

# RUNNING ON FUMES

The Destabilization of the World's Interconnected Systems as a Result of Unsustainable Human  
Proliferation on a Finite Planet

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## ABSTRACT

This thesis examines the global interconnectivity of critical and complex societal systems. Today, if consumption patterns continue to rise to unsustainable levels in concert with a soaring global population, these social and technological systems may begin to buckle, which will threaten the advancement of modern human civilization in the 21<sup>st</sup> century and beyond. The first globally-stressed system that is addressed in this paper is the global economic system. The second system I discuss is the global energy system and how it directly impacts the global economy. The following chapter looks at unsustainable population growth, freshwater scarcity, and food stresses. In the next chapter, I look into the climate system and I discuss how these changes in climate will impact the other globally interconnected systems in the future. And finally, the last body chapter of this thesis examines the world's environmental system as it relates to the depletion of vital nonrenewable resources. In my conclusion, I address what will happen if the world's leading economies maintain their current trajectory and I finish the chapter by arguing what modern society can do in order to shape a new sustainable path forward.

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## CHAPTER 1

### INTRODUCTION

In this thesis I argue that the kind of global economic growth that Americans (and the developed world at-large) have come to understand within the current societal context is now coming to an end because of a convergence of three primary factors—resource depletion, environmental impacts, and systemic financial and monetary failures. This argument is best captured in the following quotation from Richard Heinberg, author of the 2011 book, *The End of Growth: Adapting to Our New Economic Reality*:

*Many analysts who focus on the problems of population growth, resource depletion, and climate change foresee gradually tightening constraints on world economic activity. In most cases the prognosis they offer is for worsening environmental problems, more expensive energy and materials, and slowing economic growth. However, their analyses often fail to factor in the impacts to and from a financial system built on the expectation of further growth—a system that could come unhinged in a non-linear, catastrophic fashion as growth ends. Financial and monetary systems can crash suddenly and completely. This almost happened in September 2008 as the result of a combination of a decline in the housing market, reliance on overly complex and in many cases fraudulent*

*financial instruments, and skyrocketing energy prices. Another sovereign debt crisis in Europe could bring the world to a similar precipice. Indeed, there is a line-up of actors waiting to take center stage in the years ahead, each capable of bringing the curtain down on the global banking system or one of the world's major currencies. Each derives its destructive potency from its ability to strangle growth, thus setting off chain reactions of default, bankruptcy, and currency failure. The likely outcomes of a non-linearity response of the monetary-financial system to the end of growth thus constitute a wall in our path. Beyond the wall are other challenges and opportunities—challenges like oil depletion and climate change, and opportunities to reshape the economy so as to make it more sustainable over the long run, and to make it better serve human needs. The depletion of resources and the buildup of greenhouse gases are gradual processes, though their various impacts will be subject to tipping points and will provoke short-term crises. Efforts to deal with these problems—such as building low-energy transport infrastructure and low-carbon food systems—will take a generation or more. That kind of time just won't be available to us if we can't get past the financial-monetary wall. If we hit the wall at full speed, our options will be severely and suddenly reduced. The economy, and society as a whole, may undergo an abrupt, dramatic, and chaotic simplification as trade virtually ceases. So far, we are on course for full-force collision. The fundamental problems with our monetary and financial systems have not been addressed, but only papered over. Our financial-monetary system is not just vulnerable to periodic internal disruptions like credit crises, it is inherently unsustainable in the emerging context of energy and resource constraints. And if the financial-monetary system seizes up, this will imperil society's ability to respond to any and all other crises.*

*This means that, whatever our other priorities may be, we must also immediately devote effort to reforming the financial-monetary system (Heinberg 2011, 231-2).*

I fundamentally agree with Heinberg's present-day assessment of global economic conditions as well as his vision of modern civilizations' future in the near-term. In this paper, I find myself fundamentally agreeing with the central assertion that a global economic system based on infinite growth is unsustainable on a finite planet and will inevitably lead to worldwide economic and social decline. The significance of this assertion lies within the foundation of each of the world's interconnected systems that have already begun to show signs of destabilization. The interconnected systems discussed throughout this paper will include: the global economic system, energy systems (specifically fossil fuels), water cycles (systems), modern-day food systems, and the planetary climate system, which are all being precariously driven by unsustainable population growth that will ultimately result in various forms of global conflict over the coming years. James Howard Kunstler, author of *The Long Emergency: Surviving the Converging Catastrophes of the Twenty-First Century*, summarizes it this way: "these world-altering forces, events, and changes will interact synergistically, mutually amplifying each other to accelerate and exacerbate the emergence of meta-problems. Americans are woefully unprepared for the Long Emergency (Kunstler 2005, 2)."

In the first section of Chapter 2, *The End of the American Dream as We Know It*, I argue that global economic trend-lines in general will begin to trend downward over the next few decades. Subsequently, in my next section, *The New Economic Reality*, I briefly discuss how the developed world arrived at this point in economic history and I then explain that our path forward must be one that is fundamentally rooted in sustainability. Section 3, *This Isn't Philosophy, It's Just Simple Math*, examines natural limits to growth as well as factors that are

internal and external to the world's financial-monetary systems that will make it impossible for the global economy to continue growing at unsustainable levels. In the final section of Chapter 2, *Alternative Measures*, I dispute the claims made by those who argue that substitute materials and efficiency standards will enable infinite economic growth to persist into the future. Therefore, I begin by offering some historical context to my arguments in the following paragraphs.

Throughout over 95 percent of human history, mankind existed and endured as hunter-gatherers in what anthropologists refer to as *gift economies* (Heinberg 2011, 28). As civilizations expanded and grew more intricate, the tribe-based gift economy became less relevant as it transitioned into the global trade economy. It wasn't until the 18<sup>th</sup> century that economic thinking began to rapidly evolve. "Classical" economic philosophers such as Adam Smith (1723-1790), Thomas Robert Malthus (1766-1834), and David Ricardo (1772-1823) came on to the scene and introduced basic concepts, like: supply and demand, division of labor, and the balance of international trade. The notions of these 18<sup>th</sup>- and early 19<sup>th</sup>-century economic theorists founded classical economic liberalism—the term liberal in this case signifying a perspective which argues that powerful overseers should allow markets to operate freely and openly, without outside intervention, to establish prices and thereby allocate goods, services, and wealth (Heinberg 2011, 34-5).

Meanwhile, however, the most influential economist of the 19<sup>th</sup> century, a philosopher known as Karl Marx, proposed a name for the economic system that had begun to emerge: *capitalism*. It has long been assumed by many that *capital* is just another word for *money*, but there is a lot more to it than that: capital equals wealth—money, land, buildings, or machinery—that has been set aside for the purpose of manufacturing more wealth (Heinberg 2011, 37).

According to Marx's definition, *capitalism* is a system in which productive wealth is privately held. *Communism* (which was an alternative proposal from Marx) on the other hand, is a system in which productive wealth is owned by the community, or by the state on behalf of the people (Heinberg 2011, 37).

Additionally, Marx pointed out that capital tends to grow. If capital is privately owned, it *must* grow: as capitalists compete against one another, those who are able to rapidly acquire the most capital are inclined to absorb the capital of others who can't effectively keep pace. As a result, the system as a whole has a built-in expansionist imperative. Therefore, Marx wrote that capitalism is inherently unsustainable, in that when the workers reach an intolerable level of impoverishment, they will revolt against their capitalist bosses and implement a communist state (Heinberg 2011, 37).

Over two hundred years ago, a man by the name of Thomas Robert Malthus, author of the 1798, *An Essay on the Principle of Population as It Affects the Future Improvement of Society*, became the first Westerner to warn about unsustainable population growth. He argued that human population, if unconstrained, would grow exponentially while food supplies grew only arithmetically, and that therefore population would unavoidably reach natural barriers to growth. Malthus predicted that these "checks" on population would eventually emerge in the form of pandemic, war, and famine (Pearce 2010, 4).

According to *The Coming Population Crash: And Our Planet's Surprising Future*, written by Fred Pearce, Malthus predicted that the masses would eventually run out of food or suffer from diseases until deaths forcefully pushed population figures back down to former levels. And as far as Malthus was concerned, his natural law of overpopulation had already

begun to unfold, there and then: It “exists at present over the greatest part of the globe” and “with few exceptions has been almost constantly acting upon all the countries of which we have any account (Pearce 2010, 5).” In addition, Malthus claimed that there were not only natural limitations to future growth, but that the world was already operating at its capacity. He wrote: “The power of population is infinitely greater than the power in the earth to produce subsistence for man (Pearce 2010, 5).”

In Chapter 3 under the subheading: *The Peak Oil Scenario*, I begin my arguments pertaining to the global energy system with a look at the tremendous energy challenges that lie ahead. In this section of my paper, I talk about how fundamental an energy source like oil has been to the overall health (expansion) of the global economy. Oil’s unique characteristics such as its relatively low monetary costs, efficiency, and accessibility have fueled monumental advancements in agriculture, transportation, and various technologies. In the section entitled, *Premonition*, the issue of Peak Oil is addressed. As is discussed throughout my thesis, once the world’s supply of oil reaches maximum production output, the price of oil will begin to rise even further, which will begin to negatively impact every aspect of the global economy in a profound way. The final subheading in Chapter 3 reads: *The Future of Oil Production*. In this section, I draw attention to the trajectory of the world’s remaining oil reserves as of today, which plainly reveals that easily attainable oil that is of high-quality is being fully and utterly depleted at an alarming pace. This means that oil firms will have to explore and exploit untapped energy supplies that increasingly only exist in the least hospitable areas of the world; translation: higher costs associated with production and consumption as well as greater environmental risks. And the Peak Oil situation currently underway is taking place at the same time that the world’s supply

of coal has either already reached peak production status or it will do so in the near-term; natural gas will follow suit within the next few decades.

Chapter 4 comprises of three topics that are fundamentally interrelated—population, water, and food. *It's Getting Too Crowded*: I begin the first section of this chapter by discussing the global population surge that was initiated by fossil fuel utilization in the middle of the 18<sup>th</sup> century. From there, I illustrate how rapid this expansion of human beings has been and how these growth patterns have already begun to threaten global systems. Simply put, the combination of a growing population and a carbon-dependent global economy means greater levels of consumption (water, food, and natural resources) and higher levels of pollution. Today, human activities are severely disrupting ecological cycles and placing tremendous pressure upon the world's environmental systems, which have been showing signs of deterioration for quite some time now. If modern civilizations fail to deviate from their present course, climate change will be only one of many environmental issues that future generations will have to contend with. And at this rate, a changing climate will result in water and food shortages of a magnitude that may be difficult for some to even imagine. Consequently, I argue that water and food scarcity brought on by unsustainable population growth and exacerbated by a changing climate will lead to global conflict. In the next section, *Global Water Quandary*, I discuss how fundamental water—a renewable resource—is to the viability of modern society in any shape or form. Unsustainable levels of water consumption along with climate change will put the future state of freshwater in jeopardy. By 2050, hundreds of millions of people, if not billions, will find their sources of freshwater in grave decline (quality and quantity). The final section, *No Food for You*, addresses the trajectory of the world's agricultural and food systems. I discuss how the Industrial Revolution not only fueled economic growth but it also transformed agriculture. With the

discovery of fossil fuels, people were able to cultivate lands and distribute food more rapidly and on a much larger scale. However, since food and water are inextricably linked, an unsustainable population that is threatening freshwater supplies will simultaneously endanger the world's agricultural systems.

