coral reefs (the Guardian (China), 2015). Then the Chinese paved over the sand with concrete to provide the foundation (the Guardian (China), 2015). This potentially could be the precedent for how future artificial islands are created. However, these artificial islands destroy the natural

barriers that reduce the strength of waves (Quataert *et al*., 2015). As more reefs are replaced with artificial islands and reclaimed land, coastlines and low-lying islands become more vulnerable and exposed to the hazards of SLR.

However, the primary objective of the artificial islands has nothing to do with disasters and vulnerabilities levels, but rather the objective of creating new islands is to claim sovereignty over the large territory. China is building more artificial islands in the South China Sea, which is allowing for more controlled shipping routes and security, as evident in the Chinese Defense Policy Doctrine. China's new focus is to "safeguard national territorial sovereignty and maritime rights and interests, and maintain security and stability along China's periphery" (Defense Policy Doctrine discussed in Borger; Phillips, 2015). The new artificial islands have been successful in this matter, as they allow China to assert its regional dominance, as the islands are capable of being active military bases (Phillips, 2018).

Artificial islands are also used to create functional land for housing and commercial space. For example, Hong Kong will be one of the leading cities in the creation of these new artificial islands. Hong Kong has a serious housing crisis exemplified through a vast dichotomy between middle class and poor. Many of those that are poor residents are unable to afford houses in Hong Kong due to the expensive housing market, which was found to be the most expensive in the world as reported in 2019 (Performance Urbaning Planning, 2019). To address these issues, the Hong Kong Government has allocated $80 billion dollars to develop and create several artificial islands which will provide affordable housing. The 'Lantau Tomorrow Vision' project was proposed in 2019 and begins construction in 2025. It seeks to create new land and prove to be a valuable solution to solve the housing crisis (Zhao, 2019). The Lantau Tomorrow project

earmarked over 1,000 hectares of space to be made into livable, artificial islands through land reclamation processes (Sustainable Lantau Office, 2019). The change is significant as illustrated in Figure 22 - the current map of Hong Kong, to Figure 23, the proposed changes in building artificial islands for Hong Kong.

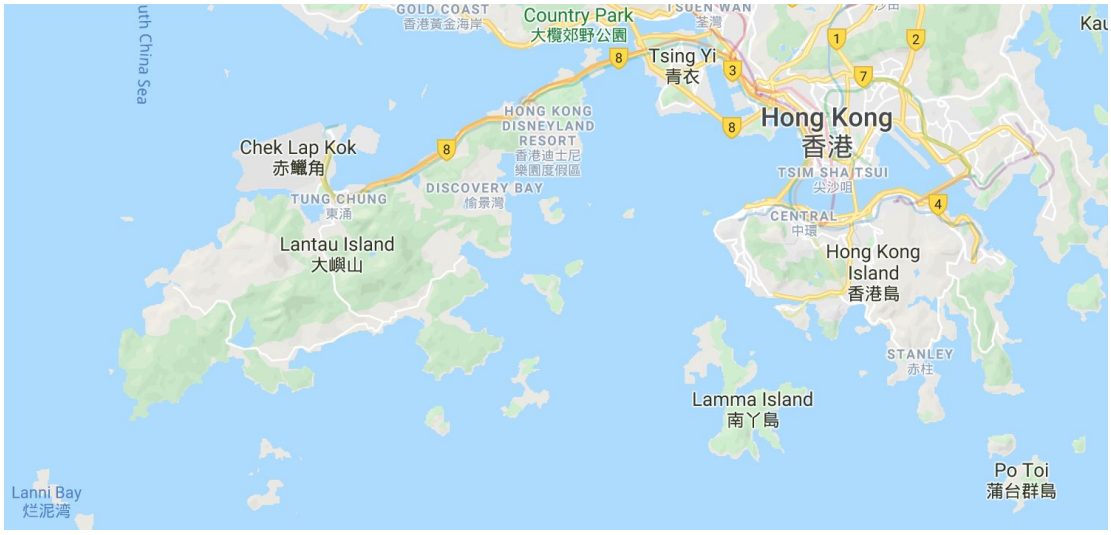

Figure 22: Map of Hong Kong in 2020 (Google Maps, 2020)

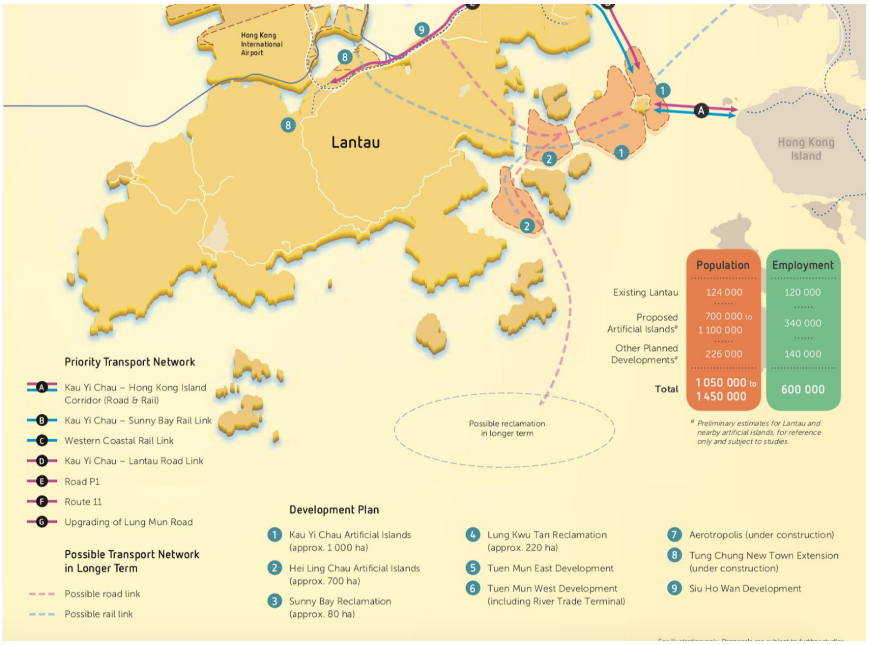

Figure 23: Map of Hong Kong for proposed artificial island development (Sustainable Lantau Office, 2019)

The pressing housing crisis is a concern for Hong Kong officials and is forcing the government to create artificial islands as a result. Unaffordable rent prices are contributing to an increasing homeless population, although some manage to afford housing by living in ‘coffin homes’. The coffin homes are illegal (as illustrated in Figure 24), subdivided units, where residents share spaces and have little room for sleep and privacy. The cost of staying in a coffin home is roughly 180 British Pounds per month, of which the funds are provided by a monthly government subsidy. Below is an illustration of one flat, where the author Benjamin Haas stayed a week in one of the coffin homes where 30 residents shared the 500 square foot flat (Haas, 2017).

