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HUMAN CONSEQUENCES OF CLIMATE CHANGE, CLIMATE REFUGEES: AN EXPLORATORY ESSAY

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Dedication

To the climate refugees of the world; past, present, and, unfortunately, of the future. May understanding and concern rise faster than oceanic sea levels.

God speed to all….

Acknowledgments

I owe a debt of gratitude to many individuals who understood, took a chance, aided me, and provided me with unmeasurable support during my graduate studies at The University of Montana. Every step of the way they all bolstered me and without their constant help and patience, this thesis would not have come to fruition. I do not even know where to begin.

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To my Mother, Tes Snyder, the woman who gave me life and always supported my educational pursuits without hesitation or question. Thank you from the bottom of my heart Mom for always being there, every step of the way.

To the love of my life, Holly Hawkes Scott; researching the topic of climate refugees and all the intricately related topics associated with this global concern darkened my outlook on life, making me a jaded and worn-out person for a very long time who felt alone in this world. Since you have come into my life, Holly, I no longer feel alone and there is no more darkness - only light. Thank you for saving me my love.

Preface

While planning my course schedule for the 2009 Spring Semester, I found myself desperately short of elective credits toward my Bachelor of Arts degree in Geography in order to graduate by the end of the 2010 Autumn Semester. From the limited course choices offered for the spring semester, only two worked with the other required courses I needed as well: Cultural & Global Competence and Global Hot Spots. Little did I know at the time, but the latter would prove to be the most stimulating course of my entire undergraduate geography program. Not only did this course forge within me a true interest in the current affairs of an ever-growing globalized society, it also provided me with a thesis topic to pursue during my anticipated master's program.

At the heart of the Global Hot Spots' curriculum were three over-arching themes: the global food crisis, the global health crisis, and the global environment crisis. These themes laid the groundwork for all topics that fueled our daily projects and peer discussions. The topics included, but were not limited to, economic globalization; rising levels of obesity in Western countries; the insurgence of global "super bugs;" issues related to projected world population growth rates; the emergence of a global north versus a global south; and projected sea-level rise owing to rising temperatures.

As a class, the first item we would broach each meeting were two questions meant to open our daily in-class discussions. But on March 12, 2009 we, as a class, failed to answer the questions for the first and only time. The two questions were: "What is a Climate Refugee; define and give examples?" and "What are ways potential Climate Refugees can alter their traditional/current homes to prevent

climate/environmental displacement? Give examples if known?" Our entire group was thoroughly puzzled by the idea of a refugee being a displaced member of a society because of climate change, let alone methods by which humans could adapt fast enough to preserve their ways of life against something so powerful as the climate change. Ever since that day, the mounting realities of climate refugees, how they have come to exist from human prehistory to the present, and the growing global issues related to their ever-increasing numbers has provided not only my thesis topic but commanded (and haunted to a certain extent) my research interests for the last four years.

However, about half way through my graduate program, my studies took a turn away from my original proposed topic of simply researching climate refugees. Through many lively discussions with my peers, co-workers, and anyone curious about my chosen topic of climate refugees, I began to realize over time that the vast majority of the people I interacted with had no idea what a climate refugee was, is, or will be. This ostensibly universal ignorance made the navigation of a discussion that revolved around climate refugees quite perilous at times. Eventually, I came to notice that there was a glaring common element among the vast majority of these people who could not come to grips with the idea of a climate refugee. Most of the individuals that I interacted with lacked the most basic understanding of how Earth functions, from a physical geographic standpoint, and the extent of codependent interaction among Earth's systems. Once I provided that information as a foundation to understand the topic of climate refugees, then these people could engage in higher discussions that revolved around displaced individuals due to either minor or extreme environmental shifts. With that in mind, I was

compelled to include in my research larger sections devoted to the elements of Earth's systems, human consequences related to the interactions with those same systems and their processes, alongside my original topic of climate refugees.

F. A. Snyder-Manetti

May 10, 2015

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Chapter 1

Introduction

Every week, Americans, along with all the other people around the world, are bombarded by the media (newspapers, magazines, radio, television, and websites) reminding us that we are living on a planet whose climate is getting warmer. Many sources point to the fact that our overall climate is getting warmer because of an escalation of a greenhouse effect caused by human activity.[1] These same sources also are constantly cautioning us that if we, as a global society, are not careful, the twenty-first century will be marked by serious climate upheaval. However, the way in which the general populace from nations across the globe perceives changing climate varies considerably.

People strive to inhabit areas around the globe where a pleasant and temperate climate operates, such as large areas within the Southwest and Northwest of the United States, Europe, the northern countries of South America and eastern Australia. Unfortunately, these same areas are facing the initial consequences of climate change just as much as areas in the less pleasant locations of the world that reside on the preverbal "edge" of devastating environmental changes. The rising rates of record breaking seasonal heat waves around the world since 1995 have given us a preview of what possibly every summer in the future will be like by the middle of this century if no action is taken.[2] But that time, which is less than fifty years away, seems so far off to

[1] Chris Stokes, *Adapting Agriculture to Climate Change: Purposing Australian Agriculture, Forestry and Fisheries for the Future* (Victoria: Collingwood, 2010), 23.

[2] W.J Bouma, G.I. Pearman, M.R. Manning, *Greenhouse: Coping with Climate Change* (Victoria, Australia: Collingwood, 2007), 41.

the overwhelming majority of people that they believe their children and grandchildren will have no problem in being able to adapt to a climate rated to be 4° C to 5° C warmer on average than it is today.[3] However, some regions are already experiencing not only the initial effects of warming, but an ever intensifying range of issues associated with overall regional warming. Whole populations, and in some cases entire culture groups, are losing their native lands – transforming these people into climate refugees.

To date, climate change has been frequently underestimated, and up to now it has largely been nonconceptualized as a danger to society. For most of the global population in industrialized countries, the phenomenon of climate change, defined by natural science from a general understanding, *might* produce social disasters. These *possible* disasters are far reaching and showcase the increase of displaced groups, categorized as climate refugees, at their forefront. Although, what seems to appear not just as underestimated, but inconceivable, are the larger issues stemming directly from the rise in climate refugees across the globe. These larger issues, such as system breakdowns, civil wars, and or mass genocide have gone largely overlooked in the industrialized world. No stretch of the imagination is needed to visualize these larger issues in practice, and a number of present-day social conflicts, wars, and security measures can already be attributed to climate change related factors. All societies across the globe are finding themselves more under pressure as the days pass; resulting from either unexpected or acknowledged changes. These changes include, but are not limited to: soil degradation; water shortages; large-scale flooding; and the rising occurrence of extreme weather events that hinder, or stop altogether, economic

[3] John Cox, *Climate Crash: About Climate Change and What It Means for Our Future* (Washington: Joseph Henry Press, 2005), 19.

development and growth; states increasing regular surveillance of regional landscapes, and restricting spaces of freedoms related to the access and use of resources; shifting baselines which change the perception of problems, allowing for the increased public acceptance of new security measures to redefine standards of normality; mass cross-border migration from the non-industrialized countries to industrialized countries; and distorted processes of how to interact with one another across cultural and transnational lines, directly derived from more intense security efforts and international resource conflicts.[4]

[4] Anup Shah, Global Issues: Social, Political, Economic and Environmental Issues That Affect Us All. September 10, 2010. http://www.globalissues.org/article/233/climate-change-and-global-warming-introduction#RisingSeaLevels (accessed October 15, 2011).

Chapter 2

Our Earth

Section 1: Deciphering Earth

Throughout human history scientists, theologians, historians, geographers, and many others have pondered the life-supporting planet we not only call Earth; but home. Earth seemingly floats in the empty blackness of space and exists as the one jewel in the cosmos known to support and sustain perpetual life. Early human astronomers during the height of ancient Greece believed that Earth had to be the center of the known universe.[5] This audacious view prevailed within the Western World until the sixteenth century, when a young man of Polish origin named Nicolas Copernicus advanced the then radical notion that all the planets in our solar system, including Earth, orbited the Sun.[6] Then, in the early seventieth century Galileo Galilei put forth the ideas stemming from his own observations of astronomical movements through the use of a telescope he designed. From Galileo's astronomical data of the moons of Jupiter, phases of Venus, and shadow movements shown by the craters on Earth's moon, he further supported the annotations of Copernicus and bolstered the theory of a heliocentric or "sun-centered" view of the universe.[7] Meanwhile, Johannes Kepler of Central Europe further refined the notion of a sun-centered universe by demonstrating

[5] Thomas R. Martin, *Ancient Greece: From Prehistoric to Hellenistic Times* (New Haven: John Yale University Press, 2000), 43.

[6] Connie Jankowski, *Astronomers: From Copernicus to Crisp* (New York: Compass Point Books, 2008), 5.

[7] Galileo Galilei, Maurice A. Finocchiaro, trans., *The Essential Galileo* (New York: Hackett Publishing Company, Inc, 2008), 26.

that the planets orbit the sun in non-circular movements, known as an ellipse.[8] But it was not until the work of Sir Isaac Newton in the early eighteenth century that the mystery of planetary motion was finally solved with absolute mathematical certainty. The final linchpin explaining the enigma of Earth's long-term climate changes was postulated by a young Serbian man during the First World War named Milutin Milanković. Milanković explained that alterations in the position of Earth on elliptical cycles in comparison to the Sun, compounded by both Earth's own physical rotation cycles and axis "wobble" cycles, referred to today as "Milankovitch Cycles," explain why the ice ages occurred in Earth's geologic past, as well as explaining the climate shifts occurring now and the foreseeable future.[9]

In the decades since the age of Newtonian discovery, countless scientific breakthroughs have provided more clues to still more mysteries about where Earth rests in the celestial scheme. But there are a few key questions which linger and resonate more than others as we slowly come to understand more about our universe. These questions include why Earth is so different from the other known planets that share our solar system. The keynote spurring the comparison stems from the one characteristic that makes Earth different from other planets – organic, living things can be found everywhere on and within her. From the harshest deserts to the deepest crevasses of the oceans to the ice-bound poles, life can be found on Earth. This enormous presence of organic-based life clearly distinguishes Earth from its planetary neighbors and is attributed to the interaction and shifts provided by Earth's environmental settings.[10]

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[8] Johannes Kepler, *Epitome of Copernican Astronomy and Harmonies of the World; Great Mind Series, Reprint Edition* (New York: Prometheus Books, 1995), 37.

[9] Brian J. Skinner, Stephen C. Porter, and Jeffrey Park, *Dynamic Earth: An Introduction to Physical Geology,* Fifth Edition (New Jersey: John Wiley & Sons, 2004), 438.

[10] Brian Skinner, *Dynamic Earth*, 21.

These environmental settings are a direct result of the fluid connections between the four spheres that exist here on Earth: the atmosphere, biosphere, hydrosphere, and lithosphere.[11] Without the four spheres, compounded by seasonal shifts within biological settings, life as we have come to know it on Earth would not exist.

Section 2: Systems Concept

At the heart of understanding the initial nuances of the interconnection of the four Earth spheres is the Earth Systems Concept. In its simplest form, a system is any ordered or interrelated set of things and their aspects.[12] These things are linked by flows of energy, or matter as distinct from the surrounding environment outside the system. The characteristics that comprise the base elements within a system may be arranged in any series or interwoven with one another. Within the systems of Earth, energy related to the base elements may be arranged in any series or interwoven with one another. Also, a system can include and be composed of any number of subsystems. Within the systems of Earth, both energy and matter are stored, retrieved, and transferred from one type to another through transformation.[13]

In most instances systems in the natural environment are mostly not self-contained. Inputs of matter and energy flow into a system and outputs of matter and energy flow from the system without impediment. These are Open Systems.[14] With the open-system concept in mind, Earth is an open system in terms of energy when solar

[11] Alan F. Arbogast, *Discovering Physical Geography* (New Jersey: John Wiley & Sons, 2007), 13.
[12] Brian Skinner, *Dynamic Earth*, 19-21.
[13] Ibid.
[14] Ibid.

energy emitted from our sun enters freely and heat energy leaves and returns to space. A system that is shut off from the surrounding environment so that it is self-contained is referred to as a Closed System.[15] Closed systems are very rare in the natural environment, but Earth is a closed system in areas of physical matter, air, and water; the only exception is the slow escape of lightweight gases from the atmosphere into outer space. The fact that Earth is both an open and closed system makes the necessity and concern over climate change all the more dire for both the present and future decades.

Most systems, open or closed, maintain a structure and character over time. A system that remains in balance when conditions are constant is termed a "steady-state condition."[16] It is marked when the amount of energy and matter in storage within a system are equal to the rates of input and output. Now a steady-state system, however, can suffer from changing trends over time, or dynamic equilibrium. Natural systems work to maintain their balanced operations and tend to resist abrupt changes. But systems can reach tipping points or thresholds when balance can no longer be maintained. Once a tipping point is reached, a system can no longer maintain its current character and will shift to a new operational level with new characteristics.[17] This tipping point concept for natural systems on Earth does foster great concern in the scientific community. Tipping points such as the overall warming of global water bodies, expanding periods of multi-region droughts, and increasing amounts of global pollution from ever expanding human activity are forcing many natural systems to their tipping point limits and changing to a new status - one of disintegration.

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[15] Ibid.
[16] Steven M. Stanley, *Earth System History,* Third Edition (New York: W.H. Freeman, 2008), 35.
[17] Steven M. Stanley, *Earth System*, 37.

Section 3: Arrangements of Geosystems

Earth's external surface is a vast area calculated to be approximately 500 million km², or 193 million mi².[18] This external surface is where four immense open systems interact, referred to as Earth's four "spheres."[19] The abiotic or nonliving spheres are the atmosphere, hydrosphere, and the lithosphere. The single biotic or living sphere is the biosphere. The constant interaction of the four spheres sustains the current environmental diversity in existence on Earth's external surface. Without this interaction, life as we have come to know it would not exist.