In the first subheading of Chapter 5, *Historical Context*, I delve into the issue of climate change and how the scientific field of climatology has developed over the past couple centuries as a result of mounting scientific evidence derived from a variety of disciplines. The study of climate change started out as an inquiry into the mysteries of the last ice age until the science eventually revealed that greenhouse gases regulate the global climate system. Scientists then began to theorize that the burning of fossil fuels would increase global average surface temperatures, thus leading to a multitude of unforeseen consequences. For the next section, *Altered Weather Patterns*, I examined the scientific evidence that points to various natural forces which have been responsible for the Earth's atmospheric shifts (changing climate) in the past. I also look at global warming trends and how our planet's hospitable climate has generated conditions that make it possible for complex life to exist and proliferate. My last section, *The Consequences of a Warmer Planet*, explores the environmental aftereffects of a warming planet as well as the impact to human beings and modern society at-large. The scientific data tells us that a hotter planet will lead to the disappearance of numerous coastal cities, more extreme weather events, and a substantial die-off of various plant and animal species—just to name a few. We can also expect global conflict to ensue when erratic weather patterns disrupt rainfall, which will further exacerbate drought-like conditions that are already threatening agricultural systems around the world.

In the section entitled, *Up For Grabs*, I start Chapter 6 by focusing on unsustainable human consumption of the world's vital resources. A look back at early human civilization reveals that empires collapsed when their lands were unable to support the fundamental needs of their growing populations. Today, one could argue that unsustainable consumption patterns in the modern world is an example of history repeating itself, however, it is also unprecedented due to the fact that for the first time ever we have technological capabilities that allow us to extract nonrenewable resources from the most inhospitable regions on the planet. For the next section, *Harder to Come By*, I turn my focus to the issue of easily accessible and high-quality resources—particularly oil. Here I discuss the critical role that “easy oil” has played in developing the economies of the world's industrial powers and how resource depletion will inevitably have the opposite effect. Under the subheading, *Corporate Muscle*, I argue that in the future only the major energy firms with advanced exploration capabilities will be credible participants in a world of scarce energy resources. The 2010 BP oil spill in the Gulf became an example of how quickly a corporate giant's survival can be put into question so suddenly. Behind the scenes, BP had to sell some of their valuable assets to competitors in order to cover their losses. The key oil companies took notice and were preparing takeover plans in the event that BP saw little chance of ever fully recovering. In the following section of this chapter, *The Interests of Nations*, I discuss the forging of alliances between emerging powers such as China and resource-rich states in Africa and elsewhere. The United States has also begun strengthening relationships with less developed countries that possess large resource deposits. And in my closing section entitled, *Looming Conflict*, I address the growing tensions between two of the world's most powerful state actors—the United States and China. In spite of their economically

interdependent relationship, each country recognizes the critical need to secure vital resources in order to sustain viability into the future.

In conclusion, any one of these monumental challenges would be extremely difficult to deal with on an individual basis; unbelievably, they are all happening simultaneously and feeding into one another. If modern society fails to deviate from its present course, the destabilization of the world's interconnected systems will speed up and intensify.

The American public must wake up from this sleepwalk in order to protect the project of civilization. Convincing people of the developed world that modern lifestyles based on consumption will lead to economic and environmental ruin will be an extremely difficult task. The notion that our modern world has begun to decline may seem absurd and even fanatical to most people. However, statistical trend-lines and scientific evidence are painting a disturbing picture of the future.

As many scientists will argue, the Earth has existed for billions of years and has undergone tremendous changes over this period of time. Our planet has an incredible story to tell and scientists of all fields have been writing and narrating each chapter for the past several hundred years. At any given time—a scientist—whether it be the geologist, the physicist, or the climatologist, will introduce new evidence and become Earth's storyteller for the moment, giving us more insight into the history of the Earth. As the range and depth of information accumulates, we begin to understand the level of interconnectivity that exists on this planet. This is not only true from a grand geophysical perspective, but also from a human perspective.

Today, the Earth's most spectacular features are being thoroughly depleted and ravaged beyond recognition. If we do not establish a new and more sustainable path forward, future

generations will be forced to experience life on a dying planet, which will ultimately threaten our long-term viability as a species. In the short-term, we face global economic contraction and a widespread energy crisis. According to Paul Ehrlich, hubris, combined with modern civilizations' lack of foresight and a lack of collective consciousness brought us to this impending tipping point. If the world is going to avert this convergence of crises, we must act now. There is still time to better position ourselves for what is unquestionably headed our way.

## CHAPTER 2

### THE END OF THE AMERICAN DREAM AS WE KNOW IT

As difficult as it may be for one to fully grasp, the kind of perpetual economic growth that generations of Americans have come to expect is now coming to an end. “Growth,” as it is described by Richard Heinberg, a Senior Fellow of the Post Carbon Institute, consists of the expansion of the overall size of the economy and of the quantities of energy being consumed as well as the increasing amount of material goods exchanging hands (Heinberg 2011, 1-2). This does not mean the United States or the world as a whole will never experience quarterly or annual gains relative to the previous quarter or year. However, general economic trend-lines when measured in terms of production and consumption of real goods will soon begin to indicate a leveling or downward trajectory instead of an upward rise. And while some businesses, states, or even regions will continue to grow, these gains will be attained at the expense of other businesses, states, or regions. Heinberg argues that from this point onward, only relative growth will be possible because the global economic system is about to collide with the fundamental barriers that presently exist and have always existed in the form of environmental limits. State actors with ambitious economic plans are going to be confronted with an ever-depleting stock of vital resources that will ultimately be divided among the most capable world powers.

According to Heinberg, the global economic crisis that began in 2007-2008, was both foreseeable and inevitable (Heinberg 2011, 1). An increasingly convoluted financial system in disarray and the bursting of the real estate bubble are the two most commonly cited causes that were instrumental in the production of this worldwide economic calamity. Today, many financial pundits maintain that the current state of the US economy is the result of uncertainty in the marketplace that is derived from the un-repayable levels of government and private debt. And it has generally been assumed that as soon as these issues are successfully addressed, the economic engines in the United States will reignite and conventional economic growth can and will resume at “normal” rates. However, pundits and commentators have largely failed to account for factors that are external to the financial system, most importantly—environmental limits to growth.

The economic conditions currently facing the world are not temporary; these conditions are essentially permanent. Heinberg identifies three primary factors that will stymie economic expansion from here on out:

- The unsustainable consumption of dwindling resources including minerals and non-renewable, climate altering fossil fuels;
- The declining health of the Earth’s environmental systems stemming from both the reckless extraction and depletion of vital resources—resulting in snowballing costs from both these impacts themselves as well as from the energy and efforts needed to avert them; and
- The destabilization of our financial systems arising from the inability of our current monetary, banking, and investment operations to adapt to both resource scarcity and mounting environmental costs—and their inability (in the context of a shrinking

economy) to effectively deal with the massive heap of public and private debt that have been amassed over the past couple of decades (Heinberg 2011, 2-3).

In spite of the frequency in which mainstream economists consistently fail to recognize environmental limits, more and more events have been emerging in recent years that illustrate how all three of the above factors are fundamentally interconnected.

In 2010, the Deepwater Horizon oil disaster in the US Gulf of Mexico became a glaring example of this type of interaction.

Clearly, the environmental costs of the Deepwater Horizon blowout illustrated the ruinous nature of a spill of that magnitude. And the fact that oil giants like BP, Shell, Chevron, and many others have had to resort to drilling for oil in more than a mile or two of ocean water demonstrates a significant development regarding global energy production. Simply put, the world is running out of easily attainable oil, therefore, oil will undoubtedly become more costly and harder to come by as time goes on.

After witnessing the effects of an oil spill of such incredible scale, one could easily make the case that the oil industry and the nations that these companies operate around and within cannot afford another Deepwater Horizon type of occurrence. The potential for future blowout catastrophes adds to the cost of doing business and therefore to the already growing cost of oil. The Deepwater Horizon event also demonstrates to some degree the chain reaction that occurs when financial institutions have to account for resource depletion and environmental damage. For instance, insurance companies have now diagnosed the risky nature of deepwater drilling and have been forced to raise premiums on these operations; moreover, the presence of gushing oil threatened regional fisheries and beaches for an extended period of time which has hammered

the Gulf Coast economy hard. The oil company responsible for this incident, BP, was pressured into making compensatory payments to the Gulf region which only partly covered the expenses and losses. The payout, which was in the tens of billions of dollars forced the company to reorganize and consequently led to lower stock values and returns to investors. The fiscal troubles surrounding BP in turn affected British Pension funds that were invested in the company (Heinberg 2011, 3-4).

If this one occurrence—admittedly a spectacular one, did not accurately exemplify interconnectivity, the economy would recover effortlessly and continue expanding without interruption. However, these events can no longer be regarded as insulated problems that will not reach the broader economy; the human economy exists within and is entirely dependent upon the global environment. The fact of the matter is, there will be more examples of economic stagnation resulting from environmental disasters, not obviously related to one another, and they will become more frequent as these environmental issues intensify. These will include but are not limited to:

- Climate change leading to regional droughts, wildfires, floods, and even famines among other unforeseen developments;
- Energy, water, and mineral scarcity; and
- A surge of company bankruptcies, bank failures, and home foreclosures (Heinberg 2011, 4).

Each of these cases will likely be viewed as an isolated incident, treated as an anomaly that stands in the way of “normalcy.” But in fact, they are all related, in that they are the outcome of

an unsustainable human population determined to consume dwindling resources without foresight, all on a finite and fragile planet.

In the final analysis, decades of mounting indebtedness has created the conditions for a once-in-a-century financial crash—which continues to ripple through the global economy, and which on its own has the capacity to generate considerable political turmoil and societal upheaval. Here is how Heinberg sums it up; “The result: we are seeing a perfect storm of converging crises that together represent a watershed moment in the history of our species. We are witness to, and participants in, the transition from decades of economic growth to decades of economic contraction (Heinberg 2011, 4).”

### The New Economic Reality

During the last couple of centuries, economic growth became the universal standard for which national well-being was measured up against. An expanding economy meant that jobs were being created and investments were yielding high returns. When the economy temporarily stagnated, as was the case during the Great Depression, financial bloodletting arose and immediately led to widespread panic and despair.

Today, the long-term viability of globally interwoven monetary and financial systems is wholly dependent upon growth. When the economy is expanding, more money and credit are made available, consumer spending rises, more goods are purchased, businesses take out more loans, and interest on existing loans can be repaid. However, if the economy is not expanding, new money is not entering the system, and the interest on existing loans cannot be paid; consequently, defaults snowball, jobs begin to disappear, incomes start to drop, and consumer confidence plunges—which means that businesses will take out fewer loans, resulting in even

less new money entering the economy (Heinberg 2011, 6). This is a self-reinforcing feedback loop that gains destructive momentum and cannot be diverted easily.

As a result, the international market economy currently in place does not have a “steady” or “neutral” setting: the options are limited to either growth or contraction. And “contraction” is just another word for recession or depression—a drawn-out period of cascading job losses, foreclosures, defaults, and bankruptcies (Heinberg 2011, 7).

Throughout almost all of human history, human beings survived by hunting and gathering. And yet individuals seem to have grown so habituated with existing societal structures that people in general have forgotten how fairly recent the phenomenon of economic growth actually is.