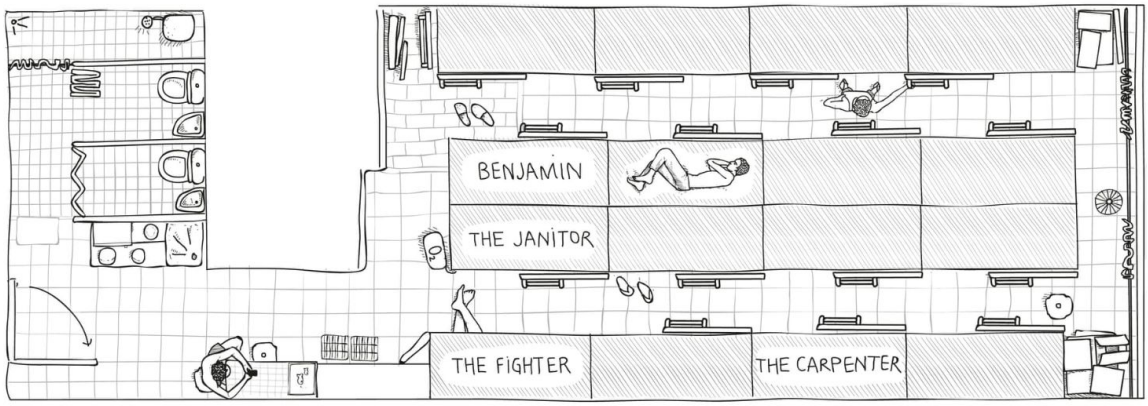

Figure 24: “A floorplan of the ‘coffin’ home. Illustration: Rachel Suming” found in the Guardian Article *My week in Lucky House: the horror of Hong Kong's coffin homes.* This illustration was from the author of the article - Benjamin Haas, who was located in the top left bed (Haas, 2017)

The ability to create islands and habitable land is impressive, but comes at a significant initial cost and recurring maintenance costs. Therefore, it is not necessarily reasonable for low-lying islands to build these artificial islands on their own. China, for instance, sets the standard for how future artificial islands will be created. Furthermore, the Chinese have offered countries such as Kiribati and other low-lying islands to create artificial islands and reclaimed land. Given that many countries would not be able to afford it, they are likely to accumulate debt in exchange for the potential to have a habitable island. As such, it is apparent that nations may not have the option to focus on long-term hazards such as SLR, as the short-term disasters are increasingly worsening.

However, for more feasible low-lying island land reclamation processes, one can analyze Tuvalu and their methods of reclamation which are currently more widely practiced. Within

Tuvalu's proposed Green Climate Fund project, they budget using previous project costs. They conducted a cost benefit analysis from previous projects, understanding the positives and negatives of equipment like beach restoration and seawalls.

Tuvalu, practices beach renourishment - where gravel and sand is dumped onto diminishing beaches. The benefits to doing beach regeneration is that there is a massive supply of sand, grave, and sediment, in which the government of Tuvalu purchases and uses to maintain their beaches. However, the consequences of these restorations is that they are somewhat costly. For Funafuti, the cost is estimated at $9,866 per metre, meaning costs for reclaiming can range in the tens of millions, something that Tuvalu may struggle to maintain decade to decade (Green Climate Fund Funding Proposal, 2016)

The costs should always be estimated to be more as a result of the increased number of higher waves and sudden-onset disasters which replenish and take away beaches. This is the case for the same reclamation practices for Tuvalu's Fongafale island which spent 1.9 million USD from 2012-2017. However, these projects to reclaim land are not without their risks which include improper construction, chemical spills, and coastal erosion in the Green Climate Fund Proposal (2016). The first risk is limited workers and resources, along with high staff turnover and is classified as a medium threat (Green Climate Fund Proposal, 2016). This is problematic as it impedes continuity and contributes to improper construction of reclamation practices. As well, these projects need to be completed in a timely manner, and staff shortages can impede their completion. Secondly, the risk of construction materials spills is considered low, but these projects use chemicals and other harmful material that seep into ground (Green Climate Fund Proposal, 2016). Spills can have serious implications on groundwater, structure and integrity of

product, and harm food security. Lastly, changes in coastal erosion is considered low risk to projects, as there are assessments conducted on the land to where the reclamation process is conducted (Green Climate Fund Proposal, 2016). However, in relation to all these coastal reclamation and developing short-term projects, there is a note of serious concern:

> Coastal protection is undoubtedly an urgent priority shared by all levels of society. At the same time, there is a sense of "consultation fatigue" within Tuvaluan communities. This is because of some of [the] past development assistance that had a series of consultations without concrete benefits on the ground. This could potentially create impatient demands to see the construction as soon as the project implementation starts (Green Climate Fund Proposal, 2016, p. 58).

The fatigue experienced by communities makes them less willing to see the benefits of these projects. Consultation fatigue can also contribute to the desire to utilize less effective construction as communities become unwilling to wait to see the results. This in essence contributes to short-term thinking, as communities are unwilling to implement projects that would assist in the long-term.

Therefore, reclamation practices which occur over years must show some semblance of working to mitigate and prevent disasters. However, since disasters like king tides and coastal-flooding are becoming more frequent and are creating higher waves with sea level rise, the beaches and practices must build their response mechanisms higher. One can infer that this contributes further to the fatigue the communities feel as the short-term development and response is just not enough to combat the increases in severity for disasters.

However, the difficulty of these practices is ultimately it is creating more housing in areas which may have greater exposure to disasters. As the artificial islands are put on top of the

natural barriers, it takes out the mitigation the area had. This means these islands, while creating more affordable housing, are creating areas which will have high exposure to disasters. Hazardous areas are cheaper to reside in, and also typically have less equipment which mitigates disasters (Youngman, 2009 ; Brym, 2008).

Therefore, the secondary disaster's cascading effects and consequences can be said to have already influenced societies and nations' response and recovery apparatuses, as evidenced by the need to create a higher artificial island. It is also apparent that nations may not have the option to focus on long-term hazards with their high costs as illustrated with the creation of an 80 billion dollar artificial island, as compared to a short-term beach restoration of which costs are increasing. Above all this, there are significant concerns with land reclamation as it creates cheaper housing with high vulnerability. As will be discussed in the following section, these practices also influence the security of food and water on the island.

Food and Freshwater Security

The land reclamation response to SLR influences multiple aspects of food and freshwater security. Each part discusses a different aspect of how there is greater insecurity, and how individuals have faced great vulnerability which will continue to worsen. This section is composed of four parts: (1) freshwater vulnerability, (2) increasing constraints on fishing and seafood, (3) agriculture insecurity (4) overreliance on imports, including foods high in sugar and preservatives.