The atmosphere consists of a thin gaseous veil surrounding the Earth between the physical surface and outer space.[20] It is held in place by the force of gravity and consists of two primary layers, an upper atmosphere and lower atmosphere. The upper atmosphere, or near space, is the area of Earth's atmosphere located roughly between eighty kilometers to 480 kilometers (fifty miles to 300 miles) above sea level.[21] The entire layer is defined as the Heterosphere and the primary area of note is the Thermosphere which extends roughly from the Armstrong Limit up to the Kármán Line. The lower atmosphere is, in turn, located from roughly zero kilometers to seventy-nine kilometers (zero miles to forty-nine miles) above sea level.[22] This layer is defined as the Homosphere and is separated into three primary areas from the ground on up: the Troposphere, Stratosphere, and Mesosphere. The lower atmosphere is much more

[18] Tim Sharp, *How Big is Earth?*. Space.com News. September 17, 2012. http://www.space.com/17638-how-big-is-earth.html (accessed June 12, 2014).

[19] Graham R. Thompson, Jon Turk, *Earth Science and the Environment* (New York: Cengage Learning, 2006), 48.

[20] Anne Klene, "Introduction & Review Climate Basics" (lecture, 336 Skaggs Building, Missoula, MT, January 25, 2011).

[21] Ibid.

[22] Ibid.

unique than near space, in that it is formed by gases originating from within Earth's crust, interior, and by the exhalations of all living things over time.[23] Scientists and astrophysicists have concluded that Earth's lower atmosphere is unique in our solar system because of two items of note. First is its unique combination of argon, carbon dioxide, nitrogen, oxygen, water vapor, and other trace gases found throughout the lower atmosphere.[24] Second is the existence of a portion of the Stratosphere that contains a higher level of ozone than anywhere else on Earth, referred to as the ozonosphere or ozone layer.[25]

The Hydrosphere is the combined mass of water found in Earth's atmosphere, on its surface held in oceans, lakes, rivers, and glaciers, and under its surface as ground water.[26] Collectively these waters form the hydrosphere and, with the portion of water held in a solid state as frozen ice, further being known as the cryosphere. All water in the hydrosphere exists in three states on Earth - liquid, gaseous, and solid. Water also occurs in two primary chemical conditions, as fresh water or saline water. Of the estimated 1386 million cubic kilometers of water on Earth, saline water accounts for ninety-seven and a half percent and fresh water only accounts for the remaining two and a half percent.[27] Of the two and a half percent of fresh water on Earth approximately sixty-eight percent is locked in the solid form of snow and ice covering the Antarctic, Arctic, and various mountainous regions throughout the world.[28] Ground

[23] Anne Klene, "Planetary Evolution" (lecture, 336 Skaggs Building, Missoula, MT, February 1, 2011).
[24] Ibid.
[25] Ibid.
[26] Jeffrey Gritzner, "Cultural Ecology; Water Lecture" (lecture, 217 Stone Hall, Missoula, MT, March 13, 2012).
[27] Ibid.
[28] Rick Gratz, "Mountains, the Water Towers of the World" (lecture, 315 Stone Hall, Missoula, MT, April, 13, 2010).

water accounts for roughly thirty percent of Earth's fresh water in both solid and liquid forms.[29] Only about two percent of the total fresh water in the hydrosphere can be found in lakes, reservoirs, and river systems on Earth's surface or in any other liquid state most accessible by living creatures.

The lithosphere encompasses the crust and a limited portion of the upper mantle directly below the crust. Earth's crust is very brittle when compared with the other layers found in the upper mantle deep beneath the outer surface. These lower layers move and shift slowly as a result of uneven distributions of heat energy and built up pressure.[30] The term lithosphere can refer to the entire solid planet; while, the external soil layer that covers Earth's land surface is more specifically referred to as the edaphosphere.[31] Typically the edaphosphere acts as a connection between the lithosphere, atmosphere, hydrosphere, and biosphere.

The biosphere is the area where physical factors and the chemical elements of Earth form the context of all life. The complex and intricate interconnected network that links all organisms with their physical environments is also referred to as the global ecosphere. It is hypothesized that the biosphere formed through either the process of biopoesis, where life was created naturally from nonliving matter like simple organic compounds, or biogenesis, where life was created from other living matter.[32] Interestingly, the biosphere exists as an overlapping closed system that is also self-regulating among the three abiotic spheres. The extent of the biosphere spans from the furthest depths of the ocean floor and the upper layers of the crustal rock to about eight

[29] Orrin H. Pilkey, *The Rising Sea* (Washington D.C.: Island Press, 2009), 25.
[30] Alan F. Arbogast, *Discovering*, 19.
[31] Alan F. Arbogast, *Discovering*, 20.
[32] Noam Lahav, *Biogenesis: Theories of Life's Origin* (London: Oxford University Press, 1999), 14.

kilometers, or five miles into the atmosphere; life as we know it is sustainable within these natural limits. The biosphere, being uniquely the realm of the biotic, is marked by the ability to evolve, face extinction, or flourish when system equilibrium is achieved, it can also reorganize its structure in order to achieve equilibrium.

Section 4: Water – The Key to All Life

All life as we know it is defined by water. Bathed and infused by water, all life is sustained, generated, and guided.[33] Water is also the foremost connection between Earth's four spheres, and the primary interactive mechanism is found in the Hydrologic Cycle. The hydrologic cycle represents the vast amounts of energy, ice, water, and water vapor flowing continuously in an open global water pumping system of elaborate measure.[34] This cycle chiefly involves the total circulation and transformation of water throughout Earth's four spheres. From the lower atmosphere to the Earth's surface, and below by several miles, this cycle has operated uninterrupted for billions of years. Of all the stages within the hydrologic cycle, none is more important to life than is the formation of surface water.[35] Precipitation that falls back to the surface of Earth from the atmosphere, either soaks into the soil though stem flow or infiltration, or flows overland in natural and manmade drainage systems as surface water. Unfortunately, surface water can be both a blessing to life and a threat to life; only time and one's immediate environment determines which.

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[33] David Attenborough, *Planet Earth;* Volume 3, Deep Ocean, DVD (London: BBC, 2007).
[34] Chris Stokes, *Adapting Agriculture*, 42.
[35] Jeffrey Gritzner, "Cultural Ecology; Water", (2012).

Chapter 3

Reports and Reality

Section 1: The IPCC and the Last Thirty-Five Years

In the relevant scientific community, the current thinking on climate change and the resulting impacts mainly stem from the Intergovernmental Panel on Climate Change (IPCC). In the late 1980s, the United Nations created the IPCC, whose "role is to assess…the scientific, technical and socio-economic information relevant to…human-induced climate change…and options for adaptation and mitigation."[36] The IPCC draws upon a wide range of experts from varying scientific disciplines, including chemists, economists, healthcare providers, lawyers, physicists, sociologists, and specialists in both the continental and marine biosphere. In 2007, the IPCC released its Fourth Assessment Report, after publishing reports in 1990, 1995, and 2001. Prior to this report being published, meetings organized by the IPCC were held around the world to give government representatives an opportunity to approve the final report's major conclusions, which highlight the interrelated and integrated problems we will have to confront as a globalized society.[37]

The report confirms the diagnosis from a scientific standpoint only. It succinctly states that the man-made greenhouse effect has continued to increase in recent years, mainly attributed to the carbon dioxide generated by our consumption of coal, oil, and

[36] Gregory White, *Climate Change and Migration; Security and Borders in a Warming World* (Oxford: Oxford University Press, 2011), 36-37.

[37] Michael E. Mann, Lee R. Kump, *Dire Predictions: Understanding Global Warming – The Illustrated Guide to the Findings of the IPCC* (London: DK Publishing, 2008), Introduction.

natural gas. The second unambiguous finding is that the climate is warming. "Warming of the climate system is unequivocal."[38] Between 1995 to 2007 eleven of those twelve years were hotter than any of the previously recorded years since 1850.[39] Many other observations bear witness to this warming trend. For example, the oceans are warming and expanding, leading to rising sea-levels, maximum snow covered surfaces are shrinking, and sea ice and glaciers are also being reduced owing to higher seasonal temperature. Determining the causes of this recent trend has been a long-term effort, and the acquisition of new data along with the considerable improvement in climate models enabled the conclusion that the majority of the warming observed since the middle of the twentieth century is most likely the result of human activity; this is in fact a 90% probability in scientific terms.[40]

The climate projections published within the 2007 IPCC report are consistent with others published in the previous reports. These projections state that there is a rise of 1.1°C to 6.4°C for the same set of greenhouse gas emission scenarios.[41] Yet, there is now greater confidence in the essential values corresponding to the varying scenarios of an increase of 1.8°C to 4°C. A warming of 3°C in one century would be categorized as a major climate change. There is a considerable level of confidence in projections concerning climatic impacts: increased precipitation in high latitudes and decreased precipitation in subtropical regions, changing wind patterns, more intense cyclone and tropical storm activity, shifting of the Hadley Cell cycles, longer periods of heat waves, reduction of sea ice, shrinking snow cover areas, expanding desertification, and, most

[38] Allison et al., *The Copenhagen Diagnosis: Updating the World on the Latest Climate Science* (Sydney: University of New South Wales Climate Change Research Center, 2009), Introduction.
[39] Ibid.
[40] Ibid.
[41] *Climate Refugees,* directed by Michael P. Nash, Sundance, 2010, first half.

frightening, an irreversible rise in sea levels.[42] These are the elements that have begun to shape our world already, and it is a glimpse into how the world will truly be by the end of this century if no action is taken.

It is an established fact that over the past few decades global warming has produced noticeable effects. There are many natural systems, particularly in temperate zones with higher temperatures, which have become affected by regional climate change.[43] For future activity within agriculture, aquaculture, open ecosystems, human health, housing, industry, and many other areas, the impacts caused by rising sea levels and changes in the frequency and intensity of extreme weather events are very likely to increase. According to the IPCC, hundreds of millions of people around the globe will be exposed to greater water stress;[44] whether by too much water in the forms of flooding events or not enough in the form of droughts. Additional threats may include lower agricultural yields from once thriving productive regions, the recession and disappearance of ancient glaciers, the expansion of semi-arid and arid regions, expanded risks to marine environments caused by ocean acidification with implications to marine and ecosystems resources, major changes and a complete altering of polar ecosystems and infrastructures, and, the most dangerous at the present time, the vulnerability of certain coastal areas and atoll island chains to rising sea levels. Unfortunately, there will be many instances in the immediate future where

[42] Jeffrey Gritzner, "Cultural Ecology; Africa" (lecture, 217 Stone Hall, Missoula, MT, March 27, 2012).

[43] John Bellamy, *The Ecological Rift; capitalism's war on the Earth* (New York: Monthly Review Press, 2010), 22.

[44] IPCC, 2007. *Climate Change 2007: The Physical Science Basis*. Contribution of Working Group 1 to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change. Chapter 1.4. http://www.ipcc.ch/publications_and_data/publications_and_data_reports.htm#1 (accessed April 3-4, 2011).

populations may be forced to leave regions tied to their cultural heritage, history, livelihood, and/or identity, thus becoming “climate refugees.”

In the daunting face of climate change, we, as a global society, must not give up pursing any feasible option to stop it from escalating further. However, owing to the scope of the challenge, the objective set by every country on this planet needs to be to stabilize the greenhouse effect. Given that climate change has already begun, there is urgency to take action. The lower the stabilization level targeted, the earlier the global average temperature must peak, and then begin to decline. It has been estimated by members of the IPCC that to ensure global warming will never rise more than 2°C over the current climate, the global carbon-dioxide emissions must start to fall by the year 2020 at the latest.[45] Further, carbon-dioxide emissions must continue to fall by thirty percent to sixty percent by 2050 when compared to the levels recorded in the year 2000. By limiting global warming to 2°C in place of the climate levels estimated to exist from 200 years ago entails that these carbon-dioxide emissions be divided by three by 2050. It is and will be a gigantic challenge to stabilize our climate. In essence, these objectives need to be achieved if the global community hopes to limit the number of climate refugees in the immediate future and beyond.

[45] IPCC, 2007. *Climate Change 2007: The Physical Science Basis*. Contribution of Working Group 1 to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change. Chapter 1.4. http://www.ipcc.ch/publications_and_data/publications_and_data_reports.htm#1 (accessed April 3-4, 2011).

Chapter 4

From Global Warming to Climate Refugees

Section 1: A Gradual Awakening

The extensive media coverage and dissemination of information on global warming over the last few years reflects the profound and growing awareness of the issue. To a varying extent, recognition of climate change has now penetrated all parts of Western society, including, but not limited to, environmental NGOs, journalists, politicians and policy-makers, public opinion, and scientists. However, the rapid pace at which society has come to accept climate change has led to the belief that atmospheric warming is a recent discovery, and nothing could be further from the truth.

In the late eighteenth century, a Swiss naturalist, Horace Bénédict de Saussure, discovered what we have come to call the "greenhouse effect."[46] He developed the hypothesis that the atmosphere, like glass, traps the sun's rays and heats Earth at a varying rate. Then, in 1824 and 1838 respectively, two French physicists named Joseph Fourier and Claude Pouillet confirmed de Saussure's findings.[47] Fourier demonstrated that the atmosphere keeps the soil temperature warmer than it would otherwise be. Pouillet was able to go a step further. He believed that water vapor and

[46] Royal Society of Chemistry, "Classic kit: Saussure's cyanometer," http://www.rsc.org/chemistryworld/Issues/2010/October/SaussuresCyanometer.asp (accessed November 23, 2012).

[47] Doc Snow, "Global Warming Science At the Barricades: Claude Pouillet, The Sun, And 1849," HubPages, http://hubpages.com/hub/The-Science-of-Global-Warming-in-the-age-of-Napoleon-III (accessed November 26, 2012).

carbon-dioxide were responsible for the greenhouse effect, and that any variation in either compound could lead to global climate change.

By 1896, a Swedish chemist, Svante Arrhenius, who would later go on to win a Nobel Prize in 1903, proved Saussure's theory to be true.[48] Arrhenius calculated that a doubling of the atmospheric concentration of carbon dioxide would result in an average temperature increase of 4°C – a century ahead of his time.[49] He also foresaw that the growing use of fossil fuels would eventually lead to global warming. The scientific elements for us to understand the moving parts directly involved in climate change were in place over one hundred years ago, allowing the global community to understand and, most importantly, anticipate the global climate change that took hold throughout the twentieth century.