In civilizations of the past few millennia, empires emerged and collapsed—while local economies and world economic activity as a whole advanced and retreated. But over the past couple hundred years, the fossil fuel revolution has unleashed economic growth at a speed and scale unprecedented in all of human history. The energies of coal, oil, and natural gas enabled countries to construct modern industrial systems, loaded with all the necessary features—highways, railroads, airports, and electrical grids. As it stands today, in just a few short centuries, growing economies everywhere will have completely depleted hundreds of millions of years’ worth of chemically stored sunlight (Heinberg 2011, 7). Through this one-time-only process, society managed to convince itself (for a fleeting moment) that it would forever be operating and benefitting from a perpetual-growth machine. In fact, this fossil fuel utilization and societal revolution was an extraordinary development that much of the world has not yet come to fully

appreciate. In the United States and now elsewhere, never-ending consumption simply became the way of life.

As the era of global scarcity begins to materialize, sustainability will have to be the new “normal.” Therefore, conventional wisdom regarding everlasting economic expansion is about to undergo a momentous transformation. For many, the end of growth seems implausible. In effect, it means the industrialized world will have to restructure economies, politics, and daily life in order to maintain societal viability. And world leaders who are not yet cognizant of humanity’s inevitable trajectory will most likely delay implementation of essential policies specifically designed to minimize civil unrest and human misery. The failure to promptly put support services in place while simultaneously making fundamental alterations to various systems—monetary, financial, food, and transportation—will hazardously expose vital societal components.

In other words, what could potentially be a somewhat startling but bearable transition of adaptation could instead become the most epic tragedy in human history. Fortunately, human beings have always demonstrated incredible resiliency in the past and should therefore be capable of enduring the end of growth. A modern society can exist in a non-growing economy, perhaps even flourish beyond it, but it will necessitate early detection, an accurate diagnosis, and effectual application.

### **This Isn’t Philosophy, It’s Just Simple Math**

Economies are systems, and as such they follow rules analogous (to a certain degree) to those that can be found in nature. For example, plants and animals must abide by ecological laws and restrictions that are ultimately governed by biological systems. In nature, if a species

recognizes that its food source has expanded, its numbers will grow to take advantage of those surplus calories—but then its food source will become exhausted as it is consumed by additional mouths, and its predators will likewise become more numerous (extra meals for them). Sooner or later, population surges (or periods of rapid growth) bang up against non-negotiable constraints and this virtually always leads to crashes and die-offs (Heinberg 2011, 15).

A modern-day example of rapid economic expansion is currently taking place in China. In just a few short decades China went from being an impoverished and underdeveloped state into the world's second-largest economy—growing at eight percent or more per year. Today, China continues to consume more than twice the amount of coal as it did in the previous decade—the same goes for iron ore and oil. The nation presently has four times as many highways as it once did, nearly five times as many cars, and has been doubling in size every ten years (Heinberg 2011, 15). At this rate, one can imagine the quantity of key resources already consumed to sustain these tremendous levels of growth; realistically however, these doublings are simply unsustainable and will inevitably come to an end.

Over the past several decades, the unsubstantiated expectations of perpetual growth have translated into exorbitant levels of consumer and government debt. An ever shrinking portion of America's wealth was being derived from technological advancements and manufactured goods, and an ever greater portion was coming from real estate purchases and sales, or moving money around from one investment to another.

As the twenty-first century arrived, the world economy could be seen jumping from one bubble to the next: the emerging-Asian-economies bubble, the dot-com bubble, the housing bubble. Savvy investors understood that ever-expanding bubbles were meant to burst, and

therefore, the shrewdest ones made a concerted effort to get in early and exit quickly in an attempt to maximize profits and avoid the subsequent mayhem (Heinberg 2011, 19).

In the financial crash of 2007-2008, as Peak Oil and resource depletion began constricting the global economic growth machine; ordinary citizens were being squeezed in a variety of other ways: loss of employment and declining real estate valuations.

According to Heinberg, during the manic days of 2002 to 2006, millions of Americans began to rely on rising home prices as a source of income, turning their houses into ATMs (as it was often phrased). Soaring real estate values enabled confident homeowners to borrow money in order to remodel a kitchen or bathroom, and banks were generally eager to hand out those loans. Meanwhile, Wall Street was finding new ways of packaging and repackaging subprime mortgages into collateralized debt obligations that would eventually be sold at a premium to investors—supposedly with little to no risk (Heinberg 2011, 20). All of this based on the assumption that property values were destined to just keep climbing.

Credit and debt accelerated in the façade of easy money. Blind optimism fueled an employment surge in construction and real estate industries, concealing underlying ongoing losses in manufacturing jobs.

The entire economic system became too dependent on impossible-to-conceptualize expectations of never-ending growth and after the oil price spike of mid-2008 and the collapsing housing market, the system began to buckle. Money was inextricably linked to credit, and credit was inextricably linked to the anticipation of growth. Once growth seized in 2008, the domino effect of defaults and bankruptcy ensued, leaving the global economy in a slow-motion tailspin (Heinberg 2011, 20).

To the degree that economic countermeasures were deployed by governments to reverse the recessionary trends, these efforts only temporarily succeeded in late 2009 and 2010. And while these attempts may have had some minimal impact, it again ignored the inescapable truth, which is—infinite economic expansion is simply not possible on a finite planet.

The passing of the limits of growth is not philosophical but physical and based on the rules of physics, chemistry, biology, and mathematics (Gilding 2011, 1-2). But many mainstream economists view things differently. Arguably, this is because conventional economic theories were formulated during the abnormal historical period of unremitting growth and a number of economists have largely based their theories and assessments on a small sample size of economic activity, and have done so with less than all the facts. One leading economist put it like this:

*Leading active members of today's economics profession...have formed themselves into a kind of Politburo for correct economic thinking. As a general rule—as one might generally expect from a gentleman's club—this has placed them on the wrong side of every important policy issue, and not just recently but for decades. They predict disaster where none occurs. They deny the possibility of events that then happen.... They oppose the most basic, decent and sensible reforms, while offering placebos instead. They are always surprised when something untoward (like a recession) actually occurs. And when finally they sense that some position cannot be sustained, they do not reexamine their ideas. They do not consider the possibility of a flaw in logic or theory. Rather, they simply change the subject. No one loses face, in this club, for having been wrong. No one is dis-invited from presenting papers at later annual meetings. And still less is anyone from the outside invited in.*

—James K. Galbraith (economist)

In the future, when economists attempt to simplify the intricate nature of a globally interconnected economic system without taking the bigger picture (natural constraints) into account, their economic projections will increasingly fall short. Despite the peer-reviewed conclusions of leading science bodies, numerous economists point to theories which argue that modern market economies are principally insusceptible to the types of limits that constrain natural systems: the two primary theories have to do with substitution and efficiency.

### Alternative Measures?

According to Heinberg, a majority of economists would probably subscribe to the notion that environmental limitations and a worldwide financial crisis do not mean the global economy is headed for eventual contraction. On the contrary, most economists view the current economic state as a temporary setback. This kind of thinking is rooted in the unfounded belief that the magic of capitalism will always enable innovators to introduce cutting-edge technologies and also think up new ways to do more with less. And these developments will lay the groundwork for new commercial products and business models. Arguably, there is a case to be made that substitution, efficiency, and innovation are absolutely key to societal adaptability in a finite world. Nevertheless, these indispensable factors are still incapable of eliminating the planet's natural limits and are themselves subject to the law of diminishing returns (Heinberg 2011, 156). Furthermore, returns on investments in these types of strategies are in many cases already rapidly waning.

Economic theory is adamant on the point: when a valuable resource becomes scarce, its price will increase, thus creating an incentive for manufacturers, sellers, and consumers to come

up with a substitute. For instance, if an energy source such as oil becomes too costly, energy companies may be forced to start developing liquid fuels from coal. Otherwise, they may have to start making larger investments in synthetic blends or alternative energy sources that are unimagined as of today. Many in the economic community currently theorize that the genius and wonder of the free market will propel this process of substitution forever; the idea being that as a resource becomes scarce and increasingly costly, another resource can take its place and be made available at lower costs by comparison. However, the replacement proving its superiority is not a requisite feature of this theory.

As economies continue to deplete the world's supply of fossil fuels, heads of state and the private sector will be desperately searching for an oil substitute. Advancements in alternative energy sources have been made, but as of today, it is difficult to classify any of them as superior—or even equivalent—from a practical, economic perspective (Heinberg 2011, 157).

In real-world applications, boosting efficiency means doing more with less, and so far, substitution has increasingly become less economically efficient. In the near future, replacing a resource of profound economic significance (like oil) with a less-efficient substitute will mean a decline—perhaps a sharp decline—in modern society's capacity to generate economic growth. If an increasing number of resources have to be replaced with inferior substitutes, the economic impact will be compounded.

The end of oil is not the only issue that resource hungry nations will have to contend with in the coming years. The availability and quality of the global supply of minerals is going to impact economies and communities everywhere, in ways that are not yet entirely clear. As of recently, mining companies operating around the world have begun to report declining ore

quality, which is concerning given that when the quality of an ore drops the amount of energy required to extract the resource rises (Heinberg 2011, 161). So in many if not most cases it is no longer feasible to substitute a rare, depleting resource with one that is more plentiful and less costly; instead, the existing substitutes are themselves already rare and depleting.

In theory, the practice of substitution can continue without end—as long as innovators have access to endless amounts of energy with which to acquire the minerals needed from ores of ever-declining quality. But to produce that energy, innovators will need more resources. Even if they are to only use renewable sources of energy, they will need steel for wind turbines and coatings for photovoltaic solar panels. And to extract these particular resources they will need even more energy, which requires more resources, which requires more energy. A continual reduction in resource quality means more energy is needed just to sustain the resource extraction process, and the energy required to serve human interests is currently in decline (Heinberg 2011, 161).

The same kinds of complications can be found with materials synthesis. In principle, synthesizing oil from almost any organic substance is quite doable. Liquid fuels (petroleum-like) can be produced from coal, natural gas, old tires, even garbage. On the other hand, this process can be very expensive and in some cases, the synthetic blend may consume more energy than it delivers as a fuel, unless the substance in its original state is already similar to oil.

These impediments do not mean that the substitution process itself is a futile endeavor. In today's market for instance, newly created catalysts in fuel cells have begun to replace depleting, expensive platinum, and new ink-based materials for photovoltaic panels have begun to demonstrate advancements in solar power. Also, renewable energy technologies such as wind,

solar, tidal, and geothermal are receiving greater investments and are presently being looked at as substitutes for coal.

In the years ahead, governments, industry leaders, and innovators are going to be forced to find a variety of new substitutes to replace the planet's non-renewable resources that have been powering economic growth for centuries. Fortunately, a number of industries have been concentrating more of their focus and efforts on research and development operations in order to develop promising alternatives. However, in the most consequential cases (including oil), it is more than likely that the prospective substitutes will be inferior in terms of economic performance, and as a result will be unable to sustain economic growth (Heinberg 2011, 161).

Once again: developing substitute resources and increasing efficiency are unquestionably effective adaptive strategies of market economies. At the same time, one must understand that there are limits to these strategies in a world which is governed less by economic theories than by the laws of physics. In the real world, upping efficiency requires investment, and investments in energy efficiency eventually reach a point of diminishing returns; the first gains in efficiency are typically inexpensive, but every further incremental gain usually costs more, until further gains become prohibitively costly (Heinberg 2011, 171-2).

At the end of the day, just as there are environmental limits to resources, there are also natural limits to efficiency. And while efficiency can lead to savings and to the development of new businesses and industries, it cannot outsource more than 100 percent of manufacturing, it cannot transport goods without using energy, and it cannot enlist the labor of workers and expect them to purchase items while simultaneously not paying them anything. Bottom line: the potential for both savings and economic growth is finite.