Freshwater Vulnerability

For many low-lying islands, there are some sources of freshwater, as well as food that is grown locally. As illustrated in Chapters Two and Three, low-lying islands have high exposure to coastal-floods, which on its own, can ruin sources of freshwater and ruin crops grown on these islands. Urbanization is influencing all low-lying islands, and this is evident in Kiribati from a report from the United Nations International Covenant on Civil and Political Rights (UNCCPR) (2020) which noted that in South Tarawa, the capital of Kiribati, freshwater taken from the groundwater deposits, started to degrade at a fast rate due to pollution and increased population. With rising population, sanitation and pollution resulted in more freshwater sources being unusable (UNCCPR, 2020). The increase in population and increased reliance on short-term responses to SLR snowballs for low-lying islands, as these cities, must expand to assist the population, but in doing so, add more exposure to their freshwater sources. Freshwater is becoming scarcer on some low-lying islands due to floods and increased use. Water is the foundation for all life, and without clean drinking water individuals may be unable to live on the low-lying islands. While there is concern with freshwater groundwater sources, the implementation of rainwater catchments systems has reduced the vulnerability in some countries including Tuvalu.

Increasing Constraints on Fishing and Seafood

The responses themselves to SLR have primarily been to restore land or reclaim it. From the case in Tuvalu, this is a short-term mechanism, which is not always useful and can have

consequences. To have a consistent source of food and water is significant for low-lying islands across the world, as the isolation means local governments must import. If islands are reliant upon outside sources, the vulnerability in terms of having enough food is critical and must be a future consideration. One of the significant consequences of land reclamation is the destruction of coral reefs. As discussed in Chapter Two, reefs not only act as a natural barrier that protects against waves and storms, and as more bleaching of the coral reefs occurs, it not only exposes the coastline to waves and storms but influences the health and replenishment of fish (Kelman, 2019). As well, ocean acidification hurts the food security systems. This means food from the coral reefs and ocean in general is going through greater strain which could affect the amount of fish and ocean products islanders are able to catch and harvest. If ocean ecosystems continue to worsen, fish may become more difficult to find.

Agriculture Insecurity

Furthermore, more frequent urbanization is reducing the usable space for farming and freshwater deposits. The Pacific Island's exposure forces individuals to move from rural locations to cities, in which pacific islands have a weak job economy (McAdams, 2012). Furthermore, most low-lying islands are typically atolls, which are very poor in soil nutrients for crops, primarily as a result of their high pH levels and others (Weeb, 2007). Additionally, atoll soils are naturally deficient in nutrients required for successful crop growth, and due to their high pH, important micronutrients such as iron and zinc (already present in very low concentrations) are made less available for plant uptake (Barr 1992; Webb 1994). Many of the usable spaces for

farming in the past do not have the same allotted space, as well the quality of soil is poor. This meaning agriculture on low-lying islands is becoming more difficult, thus increasing the reliance on imported and processed food.

Over-reliance on Imports

The problem with much of this imported food is it has terrible nutrient properties and contributes to diabetes on many of the low-lying islands (Webb, 2007). Not only is there difficulty in the fishing industry from acidification, farming from lack of space and poor soil, but the most available food is poor in nutritional value. The food is slowly killing the residents of low-lying islands. With added vulnerabilities to the sources of the nutritional food - such as farmed local food and fish, the effects of SLR are crushing for these individuals. The lack of quality soil contributes to the need to import food which is typically processed. The concern is the alarming rate of diabetes as a result of the import of cheap processed food (Webb, 2007). Therefore, you not only have food security issues for growing food on the island and fishing issues with increased reclamation projections, but there is also vulnerability from imported food. These three food issues are significant and already take a toll on the daily lives of individuals living on the islands. If we look at Tuvalu, the average life expectancy is very low at 67.9 years, ranking 178 out of 228 countries as the food they consume is not healthy (CIA, 2020).

The cascading effects of rising sea levels are significant for the inhabitants of the islands of Tuvalu. Soil erosion, more frequent disasters and king tides, less freshwater security, and less liveable land may all contribute to making the Pacific Islands unsustainable to live on in the near

future. As well, slow-onset disasters worsen the viability of agriculture, as rising sea levels threaten food and water security and land nutrients. The total viability of farming and agriculture is exacerbated by the increased coastal erosion and salinization of soil, thus forcing farmers to migrate as a result of the lack of soil and farmable land to grow food (McAdams, 2012, p. 108-109). To summarize, rising sea levels are more than the total submergence of the land. The process, in this instance, is more destructive than the end result, as the rising sea levels are destabilizing food and freshwater security, exacerbating the socio-economics, and making life more difficult for the people.

Snowball Effect - Housing in the Applied Case of Tuvalu

This applied case looks at how disasters influence how individuals live, specifically outlining how a typhoon that was 1400 KMS away, significantly influenced the habitability of the low-lying island. Ultimately this section illustrates that with more urbanization, and higher costs of living, more families are residing in hazardous areas. When sudden-onset disasters occur there will be more damage as a result of where individuals live.

Tuvalu is isolated compared to other islands in the Pacific Ocean. The nine islands of Tuvalu are widespread and require time to get from one to another, however, more residents have migrated to Funafuti over the past 50 years. Thus there are low-income families who reside on Funafuti and other rural islands. Many of which rely on agriculture to maintain their livelihood, but also aggregate harvests with food imports. Since Tuvalu is far from any other nation, imports are difficult to get. As discussed before however, agriculture is difficult to

maintain with increased coastal-floods and already low soil quality. As indicated in a report in 2006, crops on the Tuvalu islands are becoming more difficult to grow and maintain due to high tides and rainfall in the growing areas (Webb, 2007). As well, fishing requires individuals to travel further than normal as land reclamation practices in Tuvalu are covering the coral reef to reduce short-term hazards. As Simonelli (2020) describes in her article, "The lagoon looks like a long white sand beach but is layered atop the previous reef corals pushing the local fish further out" (p 8). Thus, while the imports are difficult to attain, imported food is becoming a more significant aspect to living on Tuvalu. However, it will be the effects of SLR that will ultimately shape the foundation of these systems in Tuvalu and other low-lying islands. Other significant sudden-onset disasters also shake the delicate housing, food, and water systems of Tuvalu. While individuals are assisted by the share and care system (a basic social safety net which prevents people from living in abject poverty), people still live in high exposure coastal areas which often flood. Individuals and families are unable to move as a result of the lack of resources to relocate their house. This is exemplified during the recovery process of the 2015 Tropical Cyclone Pam. This section analyzes the significant effects of Cyclone Pam, which did not directly strike Tuvalu but still had considerable consequences.

Tuvalu has a significant disaster season, during the January to April months, the king tides cause higher waves meaning there is a higher chance for the saltwater to kill any agriculture and can ruin freshwater sources (Lin *et al.*, 2014). However, the freshwater sources are not as much of a concern on Tuvalu as they used to be. This is largely due to the installation of freshwater catchment systems on houses, which allow residents to drink and use the water they collect from rain.

Moreover, tropical cyclones are prevalent during that time which puts more pressure upon the food security. In terms of historical record, Tuvalu has recorded three cyclones per decade during the 1940s to 1970s (Connel, 2015). From 1969 to 2010, there were thirty-five recorded cyclones, roughly 8 per decade (PACCSAPP, 2015).