Section 2: The Connections Grow

An American chemist and physicist named Charles Keeling established a program monitoring atmospheric carbon-dioxide levels on the summit of Mauna Loa Volcano, Hawaii in 1955. In the same year, Keeling recorded a carbon-dioxide level of 315 parts per million (ppm).[50] From climate proxy records, specifically from studies of polar ice in the form of ice cores, scientists now know that in the year 1750 the carbon-

[48] Nobelprize.org, "Svante Arrhenius – Biographical," The Nobel Foundation, http://www.nobelprize.org/nobel_prizes/chemistry/laureates/1903/arrhenius-bio.html (accessed November 28, 2012).

[49] Ibid.

[50] The Department of Chemistry at the University of Illinois, "The Charles David Keeling Lecture Series; Charles David Keeling," http://www.chemistry.illinois.edu/events/lectures/keeling/keeling_bio.html (accessed December 2, 2012).

dioxide level was on average 280 ppm.[51] The year 1750 is fundamental in climate research because it is the baseline traditionally chosen by climatologists as the beginning of the Industrial Revolution in the pre-Victorian age of Western culture. Every year since 1955, Keeling recorded the carbon-dioxide level at Mauna Loa's summit, resulting in the documented tracking of a gradual increase in the level every year.

Following Keeling's research in Hawaii, the scientific community in the early 1970s began to seriously investigate climate-change theory. In 1979, the first international climate conference took place in Geneva, Switzerland and in the same year the National Academy of Sciences (NAS) in the United States of America conducted the first major study of global warming.[52] The primary result from both the conference and the NAS study was that the global population became aware that global warming was already underway, human activity involving the use of fossil fuels was a key part in intensifying the warming, and that if measures were not taken to limit our escalating global climate change, the lifestyles with which individual cultures are accustomed could be forever altered.

In 1985, a conference of scientists and public officials was held in Villach, Austria. The two crowning conclusions of the conference were both the call for the creation of an international working group to study the issue of global climate change and the statement where "as a result of increasing concentrations of greenhouse gases […] in the first half of the next century[,] a rise of global mean temperature could occur

[51]James D. Agresti, Schuyler Dugle, "Global Warming Facts," JustFacts: a resource for independent thinkers, http://www.justfacts.com/globalwarming.asp (accessed December 2, 2012).

[52] The Department of Chemistry at the University of Illinois, "The Charles David Keeling Lecture Series; Charles David Keeling," http://www.chemistry.illinois.edu/events/lectures/keeling/keeling_bio.html (accessed December 2, 2012).

which is greater than any in man's history."[53] The United Nations recognized the power of the Austrian conference's conclusions and, working with the World Meteorological Organization (WMO) and the United Nations Environment Programme (UNEP), jointly created the Intergovernmental Panel on Climate Change (IPCC) in 1987. The duty of the IPCC was to review all scientific studies on global warming published around the world. The idea was that to bring together thousands of scientists from all corners of the world, affiliated with an extensive variety of support and research institutions, to remain as independent as possible from business lobbies and political interests.

Since 1990, the IPCC began to produce what has become known as the "Intergovernmental Panel on Climate Change Report[s]," seven editions in all to date.[54] The first report was published in 1990, and concluded that there was a strong probability that humans were impacting the climate. This conclusion led to the adoption of the "Convention on Climate Change" during the Rio Earth Summit in 1992.[55] In the second report, published in 1995, the IPCC stated that there would be an average warming of 1°C to 3.5°C by the year 2100 based on global observations. By 1997, resulting from both the IPCC's second report findings and the Kyoto Protocol, 159 countries agreed to reduce greenhouse-gas emissions by 5.2% by the year 2010 to the levels recorded in 1990.[56] A hundred years after Arrhenius's certain results, the international community, with the three most notable exceptions of the United States,

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[53] World Meteorological Organization, "International Collaborations and Partnerships on Climate Change," http://www.wmo.int/pages/themes/climate/international_background.php (accessed December, 10, 2012).

[54] Daniel Bodansky, "The United Nations Framework Convention on Climate Change: A Commentary," *Yale Journal of International Literature 451,* no. 18 (1993), under HeinOnline, http://heinonline.org/HOL/LandingPage?handle=hein.journals/yjil18&div=29&id=&page= (accessed January 5, 2013).

[55] Ibid.

[56] Ibid.

China, and Russia, modestly embarked on a long and laborious fight against the global-warming phenomenon that seriously threatens humanity.

Section 3: What We Can Say We Know about Global Warming

Evidence extrapolated from the twentieth century average global temperature curve provides evidence that the planet is warming. Twenty of the hottest years ever recorded were concentrated between 1980 and 2005, reflecting global temperature increase between 0.6°C and 0.8°C during the twentieth century.[57] The cause of this international "fever" is the greenhouse effect furthered by human induced pollution; which has developed with an intensity and speed never before seen or recorded in history.

The phenomenon of the greenhouse effect can be compared to an ordinary garden greenhouse. When light passes through Earth's atmosphere, which also traps heat, the solar rays cross the atmosphere and heat Earth. Our planet in turn radiates part of the solar energy in the form of heat, which is then stopped by a layer of gas made up mostly of water vapor, along with carbon-dioxide, nitrous oxide, methane, and other trace "greenhouse" gases.[58] This layer of gases prevents heat from escaping into outer space by acting like a roof of a garden greenhouse. In regard to the formation of the diverse environmental systems across the globe which currently exist, the greenhouse effect is generally a beneficial natural phenomenon. Without this global greenhouse effect the average temperature across the world would be -18°C instead of

[57] *Climate Refugees,* Nash, 2010, first half.

[58] Anne Klene, "Introduction to the Atmosphere and Other Related Systems" (lecture, 336 Skaggs Building, Missoula, MT, February 7, 2011).

the current 15°C.[59] The concern is over the far-reaching effects not yet fully understood of any man-made artificial increase to the overall greenhouse effect.

In 2007, the IPCC published its fourth report which stated that there is no longer any doubt about the link between the enhanced greenhouse effect and anthropogenic pollution resulting from modern human activity.[60] Based on the analysis of air bubbles captured in glaciated ice formed over thousands of years, the concentration of carbon dioxide has risen from 280 to 377 parts per million (ppm).[61] This works out to be a thirty percent increase of carbon dioxide in Earth's atmosphere since the start of the Industrial Revolution. Carbon-dioxide, which accounts for sixty percent of the increase in the greenhouse effect and remains in the atmosphere for five to ten years, has been generated by the extensive use of fossil fuels, such as: coal, oil, and natural gas. The primary purpose of the fossil fuels has been to promote industrial development and expansion, produce energy for production, expand transport systems, and provide residential needs like heating and electricity. However, at the same time the concentrations of nitrous oxide, mostly the result of intensive farming practices involving artificial fertilizers, has grown by fifteen percent.[62] Even further, the concentration of methane mainly produced from the production of cattle and rice growing has more than doubled. There is nothing natural about any of these chemical increases, and, I fear, the worst is likely yet to come.

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[59] Ibid.

[60] IPCC, 2007. *Climate Change 2007: The Physical Science Basis*. Contribution of Working Group 1 to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change. Chapter 1.4. http://www.ipcc.ch/publications_and_data/publications_and_data_reports.htm#1 (accessed April 3-4, 2011).

[61] Ibid.

[62] Jeffrey Gritzner, "Cultural Ecology; Water Lecture" (lecture, 217 Stone Hall, Missoula, MT, March 13, 2012).

Section 4: Urgent Need for Any and All Cooperation

Despite all the problems and issues aforementioned it can never be too late to act, that is until it is too late to act. The greater the increase in temperature, the more costly and harmful the consequence for the environment: meaning then the greater the need for people to act in ways to reduce the global greenhouse effect's influence on the climate. For an example, while the oceans have been rising since the 1990s at a rate of three millimeters per year compared to two millimeters over the previous one hundred years, this rate could reach ten to ninety centimeters by 2020, or even more.[63] This dramatic change in sea levels would result in the submerging of many areas vital to the existence of large groups of people around the world. The phenomenon of global sea-level rise can be explained by the thermal expansion of surface waters, the accelerated melting of both the Antarctic and Greenland icecaps, and the lessening of water retention within physical land masses which reside above the current global sea levels. Because of these far-reaching and troubling disruptions, which are but some elements leading to the overall climate disruptions both experienced now and destined for the future, up to 200 million men, women, and children may be forced into permanent exile worldwide by the end of the twenty-first century.

As humanity gains an awareness of its responsibility in aiding global warming and the related impoverishment of biodiversity, discoveries proving that we are more vulnerable than ever before feared are becoming more common. Our diversity on Earth, if not our very existence, is threatened. As evidence from the Kyoto

[63] *Climate Refugees,* Nash, 2010, first half.

Protocol, nations have initially sought to limit the causes of the problem by reducing greenhouse gas emissions.[64] The joint global effort, which is still under negotiation, will hopefully intensify; however, it is not likely to stop the warming process which is currently underway. Our international community must take the time now to prepare to confront major impacts to large-scale and small-scale environments, particularly those affecting vulnerable populations - some of which have already been permanently affected.

All over the world, vast populations are directly threatened because of the rise in the average global temperature. Populations of people living near arid regions, in Arctic areas traditionally covered in permafrost, people residing on low-lying islands or deltas and coastal areas are all imperiled both directly and indirectly from rising sea-levels and increasingly ever stronger cyclone and hurricane activity. These specific groups of people are often categorized by Western standards as poor, and living in a precarious balance with their environment. For these many, many people, global warming is the last straw and the primary factor that topples them from poverty to complete destitution; from a rooted, sedentary existence to a perpetual life of exile.

In 2005, the United Nations University initiated many avenues of research on the topic of forced migration related to global warming, the primary finding was that if global warming continued at its current pace, upwards to twenty-five million people would be forced to migrate from their traditional home "hearth zones" by 2010.[65]

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[64] Joseph E. Aldy, Robert N. Starwins, *Post-Kyoto International Climate Policy: implementing architecture for agreement…* (New York: Cambridge University Press, 2010), Executive Summary Conclusion with no page number.

[65] *Climate Refugees,* Nash, 2010, first half.

Such major migrations of large groups of people in such a short period of time is already beginning to have two massive impacts with far-reaching consequences. The first is cultural in essence, directly involving native populations and all those whose knowledge of philosophy, social organization, and the living environment has been handed down over the centuries. Groups in these situations begin to be haunted by a real fear of losing their identity when forced to uproot and move far from the ecosystems to which they have wholly adapted, and become scattered throughout a foreign city or country, and be deprived of any real or imaginary possibility of ever returning to their native lands. Currently there is a growing sentiment among these displaced groups of injustice about losing their way of life when their levels of greenhouse-gas emissions are infinitesimal compared to the developed countries of both the West and East. It is clearly a question of human rights for these men and women, as well or entire independent countries, such as Tuvalu, that are suddenly shorn of their self-determination. And for humanity as a whole, it is a matter of the irreversible loss of ethno-diversity and unique cultural heritages. The second consequence of climate-induced mass migration is wholly demographic in nature. As a population's displacement becomes increasingly expansive, it will become increasingly necessary to transport, house, and settle hundreds of thousands, possibly millions, of people from both nearby and distant lands that may themselves be fatally harmed by a direct or side effect of global warming. If there is no organization lent to these displaced peoples in advance, or negotiated with the receiving or transit countries, violent disturbances and humanitarian disasters may be unavoidable.

Section 5: Are Designated Climate Refugees Truly "Refugees?"

The international community's awareness of anthropological, climatic, and geopolitical predictions from a growing number of reports, including the reports produced by the IPCC, has escalated to the point where it must urgently address the migration issue for two major reasons. First, legal and logistical tools must be developed. Second, the international community must produce the necessary financial and political tools for effective, coordinated international action. In order to achieve these two objectives it will require the creation of a new global organization, or at the very least a significant broadening of an existing agency's mandate such as that of the United Nations High Commission for Refugees (UNHCR). Presently, the UNHCR will only honor and take care of "refugees" as they are defined by the 1951 Geneva Convention as being; any person "owing to well-founded fear of being persecuted for reasons of race, religion, nationality, membership in a particular social group or political opinion, is outside the country of his nationality and is unable or, owing to such fear, unwilling to avail himself of the protection of that country; or who, not having a nationality and being outside the country of his former habitual residence as a result of such events, is unable or, owing to such fear, unwilling to return to it."[66]

[66] Refugee Statistical Information from the U.N. High Commissioner for Refugees. http://www.unhcr.org/cgi-bin/texis/vtx/home (accessed December 2, 2011).

Too often in past history countries have hidden behind this restrictive definition of refugee qualification to refuse asylum to individuals who had to flee from the place they lived to escape danger generated from climatic forces driving environmental disasters. It is therefore necessary to update and elaborate refugee status requirements to include persons displaced by global warming as the consensus grows that a real danger exists owing to human-induced climate change. This may serve as the catalyst for international action and as the legal jumping off point for climate justice sought by populations at the mercy of global warming. Time is fleeting, but the time has come for our world's political leaders and global economic players to follow the precedent set by that of the IPCC scientists and organize an international effort. More is needed than simply an organized international effort focused on simply reducing greenhouse-gas emissions from country to country. There needs to be an organization that immediately begins the planning to absorb and disperse the mass migrations of climate refugees that will haunt our world during the twenty-first century.

Chapter 5

From Unlucky Individuals to Environmental Refugees to Climate Refugees

Some degree of climate change has always been inevitable, owing to the fact that it is partially the result of Earth's natural environmental processes. But for our future, the current effects of the observed changes in our global climate patterns are becoming increasingly clear. Future climate scenarios developed and championed by the 2007 IPCC project a world where people and nations will be threatened by massive food and water shortages, extreme weather events, devastating natural disasters, geomorphologic and geographic alterations to large areas of landscape, and deadly disease outbreaks.[67]

The events outlined in the scenarios by the 2007 IPCC reports that have come to pass will continue to cause rising economic and social costs for our global communities that promise to intensify mass human migrations around the globe. In 2006, the U.N. High Commissioner for Refugees estimated that there were 8.4 million registered refugees worldwide and 23.7 million internally displaced persons owing to the current changes in the global climate.[68] In the years to come, the inevitable forced migration of vast human populations owing to climate disruption within their native homelands is certain to increase, and the number of global refugees to be classified as *climate*

[67] Udo Fluck, "Global Hot Spots; Global Population Crisis" (lecture, 118 Health Science Building, Missoula, MT, March 12, 2009).