Furthermore, one must realize that energy efficiency will likely appear differently in a resource constrained, non-growing economy compared to the way it looks in a powerful, expanding, and resource-rich economy.

In closing: as energy becomes more expensive in a stagnating economy, energy efficiency will be crucial to human survival and well-being. The sooner that governments and big moneyed interests make sizable and intelligently placed investments in efficiency measures designed to facilitate human adaptation, people and society at large will likely be much better off. However, it is unrealistic to think that efficiency measures will lead to a continual reduction in energy consumption while simultaneously yielding perpetual economic returns. The fact of the matter is, unlike many economists, most physical scientists seem to recognize that growth within any functioning, bounded system cannot continue expanding forever (Heinberg 2011, 12).

*...[C]ommerce is but a means to an end, the diffusion of civilization and wealth. To allow commerce to proceed until the source of civilization is weakened and overturned is like killing the goose to get the golden egg. Is the immediate creation of material wealth to be our only object? Have we not hereditary possessions in our just laws, our free and nobly developed constitution, our rich literature and philosophy, incomparably above material wealth, and which we are beyond all things bound to maintain, improve, and hand down in safety? And do we accomplish this duty in encouraging a growth of industry which must prove unstable, and perhaps involve all things in its fall?*

–William Stanley Jevons (economist, 1865)

## CHAPTER 3

### THE END OF CONVENTIONAL OIL

*The 2008 crude oil price, \$147 per barrel, shattered the global economy. The “invisible hand” of economics became the invisible fist, pounding down world economic growth to match the limitations of crude oil production.*

—Kenneth Deffeyes (petroleum geologist)

#### The Peak Oil Scenario

In talks concerning the economy, much of the conversation tends to revolve around money—prices, wages, and interest rates. Yet as basic as money is to economics, energy is even more fundamental. Energy is the special ingredient that ignited the development of the modern world. Energy is not just a commodity; it is the foundation that drives any and all activity. Simply put, without energy there would be no economy.

By the late 1700s, the Industrial Revolution was underway and the process of replacing manual labor with greenhouse gas emitting machinery had begun. This revolutionary period of energy consumption transformed Great Britain, the rest of Europe, and eventually North America from civilizations which relied heavily on agriculture and trading to predominantly

manufacturing societies who became dependent upon machines and engines as opposed to animals, tools, and old-fashioned manpower (Friedman, 2009, 68-70). Each subsequent century brought new sources of energy to newly industrializing states with developing economies along with technological innovations that provided a seemingly infinite number of ways in which to exploit these various forms of power. And the potential for Western society to expand and assert influence only grew as each newly discovered fossil fuel was utilized—starting with coal, then crude oil and natural gas. The availability, efficiency, and relatively low monetary costs associated of these energy sources nurtured the advancement of Western modernization and became the apparent formula for economic growth.

Economic growth does not just need energy in a general sense; it requires forms of energy with particular characteristics. Otherwise, the sun would be able to provide the world with all the energy human beings would ever need; after all, the amount of solar energy that blankets the Earth's surface every hour is greater than the amount of fossil-fuel energy consumed globally each year (Heinberg 2011, 107). The problem is sunlight energy is diffuse and therefore incredibly difficult to capture in a concentrated manner. Large and complex economic systems require energy sources that are concentrated and manageable, and can be easily exploited. In the short run, fossil fuels embodied a combination of highly desirable characteristics: the process of extraction and utilization was relatively inexpensive in the early years, they could be transported with relative ease, and they contained a great deal of energy per unit of weight and/or volume—in most cases, delivering considerably more energy than the firewood people had grown familiar with.

Another advantageous feature of oil is its liquid nature, meaning that it (and its refined blends such as gasoline and jet fuel) can be easily stockpiled in tanks at low costs and delivered

through pipes and pumped through hoses. In addition to its versatile characteristics, portability has made oil an ideal fuel for global transport systems. Therefore, if oil is completely exhausted and a substitute fuel source that embodies oil's specific features does not materialize, world trade will basically grind to a standstill.

The phrase "Peak Oil" tends to be mistakenly understood as the total depletion of petroleum resources. Instead, it refers to the period when oil production has reached its peak output and will eventually begin its descent. Thousands of individual oilfields have already consistently demonstrated the inevitable outcome of Peak Oil. So far, countries like the US, Indonesia, Norway, Great Britain, Oman, and Mexico have experienced firsthand the peak and decline of total national oil production (Heinberg 2011, 107). At this rate of consumption, the world's aggregate supply of oil is most definitely going to run out, of this there can be no dispute. There are those who question the timing of Peak Oil and others who believe that this decline in petroleum resources could perhaps be postponed altogether.

In 2010, the International Energy Agency delved into the matter of Peak Oil and the world's future energy status. In its report, the IEA proclaimed that it was unlikely that total annual global crude oil production would ever exceed 2006 levels. In fact, all but a few large oilfields have already reached their peak output levels and are now on a long-term path of inevitable depletion (Klare 2012, 22).

According to Heinberg, scientific studies regarding oil depletion commonly start out by premising that for any non-renewable resource such as petroleum, exploration and excavation advance on the basis of the best-first or low-hanging fruit principle (Heinberg 2011, 109). This premise originated with petroleum geologists that pursued onshore regions of the planet that

were rich in hydrocarbons. Therefore, in the early years of oil discovery, sites tended to be large and conveniently located.

The biggest targets—almost all of which were identified in the span of the 1930s through the 1960s—were gargantuan, each containing billions of barrels of crude and capable of providing anywhere from hundreds of thousands to several millions of barrels per day. These behemoths were quite rare and only a few were ever uncovered. Since then, most of the world’s oilfields have gotten either smaller or less accessible, and therefore on average more expensive to pinpoint and exploit. These remaining oil sites, numbering in the thousands, contain a few thousand up to a few million barrels of oil and can pump it out at a rate of a few dozen barrels to several thousand barrels per day (Heinberg 2011, 109-110).

### Premonition

In 1976, officials from the state-run oil company *Petróleos Mexicanos*, known as Pemex, credited a Mexican fisherman named Rudesino Cantarell for inadvertently unearthing the second most prolific oilfield in the world. This gargantuan field was called “Cantarell” in his honor. For nearly three decades, the oil extracted from the Cantarell field would come to provide the Mexican government with significant financial resources. By 1981 the field was still in its early stages and it was already yielding an impressive 1.2 million barrels per day, allowing the state to substantially increase public spending and arguably safeguarding the prolonged tenure of the Institutional Revolutionary Party. At its peak, Cantarell yielded more than 2.1 million barrels of oil per day—more than any other oilfield on the planet with the exception of Saudi Arabia’s “super-giant” Ghawar deposit (Klare 2012, 19-21). Indeed, the Cantarell discovery did more to stimulate Mexico’s economic vigor than any other asset in modern times.

The rapid exploitation of the Cantarell's petroleum supply greatly contributed to its sooner than expected decline. As the field's underground cavities emptied out and the ambient pressure dropped, the constant flow of oil became disrupted. By 1995, oil output had fallen to 1 million barrels per day and the Cantarell field appeared to be degenerating beyond control. It provided its lowest recorded yield in over fifteen years, which prompted Pemex to spend \$6 billion on a daring plan to intervene. In order to reestablish previous volumes of oil production, Pemex injected considerable amounts of nitrogen into the Cantarell reservoir, aiming to increase the underground pressure. The plan actually worked as it was originally drawn up, and oil began to gush as it once did—pumping out just over 2 million barrels a day in 2003 and 2004. But the same conditions that led to the initial decline reemerged once again, and in 2005, the Cantarell suddenly found itself in free-fall. The field was only producing a meager 558,000 barrels per day in 2010—an astounding 74 percent reduction from its 2004 heights (Klare 2012, 20-1). As of today, engineers at Pemex possess few reasonable ideas and thus appear to be out of good options; meanwhile, what remains of Cantarell's oil bounty is expected to continue dropping.

The sustained degeneration of the Cantarell field will have profound ramifications for not only Mexico and the United States but the world at large. Keep in mind that the reduction in total oil output means that the Mexican government will now be facing a substantial reduction in state revenue while simultaneously trying to cope with the ongoing global economic crisis and a ferocious drug war. If the government is not able to offset the recent loss in oil revenue, Mexico's economic future will become ever more uncertain due to the fact that the Cantarell site represented such a large portion of Mexico's total oil output and a field of that size is simply irreplaceable. From 2003-2006, Mexican production was averaging 3.8 million barrels of oil per day, in 2010, that figure dropped to 2.9 million barrels (Klare 2012, 21). Since Mexican demand

for oil is on the rise even as the country continues to produce less of it, sometime before the year 2015 Mexico will have no choice but to switch from being a net oil exporter to a net importer, causing serious damage to their overall economy. Furthermore, the United States, which has been one of Cantarell's biggest buyers, will no longer be able to count on one of its most trusted and dependable energy suppliers; as a result, America will have to increase its dependency on more volatile and less reliable sources in the Middle East and Africa.

The rapid depletion of an oilfield of such magnitude has not only been a stunning occurrence in the eyes of Mexican officials, who consequently must now cope with the aftereffects. As Mark Thurber, an energy researcher at Stanford University put it: "I don't recall seeing anything in the industry as dramatic as Cantarell (Klare 2012, 22)." The dramatic emptying out of this particular field has also troubled global oil experts, who see in it a premonition of production declines at major reservoirs all over the world. As far as these experts are concerned, Ghawar and comparable super-giants in the Middle East will be next on the list someday.

The rate of oil discoveries on a worldwide basis has been in decline for over the last fifty years, and much of what is being tapped into is located in the more inhospitable regions of the planet (at ocean depths of up to three miles) and the Arctic, where the costs to operate and the risks to the environment are particularly high. According to Heinberg, this is what is to be expected as the low-hanging fruit disappear and global oil production reaches peak levels in terms of flow rate (Heinberg 2011, 111).

As to be expected, the US Department of Energy and even the IEA continue to produce mildly optimistic energy projections. Their forecasts claim that the world's production of liquid

fuels will continue to rise until 2030 or so, however, closer examination of these forecasts reveals a semi-hidden caveat: “*as long as implausibly immense investments in exploration and production somehow materialize* (Heinberg 2011, 111).” The Department of Energy and the IEA are not the only ones standing by these projections; ExxonMobil, Cambridge Energy Research Associates, and a few energy economists have also been heard echoing these optimistic forecasts. Nonetheless, Heinberg goes on to claim that the most serious analysts now expect global crude oil and liquid fuels production to begin declining by the end of this decade (Heinberg 2011, 111). Prominent oil industry figures like Charles Maxwell and T. Boone Pickens have been arguing that Peak Oil either already has begun or will commence in the near-term. And more recently, various reports and detailed studies by governments and industry groups have started to reach this same conclusion. Toyota, Virgin Airlines, and other major fuel price-sensitive corporations now take Peak Oil into account when they run calculations for their business forecast models (Heinberg 2011, 111).