This divide is illustrated in the 2015 Tropical Cyclone Pam, which was a category five cyclone that affected 50% of Tuvalu's population, according to the Tuvaluan Prime Minister (Radio New Zealand, 2015). Cyclone Pam did not directly pass over any of Tuvalu's islands, but rather, was roughly 1400 KMS away (Taupo & Noy, 2016). The significant damage came as a result of the winds and storm surges, where "almost 20% of the GDP due to damage to properties, appliances, assets, and loss to plantations and livestock" (Taupo & Noy, 2016, p. 2). The storms inundated five of Tuvalu's nine islands, making homes, agriculture, and major critical infrastructure unusable, which forced evacuations (OACH, 2015). Tuvalu has high vulnerability from cyclones because of its low-lying geographic location. The vulnerability also comes from the size of the islands, the width of the islands, how remote the islands are, and finally, the heavy reliance on agriculture (Taupo & Noy, 2016). Tuvalu's exposure to rapid-onset disasters has led to greater vulnerability for those who live in areas that flood. The socio-economic divide is not apparent in abject poverty, but rather the divide lies in where individuals live, if they live in more vulnerable areas or less vulnerable areas. With more frequent urbanization, it also means that there is more development in the hazardous areas, ultimately meaning that more families will reside in high risk areas as these houses are often cheaper to purchase and maintain.

This proved problematic during Cyclone Pam and demonstrated a dichotomy between middle-class families and lower-class households in Tuvalu. The poor households were the groups that were most affected by the cyclone. Low-income families are prevalent in Tuvalu, and their vulnerability is evident in several aspects. Low income families live in vulnerable areas on the islands of Tuvalu closer to the coastline and in line with the elevation of the sea (Taupo & Noy, 2016). Taupo & Noy (2016) observe that "[t]he average number of persons in a household is higher for poor households" (p. 35). Among the challenges for the Tuvalu community was their recovery. In Tuvalu, individuals are not able to save money, and when there is damage from natural disasters, the loss is greater than it is for wealthy families (Taupo & Noy, 2016). Many families attempt to repair and rebuild their lives with their own money, and poorer individuals are relegated to reside in the most vulnerable areas in Tuvalu, as they have less capacity to utilize structured mitigations or prepare (Taupo & Noy, 2016). Many people live in vulnerable areas as a result of socio-economic status and have limited opportunities to relocate. This is illustrated in the Noy and Taupo survey, where roughly 50% of respondents "lack the financial resources" (p 30) to relocate from cyclone-prone areas. As well, since there has been more urbanization to Funafuti city, more individuals live in these hazardous zones.

In summary the cascading effects from SLR upon social aspects of day to day life is apparent in Tuvalu with housing. There is significant vulnerability to low-income families with housing in flood prone areas, which can only expect to see more floods from SLR. However, due to the increase in urbanization, more families live in high-risk areas. These strains to housing along with the effects of food insecurity mean low-income families face a growing threat. As the relative sea levels rise, so too does the vulnerability of these families. Ultimately, these

vulnerabilities have the potential to displace individuals, forcing them to areas and other nations which have more access to healthier foods and clean water.

Conclusion

A significant problem with sudden-onset disasters on low-lying islands is that hazards are becoming more threatening to the populations due to the lack of space/urbanization, food and water insecurity, and more exposed housing. With greater urbanization, space is becoming a luxury on low-lying islands, it significantly influences the consistency of food sources. On other low-lying islands, freshwater vulnerability becomes a concern with more salt-water intrusion. As well, urbanization also increases the number of houses that are in high-risk areas, as these houses are often cheaper. These factors, coupled with increasing severity in most disasters (sudden-onset and SLR), are compounding the vulnerability, and increasing the exposure to disasters.

What this means is high ranking government officials, disaster and preparedness institutions, planning officials, and civilians in communities must take new approaches to dealing with hazards which influence their cities. Yet, the fundamental issues of socio-economic divides are highlighted during disasters, and mitigating disasters will not solve them. There are no easy answers, and as SLR occurs at a quicker pace, these cascading effects will worsen until individual voluntary leave or are displaced. Ultimately, the decision will relate to the next legal issue, if individuals are considered forcibly displaced or if they leave under their own volition.

Chapter Five: Consequences of SLR: Environmental Displacement, Climate Displacee, and Statelessness

As sea levels rise (SLR) and sudden-onset disasters intensify, vulnerability for individuals on low-lying islands increases. The primary disaster, SLR, will force individuals to make tough decisions regarding staying for as long as one can, versus voluntarily moving to a safer location. As well, the consequences of the secondary disasters - rapid-onset disaster, along with the cascading effects of food and freshwater insecurity - will force more considerations for individuals to remain on their land or relocate.

For low-lying islands that have more exposure to hazards, there is a considerable increase in risk in 'climate-induced displacement' or environmental displacement (Kalin, 2011). Environmental displacement is when an individual is displaced as a result of a natural disaster. Environmental displacement ranges in criteria from sudden loss of a home to voluntary movement. In his article *Environmentally-Induced Displacement and Human Security*, Bogumil Terminski (2013) discusses the issues of a gradual deterioration of environmental conditions; and how short term severe disasters displace many, and trigger evacuations while gaining high media-exposure rates. However, Terminski believes that the environmental displacement that occurs in long-term slow-onset hazards, such as soil degradation, water shortages,

desertification, and SLR, are more severe than short-term hazards, as they irreversibly transform the environment. The insight one can gain from Terminski is that long-term environmental displacement should be the most extensive consideration when determining a definition for environmental displacement. In the 2011 Nansen Initiative Conference, chairperson Wahlstrom believed there was a need to explore the following consequences, large scale displacement, migration, and relocation - of these long-term environmental hazards.

In summary, environmental displacement is a long-term threat for SLR that is becoming more severe and difficult to provide protection against. The most likely scenario of SLR illustrates the gradual increase of sea levels on coastal land, which causes some areas to have increased vulnerability, and threaten food and freshwater security (McAdams, 2010). This will ultimately result in inhabitable land and displacement. Ultimately, this Chapter sets out to address how displacement and relocation are implicit within SLR.

This Chapter analyzes the subsequent consequences of SLR, secondary disasters, and cascading effects. In particular, it explores the legal implications of environmental displacement and statelessness through several elements. The Chapter explores the definition of climate refugees or climate displacees, the legal issues, the solutions to the issues in relocation, the factors inhibiting relocation, statelessness, and then concludes with an analysis on a 2019 case of refoulement by a Kiribati Citizen.

Climate Displacees

For residents on low-lying islands, SLR and other disasters threaten entire communities and individuals. These individuals and groups risk displacement, and once displaced from the

environment, they may lack agency and are forced to relocate within the same country or outside of it. These individuals become 'climate refugees' or climate displacees who are displaced by the climate, either by sudden-onset or slow-onset disasters. The source of environmental displacement can range from desertification, rising sea levels, drought, to floods, hurricanes. Not only do climate refugees experience the hardship of displacement, but they encounter additional problems such as a lack of legal protections.