[68] Refugee Statistical Information from the U.N. High Commissioner for Refugees. http://www.unhcr.org/cgi-bin/texis/vtx/home (accessed December 2, 2011).

refugees will rise to levels never before seen or experienced in documented human history.

The scope of the events has been outlined by numerous private and government funded research into human reactions to various climate scenarios. Over the last two decades there has been further examination through written discourse by many scholars, scientists, enthusiasts, and government officials across the world on these human reactions. Such a large pool of contributors has led to many different approaches to examine the topic of refugees created and dispersed by climate change and intense weather events. However, these same groups of scholars, scientists, and others seem to take for granted the depth of the knowledge, understanding, and regard held by individuals within their immediate circles, versus the general public that is not directly affected or interested in climate change. The term "*climate refugees"* circulates with high frequency among current lay and scholarly discourses directly on, or related to, the topic of climate change and environmental degradation; but the role of the term's development as a representation of global climate change has not been extensively examined. An examination of the term *"climate refugees"* indicates that it is often used somewhat interchangeably with a range of similar terms, including "environmental refugees," "climate migrant," and "environmental migrant."[69] The term *"environmental refugees"* is actually regarded as the precursor to the vernacular development of *"climate refugees"*, but both terms have a similar origin. The two phrases were coined and became internationally recognized as a result of the environmental movement that occurred in North America during the late 1960s and lasted through the mid-1970s.

[69] Jonathan Cowie, *Climate Change, Biological and Human Aspects* (Cambridge: Cambridge University Press, 2007), 132.

Since their inception and acceptance, both terms have taken on specialized roles independent from one another, even though the term *“climate refugees”* may have never existed without *“environmental refugees”*.

Section 1: Vernacular Development

Arguably, the greatest success of the twentieth century has been to free ourselves from utilizing superstition and tradition to answer great questions about the physical world where we exist. This has been accomplished through the constant redefining of subject fields to produce a greater comprehension of our world, within both the scholarly and public realms of knowledge and resulting in the promotion of distinctive analytical and methodological approaches unique to each subject field of inquiry. Over the course of the twentieth century as each subject field began to evolve, each became distinct from one another, lending a need to develop a specialized vocabulary to further promote each evolving field’s validity. Developing a specialized vocabulary offered an avenue for more rapid and exact reference to the analytical and methodological approaches being pioneered and fostered within each field. However, this specialization of terminology also resulted in the need for an even greater expertise from the so-called “specialists” within each discipline. This evolving process of redefining subject fields, which led to the specialization of the vocabulary within separate subject fields of study and inquiry, represents the context of the distinction of the term *“environmental refugees”* from that of “*climate refugees.”*

Environmentalism within the United States has a long and rich history in the modern era, and can be defined as beginning when both public and private interests desired to protect certain lands during the early twentieth century. In general, the development of environmental awareness, or concerns, follow a three-theme process: first, acknowledgement of active local or regional problems that occur in the environment are brought to light; second, efforts to correct the problems start as locally based movements; and third, locally based movements grow to become the forefront of a national sentiment that eventually influences federal reactions. Throughout the 1950s, 1960s, and 1970s this process kept repeating itself until the idea of environmentalism was divorced from the notion of inclusive conservation, traditionally championed from the 1910s to 1940s. The traditional subject fields of study in biology, geology, meteorology, and history prior to the late 1960s struggled to meet the mounting public shift in sentiment toward the environment from conservation to preservation through restoration. This academic separation of concepts forced by the environmental movement allowed for new, specialized subject fields to appear within university systems across the United States, such as, ecology, environmental studies, environmental history, climatology, environmental geography, and human-environmental studies. These redefined fields of study could then allow for highly trained, specialized individuals to meet complex current and developing environmental problems of the present and future landscape. Prior to the late 1960s though, the term *environmental refugee(s)* was not widely published or popularized within or outside the fields noted above.[70] But two events unique to the United States, which occurred in the

[70] Louis S. Warren, *American Environmental History (Blackwell Readers in American Social and Cultural History)*. (Massachusetts: Blackwell Publishing, 2003), 23, 44, 47, and 67.

late 1960s, laid the groundwork for environmentalism to alter the traditional perspectives on human environmental interactions and pilot the vernacular development and acceptance of the notion of *environmental refugee(s)* – the 1968 "Earthrise" photos and the 1969 Cuyahoga River Fire.

Section 2: What We Truly Learned from Space: The 1968 Earthrise Photos

By 1968, the Space Race between the United States and the Soviet Union was in full swing, and one event in particular not only marked yet "another first in space exploration for the United States,"[71] but energized the American environmental movement, and later the movement across the world.[72] That event was the capturing of the "Earthrise" photos on December 24, 1968, by astronaut William Anders during the Apollo 8 NASA mission, notably the first manned voyage to orbit the Moon.[73] The televised viewing of the Earthrise photos on Christmas Eve, 1968 held the record for many decades as the single most watched live-telecast ever in the history of televised broadcasting,[74] and the images have been called "the most influential environmental photograph[s] ever taken."[75]

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[71] John M. Logsdon, *John F. Kennedy and the Race to the Moon; Palgrave Studies in the History of Science and Technology* (New York: Palgrave Macmillian, 2010).

[72] Frank Uekoetter, *The Turning Points of Environmental History* (Pennsylvania: University of Pittsburg Press, 2010).

[73] Deborah Cadbury, *Space Race: The Epic Battle Between America and the Soviet Union for Dominion of Space* (New York: HarperCollins, 2006).

[74] Guinness World Record. *Guinness World Records 2012* (New York: Guinness World Records, September 13, 2011).

[75] Quote accredited to Galen Rowell, acclaimed nature wilderness photographer, writer, and environmental advocate active in the 1960s and 1970s environmentalism movement in the U.S. Quote found on http://science.nasa.gov/science-news/science-at-nasa/2009/17jul_discoveringearth/ (accessed December 2, 2011).

The Earthrise photos were the first color pictures of Earth taken from deep space, and quickly became icons used by the environmental movement to demonstrate how delicate our planet is, being surrounded by the emptiness of space both devoid of life and color. These photographs were then used by the environmental movement as a vital vehicle to sway the public, at large, to start viewing the Earth as being increasingly fragile as detrimental human exploitation of the landscape increased.[76] Within the United States, efforts to promote, preserve, and protect our regional and national environments from massive environmental degradation became the battle cry for environmentalism after 1968. An awareness of natural environmental limits was set in motion by the Earthrise photos and quickly became a paramount concern within the environmentalist movement. Questions began to surface based on the fear that an established natural system could suddenly fail and no longer support habitation by human communities, forcing these communities to migrate. Had human or natural induced environmental degradation produced this result in the past? If so, at what scale was it influential and where did those who were displaced move to? And what consequences of that forced migration ensued? This growing awareness of natural environmental limits generated during the late 1960s marked the acknowledgement and acceptance of the concepts needed for the term *"environmental refugees"* to develop, and move the dialogue a step closer to the now inevitable development of the term *"climate refugees."*

[76] Frank Uekoetter. *The Turning Points*. 2010.

Section 3: Fear from Our Forgotten Backyard: The 1969 Cuyahoga River Fire

If the Earthrise photos succeeded in promoting a greater sense of how fragile Earth really is, especially considering that it is our only home and requires careful stewardship to preserve it, then the 1969 Cuyahoga River Fire succeeded in showcasing a natural system that had shutdown as an extreme result of environmental degradation caused by human induced changes to the environment from mass industrialization and pollution.[77] Located in the northeast corner of Ohio, the Cuyahoga River is famous for being "the river that caught fire"[78] in 1969, helping to fuel the environmental movement in the late 1960s and early 1970s. It has never been determined what caused the fire, but it lasted just over thirty minutes, resulting in a conflagration that spanned over five miles of riverfront, and caused approximately fifty thousand 1960s' dollars in damages to private property and public infrastructure.[79] However, this was not the first time that the Cuyahoga River caught fire due to the extensive pollution of its waters. In fact it was the tenth fire to occur on the river and one of the least damaging.[80] But the timing of the fire and the reasons contributing to the event's occurrence are the vital elements explaining why it became famous. In the wake of the environmental interest and awareness created by the Earthrise photos of 1968, this event became another poster child for the environmental movement and drew national attention to the extent that environmental degradation had occurred and its potential for environmental calamities within the United States.

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[77] Carol Poh Miller, *Cleveland: A Concise History, 1796-1996 (The Encyclopedia of Cleveland History) Second Edition* (Indiana University Press, 1997).

[78] Ohio History, *Cuyahoga River Fire*. http://ohiohistorycentral.org/entry.php?rec=1642 (accessed December 2, 2011).

[79] Ibid.

[80] Carol Miller. *Cleveland*. 1997.

The popularized legacy of the 1969 Cuyahoga River Fire is that it stands primarily as *the* environmental calamity that first brought national attention to the need for addressing other potential environmental problems across the United States before more calamities could occur. This need to address other environmental problems that were created by humans struck a chord deep within the public's minds regarding their relationship with the surrounding environment. This personified fear was "…of the invisible things in the environment, like chemicals, pesticides, and toxins…"[81] resulting from decades of human exploitation of the physical landscape that culminated in the Atomic Age of American society. The Atomic Age, as it has come to be regarded, spanned the mid-1940s to 1960s, was the direct result of the World War II era, and capitalized on American culture becoming more complex through imposed and popularized avenues of industrialization and mass consumerism. In order to maintain this culture and its accompanying "comfortable" way of life, the sacrifice became the public's mental and physical removal from the natural world, ultimately forcing us to forget about our backyard entirely as it were. And this extreme degree of separation from the natural world increases with every new technological advancement introduced into modern cultures.[82]

[81] David Brooks - PhD Candidate, History Department, University of Montana, "*Environmental History of Montana and U.S."* (lecture, Music Building Auditorium Room, University of Montana, Missoula, MT, November 19, 2008).

[82] James Deetz. *In Small Things Forgotten: An Archaeology of Early American Life* (New York: Anchor Books, 1996), 31.

Section 4: Sacrifice to Awakening

The environmental movement of the 1960s and 1970s broke the public's self-imposed separation from the natural world by utilizing both the Earthrise photos and the Cuyahoga River Fire to alert the general public to the extent of human-induced degradation within the lithosphere, hydrosphere, and biosphere of the Earth System.

Collectively, these events reminded the public of how the natural environment existing on the ground was sacrificed at home and abroad in order to allow American society to experience the comforts from advancements allotted through the development of the Atomic Age. But the environmental movement during those two crucial decades failed to showcase the degradation occurring within Earth's atmosphere as well. Environmentalists lacked active and dynamic examples that could have promoted further awareness of the last system that supports our current biosphere.[83] To rectify this failure in guiding environmental awareness and concern of the public to all three of the systems that support the biosphere of Earth, the environmental movement would have to wait for two vital events to occur. These events would also mark the final evolution and separation in the vernacular development of the term *"climate refugees"* from the earlier acknowledgement of *"environmental refugees"* already set in motion by the Earthrise photos and Cuyahoga River Fire. The first event would not fully materialize until the mid-1980s, with the discovery and formal confirmation of the Polar Region ozone holes in the stratosphere, specifically the Antarctic ozone hole. The second event came after the slow increase of forced human

[83] John R. McNeill, Paul Kennedy, *Something New Under the Sun: An Environmental History of the Twentieth-Century World (Global Century Series)* (New York: W. W. Norton & Company, 2001).

displacement during the 1990s and 2000s from increasing “super storm” activity, culminating in the largest forced migration in modern history from a weather event, represented by Hurricane Katrina in 2005.

Section 5: The “Ozone Hole(s)”

On May 15, 1985, during the decade that was known for its “big hair and ice-cold wine coolers”[84] in the United States, scientists of the British Antarctic Survey announced the discovery and confirmation of a “hole” in the Ozone Layer of the atmosphere situated over Antarctica.[85] Located in the lower portion of the stratosphere, the ozone layer of Earth’s atmosphere contains high concentrations of ozone (O_3). These high concentrations of ozone afford the atmospheric layer the ability to block and absorb up to 97% of the Sun’s high frequency ultraviolet (UV) light. UV light is known for its potentially damaging affects to all life forms on Earth, especially in the form of skin cancers and cataracts for humans.[86] Ozone is created naturally when oxygen molecules (O_2) in the atmosphere are broken into two free oxygen atoms by sunlight, allowing the free single atoms to bond with unbroken O_2 molecules. However, ozone molecules are highly unstable and easily broken up by certain trace elements, such as

[84] Brain Handwerk, *Whatever Happened to the Ozone Hole?*, National Geographic Daily News: May 5, 2010, http://news.nationalgeographic.com/news/2010/05/100505-science-environment-ozone-hole-25-years/ (accessed December 7, 2011).

[85] Ibid.

[86] Cecie Starr and Ralph Taggart, *Biology, The Unity and Diversity of Life, Tenth Edition* (USA: Books/Cole-Thomson Learning, 2004).

the man-made synthetic halocarbon refrigerants popular since their creation during the 1920s.[87]

Since the 1970s, scientists had theorized about the chemistry that could lead to ozone depletion in the atmosphere anywhere on Earth because of the increase in the commercial application of atomic halogens during the 1940s and 1950s; specifically, man-made halocarbon refrigerants like freons, halons, and chlorofluorocarbons (or CFCs) widely used as refrigerants, propellants, and solvents.[88] But, by 1985, it had become dramatically clear that a huge hole existed over Antarctica as a direct result of human industrialization and mass production patterns propagating the use of atomic halogens since the 1920s. These synthetic chemicals introduced into the environment are such a problem for the ozone layer because they can remain stable for decades once established in the upper atmosphere. In the case of both polar regions, but especially in Antarctica, the synthetic chemicals (primarily the CFCs) pool in a higher concentration because of Earth's coriolis force circulating and moving the chemicals within the atmosphere.[89] The higher concentrations of CFCs then led to compounding the destruction of the ozone molecules from year to year because of the "rarefied [nature of the] air"[90] which exists in the polar regions.

These observed and projected decreases of ozone molecules in the ozone layer above the polar regions generated an unprecedented worldwide concern because of the variety of biological consequences that may result from increased UV exposure owing

[87] William F. Ruddiman, *Earth's Climate Past and Future Second Edition* (New York: W. H. Freeman and Company, 2008).