At closer examination, one could make the case that the arguments being made by Peak Oil naysayers are essentially identical to the arguments being made by Peaksters, only in less accurate and more obtuse ways. For instance, pundits like Daniel Yergin of Cambridge Energy Research Associates claims that there may one day be a peak in the demand for oil but not in supply. However, since this reduction in demand is being driven by rising oil prices—it is difficult to see any distinction. Also, some have claimed that the world is seeing the end of cheap oil but not the end of oil itself. They point to massive and, in some cases, expanding petroleum reserves worldwide—however upon further analysis these supposed reserves only exist on paper (claimed numbers based on no explicit evidence), or they consist of bitumen and other oil-like substitutes that require special extraction and processing methods that are slow to develop,

costly, and energy-intensive (Heinberg 2011, 112). Today, the mounting evidence makes it difficult for even the most enthusiastic oil boosters to deny the fact that the world has entered a new era in which prices of liquid fuels are only going to increase with time. And as far as Heinberg is concerned:

*Quibbling over the exact meaning of the word “peak,” or the exact timing of the event, or what constitutes “oil” is fairly pointless. The oil world has changed. And this powerful shock to the global energy system has just happened to coincide with a seismic shift in the world’s economic and financial systems. The likely consequences of Peak Oil have been explored in numerous books, studies, and reports, and include severe impacts on transport networks, food systems, global trade, and all industries that depend on liquid fuels, chemicals, plastics, and pharmaceuticals. In sum, most of the basic elements of our current way of life will have to adapt or become unsupportable. There is also a strong likelihood of increasing global conflict over remaining oil resources (Heinberg 2011, 112-3).*

Arguably, the events surrounding the Cantarell’s reign and demise provides a microcosm of the global resource predicament. A number of the world’s primary sources of oil—and of coal, natural gas, uranium, copper, and an assortment of other vital materials—were, like Cantarell, discovered many decades ago and have now begun to offer less and less in terms of quality and production. If newly exploited reservoirs are not comparable in size and productivity, the global economy may be forced to grapple with diminishing returns in the near-term. According to David Luhnow of the *Wall Street Journal*, “Nearly a quarter of the world’s daily oil output of 85 million barrels is pumped from the biggest 20 fields...And many of those fields, discovered decades ago, could soon follow in Cantarell’s footsteps (Klare 2012, 22).” A similar

outlook is also applicable in the case of other raw materials, even if the details are slightly different in each case. Since it is unlikely that new discoveries will be made in the world's existing, well-explored resource zones, any further rise in global consumption will require replenishment from untapped reserves in more remote and often more inhospitable areas.

## The Future of Oil Production

At the start of the twenty-first century, the BP Corporation—once recognized as British Petroleum—announced that it was diverting its primary focus from oil and natural gas to the advancement of renewable energy sources such as solar, wind, and biofuels. BP's chief executive officer at the time, John Browne, proclaimed that the company needed “to look beyond oil and gas to fuels which can be produced locally and which do not threaten the sustainability of the world's climate (Klare 2012, 41).” The company proceeded to employ an advertising campaign in order to rebrand itself “Beyond Petroleum,” and BP's logo had suddenly become a green-edged sunburst.

Despite the praise that Browne received from political figures and environmentalists, he was soon replaced as CEO by Tony Hayward, who immediately deemphasized the company's alternative energy plans and restored BP's traditional focus on petroleum. In seeking to regain BP's oil initiatives, however, Hayward, was confronted with an intractable dilemma: most of the world's large, onshore sites have already been explored and greatly depleted. If BP was going to maintain supply lines and profitability, it would have to drill in the planet's deep waters at ever-increasing distances from the shore and at ever-greater depths. Therefore, following in the footsteps of other private oil companies, BP began concentrating their efforts on the extraction of

untapped reserves in more remote and more expensive areas that would soon prove to be quite dangerous and unpredictable.

In September 2009, the Deepwater Horizon, a mobile drilling rig leased by BP, managed to dig the deepest well ever documented: the 35,055 feet Tiber prospect, located roughly 300 miles off the Texas coast. Initial scientific reports revealed that Tiber was housing approximately six billion barrels of oil, making it one of the largest fields ever discovered on US territory (Klare 2012, 42). Thrilled by the Tiber prospect, BP officials then located another promising exploration site about 50 miles south of the Louisiana shoreline. After many months of drilling, this well, known as Macondo, also managed to reach a substantial reservoir of oil. Upon completing their assigned task of drilling down to the petroleum layer, crewmembers of the Deepwater Horizon started to seal the well in preparation for the relocation to yet another exploration site in the Gulf. On April 20, 2010, as the crew attempted to complete the seal for the regular production platform, it became unstable as a volatile blend of petroleum and gas escaped and shot up a connecting tube to the rig. The ensuing blast killed 11 of the 126 workers on board and unleashed an enormous underwater oil gusher that would endure for several months (Klare 2012, 43).

The Deepwater Horizon disaster managed to attract a lot of attention from the media and the public at large, which led to many questions being asked of oil companies regarding the risks associated with deepwater operations. Several commentators, especially those who had known ties to the oil industry itself, claimed that the events surrounding the disaster were anomalous and should not be viewed as a potentially common occurrence. In their view, negligence and lack of oversight at BP headquarters led to a sequence of errors that together resulted in this one-of-a-kind event. Nevertheless, further analysis revealed much more than the oil industry was willing

to publically admit. For starters, drilling for oil in deep offshore waters poses incredible dangers and unforeseen threats to any company that undertakes this challenge. In spite of this, the major energy firms with the means to explore and drill see no other option but to exploit what is left of the world's fossilized energy.

The inherent risks that come with drilling in deep-offshore sites are partly a product of the physical environment itself. As expected, personnel and equipment face unique and often unforeseen stresses from the incredible amounts of pressure that exists at these depths. In addition, offshore rigs have already shown particular vulnerability to the elements, including hurricanes, typhoons, and of course, floating ice in the northern polar region. And as oil companies along with their exploration teams continue to expand their presence, they will begin to encounter a growing opposition in politically contested waters. More and more countries are beginning to lay claim to parts of the Arctic that are widely believed to contain significant undersea deposits. As a result, verbal disputes between neighboring powers are already underway. As the world becomes even more dependent on deepwater oil and gas, these challenges will begin to multiply (Klare 2012, 43-4).

For more than fifty years, oil companies have been extracting oil from coastal areas. These shallow waters allowed energy firms to place conventional (onshore) drilling towers onto platforms and exploit the oil in that area without much complication. But deepwater drilling (drilling at depths greater than 1,000 feet) on the other hand is something new and entirely different. This kind of activity required large investments in order to develop the sophisticated technologies needed for deepwater exploration. Even newer is the practice of drilling ultra-deepwater wells, located at depths of at least one mile. Operating at such depths requires highly

specialized rigs that can cost anywhere from hundreds of millions to as much as several billion dollars.

The current trajectory of global oil production and consumption is now clear. The oil industry has become keenly aware of these trends as they are forced to spend more money to explore and produce their product. According to Klare, the degree of difficulty and the enormous costs of ultra-deepwater exploration have led some to compare it to space exploration. In the aftermath of the Deepwater Horizon disaster, a national commission was assigned to investigate all matters surrounding that incident and the practice of deepwater drilling. The report noted that in 1996—six months before NASA launched the celebrated Pathfinder probe to explore the surface of Mars—Shell had already begun to deploy an oil platform called Mars in the deepwater Gulf. The commission also went on to state that: “At a total cost of \$1 billion, Shell’s Mars was more than three times as expensive as the Mars Pathfinder, and its remote technologies and engineering systems were arguably more sophisticated (Klare 2012, 44).”

The complexity and costs associated with these types of investments are considered critical to energy firms that are aware of the inevitable decline in oil productivity but are committed to maintaining the world’s current rate of consumption. In a 2010 report by an energy expert named Michael Smith, the largest oil companies are on a path to spend roughly \$387 billion on offshore drilling operations between 2010 and 2014—a 33 percent rise over the amount spent in the previous five-year span. Smith also predicts that between 2010 and 2014, the major energy corporations will drill a record 20,000 offshore wells, with an ever-growing portion of these to be found in deep and ultra-deep waters (Klare 2012, 44-5).

With such enormous investments being made to offshore operations, and with the continued depletion of the largest onshore sites, a greater and greater share of the world's oil and natural gas will be extracted from offshore oilfields. In a recent scientific assessment, energy analyst John Westwood found that 35 percent of the world's oil will come from offshore areas by 2020, up from about 28 percent in 1995. More significantly, deep and ultra-deep wells will make up about 10 percent of global oil production in 2020 compared to only 1 percent in 1995. Westwood also projects that after 2015, onshore and shallow-water oil wells will reach their peak levels of output and not yield any further increases, leaving deep-offshore fields as the only source of growth to power the global economy. These same calculated forecast models apply to natural gas production as well. In the year 2000, roughly 27 percent of the world's natural gas supplies came from offshore locations, that share is expected to rise to 41 percent by 2020 (Klare 2012, 45). Therefore, any energy firm determined to remain in the hydrocarbon production business will have to commit to an expanding presence in the major drilling zones.

Of course, oil production will not come to a sudden halt at the peak, but will instead begin its descent gradually over many decades; therefore these impacts will emerge incrementally and cumulatively, interrupted by sporadic economic and geopolitical crises resulting from oil scarcity and inflated prices (Heinberg 2011, 113).

According to Heinberg, oil importing countries (including the US and most of Europe) will experience by far the worst consequences. The reason being, oil that is presently available for the export market will dwindle much faster than total global output, since oil producing states will satisfy domestic demand before servicing foreign interests, and several exporting nations have high levels domestic demand growth (Heinberg 2011, 113).

## CHAPTER 4

### OVERPOPULATION, WATER STRESS, AND THE FOOD DILEMMA

The Earth is operating at full capacity. In a global economic system that is presently running out of easily accessible and high-quality fossil fuels (particularly oil), unsustainable population growth will further disrupt these already fragile systems. Obviously, an expanding population leads to higher rates of consumption. And even though a large and growing share of the human population now has below-replacement fertility, the expansion of human numbers will persist for many decades because of the momentum of population growth.

#### It's Getting Too Crowded

After the invention of agriculture, population growth started to accelerate. At around 5 million or so people when farming first began, the world's population grew to an estimated 250 million humans at the height of the Roman Empire (Ehrlich 2004, 80).

In the early years of the Industrial Revolution, the number of people occupying this planet stood at around 700 million. Industrialization facilitated advancements in agriculture and improved sanitation for urbanizing population throughout Europe and North America, eventually transforming millions of people's lives. Better health and nutrition contributed to the reduction in death rates as the role and perceived value of children changed, and the population surged,

reaching 2 billion worldwide by 1930 (Ehrlich 2004, 81). As life expectancy increased in the industrialized parts of the world, birthrate gradually fell, but both death and birthrates saw little change anywhere else.

Industrialization also led to increased trade between continents and nations. And in order to sustain their expanding industrial systems, nations in Europe, North America, and, later, Japan increasingly sought raw materials from other regions of the world. This exploitation of resources brought these early industrializers more and more wealth, while non-industrial regions remained largely excluded from the benefits of modernization (Ehrlich 2004, 81).

The further reduction of death rates enabled the twentieth-century population boom. Over the course of just seventy years, between 1930 and 2000, the global population tripled in size, climbing to 6 billion (Ehrlich 2004, 81). In 2011, the world's population grew to an increasingly precarious figure of 7 billion. If this present-day trajectory endures, that number is expected to reach 8 billion within the next fifteen years. And by 2053, projections from the United Nations indicate that there will be more than 9 billion people on the planet, thanks to advancements in health care, disease eradication, and economic growth (Friedman 2009, 65).

According to the United Nations Population Division report (March 13, 2007), of the 2.5 billion new people expected to exist in 2050, a majority of them will be absorbed by the poorest and least developed regions, whose population is projected to grow from 5.4 billion in 2007 to 7.9 billion in 2050. The assessment then goes on to state: "In contrast, the population of the more developed regions is expected to remain largely unchanged at 1.2 billion, and would have declined, were it not for the projected net migration from developing to developed countries, which is expected to average 2.3 million persons annually (Friedman 2009, 65)."