Background - The Problem

The most significant problem for those displaced by the climate - climate displacee - is that there is inadequate legal protection. Climate displacees do not qualify as refugees as they do not fall under the category of those displaced because of their "race, religion, nationality, membership of a particular social group, or political opinion" (UNHCR- United Nations High Commission for Refugees 2011, p. 3). The United Nations Convention for Refugees states that refugees must be unable or unwilling to return to their place of origin as a result of persecution (UNHCR, 2010, p. 3).

An Inter-Agency Standing Committee document (2008) illustrates why environmental displacement can consequently create poverty, which does not fall under the criteria of the Convention and Protocol Relating to the Status of Refugees. The primary reason for this is that during the creation of the 1951 Refugee Convention, environmental factors were not considered, and that environmental displacement or other factors do not meet the criteria. In fact, the document goes as far to recommend not using the term climate or environmental refugee, as the

Inter-Agency Standing Committee believes the terms could undermine international legal protections and misinform individuals about the climate and refugees. For the purposes of this chapter, the term climate displacee is used instead. Finally, they discourage the term as they believe it will further create general confusion about the term, and the relationship between environmental displacement and migration (IASC, 2008). However, from this lack of legal protection for climate displacees, individuals may be threatened with statelessness. Thus, the onus falls upon the state to internally relocate individuals.

Internal Relocation - The Only Available Protection

The difficulty in finding protection for individuals displaced is that there are very few organizations that can enforce protections. International organizations including the United Nations, non-government organizations, and corporations, all have the ability to influence political decisions and lobby for more human rights and laws. However, there is only one apparatus that can actually enforce laws and human rights - the state. Therefore, while international organizations such as the United Nations High Commission for Refugees or Red Cross may act as an institution within a nation, they do not have the authority to enforce legal rights and laws.

The Doctrine of Internal Displacement lays out the criteria for who should be considered for those who are displaced. It states, “Internally displaced persons are persons or groups of persons who have been forced or obliged to flee or to leave their homes [...] as a result of [...] natural or human-made disasters, and who have not crossed an internationally recognized state border” (OCHA, 2004, p. 5). This is to say the environmentally displaced have rights within the

nation of origin. Their governments should be working to reduce the conditions that lead to displacement, which should be the case in low-lying islands who experience SLR. Furthermore, Principle 28 (OCHA, 2004, p. 14) of the Doctrine of Internal Displacement elaborates on a state's responsibility to resettle individuals:

> Competent authorities have the primary duty and responsibility to establish conditions, as well as provide the means, which allow internally displaced persons to return voluntarily, in safety and with dignity, to their homes or places of habitual residence, or to resettle voluntarily in another part of the country. Such authorities shall endeavour to facilitate the reintegration of returned or resettle[d] internally displaced persons.

Principle 28 is significant for the environmentally displaced, as it places the onus of responsibility on states, to make governments help their own citizens, by assisting them with resettlement. Moreover, it also identifies safety and dignity as guiding principles to resettlement. However, the reality of relocation is grounded in Kalin's theory of climate displacement; wherein time and magnitude are critical factors. For states with limited access to funds, having to investigate if individuals moved on their own or if they were displaced may be infeasible. Therefore, the perception of slow-onset disasters can be descriptive in the way that it displaces individuals, but also forces legal ambiguity.

Thus, the state and the apparatus of a nation are crucial to the protection of individuals, none more so for those who are environmentally displaced and relocated. This is primarily a result of the (OCHA) Office for Coordinator of Humanitarian Affairs' Guiding Principles on Internal Displacement (2004), which is the only legal mechanism able to protect those environmentally displaced. This was reflected in a UN document called *Planned Relocation*

Disasters and Climate Change: Consolidating Good Practices and Preparing for the future (2014), where forced or involuntary relocation within the same country is one of the mechanisms that must be used as an obligation of the state.

In terms of relocation, it has been used historically as a mechanism to combat sudden-onset disasters. Historically, voluntary relocation in New Zealand, Hawaii, and other Pacific Islands have been used as a response mechanism to coastal erosion and sudden-onset disasters (Campbell & Bedford. 2014). Entire villages would relocate as a means of survival (Campbell & Bedford. 2014). In the 1940s, groups/communities in the Pacific Islands arranged for migration periods to unaffected islands during difficult times when seasonal disasters would occur. These historical treaties were effective, as they allowed for flexible population movement. In addition, certain groups/tribes would move preemptively for seasonal sudden-onset disasters such as hurricanes/cyclones. When these migration periods were in effect, the treaties ensured the continuation of these group's cultures and the overall safety of communities. The most significant problem with the preemptive movement, however, is the question of cross border migration - moving a nation's population into another country. Cross border relocation triggers legal problems, as nations must have their own land and sovereignty, which may not be possible if an entire population is displaced to another country. Realistically, cross border is not an option currently, as individuals do not classify as refugees, nor have there been any cases of large-scale relocation across borders.

For the low-lying island nation of Kiribati in the Pacific Ocean, there is speculation that preemptive relocation is one of the objectives going forward. Kibrati has made significant progress in what individuals believe could be the plan to preemptively move their population.

Specifically, Kiribati generated the funds necessary to purchase an island, which then presented an opportunity. Kiribati's relocation plans started in 2014 when it purchased an island in Fiji. The island allowed the Kiribati Government to use it for agricultural purposes, which enabled them to develop infrastructure and other parts of the island (Radio New Zealand, 2017). Therefore, Kiribati has the ability to relocate internally displaced people, in a safe, dignified way, should the need ever arise.

Not only did the Kiribati government make considerations about relocation, but dignity. The government is intending to develop the island, and therefore, the island should have a source of basic necessities and labour market (Radio New Zealand, 2017). The specifics of what the Kiribati government is doing to develop the purchased island is still unclear, however they are preparing to plant and cultivate vegetables (Radio New Zealand, 2017). What remains to be seen is the items residents will be allowed to bring. Governments must focus on food and freshwater security. Another consideration is ensuring the island or land allows individuals to be safe and live sustainably. Dignity for how to develop the island must be made. Economist Kelly Wyett (2014) discusses how existing migrants who settle down on a new island will reduce the costs for future migrants to settle. Although initial costs for critical infrastructure are expensive, after their implementation, they only need maintenance costs and workers, which are both settled as individuals move to the island. Therefore, pre-planning for movement will encourage island development before all residents are moved. This is seen in the chain of islands of Tuvalu, where a court case which took place in 2017 illustrated the varying complexity of international law and environmental displacement.

However, there is legal ambiguity when purchasing land from another country for preemptive relocation. Scholars Yamamoto & Esteban (2017) state, “the purchase of the land does not automatically transfer sovereignty over it” (p. 153). This presents a sovereignty challenge, as there is a possibility of statelessness, as discussed in the next section. Therefore, movement within the same nation is the best and more viable option, as there is no loss of citizenship, culture, or representation from the government. Furthermore, the difficulties in the relocation are twofold, finding space to move its citizens as the most habitable land is already in use. Secondly, finding the capital to purchase and develop other islands is difficult as many low-lying nations have a little financial capacity.