[88] Stephen O. Andersen and K. Madhava Sarma, *Protecting the Ozone Layer: The United Nations History* (USA: Routledge, 2002).

[89] William Ruddiman, *Earth's Climate*. 2008.

[90] Roberto Bargagli, *Antartic Ecosystems: Environmental Contamination, Climate Change, and Human Impact (Ecological Studies)* (New York: Springer, 2007).

to ozone-depleting substances. This world-wide concern developed from a public outcry to eliminate international use of substances believed to cause ozone depletion, forming the groundwork that led to the creation of the Montreal Protocol. The Montreal Protocol became an international treaty of force on January 1, 1989, designed to protect the ozone layer by phasing out the production and use of ozone-depleting substances, and if adhered to could allow the ozone layer to recover to pre-1950s levels as early as 2050.[91] Owing to its widespread adoption and almost universal implementation, the Montreal Protocol is hailed as an example of exceptional international cooperation. For environmentalists though, the Montreal Protocol was a great achievement, but not the most important result of the international sentiment that came to exist with regard to the hole in the ozone layer.

The most important result was the needed connection for the public to finally see how human induced degradation of the natural environment touched all four areas of the Earth System – in this case the atmosphere. Pollutants from human alteration to the landscape, for the sake of industrialization, had not only drastically affected Earth's land and water, but the hole in the ozone layer showed how Earth's air was negatively affected - and invisible to the naked eye. The discovery of the hole in the ozone layer was the final linchpin for the environmental movement to be able to testify that all four areas that allow for the current state of the Earth System to exist had been degraded by past and present human activity. The revelation of the hole in the ozone layer, caused by modern industrial practices that employed synthetic chemicals, also began to generate more questions about what else human industrial activity may have done to

[91] Christos Zerefos, G. Contopoulos and Gregory Skalkeas, *Twenty Years of Ozone Decline: Proceedings of the Symposium for the 20th Anniversary of the Montreal Protocol, First Edition* (New York: Springer, 2009).

Earth's atmosphere as well. Slowly, ideas and questions related to the concept of environmental refugees generated during the 1960s and 1970s from human induced degradation to the lithosphere and hydrosphere began to be applied in the late 1980s and early 1990s to the possible problems of degradation within the atmosphere. Thus the concept and term of *"climate refugees"* was separated from *"environmental refugees"* for the first time. If humans could become *"environmental refugees"* because of human pollution degrading the landscape so as not to support human life, then humans could also become climate refugees from human caused degradation to the surrounding air and its alteration of climate. But it would not be until the advent of the twenty-first century that the term *"climate refugees"* would stand alone from situations related to *"environmental refugees"* and act as an independent representation of global climate change.

Section 6: Super Storms

Since the mid-1990s global climate change, also categorized as global warming, has been a reference title to represent the increase in average global temperatures contributed to by both natural events and human activities worldwide. The observed increase in averaged global temperatures has been accredited to the rise of various so-termed "greenhouse gases" accumulating in our atmosphere; and carbon dioxide (CO_2), though not the most potent greenhouse gas, is the most significant of these in promoting rising global temperature.[92] Human activity, specifically industrial activity, has caused an imbalance in the natural cycle of carbon sequestering within the

[92] William Ruddiman, *Earth's Climate*. 2008

terrestrial landscape.[93] Though greenhouse gases are essential for our planet to support the biosphere as we know it, Earth may be able to deal with slightly increased levels of greenhouse gases. But too much greenhouse gas will affect the health of the whole planet through massive changes in climate.

Throughout Earth's geologic history, climate has proved to be variable, and it is a fact that humans are not the sole cause of the trend leading up to the current global warming, and the ensuing global disruption in traditional climate patterns.[94] However, human induced degradation of the biosphere, hydrosphere, lithosphere, and especially the atmosphere owing to human industrialization processes are occurring at a rapid rate and large scale. This means that ecosystems have fewer chances to adapt to the changes wrought by humans complicating natural processes that took millennia to balance and come to fruition. These changes to our traditional climate patterns became observably apparent in the last thirty years, but especially during the 1990s and into the 2000s. The last twenty-one years of climate change have been represented by massive food and water shortages, devastating natural disasters, geomorphologic and geographic alterations to large areas of landscape, and deadly disease outbreaks; but none of these calamities were more important to the final stage in the vernacular development of the term *"climate refugees"* than were the increased frequency of extreme weather events.

[93] Cowie, *Climate Change*. 2007

[94] Robert W. Christopherson, *Elemental Geosystems, Sixth Edition* (New Jearsy: Prentice Hall, 2009), Introduction.

For the United States, the 1990s witnessed more large-scale weather events categorized as “super storms” than in any prior decade.[95] As the decade progressed, each year seemed to be marked by an even larger and more damaging storm than was experienced the previous year. Weather events such as the Halloween Gale of 1991, 1992’s Hurricane Andrew, the 1993 Storm of the Century, 1994 Tropical Storm Alberto, the Blizzard of 1996, 1998 Hurricane Bonnie, and 1999 infamous Hurricane Floyd became the hallmarks of this decade.[96] Each of these events impacted the daily routine of fifty to 100 million people, if not more, over the course of several days to several weeks in some cases.[97] But thanks to these events being predicted with relative accuracy, the general population was able to respond accordingly to the weather warnings, resulting in the total destruction and death from each event being limited. In retrospect though, the super storms of the 1990s, while typically increasing in power and frequency from year to year, did not trigger mass amounts of people to become climate refugees and force these migrants to permanently abandon their homes and relocate to some other part of the United States to live out their days. That all changed in 2005 with Hurricane Katrina.

[95] Anup Shah, Global Issues: Social, Political, Economic and Environmental Issues That Affect Us All. September 10, 2010. http://www.globalissues.org/article/233/climate-change-and-global-warming-introduction#RisingSeaLevels (accessed October 15, 2011).

[96] NOAA Satellite and Information Service. *Climate Timeline Tool, 1990s*. http://www.ncdc.noaa.gov/paleo/ctl/10.html (accessed December 10, 2011).

[97] Patricia Viets, *Extreme Weather Events To Continue And Likely Increase; Effects On Society More Intense*. NOAA News. September 22, 2000. http://www.noaanews.noaa.gov/stories/s504.htm (accessed November 27, 2011).

Section 7: Katrina

The 2005 Atlantic hurricane season has come to be regarded as the most active hurricane season for North America in recorded history. The impact of this particular season on the U.S. was "widespread and ruinous," and of the five major hurricanes to make landfall that season, the Category 5 Hurricane Katrina became the most costly natural disaster in the history of the U.S.[98] In late August of 2005, by the time Hurricane Katrina had crossed into the Gulf of Mexico, over two million people had been evacuated from cities like New Orleans (1 million alone), Gulfport, Bâton Rouge, and surrounding smaller towns and rural areas in preparation for Katrina's landfall on the Gulf Coast.[99] Although most key areas survived the initial power of the hurricane making landfall, the flooding that followed after inland levies were breached from over saturation of the inland watersheds left thousands of people stranded on rooftops and caused millions of dollars in untold damages to the urban landscape. Once the storm had dissipated and passed, the American public and government of the United States assumed that the Katrina evacuees would return to repair their homes and rebuild their lives as in past cases of hurricanes experienced by the region's inhabitants, but that would not be the case.

In New Orleans where roughly one million Katrina evacuees originated prior to the hurricane making landfall, some 700,000 returned but 300,000 did not, nor did they plan to do so once the extent of the damages became apparent in the following months

[98] MyWeather. *2005 Hurricane Season in Review*. MyWeather.net. http://www.myweather.net/targeted_forecasts/06hurricane_page/hurricane_katrina2.asp?host=NATL (accessed December 9, 2011).

[99] CNN News. *New Orleans Evacuations Under Way*. CNN. September 1, 2005 http://articles.cnn.com/2005-08-31/weather/katrina.impact_1_orleans-mayor-ray-nagin-shelterspricess/3?_s=PM:WEATHER (accessed December 9, 2011).

of September and October of 2005.[100] Most individuals only took their immediate family and a few belongings with them to the evacuation centers to which they were initially transported; nothing else. Back where they came from, the evacuees had no home, job, or life to return to. At this point, they ceased being evacuees and became climate refugees. In fact, the Katrina evacuees did not know at the time, but the 300,000 demarcated climate refugees emerged as the first and largest wave of modern climate refugees from a single weather event in the entire world. In the end, what has been found to be the most ironic testament to Hurricane Katrina's impact on the U.S. Gulf Coast Region is that it caused the largest wave of modern climate refugees in the United States – one of the three countries (China and Russia being the other two) most responsible for the rise in atmospheric carbon dioxide that is warming Earth and causing the advent of these more numerous super storms.

Section 8: Climate Refugee Legitimization

The defining characteristic of our time will become the ever-increasing flow of both environmental and climate refugees across the world. Hurricane Katrina proved to be the final legitimizing event in the long vernacular development of the term *"climate refugees"* as representing people who are displaced from their traditional homelands exclusively due to climate change caused by current and projected global warming. Aside from a single instance in 2001 with the Newcastle Herald of New South Wales,

[100] Koko Warner, *In Search of Shelter: Mapping the Effects if Climate Change On Human Migration and Displacement* (Georgia: CARE International, 2009), 36.

Australia,[101] newspapers working in both respectable international and national news media begin to use the term *"climate refugees"* actively in articles related to climate issues by 2006.[102] News agencies like ABC, The New York Times, the Australian News Wire, Herald Sun, and many others were all employing the term *"climate refugees"* to its full extent in order to inform a heightened concern for climate change and its growing consequences. Once incorporated into the daily vocabulary of international news distributors, terminology never goes away and is always there to be used at the drop of any headline it may pertain to.

Over the long term, climate refugees displaced by rising sea-levels will eventually dominate the flow of displaced people when compared to other types of environmental and political refugees. As projected by some of the scenarios contained in the 2007 IPCC reports, even the conservative estimate of a half a meter (one and a half feet) rise in sea-level over the next 100 years would inundate large parts of low-lying cities, major river deltas, and low-lying island countries. Among the earliest climate refugees from sea-level rise will be rice-farming families from Asia's low-lying river delta regions; specifically, large deltas in the countries of Vietnam, Korea, Thailand, Cambodia, Bangladesh, and China. Scientists recognize the primary contributing factors behind the rising sea levels, but the ultimate range of effects from predicted sea-level rise to the human populations most vulnerable are yet unrealized, and all they can do is estimate at this point. Countries in Asia, which are expected to shoulder more of the direct effects owing to rising sea-levels, stand a better chance of persevering their livelihood if

[101] The Newcastle Herald, *ChannelSurf*. NSW, March 26, 2001. ChannelSurf (accessed May 13, 2015).

[102] The Daily Telegraph, *Climate Refugee Concern*. Sydney, August 18, 2006. Climate refugee concern (accessed May 13, 2015).

they accept that climate change is a reality and they take immediate steps to minimize the potency of the threat now.

Section 9: Case Application: Vietnam

The most profound consequence of our current global climate state has proved to be the overall water-level rise observed in Earth's oceans and seas. Sea-level rise owing to changes in Earth's climate patterns is a serious global threat, and will produce an unprecedented number of people forced to abandon their traditional homelands – demarcating these groups as climate refugees. Continued growth of greenhouse gases and associated global warming has ushered in a warmer global climate, which has raised the average global temperature by 2°C over the course of the twentieth century.[103] Over the last century, sea levels have risen at an average rate of 1.2-2.2 millimeters per year.[104] If this rate were to continue at its current pace, water levels can be expected to rise by a minimum of half a meter by the year 2100. If even the most conservative expectation were to become reality; rising sea levels will create substantial geomorphologic and geographic alterations to the world's coastlines.

As both temperatures warm and human activities increase globally, as are predicted for the future, the oceans will warm and expand, ice sheets and glaciers will

[103] Stefan Lovgren, for National Geographic News, April 26, 2004, *Warming to Cause Catastrophic Rise in Sea Level?*, http://news.nationalgeographic.com/news/2004/04/0420_040420_earthday.html (accessed April 4-6, 2011).

[104] IPCC, 2007. *Climate Change 2007: The Physical Science Basis*. Contribution of Working Group 1 to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change. Chapter 1.4. http://www.ipcc.ch/publications_and_data/publications_and_data_reports.htm#1 (accessed April 3-4, 2011).

melt, and precipitation will be less likely to be held in landforms owing to extensive devegetation. Sea levels will therefore rise, and the direct impacts on both vulnerable regions and environments will be extensive. The resulting impacts for vulnerable regions will include, but not be limited to, coastal erosion, landslides, inundation, and relocation, changes in ground-water characteristics, such as the salinization of aquifers, higher storm surge flooding, and loss of animal and human habitats.[105] Needless to say, the same ways in which regions and environments will be extremely impacted will also alter the multitude of ways in which humans utilize those same areas for their existence.

According to the IPCC, for almost all island-based countries and a sizable number of continental countries will be challenged over the coming centuries.[106] With regard to the implications of sea-level rise on population location, infrastructure planning, and GDP output, the top five continental countries poised to produce the highest volume of future climate refugees are currently Vietnam, Bangladesh, Egypt, Suriname, and Mauritania, because of their geographic vulnerability to climate change.[107] Of those, only the country of Vietnam has demonstrated a determined and active concern for its future preservation when combating the expected rising sea-levels as outlined by the 2007 IPCC report, because of the progressive outlook on climate change taken by the current government.

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[105] M.L. Parry, Canziani, O.F., Palutikof, J.P., van der Linden, P.J and Hansen, C.E. (eds) (2007), Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change 2007 (Cambridge: Cambridge University Press, 2007).

[106] IPCC, 2007. *Climate Change 2007: The Physical Science Basis*. Contribution of Working Group 1 to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change. Chapter 1.4 (Cambridge: Cambridge University Press, 2007).

[107] Climate.org. *Low lying areas – Impacts & Vulnerabilities; Including Floodplains, Coastal Areas, Islands, and Deltas.* http://www.iwahq.org/Home/Water,_climate_and_energy/Climate_change_adaptation/Climate_change_vulnerabilities/Low_Lying_Areas/ (accessed April 2-6, 2011).