In the future, as the population soars to 9 billion and natural resources begin to disappear; viable cities will become a magnet. In 1800, the world's largest city, London, housed approximately one million people. By 1960, there were 111 cities with populations over one million people. In 1995 that figure reached 280, and now there are over 300, according to UN population fund statistics. The number of megacities (ten million or more inhabitants) in the world has gone from 5 in 1975 to 14 in 1995; that number is expected to rise to 26 cities around 2015. Rapidly expanding populations are already overwhelming infrastructure in these megacities—nineteen million people in Mumbai alone—as well as driving loss of arable land, deforestation, overfishing, water scarcity, and air and water pollution (Friedman 2009, 65).

These unsustainable levels of growth have captured the attention of the Central Intelligence Agency. Michael V. Hayden, the former director of the CIA, stated that his analysts now list demographics as the most worrisome trend—ahead of terrorism. In 2008, General Hayden gave a speech at Kansas State University where he stated:

*Today, there are 6.7 billion people sharing the planet.... By mid-century, the best estimates point to a world population of more than 9 billion. That's a 40 to 45 percent increase—striking enough—but most of that growth is almost certain to occur in countries least able to sustain it, and that will create a situation that will likely fuel instability and extremism—not just in those areas, but beyond them as well. There are many poor, fragile states where governance is actually difficult today, where populations will grow rapidly: Afghanistan, Liberia, Niger, the Democratic Republic of Congo. Among that group the population is expected to triple by mid-century. The number of people in Ethiopia, Nigeria, and Yemen is likely to more than double. Furthermore—just beyond the raw numbers—all those countries will therefore have, as a result of this, a*

*large concentration of young people. If their basic freedoms and basic needs—food, housing, education, employment—are not met, they could be easily attracted to violence, civil unrest, and extremism* (Friedman 2009, 66).

The population surge that has transpired over the last few centuries can be greatly attributed to the discovery of fossil fuels in conjunction with an energy-intensive development process that has led to a rapid and unrelenting economic expansion. Scientific ingenuity and aptitude has continuously found new ways to provide people with added comfort and convenience in their everyday lives while simultaneously increasing efficiencies in societal systems. What the world ends up with is an ever-growing demand for energy, minerals, food, water, and other vital resources. Given the fact that what the Earth has to offer is ultimately exhaustible, it is mathematically irrefutable that mankind's current rate of consumption is simply unsustainable.

In the later years of the 20th century began an unprecedented process of broadening and deepening global interconnectedness in all aspects of modern civilization. This worldwide integration has come to embody a transformation in a myriad of fundamental societal components such as: politics, economics, communications, culture, and technology. One of the greatest factors that began to level and intensify the economic playing field was the invention and proliferation of the personal computer, which empowered individuals to imagine and create their own digital content in a multitude of ways. The next noteworthy breakthrough of was the emergence of the Internet, the World Wide Web, and the Web browser. This computerized interconnectivity led to the radically innovative development of software and transmission protocols, which made everyone's computer and software interoperable—thus enabling information to travel greater distances in a much more rapid manner (Friedman, 2009, 66-7).

Suddenly, millions upon millions of impoverished people began entering the global marketplace and climbing the economic ladder into the middle class. Newly Industrialized Countries (NICs) like China and India that have been historically underdeveloped and are presently home to a combined population of nearly 2.6 billion people have established economic systems that are now facilitating a more modern existence for several hundred million additional people (<http://usatoday30.usatoday.com/news/world/story/2011-10-30/china-india-tackle-population-growth/51007544/1>). Therefore, the convergence of unsustainable population growth fused with a high-energy and high-resource consuming lifestyle has become one of the greatest perils to the global environment.

### Global Water Quandary

Water, or H<sub>2</sub>O, is arguably the most essential natural substance on our planet. Earth or any other planet for that matter would be unable to support complex life without H<sub>2</sub>O. Water is inextricably linked to human health and it is inextricably linked to ecosystem health. Water is fundamental to growing the food required to feed a world of seven, eight, or even nine billion people. And unlike fossil fuels, water is a renewable resource. But somehow, people have found a variety of ways to threaten the Earth's supply of freshwater which will inevitably put human sustainability in jeopardy. The experts—hydrologists, engineers, environmentalists, diplomats—have begun to view these trends with a growing sense of concern, and this is before population growth is taken into account as well as a warming climate that will only exacerbate the pressure on water supplies (Prud'homme, 2011, 12).

Here in the United States, conventional wisdom has always revolved around the notion that Americans had access to some the best water in the world. In the culture of excess and

hubris, the American people got used to the idea that consumption and growth had no ceiling, and talk of conservation simply had no place in the US. American exceptionalism, as many have called it, meant that Americans would always have the cleanest and most abundant supply of H<sub>2</sub>O, available at whatever desired temperature or volume. This water would be delivered to American household in an endless stream, however it was preferred, whenever wanted it was preferred, and at little to no cost. This briefly explains the range of habits that Americans have grown up with and grown accustomed to regarding water consumption.

In the coming years, limits to freshwater could restrict economic growth by impacting society in four primary ways:

- by increasing mortality and general misery as a growing number of people find it increasingly difficult to fill basic and essential human needs related to drinking, bathing, and cooking;
- by reducing agricultural output from currently irrigated farmland;
- by compromising mining and manufacturing processes that require water as an input; and
- by reducing energy production that requires water (Heinberg 2011, 124-5).

As water becomes increasingly scarce, efforts to avert any one of these four impacts will likely exacerbate the situation with regard to at least one of the other three.

There is now widespread apprehension among experts and various agencies that the world's freshwater supplies are being critically overused and degraded, so that water exhaustion will dramatically spread at the turn of each coming decade. All over the world, rivers and streams are being overdrawn, and aquifers are being depleted. Pervasive environmental neglect has resulted in the pollution of both surface water and groundwater. As the century wears on,

sources of flowing surface water—snowpack and glaciers—will further recede with the acceleration of climate change (Heinberg 2011, 125).

To better understand this emerging crisis, one could start by recognizing that in the year 2000, roughly 1.2 billion people were without safe drinking water. The UN projects that by the year 2025, some 3.4 billion people will be facing water shortages. Scientists and other environmental experts would likely point out; this is not just about leaving the water running for too long.

Unsustainable population growth and climate change in the form of altered weather patterns will further endanger what remains of the planet's already vanishing freshwater supplies. So far, countries like Australia and Spain have recently suffered through record droughts that resulted in critical water shortages. States with giant populations and widespread pollution such as China and India, have been mostly concerned with distributing water to its population centers and less concerned with the quality and the safety of that water; leading to health problems and environmental degradation. Meanwhile, environmentally fragile regions in Africa continue to experience a decline in rainfall levels, which according to climatologists, will only continue to drop as each decade passes. In 2030, Africa is projected to be facing extreme and widespread drought. Today, tensions have already begun to rise over water availability, which is resulting in violent conflict (Prud'homme, 2011, 10). And the privatization of water in parts of Central America has triggered pockets of armed hostilities and human suffering.

A recent study conducted by a team of researchers at the University of Utrecht and the International Groundwater Resources Assessment Center in Utrecht in the Netherlands produced findings that illustrate the speed with which freshwater is disappearing. According to the report's

estimates, groundwater depletion worldwide went from 99.7 million acre-feet (29.5 cubic miles) in 1960 to 229.4 million acre-feet (55 cubic miles) in 2000, which is significant because when groundwater is withdrawn and used, it eventually finds itself in the world's oceans, resulting in sea-level rise. On the other hand, water expert Peter H. Gleick of the Pacific Institute claims that, "as groundwater basins are depleted, there won't be as much water left to send through rain clouds to the oceans (Heinberg 2011, 125).

In the US, the Colorado River—which provides water to cities like Phoenix, Tucson, Los Angeles, Las Vegas, and San Diego, as well as supplying most of the irrigation water for the Southwest—is trending towards functional depletion by the end of this decade. The snowpack that has always replenished the Colorado River is now being diminished by climate change and is projected to be at 40 percent below normal in the coming years (Heinberg 2011, 125). Moreover, unsustainable water withdrawals are expected to increase as population in the region expands. Heinberg points out that it is important to distinguish between water withdrawal and water consumption. He states: "Water withdrawal represents the total water taken from a source while water consumption represents the amount of that water withdrawal that is not returned to the source, generally lost to evaporation (Heinberg 2011, 126)."

The devastating effects of climate change are being felt throughout the world as altered weather patterns begin to greatly disrupt rainfall. A growing number of life-threatening water shortages have been developing in parts of Africa. In 2009, a massive drought left thousands of families in Somaliland without drinking water. As water wells dried up, limited quantities of water had to serve very large populations. This event displaced approximately 100,000 people and killed off livestock (Heinberg 2011, 127).

Agricultural irrigation makes up about 31 percent of freshwater withdrawals in the US, according to the USGS. Water scarcity is not only going to impact the Third World. In California, one of the most productive agricultural areas in the US in terms of crop output, is now facing intermittent water shortages. In 2009 for example, farmers in Kern County (located in the southern portion of the Central Valley) received only a portion of their normal water allotment from Federal and state water projects. The agriculture typically produced in these parts is highly water-intensive: a single orange needs 55 gallons of water, while each pear requires 142 gallons. This drought hammered Kern County hard and kept tens of thousands of acres of farmland from being cultivated (Heinberg 2011, 127).

In the event of inadequate snowpack, farmers, ranchers, and cities offset these losses of running surface water by pumping more from wells. But in more and more cases, short-term solutions generally lead to long-term dilemmas. One such instance can be seen unfolding beneath the Great Plains; the Ogallala aquifer, a vast source of freshwater which spans eight states (South Dakota, Nebraska, Wyoming, Colorado, Kansas, Oklahoma, New Mexico, and Texas), and provides water to 27 percent of the irrigated land in the United States (Heinberg 2011, 127). The aquifer supplies drinking water to 82 percent of those who live within its boundary and it is also utilized for ranching and for growing corn, wheat, as well as soybeans.

As essential as water scarcity clearly is, one should not overlook the decline of water quality as a serious threat to human wellbeing. Since the 1970s, America has depended on the Environmental Protection Agency (EPA) and various laws such as the Clean Water Act and Safe Drinking Water Act, which have been reinforced by the tightening of state and local regulations, to monitor and protect the countries' water supplies. Fast forward to the beginning of this century, the evidence reveals that between 2004 and 2009, the Clean Water Act (CWA) was

violated no less than 506,000 times by more than twenty-three thousand companies and numerous facilities (Prud'homme, 2011, 10-1). The EPA's comprehensive data covers only that five-year span, but it indicates violations were on the rise and various polluters illegally withheld information about their discharges. Studies and tests done by nonprofit watchdog groups and a variety of environmental organizations have found that tap water in forty-five states along with the District of Columbia was polluted with 316 distinct contaminants. In recent years, researchers have found traces of chemicals and other pollutants that have gone unregulated by the EPA, therefore excluding several contaminants from environmental safety standards.

The quality of the planet's remaining freshwater supplies should be of great concern to individuals who are concerned about overall human health and basic survival. Nonetheless, the quality of our drinking water is not the only thing that people need to start worrying about. In the future, something that will truly catch people's attention is the first rich city in the world that runs out of water. The availability of water will determine whether or not a region remains viable. Take the idea of peak water for instance. Peak water does not mean that planet is going to run out of water. As discussed earlier, water is a renewable resource. Peak water effectively means that society is running into constraints and limits on water use, water availability, and water quality. If economies continue to over pump and deplete nonrenewable fossil ground water supplies and nonrenewable aquifers faster than nature can naturally replenish it, the impact will be profound and it is bound to ripple out. As modern society runs into peak ecological limits, the use of additional water will cause more ecological harm than it provides economic benefit (Glennon 2009, 71).