Ultimately, if states cannot relocate citizens, then there is significant displacement. However, to understand who gets protection and who does not, it is important to understand the criteria for how we define environmental displacement.

Voluntary versus Forced - the Criteria for Relocation and Assistance

Understanding environmental displacement in a long-term context raises the question of whether communities and individuals have domestic or international protection if displaced by their environment. Walter Kalin (2011) further discusses the significance of slow-onset disasters and how SLR is changing the way policymakers think about responses and prevention measures. Kalin's discussion is centred around ‘habitability’ and if a family should make deliberations on relocating to avoid slow-onset disasters. The crucial difference is whether the move/migration to a different area or nation is permanent or if people may return. For Kalin, two factors are

analyzed for each case of environmental displacement - the natural disaster is assessed with time/duration element (length of time the disaster occurs) and a magnitude/severity component.

Time/Duration

In the discussion of time, an essential consideration within the debate is the type of displacement. There are two types of environmental displacement - forcible displacement or voluntary movement. According to Scholar, Dr. Graeme Hugo (2010), the forcibly and voluntary migration debate should be seen as a continuum where most groups fall more in the middle, instead of just classifying people as 'voluntarily moving' or 'forcibly displaced.' This creates legal ambiguity when determining if a group should be considered for additional assistance, as it is difficult to differentiate voluntary movement from forcibly displaced. According to Dr. Hugo (2010), people who are forcibly displaced "do not make preparations; maintain greater commitment to origin; are likely to be in a state of stress; [and] are less likely to bring assets; are less; likely to have connections at origin," (p 12). Rapid onset disasters like hurricanes immediately displace individuals, classifying them more towards the forcibly displaced side. It becomes more challenging to discern the difference between voluntary and forced population movement for slow-onset disasters compared to rapid-onset disasters, however. In slow-onset disasters such as SLR, there are small incremental changes over time, meaning there is a lack of destruction in a short period (Hugo, 2010). While forcible displacement is typically through a single event that occurs quickly, which gains more media attention, whereas with slow-onset disasters they do not receive the same media coverage as the large scale disasters, and complicate the justification of displacement. In particular, for example, since the people of Tuvalu are

facing a disaster that occurs incrementally over time, it brings more challenges in recognizing if the people are moving as a result of the environment or if they are being displaced. This adds to the complexity of how the people are displaced and makes it more challenging to include them in the convention's criteria.

However, the difficulty in categorizing the environmental displacement is twofold, one there are questions raised as to the actual displacement of the natural environment. Since there is incremental change year to year, there is no instant displacement. For instance, farmers who rely on selling their crops and food on islands are experiencing greater difficulty as increased coastal erosion, and saltwater flooding occur from rising sea levels. This forces the farmers into difficult situations and illustrates the discussion point of forcible displacement through sudden disaster, or are they voluntarily moving. The problem becomes how courts and refugee agencies distinguish between forcibly being displaced by sea levels, which cause substandard economic conditions compelling them to move, compared to voluntary movement as a result of poverty such as economic conditions. When analyzing voluntary versus forcible movement discussions, scholars Bedford and Campbell (2014) distinguish them by referring to those who are forcibly displaced as typically being part of a community. Forced displacement occurs to entire villages or societies (Campbell & Bedford, 2014). Comparatively, voluntary migration is not typically as large scale, and only occurs to households or individuals (Campbell & Bedford, 2014).

Magnitude/Severity

The size of the group displaced matters for the criteria of environmental displacement. Rapid-onset disasters displace more individuals at once, making the response somewhat more

visible to the general public compared to slow-onset disasters. Specifically, the subtlety of SLR is that it occurs incrementally, yet severely to the point of permanent displacement. Another consideration of SLR is the size of the group it incrementally displaces. SLR displaces small amounts of people over a long period of time. Thus the criteria of environmental displacement is often geared towards those who receive more considerable attention. The optics of the situation are essential, as international lobbying may be the impetus that redefines the criteria for the refugee convention. As well, slow-onset disasters increase the complexity of legal protection, as it is challenging to include a small number of people incrementally leaving overtime. Therefore those displaced by low magnitude events over time may not get the recognition others to do for high severity magnitude events. Ultimately, slow-onset disasters can trigger long-term displacement in small amounts; however, it also means those individuals may not be considered for internal displacement as they 'voluntarily moved'.

To summarize, this debate on voluntary movement and displacement is reliant on the size of the group moved and the relative amount of time. This is a significant problem going forward, as individuals who are displaced by the environment may voluntarily move, yet receive no protection. The difficulty in determining displacement versus voluntary movement is undoubtedly a legal problem, and it can also produce circumstances where individuals do not have any protections at all as many individuals are perceived as moving on their own or voluntarily.

Additional Factors Inhibiting Relocation

International Factors

There is a significant gap in international protection for individuals who are environmentally displaced to claim refugee status. The various factors of SLR, secondary hazards, and other cascading effects will create vulnerability for many individuals.

The low socio-economic class has no bearing over if one is considered as a refugee, as this would expand the criteria exponentially. It is only those displaced and persecuted who fear for their safety who are considered refugees. However, this leads to the other side of the argument, displacement by the environment may lead to fear of safety and an inability to return to the country of displacement. People who are poor that do not have ability to immigrate are left with the option to become migrant workers or to remain on their low-lying islands. This particular situation is exemplified in the 2016 decision by a New Zealand Supreme Court, discussed later in this chapter, which sets a precedent that those who will be displaced by the environment in the future will likely not be considered for refugee status.

To summarize, those displaced by the climate - or 'climate-refugees' are not considered for refugee status due to the fact they are not persecuted as a result of their 'race, religion, nationality, etc.' (IASC, 2008, p. 4). Ironically, the 'climate-refugees' are protected under the OCHA's Guiding Principles on Internal Displacement (2004), stating that nations have a duty to protect those internally displaced. Nations like Kiribati demonstrate reasons why domestic protection is critical, evident in the process for claiming refugee status for environmental displacement. Those individuals - like on Kiribati- who are displaced by the climate cannot claim

refugee status, yet must rely on the state for protection. The flaw is many of them would face similar experiences as *de facto* stateless individuals.

Domestic Factors

According to the 1933 Montevideo Convention on the Rights and Duties of States written by the League of Nations (1936), there are four necessary elements of statehood. They include a defined territory, a permanent population, an effective government, and the capacity to enter into relations with other states. As McAdams (2010) highlights: "For present purposes, the relevant question is whether a State ceases to meet this criterion of statehood when a large proportion—or all—of its population lives outside the State's territory" (p 8). For McAdams, mass-migration to different nations will also make individuals lose their political representation and legal status, which could result in statelessness. Another protection mechanism McAdams (2010) states is self-governance within another country; however, this would entail a loss of autonomy but would allow a nation's people to maintain such governance, and maintain a sense of culture, nationality, and identity.