In order to initiate progressive thought toward long-range government planning of population control, civic development, and economic investment, the Ministry of Natural Recourses and Environment (MONRE) of Vietnam released documentation in August of 2009 that was to be the first step in "mainstreaming" climate change assumptions within other ministries of the Vietnamese government.[108] This documentation was grounded on a set of scenarios compiled by MONRE for the expected change in sea-levels, severity of storms, and other climate change events based on historic data and the best current estimates by both the international and Vietnamese scientific communities. These scenarios outline Vietnam's most vulnerable regions owing to climate change, and compounded by extensive devegetation in the two large low-lying deltas of the Mekong River in the south and the Red River in the north. Regarding sea-levels specifically, MONRE predicts that the average level of Vietnam's seas will rise by sixty-five to 100 cm by the end of the twenty-first century. For the two great delta regions of Vietnam, this projected rise in the seas would submerge and inundate a little under half of the total land found in both deltas with saltwater. This same land is where two of Vietnam's largest urban complexes are located, over twenty-four million people live, and nearly sixty percent of the country's rice, along with other staple crops, is grown. The MONRE scenario reports emphasize that the predicted sea-level rise represents a certain threat to the economic future of Vietnam, based on the current models, if no measures are taken in the immediate coming decades, like investing in both traditional and new innovative measures to combat the rising tides.[109]

[108] Ministry of Natural Resources and Environments (MONRE). *Climate Change Scenarios Will Guide Government's Planners*. Translated and Presented by Press Center in August 2009. http://www.presscenter.org.vn/en/content/view/921/27/ (accessed July 18, 2011).

[109] Ministry (MONRE). *Climate Change Scenarios*. 2009.

For Vietnam, the key points of concern are the two delta regions of high economic value and human habitation; both the Red River Delta in the north and the Mekong River Delta in the south. These areas are where the country's investment and development of rice production has made it the world's second largest exporter of that staple agricultural product.[110] Regrettably, both of the delta regions have sizable land areas where the elevation above sea-level is currently only three meters at most. That means that without any expansion of either hard or soft structures to combat the anticipated rising sea levels of fifty cm by 2100, over seventy percent of Vietnam's key rice production fields will become too inundated with water to produce rice, let alone support a human subsistence lifestyle.[111] Vietnam is only one out of several countries that face massive infrastructure damage and devastating economic possibilities in the near future; but at least three quarters of Vietnam's current land surface will remain above the climbing sea level by 2100, if the current estimates stand true.

Section 10: Case Application: Newtok, Alaska

Newtok, Alaska, is a town situated on what is now an island in the Ninglick River of western Alaska, and it is sinking into the alluvial soil of the river's path.[112] There is currently a population of 354 ethnic Alaskan natives who permanently reside within

[110] Tyron Venn, "Impacts of Climate Change on Vietnam; Both on Livelihoods and Infrastructure" (lecture, Mansfield Library, The University of Montana, Missoula, MT, November 15, 2010).
[111] Ibid.
[112] Suzanne Goldenberg, "America's First Climate Refugees: Newtok, Alaska," *The Guardian*, May 13, 2013.

Newtok.[113] This inhabitance live everyday hoping that tomorrow will not bring the final chapter to their town and cultural home.

The village of Newtok situated in a region of western Alaska is being threatened by advancing erosion caused by the Ninglick River. This progressive erosion is due to rising annual temperatures recorded over the last fifteen years which has also exacerbated the already noticeable rise in permafrost degradation.[114] Seasonal flooding of the village has also increased due to a rise in annual storm activity in the region. The combination of ever larger areas of permafrost thawing compounded with the rise in annual storm activity in the region has intensified the extensive amount of erosion damage done to the town of Newtok in recent years. Furthermore, recent studies have concluded that the town must relocate because there is no other permanent cost-effective alternative for the remaining village inhabitants to stay on the site.[115] The town is going to wash away in the immediate future, and there is no saving it.

In 2006, Newtok Village requested the assistance from many Alaskan state and U.S. federal agencies to aid the inhabitants in their relocation to a new site within the region of their cultural heritage.[116] A Newtok Planning Group was formed in late 2006 to coordinate any and all agencies that needed to be involved in the town's relocation. A site was selected and the new town was named Mertarvik, Alaska. Since 2006 a community layout plan has been developed, town site and subdivision surveys have

[113] Ibid.
[114] William Yardley, "Engulfed by Climate Change, Town Seeks Lifeline," *New York Times*, May 27, 2007.
[115] Ibid.
[116] State of Alaska - Department of Commerce, Community, and Economic Development. *"Planning and Land Management: Newtok Planning Group*." http://commerce.state.ak.us/dnn/dcra/PlanningLandManagement/NewtokPlanningGroup.aspx (accessed June 16, 2015).

been conducted; studies were also conducted for water, sewer, and alternative energy infrastructure, housing, quarry development, and a future airport.[117] By 2012, the Newtok Planning Group finished and produced the "Mertarvik Strategic Management Plan."[118] It provides the ordered blueprint for the relocation of the Newtok inhabitants to the new town of Mertarvik.

Unfortunately, the smooth transition from Newtok to Mertarvik stalled in August 2013. Control over the native political government within Newtok degraded and broke down because of an internal political conflict among native leaders due to a final freeze on government funds for the projected move.[119] This internal dispute exposes the severe strain currently being experienced on native Alaskan villages, like Newtok, in dealing with the effects of climate change. Many native villages in similar situations to Newtok are either losing land to erosion or are sinking into melting permafrost. A very small amount of villages have started the process of relocation but none had progressed as far as Newtok in locating a new site, completing a relocation plan, and beginning the slow process of negotiating through the numerous amounts of state and federal agencies to secure funds for the relocation to Mertavik. But with the financial freezing of all funds generated prior to August 2013, compounded by the political breakdown of native government within Newtok; all progression to relocate the people of Newtok is stalled indefinitely at this point. Once their village's location is made uninhabitable by nature, and the new village site is not complete, he native inhabitants of Newtok fit the mold perfectly to be termed as climate refugees.

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[117] Ibid.
[118] Ibid.
[119] Suzanne Goldenberg, "Relocation of Alaska's Sinking Newtok Village Halted," *Environment-Climate Change Desk*, August 8, 2013.

Chapter 6

The Rising Tide; Elements Behind the Growth of Climate Refugees

Sea-level rise owing to climate change is a serious global threat, and for the first time in history the scientific evidence is now overwhelming. The most profound consequences of our current global climate state is the overall water level rise seen in Earth's oceans and seas. At the present time, ocean and sea levels are rising at an average rate of 1.2-2.2 millimeters per year, over the last century.[120] If this rate were to continue at its current pace, by the year 2100 water levels can be expected to rise in our oceans and seas anywhere from eighteen to fifty-nine centimeters. If even the most conservative expectation were to become reality, rising sea levels will create substantial geomorphologic alterations to the world's coastlines and river-delta regions. This is an important concern to the global community because there will be a direct impact to substantially large portions of Earth's human population.

According to the IPCC's 2007 report, current climate change will produce many negative effects to the environment, including, but not limited to: a higher frequency of heat waves; increased intensity of storms, floods, and droughts; a large loss of biodiversity; and increased sea levels around the globe.[121] Coupled with human involvement, these three negative effects are indirectly what create the three primary

[120] IPCC, 2007. *Climate Change 2007: The Physical Science Basis*. Contribution of Working Group 1 to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change, Chapter 1.4, http://www.ipcc.ch/publications_and_data/publications_and_data_reports.htm#1 (accessed April 2-8, 2011).

[121] Ibid.

contributors to sea-level rise. Within the last ten years, studies of sea-level rise during the whole of the twentieth century, and the first decade of the twenty-first century, have cited the primary contributing factors to be: ocean thermal expansion, glacial melt (primarily from Greenland and Antarctica), and the change in terrestrial storage (or terrestrial water storage, TWS).[122]

Section 1: Three Causes

The first attributed cause of sea-level rise, thermal expansion of ocean water, in context, is the increase in volume, or the decrease in density, of water as a result of increased temperature. The current sea-level is expected to rise on average, with a "best estimate" by the 2007 IPCC report, by a minimum of half a meter (that is fifty centimeters or 19.8 inches) by the year 2100. Of that total fifty centimeters, ten to twenty-five centimeters is expected to be a direct result of thermal expansion of ocean water.[123] Owing to the higher average annual temperatures experienced each year, low-lying coastal regions, located in the low- to mid-latitudinal tropics, will experience the higher estimated range of sea-level rise from the thermal expansion of ocean water. Specifically, regions of land that consist of an island or island groupings, continental shorelines, and delta based areas will be the most vulnerable to dangers of sea-level rise caused by the thermal expansion of ocean water.

[122] Andrew Goudie, *The Human Impact on the Natural Environment, Sixth Edition* (Oxford: Blackwell Publishing, 2006), 243.

[123] NOVA, Science In The News. *Getting into hot water – global warming and rising sea levels.* Published by the Australian Academy of Science, Australian Greenhouse Office, http://www.science.org.au/nova/082/082key.htm (accessed April 4-6, 2011).

The second cause attributed to current sea-level rise is the result of massive global de-glaciation from rising average global temperatures. This deglaciation, in turn, has created larger volumes of glacial melt, which eventually flow into the oceans of Earth. Mountain glaciers and ice sheets are large, slow moving reservoirs of frozen fresh water; they cover approximately ten percent of Earth's land surface and exist on every continent except Australia. Scientific records from many sources, beginning as early as the mid-nineteenth century, can prove that most of the world's mountain glaciers and ice sheets in Greenland and Antarctica have been losing a sizable portion of mass over the last 140 years. At present, the two primary glacial bodies of concern are the ice sheets of Greenland and Antarctica. Both of these ice sheets, when combined, contain enough potential melt water to raise the average mean sea level by almost 65 meters. [124] So small changes in either of their volumes will have a significant effect on sea-level trends in the future.

Finally, the third attributed cause of sea-level rise has been suggested to be the change in the land's physical ability to withhold and store water, termed terrestrial storage. Terrestrial storage includes many types of land-surface processes that play major roles in the climate system; specifically, in the amount of water that the physical land surface can absorb, retain, and prevent from flowing into larger, long-term reservoirs of water like our oceans. Terrestrial water storage consists of ground-waterstorage, like aquifers; soil moisture retention, like permafrost; and wet biomasses, such as tropical rain forests or bogs.[125]

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[124] R.W. Christopherson, *Elemental Geosystems, 6th Edition* (Prentice Hall: Upper Saddle River, 2009), Section on Glacial Ice Melt.

[125] Matt Rodell, for the NASA Goddard Space Flight Center. *Remote Sensing of Terrestrial Water Storage and Application to Drought Monitoring.*

The variability of land to retain water tended to traditionally revolve around snow and ice fall in the polar and alpine regions, high soil moisture withholding in mid-latitude regions, and surface water retention in wet, tropical regions.[126] However, owing to human alteration, exploitation, and eventual urbanization of the physical land, compounded by the average warming temperature trend seen in our global climate, the traditional options and ability for the land to retain water are becoming more diminished. This reduction in terrestrial water storage ultimately impacts the hydrological cycle, its integral role as part of the climate system, and allows for still higher volumes of surface water runoff. Rather than being absorbed into the ground, it will end up in larger water bodies, including our oceans.

As these three primary contributors have heavily influenced past water levels in our oceans and seas over long interdecadal to geologic time scales, they are expected to continue to be the leading factors that will guide future sea-level change. However, there is a lack of consensus on which of the three is expected to be the dominating factor driving sea-level change. Data collected from the studies of sea-level rise that correlate directly to the rising average global temperatures over the majority of the twentieth century, cite thermal expansion of ocean waters as the overwhelming cause ofthe measured rise in global water levels.[127] While thermal expansion is a less obvious process than melting ice (because an individual cannot watch it happen), the 2007 IPCC report projects that thermal expansion will be the main component of expected sea-level rise over the next century.

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http://www.drought.gov/imageserver/NIDIS/workshops/remotesensing/abstracts/matt_rodell.pdf (accessed April 4-6, 2011).

[126] Ibid.

[127] J. Stuart Godfrey Church, David R. Jackett, and Trevor J. McDougall, *A Model of Sea Level Rise Caused by Ocean Thermal Expansion*. CSIRO Division of Oceanography, Hobart, Australia. Journal of Climate, American Meteorological Society. Volume 4. April 1991 (Tasmania: 1991), 438-456.

More recent data compiled within the last three years, on rates and totals of mass waste and de-glaciation of both the Greenland and Antarctic ice sheets, point to a greater significance on past sea-level rise through glacial melt than previously thought. The range of uncertainty about future global temperature projections and how rapidly they will affect (or in other words…melt) the current large ice sheets in both Greenland and Antarctica will ultimately be the deciding factor in whether thermal expansion of ocean water or glacial melt will be the dominate factor in determining future sea-level trends.

Section 2: Traditional Limiting of Sea-Level Rise Impacts

Traditionally, the need to limit the impacts on human activity within regions vulnerable to fluctuating sea-levels has been one grounded in the necessity mindset of "defensive measures" and the belief that these are the only options to combat rising tides.[128] Early human efforts to alter an area in order to limit the effects of sea-level rise often consisted of "hard structures" or "hard engineered measures;" in order to, provide a defense from various impacts of sea-level rise, such as erosion and storm-surge flooding.[129] These hard structures began in human history as forms of primitive sea walls, consisting usually of staked lumber, stones, or a combination of the two medias used to limit water damage to an area. Many variations of sea walls developed over

[128] United States Environmental Protection Agency. *Coastal Zones and Sea Level Rise.* Section on "Climate Change – Health and Environmental Effects". http://www.epa.gov/climatechange/effects/coastal/index.html (accessed April, 6-8, 2011).

[129] Climate.org. *Low lying areas – Impacts & Vulnerabilities; Including Floodplains, Coastal Areas, Islands, and Deltas.* http://www.iwahq.org/Home/Water,_climate_and_energy/Climate_change_adaptation/Climate_change_vulnerabilities/Low_Lying_Areas/ (accessed April 2-6, 2011).

human history and are still employed today in most countries worldwide, but especially in the non-industrialized countries of the world because of their low cost and relative ease to build.