The UN has referred to water as "the defining resource of the twenty-first century" and has warned of "a looming water crisis" in years to come. Ismail Serageldin, the World Bank's

leading environmental expert, previously stated that, “The wars of the twenty-first century will be fought over water (Prud’homme, 2011, 12).”

## No Food for You!

In addition to water, food is an essential component of economic growth. People need food for their very existence so it plays a key role in societal advancement. Throughout human history, when food production systems began to destabilize, civilizations tended to breakdown. Numerous examples of collapse have been repeatedly identified. For example, both the Roman Empire and the Mayan civilization—among others—eventually succumbed to declining food production.

The Industrial Revolution led to the transformation of food production and transport networks. The emergence of the twentieth century agricultural system was an unprecedented feat: grain production jumped to an incredible 500 percent (from under 400 million tons in 1900 to nearly two billion in 2000). Levels of productivity exponentially increased thanks to cheap and temporarily abundant fossil fuels (Heinberg 2011, 130).

The challenges surrounding increased food production are emerging from all directions: water scarcity, topsoil erosion, declining soil fertility, limits to arable land, declining seed diversity, increasing requirements for inputs, and growing costs of fossil fuel inputs (Heinberg 2011, 133). But as the fuel needed to produce and transport food becomes more costly, food prices will begin to rise as well.

Issues pertaining to unsustainable levels of food consumption extend beyond farms. In the world’s oceans for instance, fish like cod, sardines, haddock, and flounder are now endangered. In 2006, a number of ecologists and economists were predicting that the world

would run out of wild seafood by 2048 if current trends persisted. Their assessment revealed that as of 2003, 29 percent of all fished species had collapsed, meaning they were at least 90 percent below their historic maximum catch levels.

Presently, demand for food is beginning to gradually outpace supply. Food producers' ability to meet growing needs is increasingly becoming more burdensome due to growing human populations, falling freshwater supplies, the rise of biofuels industries, expanding markets within industrializing nations for more resource-intensive meat and fish-based diets; dwindling wild fisheries, and climate variability (Heinberg 2011, 136-7). At this rate, society could be facing a worldwide food crisis sometime in the next two or three decades.

## CHAPTER 5

### CLIMATE CHANGE

#### Historical Context

The scientific unearthing of climate change emerged in 1824 when a French physicist by the name of Joseph Fourier first identified the Earth's natural "greenhouse effect" and discovered that "greenhouse gases" trap heat radiated from the Earth's surface after it has absorbed energy from the sun. In an effort to better understand whether northern Europe had been covered by ice thousands of years ago, a number of 19<sup>th</sup> century scientists began to unwittingly piece together the climate change puzzle that Fourier had initiated. In 1859, Irish physicist John Tyndall conducted experiments that measured the absorptive powers of various "perfectly colorless and invisible gases and vapors," which later revealed great variation in the abilities of these particular gases to absorb and transmit radiant heat (<http://earthobservatory.nasa.gov/Features/Tyndall/>). Tyndall concluded that among the assortment of greenhouse gases, most notably: water vapor, carbon dioxide (CO<sub>2</sub>), methane (CH<sub>4</sub>), nitrous oxide (N<sub>2</sub>O), and ozone (O<sub>3</sub>)—water vapor has the greatest absorption capacity of radiant heat and is therefore the most essential atmospheric gas regulating the Earth's surface temperature. Due to the fact that the sun is roughly 93 million miles from Earth, greenhouse gases are tasked with generating a blanket of warmth by only

allowing about 30% of the sun's heat to escape back into space; without the presence of these gases and vapors, the molecules responsible for capturing heat radiation would not exist and the Earth would find itself in a perpetual ice age (Cullen 2010, 18-9). On the other hand, scientific consensus asserts that a considerably large and sustained increase of the same atmospheric constituents would produce an uninhabitable environment similar to the one found on the Planet Venus, which was once covered by large quantities of liquid water several billion years ago. The runaway greenhouse effect that Venus is presently suffering from has stripped the planet of its Earth-like conditions and has elevated the average surface temperature to approximately 900° Fahrenheit.

In 1896, Svante Arrhenius, a chemist who became Sweden's first Nobel Laureate and arguably the father of climate change science, was the first to speculate on the "man-made greenhouse" effect. Arrhenius claimed that the temperature of the Earth's surface was influenced by the heat-absorbing properties of the atmosphere enveloping it, and his calculations estimated that a doubling of CO<sub>2</sub> would gradually raise global temperatures by 5-6 degrees Celsius (Cullen 2010, 25-6). Even with visible evidence that climate could be delicately balanced; the study of global warming underwent prolonged inactivity until 1938, when British engineer Guy Callendar gathered records from 147 weather stations around the world and was able to show that temperatures had risen over the past century. This global warming trend coincided with climbing carbon dioxide concentrations in the atmosphere, which Callendar suggested was directly linked to industrial scale burning of fossil fuels. At the time, there were some in the scientific community who generally dismissed the perceived threat of a slight deviation in global temperature, as they were confident that the oceans would absorb and naturally dissolve the vast majority of carbon dioxide emissions. However, US oceanographer Roger Revelle and Austrian

geochemist Hans Suess exposed this conjecture in 1957 when they discovered the process in which excess atmospheric carbon dioxide is expelled by seawater through a complex chemical buffering system. By way of conclusion, Revelle stated that “Human beings are now carrying out a large scale geophysical experiment of a kind that could not have happened in the past nor be reproduced in the future. Within a few centuries we are returning to the atmosphere and oceans the concentrated organic carbon stored in sedimentary rocks over hundreds of millions of years ([http://scilib.ucsd.edu/sio/biogr/day\\_quotations-from-roger-revelle.pdf](http://scilib.ucsd.edu/sio/biogr/day_quotations-from-roger-revelle.pdf)).”

By the end of the 1950s, a growing number of scientists began to acknowledge the possibility that human activities could in fact alter the state of the Earth’s climate. In 1958, American climate science pioneer Charles David Keeling from the Scripps Institution of Oceanography at UC San Diego started taking a vast number of long-term measurements of atmospheric CO<sub>2</sub> at the Mauna Loa Observatory in Hawaii and in Antarctica. Within the next few years, Dr. Keeling became the first scientist to provide unequivocal proof that global atmospheric concentrations of carbon dioxide are indeed rising. He was able to confirm this steady upward trend of CO<sub>2</sub> in the atmosphere by using very precise and systematic measurements that produced a calculated data set now recognized widely as the “Keeling Curve (Cullen 2010, 26-7).” His investigations led to a vital and iconic geophysical record that constitutes the master time series documenting the changing composition of the atmosphere. These measurements illustrate the effect that mankind is having on the environment, predominantly through the combustion of fossil fuels and the cutting down of carbon-absorbing forests. Dr. Keeling’s extensive data collection methods have proven to be instrumental in identifying a true measure of the global carbon cycle (Cullen 2010, 28-9). The Mauna Loa

monitoring system, or Keeling Curve, is the cornerstone of climate science and remains the longest continuous record of atmospheric carbon dioxide levels (1958-present) in the world.

Fast-forward to 1988, the United Nations had just established an international scientific working body known as the Intergovernmental Panel on Climate Change (IPCC). This group was formed in order to assess whether climate change was unfolding, what the root causes of global warming might be, and what the consequences of future climate change will mean for human civilization at large. The IPCC was not tasked with conducting original research, but instead tasked with gathering and summarizing peer-reviewed scientific research published in various scholarly journals. Starting with the first published issue back in 1990, the IPCC has since produced three periodic assessment reports that addressed a broad range of issues surrounding the science of climate change. In the IPCC's Fourth Assessment Report (2007), the group stated that: "Warming of the climate system is unequivocal, as is now evident from observations of increases in global average air and ocean temperatures, widespread melting of snow and ice, and rising global average sea level (Pollack 2009, 129-30)."

### Altered Weather Patterns

Current scientific estimations place the age of the Earth at around 4.5 billion years. In its history, our planet has been impacted by an innumerable amount of cataclysmic events which resulted in drawn-out periods of extreme volatility and inhospitable planetary conditions (Cullen 2010, 24). Archaeological evidence, cutting-edge technologies, and a multitude of scientific measurements have revealed that awe-inspiring forces of nature can emerge in many forms and at any time, like an erupting super volcano for instance, which has repeatedly led to a rearrangement of ancient landscapes as well as to the extinguishment of plant and animal species

even as recently as 74 thousand years ago. It is a commonly held scientific belief that a giant asteroid (metal and rock formation), meteorite (rock formation), or comet (ice and rock formation) slammed into the Earth nearly 65 million years ago just off the coast of the Yucatán Peninsula (Klare 2012, 20). This calamitous episode produced a global cloud of ashes and dust that poisoned the oxygen, obstructed sunlight, and eradicated the food supply for dinosaurs and countless other species. An asteroid strike of incredible magnitude would lead to a massive and abrupt atmospheric shift—an abrupt atmospheric shift that scientists now routinely identify as climate change. It is becoming clearer that the climate, like many things in nature requires balance in order to function in an optimal way. The notion of balance is not only a fundamental principle applied to an assortment of mathematical equations, maintaining a degree of balance is fundamental to the planet's ecological viability as well.

For the ten thousand years that constitute human civilization, mankind has existed during one of Earth's most welcoming geological eras. These temperate conditions have produced a near-perfect ecological balance that has played an inextricable role in establishing the aggregate of hospitable surroundings for the immeasurable array of primordial organisms and diverse life forms that subsist on this planet. In the last ten thousand years, the global average surface temperature has hovered around fifty-eight to sixty degrees Fahrenheit and has therefore supplied our world with a climate that is warm enough to melt away ice sheets that once covered the centers of our continents (McKibben, 2010, 1). These ideal temperatures are conducive to agricultural development in general and have contributed greatly to human population growth and societal expansion throughout the world. Our warm and cozy planet simultaneously produces conditions that are cold enough to channel drinking and irrigation water into plains and valleys from frozen mountain glaciers year-round. The mild nature of our climate has also

permitted us to construct modern cities complete with towering structures in close proximity to oceanic bodies of water that have remained tranquil and level, or at high enough altitudes that disease-bearing mosquitoes would not be able to overwinter. A comprehensive examination of the Earth's ice core samples provides scientists of all fields with a treasure trove full of incalculable information that particularly enables climatologists to differentiate between the average global temperature of an ice age and the average global temperature during an interglacial period like the one we find ourselves in now. It is worth noting that the difference between the world being held in a tight grip of frost and being seasoned for human development is a mere 5-6 degrees Celsius (Friedman, 2009, 74).