Relocation in the same nation from SLR will generate future problems as some states do not have the capacity to assist everyone. One of the difficulties is that some nations, such as Tuvalu, will not have the capacity to relocate their citizens within their own nation. This is critical to assisting individuals who have been displaced by the environment; however, many small developing island states (IDIS), including Coromos and Tuvalu, do not have the economic capacity.

Furthermore, if their state is unable to assist them in relocating within the same country, they could be deemed stateless. They are typically people who have been displaced and cannot return to their home (place of origin) as a result of environmental destruction. The difficulty with states being the primary enforcer and actor in relocation and protection is some states, including island nations, are they have low capacity and may not be able to provide the full extent of these rights. In legal terms, a lack of capacity can make a citizen of a nation, stateless. The next section discusses statelessness, and how individuals can be vulnerable from being displaced.

Statelessness: *de jure* and *de facto*

What happens if individuals cannot relocate or if the state cannot assist? As illustrated in a committee of the United Nations, the Inter-Agency Standing Committee document (2008), it was discussed that in the event of significant loss of territory of a state from rising sea level change, there would be no legal framework to cover those affected:

> *Potential Gap 3:* Should a state lose its entire territory, one of the constituent elements of statehood, it is not clear whether its statehood would continue to be recognized by the international community. There is a risk that its population would be rendered stateless. While UNHCR has a mandate for the prevention of statelessness and the protection of stateless persons, specific arrangements will need to be forged which permit for their movement elsewhere and prevent statelessness (p. 3).

Those displaced by the environment are typically referred to as climate refugees in the media. However, as noted in the above quotation, these individuals would not be recognized by the UNHCR as climate refugees.

There is no consensus on the multitude of definitions for statelessness. There are two types of stateless people which are highly relevant to environmental displacement, *de jure* and *de facto*. The United Nations Declaration of Human Rights covers necessities and, to an extent, allows stateless people to have rights; however, a significant issue is who guarantees those human rights.

According to the United Nations 1967 definition (UNHCR, 2019), *de jure* stateless individuals are when they do not possess the nationality of a country under that nation's law. Whereas a *de facto* stateless individual "refers to those who have nominal citizenship, but who do not enjoy the rights or protections associated with said citizenship in practice." (Belton, 2011, p 950). As well, *de facto* stateless groups should gain more rights as they are citizens of a state, but the country of origin may be unable to deliver rights to them, nor may they want to. *De facto* statelessness is a tricky concept in this manner as rights should be administered, but are not, often inciting poverty and marginalization onto the stateless group. These indicators influence the methods each stateless group/individual can take to guarantee their human rights. While *de facto* citizens have citizenship, they are not ensured every right that full citizens have.

In terms of *de jure* statelessness, the only way an individual would be classified as this type of stateless is if the nation ceased to exist. An example of how this would happen is the sinking island phenomena where a state and its island territories would sink completely. However, displacement is more likely to occur as a result of greater exposure and more insecurity in food and freshwater sources. Therefore, while *de jure* statelessness is an important concept, it can be inferred that environmental displacement primarily deals with *de facto* statelessness.

Legal Scholar Hannah Arendt (1945) states the expulsion of stateless people is illegal; however, there is not a legality system for enforcing the mechanism of international law. As such, stateless individuals who are within the borders of a state, may be subject to further displacement. Therefore, refugees, internally displaced peoples, and those environmentally displaced, can be considered a type of *de facto* stateless. This is largely a result of a lack of capacity to assist some individuals, or in other cases can be a consequence of nations not wanting to assist groups. This is the kind of issue, environmentally displaced individuals will go through, without external protection or if their state lacks the capacity to assist them. Moreover, if those displaced are forced onto other land, they face significant consequences. Stateless consequences include false citizenships or the ability for states to withhold rights, and many individuals then are unable to access food, water, shelter, or other requirements during crises from a government; ultimately, they face increased vulnerability and death (Belton, 2011). Furthermore, *de facto* people don't have viable economic, social, political, or civil rights, making them no more than tourists with no rights in their own land. While states are required to meet these needs as it can be a matter of life and death; the states may withhold their rights and protections. Therefore, without international protection as discussed in the next section, there is a clear gap in assisting those who cannot be assisted by their state.

The international laws and conventions currently in place are inadequate protection for treating rising sea level displacement, as seen in Tuvalu. It is almost inevitable that climate and rising sea level displacement will be produced from rising sea levels.

Applied Case Study: Kiribati

The term refoulement was created with the United Nations High Commissioner for Refugees (UNHCR, 2019) during the 1951 convention and revised in the 1967 Conventions relating to the Status of Refugees. Refoulement is the process of sending a refugee back to their place of hardship or persecution in which the individual's life would be threatened (UNHCR, 2007). In a 2019 refoulement case, the New Zealand Tribunal set a new precedent where individuals are not allowed to be sent back to a place where they might endure hardship and potential death. Specifically, there are conditionalities such as, the land has to be exposed to somewhat severe natural disasters and the nation must be unable or incapable to intervene to improve the safety of the land.

In 2007, Ioane Teitiota, a citizen of Kiribati moved to New Zealand with his wife. He was arrested in 2010 for staying past what his visa allowed (New Zealand Supreme Court, 2015). After he was arrested he claimed refugee status in New Zealand as he believed the conditions in Kiribati were creating hardship (New Zealand Supreme Court, 2015). However, the application was denied as climate change does not count towards the criteria for refugee status. Teitiota was sent back to Kiribati, which he claimed the Government of New Zealand violated the right of refoulement. Specifically, Teitiota made a claim as SLR for Kiribati has worsened and resulted in "(a) the scarcity of habitable space, which has in turn caused violent land disputes that endanger the [Teirota's] life; and (b) environmental degradation, including saltwater contamination of the freshwater supply" (UNPPCR, 2020, p 6) Yet the committee believed that

the state of Kiribati is taking affirmative actions and that by reducing existing vulnerabilities, the state is to assist its population.

After a review of sending Teitiota's back to Kiribati against his will, the Tribunal found that New Zealand did not violate principles of refoulement as the evidence he complied for the threats against his life was not enough. Furthermore, the state of Kiribati, had been implementing adaptation measures - purchasing a relocation island, building more sea walls, etc. This was reflected in the document where the Tribunal said (UNCCPR, 2020), “The Committee is of the view that without robust national and international efforts, the effects of climate change in receiving states may expose individuals to a violation of their rights under articles 6 or 7 of the Covenant, thereby triggering the *non-refoulement* obligations of sending states” (p. 13).