Over time, as human technology advanced, specifically in areas of architectural and engineering practices, it allowed for more complex and powerful hard structures to be employed as defensive measures against unwanted rising water levels. Modern hard structures commonly used in industrial countries today, often made of formed concrete, include jetties, groins, sea and breaker walls, and dykes. These structures are primarily designed to protect coastline beaches, coastal wetlands, and both human improvements and buildings from erosion.[130] However, today these types of defensive measures against rising sea levels are being criticized because of their more recently realized drawbacks. Regardless of their extreme effectiveness in protecting and preserving human activity, many countries are turning away from hard structure techniques. These hard structures have proven to increase and intensify erosion down beach in areas that lack hard structures. Hard structures that restrict, or prevent entirely, "longshore drift" from occurring, are very challenging to improve once installed, and are highly cost prohibitive for a new installation to achieve the needed scope for the now conservatively predicted half a meter sea-level rise by 2100.[131]

[130] Emily Jack, *Coastal Erosion And The Ban On Hard Structures.* http://www.learnnc.org/lp/editions/nchist-recent/6374 (accessed April 5-8, 2011).
[131] Ibid.

Section 3: Future Tools for Limiting Sea-Level Rise Impacts

In the last thirty years, there has been an increasing need for humans around the world to find new, innovative ways and techniques to contend with the threat of rising sea levels, especially in the non-industrialized countries that are most at risk. Instead of relying primarily, if at all, on the large-scale hard structures, non-industrialized countries across the world have turned to nature and natural occurring structures for inspiration. Currently, certain South Asian countries like Vietnam are leading the world in these types of innovations, either of their own design or using practices borrowed from others.[132] The current innovations to control the predicted trends of future sea levels are still defensive in nature and preserve aspects of their hard structure counterparts as being, in essence, "walls." But they are innovative in replacing the expensive, man-made hard structures of the past. These "soft structures," as they are coming to be known, are usually modeled after naturally occurring specialized coastal plant based networks and coral reef networks that form in the shallow ocean waters off coastlines. The two crowning examples are that of mangrove forests and artificial reefs constructed of oysters.[133]

Over the last ten years there have been huge efforts made by, and for, Pacific island and South Asian countries, such as Vietnam, to both stabilize and regenerate existing mangrove forests, or develop mangrove forests in current coastal environments that originally did not house any variety of the species. There are over fifty known

[132] Tyron Venn, Impacts of Climate Change on Vietnam, 2010.

[133] ReefBall.org, The Reef Ball Foundation is a 501(c) 3 publicly supported non-profit and international environmental NGO working to rehabilitate marine reefs – Create an Oyster Reef, Plant Mangroves. http://www.reefball.org/ (accessed April 4-7, 2011).

varieties of true mangroves throughout the tropical and subtropical latitudes of the world, where they dominate three quarters of the total coastlines. There are both tree and shrub varieties, which are varied in adaptability to saline conditions in coastal sediment intertidal habitats where they characteristically form saline woodland habitat often termed mangrove forests or swamps.

These highly specialized plants have come to be valued in many countries because of three unique characteristics that are found to be emulated by most varieties of the diverse species, and are looked upon to help combat rising sea-levels principally over any other plant variety. First, once established as a large forest, mangroves act as a natural wall to protect coastal areas from erosion, storm surges, and tsunamis because their massive root systems are highly efficient at dissipating wave energy. Second, their root systems slow down tidal water enough that sediments are allowed to be deposited, promoting soil build up (even serving to extend the coast line out to sea) in areas that would otherwise be eroded and eventually succumb to rising water levels. Third, the mangrove forests provide the framework for a diverse ecosystem that supports large levels of biodiversity for both aquatic and marine life. These reasons are why national governments, like that of Vietnam, are pushing for greater expansion of mangroves in regions of high human investment that are very vulnerable to sea-level rise. However, a mangrove forest's protective value has often been overstated; wave energy in areas where a mangrove forest naturally grows are typically lower in strength on average, so the plant's relationship to coastal erosion can only be measured over long periods of time. Also, despite popular, and often large, restoration efforts of mangrove forests, they remain a primary source of fuel for populations in non-

industrialized countries, and the areas where they are located are highly sought after by developers for agricultural or commercial pursuits of one form or another. This has ultimately resulted in the removal of over half of the world's mangrove forests in the modern era and severely hinders the future promotion and propagation of this specialized plant species.[134]

Shallow coral reefs found off coastlines around the world are often Mother Nature's version of our man-made hard structure sea walls, and humans have been mimicking this marine structure for quite some time in the process of what has become known as artificial reef construction.[135] Often it is a man-made underwater structure of varying inorganic materials for the purpose of promoting marine life for both recreation and commercialized fishing in areas otherwise consistent with a featureless bottom. Historically, artificial reef construction has occurred for thousands of years in human history, although the historic uses of artificial reefs were associated with situations of sea power and naval control, rather than aquaculture.[136] In recent years though, many groups have come to realize the utility of coral reefs in combating rising sea levels. Most hope that if the right material is found to act as a universal base for a reef system that could be organized along coastlines around the world, it could potentially replace the implementation of traditional hard structures of concrete based sea walls globally.

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[134] James A. Danoff-Burg, *Mangrove Forests,* PowerPoint Presentation, www.columbia.edu/ite/care/secu/lectures_files/ppt/mangrove.ppt (accessed April 9, 2011).

[135] South Carolina Department of Natural Resources, *Marine Artificial Reefs*; *Sea Science, An Informative / Educational Series from the Marine Resource Division.* http://www.dnr.sc.gov/marine/pub/seascience/artreef.html (accessed April 5-8, 2011).

[136] Marc Jason Gilbert Adas, Stuart B. Schwartz, and Peter N. Stearns, *World Civilizations – The Global Experience; Volume 1, Third Edition* (New York: Addison-Wesley Education Publishers Inc., 2001) Persian, Greek, and Roman Naval Histories.

One group out of Atlanta, Georgia, known as The Reef Ball Foundation, claims that oysters are in fact the material of choice.[137]

The word oyster is commonly used as a name for a specialized variety of mollusks which can live in both fully aquatic and intertidal environments along coastlines. They are often regarded as a keystone species and can provide a diverse habitat for many marine species. Oysters survive by absorbing calcium and carbon dioxide within ocean water, and in turn create growth and multiply by generating stone reefs strong enough to act as a sea wall.[138] If groomed correctly, by the time that it fully matures, usually within one year from its inception, artificial oyster reefs have the potential of increasing the surface volume of any surface by fifty percent. This type of artificial reef construction is fairly new, not yet extensively used outside of the eastern coast of the United States, and lacks long-term analysis of its effectiveness in combating rising sea levels. Even though countries, including that of Vietnam, have already implemented or are planning on implementing this type of artificial reef construction for the purpose of combating rising sea level there is no long-term confirmation that this type of soft structure will do anything against sea-level rise.

[137] ReefBall.org, The Reef Ball Foundation is a 501(c) 3 publicly supported non-profit and international environmental NGO working to rehabilitate marine reefs – Create an Oyster Reef, Plant Mangroves. http://www.reefball.org/ (accessed April 4-7, 2011).

[138] Alabama Department of Conservation and Natural Resources, *Protecting Storm Swept Coastlines,* http://www.inhabitat.com/protecting-eroded-coastlines-with-oyster-seawalls/attachment/16524/ (accessed April 5, 2011).

Section 4: An Extreme Solution to Massive Displacement of Humans

Then there are the countries, mostly island groups and island-based nations where their entire environment will be made completely uninhabitable by the predicted sea-level rise in eighty-nine years. What, if any, are the options for extreme circumstances where whole human communities become totally displaced by sea-level rise? There is no economically feasible option for this extreme circumstance at this time. However, at least one option could prove to become viable in the future, if only money were put into its research and development now. After all, today's ideas are tomorrow's reality.

There are few large-scale design solutions that currently address mitigating the inevitable tide of completely displaced human communities that will result from sea-level rise. The most audacious of these has come to be known as the "Lilypad" Floating City. Designed by a Belgian architect named Vincent Callebaut in 2002, this concept presents a completely self sufficient floating city. The entire idea for the Lilypad is clearly inspired through the biomimicry of giant fresh- and salt-water based lily pads that often are found in both the Amazon of South America and the Congo region of Africa. Through the use of recently mastered, and ever improving green energy production technologies like wind, solar, and tidal powered energy production technologies. It is envisioned that the concept could produce entirely all of its own energy. Conceptually, these Lilypads would be designed to support a diverse biological environment, hold approximately 50,000 humans each, and are intended to rest either near an existing coast or float around the ocean, traveling according to where the ocean currents take it.

However, this potential option for whole human communities that become totally displaced by sea-level rise is nowhere close to happening anytime soon. Yet there is value in progressive futuristic designs, like that of the Lilypad, because they can inspire solutions, which at some point might actually provide real solutions to large issues derived from climate change.

Section 5: Power of the Rising Tide

At this point there is still an unending debate, playing out globally, as to whether global warming is in fact ushering in an unnatural climate change that was caused entirely by the actions of human development throughout the most recent history on Earth. While the debate drags on, profound consequences resulting from observed climate warming trends are playing out in smaller time scales than ever seen or experienced before in recorded human history. Overall, current scientific evidence shows that our global climate is in a progressive warming state, resulting in empirically measured changes to our diverse biological environments; and one of the most profound consequences of these changes is that of the rising average water level seen, experienced, and expected to develop in Earth's oceans and seas. Scientists recognize the primary contributing factors behind the rising sea levels, but the ultimate range of effects from predicted sea-level rise to the human populations most vulnerable are yet unrealized, and all they can do is estimate at this point.

Historically, humans willing to combat past trends in global water levels of the oceans and seas, whether by luxury or necessity, have built certain engineered

techniques and structures for the sole purpose of preserving existing coastlines and human improvements thereof. However, today, not all human communities benefit from the most advanced of those man-made engineering feats. There is a growing effort to develop comparable, but more naturally based, technology that can be applied uniformly and economically across vulnerable environments to sea-level rise; in order to preserve existing human interests to an area of land. But the ideas are few, and the ones that have been implemented, at any scale to test for their resulting positive impacts, cannot yet be used for long-term impact evaluation. It is said that all adversity is the grandfather of innovation, and there are innovative ideas for when the time comes for how whole human communities could adapt to extreme changes to their traditional environments. Most of these progressive, futuristic designs are grounded in existing technology that could potentially make these innovations into a reality as viable options. However, a lack of both monetary and societal support prevents any of these concepts from leaving the drawing board. Currently, humans across the globe are at a metaphorical crossroads with the scale of unprecedented environmental threats challenging them. As a whole, human communities can either choose to take action now and begin the required work toward preserving their diverse existences in their traditional lands, or not, and face the power of the rising tide without any protection. The facts are everywhere, change is happening, and the challenges are continuing to expand in their scope. On which of the two roads will we choose to proceed?

Chapter 7

Case Study; My Australian Observations

While attending classes during the Autumn 2011 semester at The University of Montana, I had the fortune to meet Mr. Thomas Perrigo, CEO of the National Trust of Western Australia. Through subsequent discussions following our introduction, it was mutually decided that I should apply for one of the annual student internships the National Trust offered to both local and foreign graduate student level applicants. It came to pass that I was one of the three students selected for the Trust's Winter Internship for June to August of 2012. The following two sections are both a product of my internship at the National Trust of Western Australia and my personal observations during my independent exploration in the continent.

I would like to make note, specifically, that almost all of the knowledge I gained during my time in that remote area of the world was acquired, more often than not, through personal interviews, discussions with individuals and groups on trains, in busses, dining halls, arranged encounters, and by good chance that always started with a smile and a hardy hand shake of greeting. These observations are mine and mine alone, all recorded in a daily journal that I kept by my side every second while in Western Australia.

Section 1: White Western Australians

Perth, WA, is regarded as the most isolated culturally western city in the world; yet it is home to a diverse population in a large city scape and once outside city proper, it includes a vast array of sprawling suburban towns which eventually give way to a seemingly endless countryside of farms and livestock stations. As an outsider, Perth and its immediate living zone appeared to me as a striking reminder as to what Los Angeles, California was like when I was a child, although cleaner and the English speakers sound a little different to an untrained ear. But once I had the ability to venture outside the city and into the countryside for long periods of time, all nostalgic similarities stopped there. The "Australian Bush" as it has come to be globally known by is a formidable landscape not for the weak, weary, or ignorant.[139] It is in the Bush where the modern western Australian is meeting climate change and, dare I say, might face great challenges in the not so distant future.

Water it is on the mind of every western Australian I interacted with, regardless of their place in society or economic livelihood. During my time in Western Australia I came to learn immediately that the expanding lack of fresh, drinkable water from local sources was dwindling rapidly. Perth and its surrounding populated spaces were on their twelfth year of drought and dire actions in both the social and political realms were reeling to combat the burden of conserving, reallocating, and searching for new sources of secure fresh water. This also is true for the National Trust as well, with regard to the properties it holds, in trust, for the people of Australia. For example, take one of the

[139] Thomas Perrigo, interview by author, National Trust of Western Australia offices, Old Observatory Building, Perth, WA, Australia, July 16, 2012.

original properties supplied to the National Trust, No. 1 Pump Station. This property is located at Mundaring Weir (weir is the Australian term for a water storage reservoir) and was historically the beginning of the Golden Pipeline that brought drinking water to the eastern gold fields.[140] Mundaring Weir is significant to the populace of Perth today because it is the largest of three water storage reservoirs which supply Perth and its surrounding suburban areas with their daily water for homes and businesses. Unfortunately, the water levels in two smaller weirs have completely receded to below the soil and Mundaring Weir's water has fallen to critical levels below sea level. This state of such a low water level makes the Weir vulnerable to salinization of the remaining potable water. For the National Trust this bodes ill for the future of the property as an educational site for one of Australia's most significant industrial heritage sites because without water in the Mundaring Weir, much of the visual significance attached to the functional site is lost.[141]

Salinization of fresh water sites, like Mundaring Weir, underground aquafers, and inland river systems is the looming disaster egging on fear and uncertainty for western Australians. It truly is the primary concern and lots of government funding appears to have been diverted to develop and employ modern technology in order to provide, at the very least, a secure source of drinking water for the populace of Perth.[142] The primary technology at the forefront of municipal investment is in a string of desalinization facilities planned for along the coastline. The plan calls for a total of ten large scale desalinization facilities to be up a running by 2025.[143] By June of 2012, four

[140] Enzo Sirna, interview by author, National Trust of Western Australia offices, Old Observatory Building, Perth, WA, Australia, July 3, 2012.
[141] Ibid.
[142] Perrigo, interview.
[143] Ibid.

of these fresh water manufacturing facilities have been completed in less than three years, two more were under construction during my time in Western Australia, and the remainders are to be completed in the subsequent years. Other avenues of investment include education of the youth about water conservation tactics, social stresses such as increased taxation on overwater use, and even social hazing such as advertisements geared to encourage citizens to push their friends and neighbors to not water their lawns or wash their cars at home. Apparently, these methods are helping the water shortage situation, but slowly. From my vantage point too slowly because they are reactive based in nature, rather than a proactive approach that actively seeks to find a primary catalyst to the water shortage and then actively correcting or countering that catalyst. For me one catalyst I observed stems from farming practices noted while exploring the countryside due east of Perth.

Farming practices employed in Western Australia, albeit quite mechanized for efficiency, are very simple, wasteful, and non-progressive. The primary crops are canola, barley, wheat, hay, and sheep.[144] Most of the plant based crops are planted with “air planting techniques”, also called gravity seeding with shallow spring type cultivators.[145] This type of planting technique combined with some rudimentary dryland farming techniques has proved productive in the past for this region. But the extensive drought brought on by local climate change has failed to abate, forcing the farming community to draw on more water extracted from local aquifers to continue their farming practices. This extraction was so extensive in many areas I visited that the full effects of inland salt poisoning of both the cultivated crop lands and the wild Bush was

[144] Elise Woods, interview by author, National Trust of Western Australia offices, Old Observatory Building, Perth, WA, Australia, July 4, 2012.
[145] Ibid.

devastating. Without allowing for proper recharge of the aquifers in these areas due to the primitive western commercialized farming of the region, not only have these farmers irreparably damaged the capabilities of the soil strata to support vegetation, be it farmed or wild. They have also endangered their neighbors downstream in Perth which falls at the end of the total watershed for the area. These farmed areas are cheating the urbanized areas out of what water would flow down from the higher locations within the watershed when rain happened to occur.

There are techniques employed by drought stricken farmers here in the United States that promote a much heathier farming environment than is currently employed in Western Australia. The techniques include the utilization of man-made water catchments built within the field systems, the planting of tree based windbreaks of drought resistant trees within a field system, implementing double cropping, employing closed irrigation systems rather than free flow or sprinkler irrigation systems, etc. Types of organic and water wise farming could be easily applied to the Bush landscape but most of the farmers I interacted with would not bother to even consider any new ideas at this point.

For a culture typically regarded as overall holistic in thinking and approaching problems with open minds to tackle any situation, I found white western Australians to typically be more closed minded and guarded the further one traveled from the city proper. In their current state of climate, some western Australians commented to me that the area may have to begin to depopulate until equilibrium can be reached for the area. But too many people have invested interests in the area, be it foreign or domestic, for that to be an option. Many of these modern stalwarts are simply holding

their breath for a technology to be the saving grace, like the desalinization facilities the local government is feverishly constructing. Regardless, water is and will always be a concern for white western Australians and until the rains come again and their past climate returns, they will have a challenging future ahead of them full of forced adaptations and changes.

Section 2: Aboriginal Western Australians

The Aboriginal Australians, also simply referred to as Aborigines, are one of the world's oldest and consistent traditional cultural societies.[146] Although there is incredible diversity within all levels of Aboriginal Australian culture and groups, Aborigines are legally defined as people who are members "of the Aboriginal race of Australia," indigenous to the Australian continent which includes mainland Australia, the island of Tasmania, and the Torres Strait Islands.[147]

Aborigines from western research based in recent genetic studies support the standpoint that there was at one point during the peak of the Holocene a southern migration route from India to Indonesia and finally to Australia.[148] A 2009 genetic study found similarities among India's archaic populations and modern Aborigines.[149] Along with this correlation, the genetic markers indicated that modern Aboriginals are

[146] Sarah Holt-Forman, interview by author, National Trust of Western Australia offices, Old Observatory Building, Perth, WA, Australia, June 29, 2012.

[147] Parliament of Australia, *Australian Constitution*, Section 51 (XXVI) of the Australian Common Wealth, http://www.austlii.edu.au/au/legis/cth/consol_act/coaca430/s51.html (accessed October 13, 2014).

[148] Patty Cullan, interviewed by author, Oxfam (NGO) offices, Bainebridge, WA, Australia, June 30, 2012.

[149] Jay Cook, interviewed by author, Department of Aboriginal Affairs of Western Australia, Albany, WA, Australia, July 21, 2012.

decedents of migrants who began peopling the Australian continent around sixty to fifty thousand years ago.[150] This time of migration and peopling of modern Australia is quite significant because Aboriginal Australians have occupied the same territory continuously longer than any other human population. Aside from areas of human habitation on the African continent this consistent sedentary lifestyle is pivotal to begin to understand the mindset and traditions embedded within the aboriginal being. Let alone when one attempts to understand the unique power of both cultural traditions and the historical expectations that individual groups, or "mobs" of Aboriginals immolate and live within.

During my time in Western Australia from May to August of 2012, I was exposed to a handful of individual and extended Aboriginal family units, but none were more intent in sharing their culture and traditional knowledge with me than members of the Noongar group, specifically the Wardandi Noongar. The Noongar of Australia, an Indigenous Australian people, reside in the southwest corner of Western Australia, where their traditional hearth-zone extends from Geraldton on the western coast to Esperance on the south coast.[151] Prior to European colonization of Western Australia, the Noongar inhabited the region from Jurien Bay to the southern coast of Western Australia and east to what is now modern day Ravensthorpe and Southern Cross.[152] Linguistically the Noongar spoke formally various dialects of the Noongar language which fell within the larger Pama-Nyungan language family.[153] However, today the Noongar generally speak Australian Aboriginal English which is a pigeon adaptation of

[150] Ibid.
[151] Bill Webb, interviewed by author, Wardan Center, Margaret River, WA, Australia, July 1, 2012.
[152] Ibid.
[153] Holt-Forman, interview.

the Australian English language combined with Noongar words and grammar.[154] Within the Noongar social structure, there are fourteen recognized sub-groups, or fractured tribes as we, as Americans, would recognize them: the Amangu, Juat, Whadjuk, Balardong, Njakinjaki, Pindjarup, Wilman, Wardandi, Kaneang, Koreng, Wudjari, Njunga, Pibelman, and Minang.[155]

Traditional Noongar made a living by hunting and trapping a variety of game afforded and supplied by the Australian shoreline and countryside. The options for game included, but were not limited to the hunting of kangaroos, possums, wallabies, various fish species, and the gathering of an extensive range of edible wild flora.[156] The Noongar developed and employed a broad range of specialized tools in order to harvest necessities from the Bush to sustain the family units and extended family for which they are responsible.[157] The traditional tool chests of the Noongar primarily included the famous boomerang, of there is a unique shape and design paired to each animal one was expected to hunt. Other tools utilized by the Noongar include fish traps constructed from bark and reeds, spears and knives tipped with blades of quarts rather than flint, and simple grinding and filtering tools to remove toxicity when working with various nuts and roots.[158] Wild food in Western Australia was readily available, very easy to procure, and usually easily managed at short distances from encampments for the Noongar.[159] This easy access to sources high in protein afforded a lot of extra time for members within all levels of society to pursue both intense cultural pursuits such as painting in the

[154] Cook, interview.
[155] Webb, interview.
[156] Ibid.
[157] Ibid.
[158] Ibid.
[159] Cook, interview.

form of rock art, and extensive leisure activities tied to traditional ceremonies such as coming of age ceremonies for young boys and girls.[160]

Prior to European arrival in Western Australia the Noongar population has been estimated at between 6,000 and some tens of thousands.[161] Once Europeans had arrived in Western Australia, especially in the region inhabited by the Noongar, a Captain James Stirling noted that the Noongar in particular "seemed angry at the invasion of their territory."[162] However, at one of the first formal meetings between the Noongars and the first European settlers the two groups exchanged goods and basic communication in a relatively pleasant arrangement.[163] During the early days of what came to be known as the Swan River Colony, which later became the city of Perth, the Noongar and White settlers lived close by each other in a relative state of peace.[164] Overall, the few hundred settlers that lived in the colony were very afraid of the Noongar people and were under orders by the colonial government to keep their distance from the Noongar. Unfortunately, problems arose between the Noongar and White settlers once convict labor began being imported to the Swan River Colony and the physical dimension of the colony began to expand further into the Bush.[165]

British colonization and the expansion of the Swan River settlement disrupted Noongar life, culture, and customs. For many Noongar this era was the beginning of two hundred years of oppression, violence, and marginalization.[166] White settlers had taken up the best land and water sources, imported stock, ate or destroyed local fauna,

[160] Holt-Forman, interview.
[161] Cullan, interview.
[162] Holt-Forman, interview.
[163] Ibid.
[164] Ibid.
[165] Ibid.
[166] Webb, interview.

and traditional food sources over a short time frame became depleted and nonproductive. When the Noongar people began to take White settlers stock to replace the food sources eliminated or heavily reduced through the expansion of White settlement, the Noongar were often sentenced to harsh jail terms or extensive labor punishments.[167] Ultimately, the European colonization of the southwestern section of Western Australia resulted in both extensive violence and new diseases which took a heavy toll on the overall Noongar population. Today the Noongar themselves number just slightly over 28,000, with the overwhelming amount of the group's population residing within the Perth Metropolitan Area proper.[168]

During my time in Western Australia I was introduced to the Wardandi Elder Bill Webb, who is the primary officer of the Wardan Center of Margret River area and Wardandi Elder tied to cultural preservation. Bill was invaluable to my exposure to the Noongar People and, specifically the Wardandi Noongar's cultural traditions, beliefs, and modern concerns. According to Bill, stories command history for the Wardandi and they are the entire heart of their culture.[169] These ancient stories tell of a great rise in sea levels approximately 8,000 BP.[170] This rise in sea levels forced Bill's ancestors to relocate and move inland in order to survive. These ancient Wardandi simply adjusted and moved their lives to accommodate the new shorelines.[171] Bill and his fellow Wardandi are convinced that they originated from the Indian Ocean, meaning the land now covered by ocean water rather than using the ocean as a movement vehicle.[172] To

[167] Cullan, interview.
[168] Webb, interview.
[169] Ibid.
[170] Ibid.
[171] Ibid.
[172] Ibid.

this day all Wardandi, including Bill, still have personal stories tied specifically to areas that are now underwater such as old hunting grounds and burial sites.

The key to the continued perseveration of the traditional knowledge in order to exist for the future, according to Bill at least, is in "Native Title."[173] Native Title provides Aborigines of all groups in Australia the ability to actively practice traditional techniques of hunting, ceremony, and education regardless of private or public space where the action is conducted.[174] The powers conveyed to Australian Aboriginals through the law of Native Title provides much more than the ability to simply preserve historical knowledge but is vital in future safeguards of working traditional knowledge and practices.[175] For Bill though, Native Title is extremely important to his people's future preservation when reacting to years of culture clash and violence resulting from White interactions. But what he truly fears is larger forces such as climate change and, what he called environmental "up evil".[176] For events like climate change Bill and his people do not fear the change itself because it would be part of the natural order of things; however, he and the Wardandi truly fear that they will not have the skills to survive in the changing landscape. By skills I need to elaborate that Bill only meant traditional skills and knowledge, not a hybridized set of skills of Western and Aboriginal but "only time tested skills of [his] ancestors."[177] When I asked Bill what would happen if the time tested skills began to fail in the face of a changing climate and landscape, he simply could not answer. The raw fear in his face was the most telling to me. I realized that, in a way, Bill was truly gambling with the ultimate preservation of his culture and people by

[173] Australian Native Title Act of 1993, Commonwealth Consolidated Acts, http://www.austlii.edu.au/au/legis/cth/consol_act/nta1993147/ (accessed March 14, 2015).
[174] Ibid.
[175] Webb, interview.
[176] Ibid.
[177] Ibid.

openly ignoring Western skills and what it has to offer with the changing climate patterns of Western Australia.

Chapter 8

Conclusion

Beyond the fight against greenhouse gas emissions, the greatest challenge against all societies across the globe is the battle against the effects of global warming, which has already become a reality. There are two struggles that overlap that must be rectified sooner than later: first to aid people currently in distress, and second to stem the rising tide of climate refugees out of concern for the future. Will populations yet to be affected be moved by accounts of those victimized by twentieth century human activity? Will compassion, which impels us often, command a response to donate money to help victims of, say a tsunami for which the vast majority of people around the globe have no direct responsibility, reach a point where we are willing to change our daily lifestyles? This tsunami example is just one of the myriad of reasons responsible for the increasing need for migration described in this document. I fear that many of us would donate money in an instant, rather than changing our current way of life.

However, we must begin to alter our daily way of life. If we as a global people do not, the growing frequencies and power of disasters, be they natural or social, will not only affect people on the other side of the world but could engulf our own country as well. There is every reason to consider climate refugees as not merely a current reality limited to certain areas but rather as a future reality affecting many more regions if we refuse to change our ways. At the very least our geographic maps will have to be redrafted, of course, which is only a matter of completing topographic surveys. But far more important - is the fact that a greater number of people will have to crowd into a

smaller amount of physical space. Current immigration patterns provide only a minor glimpse of the problems that will be triggered by ultimate climate-change migration.

In order to minimize the predicted worsening of this global situation, we, as a coordinated global community, have to face it head on. The projections of the Intergovernmental Panel on Climate Change are considered “average projections” or compromises, even though more dramatic outcomes should be expected. At a minimum the inevitable rise in sea levels will also raise the level of normal spring tides, and storms will become more terrifying than those that have already ravaged our coasts in past years. Will developed industrialized coastlines still be able to sustain human life?

We are all children of Earth and, faced with the peril of global warming, must find a better way to organize our societies, and we must do so quickly, especially since another danger deserves serious consideration; the loss of biodiversity in all its aspects. The time for change is upon us, and we have no choice but to succeed – anything less means the utter destruction of our way of life without any other choice left.

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