However, the case sets two legal precedents for future individuals who will be displaced by climate change and the environment. One of them is positive, and the other is somewhat negative. One positive element is that there seems to be an acceptance that climate change and slow-onset environmental disasters are displacing people. Therefore, the voluntary movement element where people are subtly displaced is no longer as complex for legal cases. This is articulated on page 13 in sections 9.11 and 9.12 (UNCCPR, 2020):

> Both sudden-onset events (such as intense storms and flooding) and slow-onset processes (such as sea level rise, salinization, and land degradation) can propel cross-border movement of individuals seeking protection from climate change-related harm. [...] Furthermore, given that the risk of an entire country becoming submerged under water is such an extreme risk, the conditions of life in such a country may become incompatible with the right to life with dignity before the risk is realized. [...] In the present case, the Committee accepts the author’s claim that sea level rise is likely to render the Republic of Kiribati uninhabitable. However, it notes that the timeframe of 10 to 15 years

This is significant as slow-onset disasters can trigger displacement and not necessarily voluntary movement over time. By noting slow-onset disasters and SLR (with its cascading effects and secondary disasters), there is less complexity when analyzing displacement movement, allowing for future individuals displaced by environmental disasters to have a better chance to be noted as persecution and flea for their lives. In regards to the 10 to 15 year timeframe, this is an accurate estimate in the authors opinion. It supports current changes in relative sea level, and habitable factors such as access to fresh water and food.

The other positive element is that refoulement may be less likely for individuals displaced by environmental disasters. This is contingent, however, on the negative element, which sets a higher benchmark for claiming non-refoulement. The primary negative element is if the country has the ability to lessen the damage or intervene, then the international community will allow it to, even with the Tribunal noting that Kiribati may be uninhabitable by 2030 to 2035 years. This seems maybe one of the legal precedent benchmarks set in the case that if the country can relocate the population, then there is no need for international legal protection. This affects an entire group of individuals who do not have the financial capacity to help themselves and also will force more nations to focus on short-term responses, which will be convoluted and worsen disasters in the long-term (UNCCPR, 2020).

Interestingly, Committee Member Duncan Laki Muhumuza was one of two members who were against the conclusion the Tribunal reached. One of the reasons is because this conclusion creates a high legal benchmark for future cases of refoulement. Muhumuza states (UNCCPR, 2020, p. 18):

> In my view, the author faces a real, personal and reasonably foreseeable risk of a threat to his right to life as a result of the conditions in Kiribati. The considerable difficulty in accessing fresh water because of the environmental conditions, should be enough to reach

> the threshold of risk, without being a complete lack of fresh water. There is evident significant difficulty to grow crops. Moreover, even if deaths are not occurring with regularity on account of the conditions (as articulated by the Tribunal), it should not mean that the threshold has not been reached. It would indeed be counterintuitive to the protection of life, to wait for deaths to be very frequent and considerable; in order to consider the threshold of risk as met.

These are considerable statements as it seems that death and the perception of death from the climate must occur and be reported in order for individuals to gain international protections. Muhumza's statement about waiting for death rings true as these individuals have significantly exposed the environmental disasters, the effects of SLR, and harm to the food and freshwater. These individuals should have more international protection considering the small state capacities of the low lying islands. Which ironically was a point Muhumaza made (UNCCPR, 2020, p.18):

> Lastly, while it is laudable that Kiribati is taking adaptive measures to reduce the existing vulnerabilities and address the evils of climate change, it is clear that the situation of life continues to be inconsistent with the standards of dignity for the author, as required under the Covenant.

Therefore, the benchmark for the new case is developed around nations not having the ability to integrate resilience into their country. This is highly problematic as no country will ever give up their own territory; no country will ever stop fighting for their land.

Conclusion

SLR, the secondary disasters, and its cascading effects, will trigger environmental displacement on a mass scale. While displacement will occur incrementally and slowly, it will ultimately force a choice for many individuals. With SLR and its consequences, the choice is between moving voluntarily or remaining on vulnerable islands and being forcibly displaced. However, the difficulty of the legal implications of SLR and slow-onset disaster is that they can have low magnitude and long timeframes, making them difficult to assess in terms of impact and displacement. This can often mean individuals may not be considered for internal displacement as they 'voluntarily moved'.

There is one form of protection in the Doctrine of Internal Displacement, which proclaims that States have a responsibility to relocate their own citizens in a safe and dignified manner. Yet, there are a few problems with the state being the only protection mechanism against environmental displacement. One of these problems is that some states lack the capacity to assist those individuals and help relocate them, as well as the perception of slow-onset disasters on making people leave 'voluntarily'. This lack of assistance has led some individuals to becoming stateless, where they will have few rights and opportunities. If individuals are not provided for by their state, they will face the worst case and try to claim refugee status as a result of environmental displacement. However, since there is no persecution, they will not meet the criteria.

The applied case of Kiribati sets high standards for asylum seekers who are then sent back against their will. As a result of this case of refoulement, individuals displaced by the climate

now can be sent back if a government is not conducting meaningful development practices to combat climate change and if there are serious concerns with exposure.

Conclusion - SLR and Society

Society is inhibited by a short-term view of important topics such as politics, economics, technology, and commercial products. With more prevalent internet and social media, individuals have adapted to the immediacy of now and getting things they want quicker. This includes decisions for disaster mitigation and disaster preparedness which focus on short-term quick fixes rather than more sustainable solutions. In reality, however, effective disaster mitigation and disaster preparedness is more than simply building a wall to prevent higher storm surges. Individuals often live in places which have significant vulnerability, yet expect money and government apparatuses to assist them when they encounter disasters. While these apparatuses are increasing awareness of the issues, it raises a serious question in which society must ask itself: Should communities continue to develop in hazard prone areas? Should humans inhabit areas which may see significant vulnerability in parts of the year and inevitable danger in the long-term? While there is no current answer to where individuals would go when disasters are looming, such as in situations facing low-lying islands, these questions need to be addressed as the threat of SLR and climate change will affect every aspect of how humans will live in society.

While certain hazards are known to occur naturally, there are inherent social elements that are amplified during disasters. These thoughts are echoed by scholar Klinnenberg's (1999), where he states that, "environmental events [are] revealers of social conditions that are less visible but nonetheless present in everyday life" (pg 242). Differences in race, age, and wealth affect who has greater exposure to disasters. Further to this point, the socio-economic divide in

society produces increased consequences for the impoverished, as illustrated in the cases of the low-lying islands of Tuvalu and the Maldives. As low-lying islands grapple with the inevitability of disasters and effects of SLR, considerations on who is affected and what solutions are available to them are of utmost importance.

To conclude, the MRP has discussed many facets of SLR and the effect it has on communities. Ultimately, it raises questions surrounding the dichotomy between the rich/middle class and the poor/impoverished in terms of disaster mitigation. Moreover, the other significant theme of the MRP is that society is focused primarily on the short-term results instead of long-term results. As the sea expands and rises, society must raise questions whether certain areas are habitable or not, and what can be done about this. The unfortunate reality is that there will likely not be many changes in the near future, as individuals are trapped by financial constraints, four-year cycles of politics, and sometimes a resistance to change. It is the author's belief that society may respond too late to SLR, and that for people to understand the hazard and threat it poses, they must experience it.

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