As the global average temperature begins to gradually change, the environmental conditions on this planet will begin to change along with it. Today, state-of-the-art climate models continue to produce endless streams of data that consistently demonstrate the potential climatic impact of even the most miniscule divergence in surface temperature. These empirical studies and scientific projections are based on measurements taken from thousands of weather stations, ships, and buoys across the planet, as well as from satellites. Before the data is processed by unaffiliated research groups from around the globe, these measurements are independently compiled and analyzed by climate experts that must identify and adjust for the effects of changes in the instruments used to gauge temperature, the measurement site and time, the environmental conditions around the measuring locale, and even factors such as satellite orbital shift. One example of a measurement variable that must be factored into a climate estimate is the growth of cities, because societal development can lead to localized "urban heat island" effects which would likely end up shaping one's final model calculations. What has become increasingly clear in recent years is our planet's temperature trajectory, which continues

to scale upward according to a growing number of empirical studies and independent observations. These temperature records receive daily verification/substantiation from alarming events such as: the melting of Arctic sea ice, the retreat of mountain glaciers on every continent, reductions in the extent of snow cover, premature blooming of plants in spring, and accelerated melting of the Greenland and Antarctic ice sheets

(<http://www.globalchange.gov/publications/reports/scientific-assessments/us-impacts/full-report/global-climate-change>). Because snow and ice are light-colored and reflective, they expel a large proportion of the sun's energy back into space limiting the amount of heat that the Earth's surface absorbs. But as the world gets hotter, more ice will melt, exposing the darker-colored land or water below, which in turn leads to more ice melting, resulting in another feedback loop.

The broad scientific understanding today is that the Earth has already had to endure an average temperature increase of 0.8 degrees Celsius (1.44 degrees Fahrenheit) over its recorded level in the year 1750, with the most rapid and substantial temperature climb occurring since 1970 (Brown, 2007, 61). According to the IPCC, climatologists from around the world overwhelmingly agree that the rising global temperatures our planet is currently experiencing cannot be viewed only as a statistical deviation from the norm, but quite possibly an unmanageable and irreversible warming trend that has been centuries in the making. Unfortunately, climate model projections have consistently failed to illustrate any sign of deceleration; scientists explain that this is ascribed to the fact that CO<sub>2</sub> lingers in the atmosphere for several thousand years, which has become increasingly more clear that human activities associated with industrial scale manufacturing is primarily to blame.

## The Consequences of a Warmer Planet

The most difficult hurdle facing the scientific community and their efforts to convince the world of human-made climate change is the natural variability of climate. Climatology has often been confused with meteorology and the daily forecasting reports that take place on *The Weather Channel*. In fact, climatologists study patterns of weather as they occur within the seasonal cycle. Employing the same basic principles found in mathematics and physics, climate science looks at averages, extremes, timing, precipitation, and spatial distributions of temperatures. This accumulation of scientific knowledge enables the world's climatologists to better understand altered weather patterns (climate change) and the events that are most likely associated with climate disruption; events like blizzards, heat waves, and other extreme storms are expected to increase in frequency and intensity as greenhouse gases continue to buildup in the atmosphere.

According to the director of the NASA Goddard Institute, James Hansen, biological productivity mostly occurs in the summer months, making it the most essential season for humanity and arguably the most impactful season for climate change itself. So far, the effects of global warming have prolonged summer-like conditions, causing spring warmth to come sooner in the year as well as postponing the cooler conditions that are symptomatic of fall, reducing the span of both spring and fall. For example, flowers are blooming earlier and trees are leafing earlier. We are witnessing birds coming back from migration earlier. Species are moving their ranges farther North to get to cooler conditions. Species are migrating from south to north and from the valleys up to the mountain tops. Natural ecosystems have adapted to the steady climate that has existed on this planet for more than ten thousand years

([http://www.columbia.edu/~jeh1/mailings/2012/20120105\\_PerceptionsAndDice.pdf](http://www.columbia.edu/~jeh1/mailings/2012/20120105_PerceptionsAndDice.pdf)). But as the

world's long-term temperature trend continues to scale upward, the volatility of weather patterns will be destabilizing and profound.

As the future approaches, heat waves in Europe and North America are expected to become more intense, more frequent, and longer lasting in the second half of the 21<sup>st</sup> century. Climate models have already shown that present-day heat waves over these areas coincide with a specific atmospheric circulation pattern that is intensified by ongoing increases in greenhouse gases, indicating that these regions will experience more severe heat waves as time passes. On July 13, 1995, the temperature in Chicago reached 106 degrees, while the heat index (combination of heat and humidity) climbed above 120 degrees. After each blistering summer afternoon, those that weren't fortunate enough to have air-conditioning had to also endure unusually high temperatures at night. This was just the beginning of a heat wave that would last a week and set new energy consumption records. The tremendous demand for energy led to the failure of some of Chicago's power grids, which cut off electricity to 49,000 households at one point (<http://www.press.uchicago.edu/Misc/Chicago/443213in.html>). As a result, the city's beaches were swarmed and over 3,000 fire hydrants were opened. When emergency crews arrived to seal the hydrants and restore water pressure to some neighborhoods that were also dealing with power loss, they were pelted with rocks and threatened with bricks by various residents.

The intensity of the heat not only endangered the lives of Chicagoans but also began to test the integrity and durability of the city's infrastructure. Roads started to buckle and train rails began to warp. City workers were tasked with watering bridges in order to prevent them from locking when the plates expanded. Thousands of citizens began to overwhelm Chicago's hospitals as more and more people developed severe heat-related illnesses from the relentless

exposure to heat. Residents came across emergency rooms that closed their doors to new patients and ambulance crews that had to drive around for miles in search of an open bed. Chicago police officers transported hundreds of bodies to be autopsied by the Cook County Medical Examiner's Office, which was operating beyond capacity. Only three days into the heat wave, the morgue, which houses 222 bays and receives an average of about 17 bodies per day, required a fleet of refrigerated trucks to temporarily store the bodies. According to the "excess death" rate measure, which determines the difference between reported deaths and the average number of deaths for any given period, 739 Chicagoans above the norm died during the week of the heat wave (<http://www.press.uchicago.edu/Misc/Chicago/443213in.html>). As the example in Chicago has demonstrated, climate change in the form of searing heat not only has environmental implications (drought, wildfires, and famine), but also takes a direct human toll. In the future, as societal pressures (population, energy, climate, food, water, and economic) brought on by environmental stresses begin to converge, governments from the federal down to the local may be unable to manage these crises simultaneously.

The relationship between carbon dioxide levels and global surface temperatures is being felt in a variety of ways and on many fronts. In recent years, higher temperatures have led to decimated grain harvests and diminished crop yields. Crop-withering heat waves and associated drought have begun to threaten agricultural development in key food-producing regions. This combination of a vulnerable agricultural system and the nutritional needs of a growing population will lead to higher food prices in the short term. In the long term, the unsustainability of the human population will most certainly result in a degree of food scarcity for much of the world (Brown, 2007, 59-62). More people have come to understand that the world's agricultural systems are almost wholly dependent upon cheap oil. It takes a tremendous amount of diesel fuel

to plant, harvest, and produce food that will then be distributed all these vast distances. As has been discussed, the world is running out of easily accessible and high-quality oil. Promises that many industrialized powers have made to its citizenry will not be kept. The unrealistic expectations of perpetual growth are expectations that have been largely based on the assumption that oil will always be plentiful. This kind of thinking is problematic since the peaking of oil production is approaching at a time of great uncertainty.

As the price of oil continues to climb, so too will the cost of living for consumers everywhere. And as the world continues to add more producers and more consumers to the globalized economy, consumption patterns will inevitably change and there will be an ever-growing tension for natural resources. Citizens of the developing world who were once riding bikes or taking public transportation are now in a financial position to own a large and inefficient automobile and they are also able to start eating differently now—meat-based diets. As the American way of life becomes increasingly unsustainable, the rest of the world will be trying to acquire a similar type of lifestyle that Americans have grown accustomed to for so many years. Ehrlich goes on to state: “As things are today, even without any further increases in world population, if every person in the world were to start consuming as Americans do, humanity would require the resources of at least two additional planet Earths to support it (Ehrlich 2004, 82).”

Completely unaware of what they were uncovering as they monitored the icy waters of the Arctic, the US Navy inadvertently contributed to the weight of evidence supporting what many started to believe were the direct effects of a warming planet. Submarines operating in the Arctic Circle were equipped with technology that delivered accurate readings of the thickness of the ice sheets above them in order to locate a suitable place to surface. Once the Pentagon

released several decades worth of data, researchers were beginning to truly understand the speed with which the ice at the North Pole was retreating. Our world without the presence of ice is no longer a farfetched notion according to a growing number of climate scientists. In the not-too-distant future, if Earth were to lose its polar regions, the consequences for planet and people alike would be dire. All over the world, as the climate warms, mountain glaciers are melting at faster and faster rates. Today, one quarter of the Earth's population gets its drinking water and agricultural water directly from mountain glaciers. These glaciers provide stream flow in the summer during the dry months that can be used to irrigate crops. In Asia for example, mountain glaciers on the Tibetan plateau act as a giant reservoir for billions of people. The Tibetan plateau in the Himalayas feeds into the six great rivers of Asia: the Indus, the Ganges, the Mekong, the Brahmaputra, the Yangtze, and the Yellow; all of which depend on the seasonal replenishment of melting winter snow and ice for a large fraction of their water. Altogether, these rivers feed nearly three billion people who are already seeing signs of water stress, partly resulting from unsustainable practices of mining groundwater

[http://democrats.energycommerce.house.gov/Press\\_111/20090212/testimony\\_schrag.pdf](http://democrats.energycommerce.house.gov/Press_111/20090212/testimony_schrag.pdf)).

In other parts of the world, such as northern Europe, they have been getting pummeled by endless rain. And the latest climate assessments are predicting that the UK will suffer from massive flooding, water shortages, soil erosion, and wildlife disruption due to climate volatility over the coming decades (<http://www.guardian.co.uk/commentisfree/2012/oct/15/extreme-weather-starvation-food-production>). However, the most serious threat facing the UK and other low-lying cities is the disintegration of our polar regions that would unavoidably lead to sea level rise. According to the Intergovernmental Panel on Climate Change, if the Arctic ice sheet were to completely melt and liquefy into the ocean, the IPCC's latest assessment report projected that

by the year 2100, the planet's oceans would rise somewhere around one to three feet above current levels and redraw the map of the world. Considering that nearly 70% of the world's population resides in coastal regions, it is safe to assume that hundreds of millions, probably billions of people will be forced to abandon the lands that they now inhabit (Tidwell, 2007, 69-71). People will be under intense pressure to migrate and they will be seen moving across borders by the droves. Mass migrations of such great magnitude will likely be among the most difficult challenges that host civilizations may have to cope with.

### Final Thoughts

It's been about 188 years since Joseph Fourier along with various other 19<sup>th</sup> century scientists set out to determine why the Planet Earth fell into periodic ice ages. Now, the study of the climate has moved from being a relatively minor branch of scientific research to a megascience among mainstream scientists of varied fields. Professor Erland Källén, a meteorological expert of Stockholm University remarked that "Even when I came to this field 20 years ago, I was very sceptical about global warming. There were too many uncertainties I just couldn't see how anyone could say anything sensible about it. Now, I struggle to see what other explanation there could be

<http://www.guardian.co.uk/environment/2005/jun/30/climatechange.climatechangeenvironment2>)."

Over the past several decades, the evidence supporting climate change has mounted and a consensus among the scientific community continues to strengthen with each newly produced study. Unfortunately, a degree of global warming has already begun and the evidence to prove it is no longer confined to a science-based formula. People around the world who have not yet

come to recognize the impact of global warming or even in some cases believe in the science of global warming, will soon be force-fed an overwhelming amount of anecdotal evidence pertaining to the real-life consequences of a warming planet. It is critically important to remember how fundamental the Earth's climate is to civilization and to everything individuals generally care about. It is just a fact that human beings exist within the climate system; humans are not independent of the environment, nor are they immune to the planet's natural limits. Globally, the science reveals that temperature, rainfall patterns, heat stress, availability of water resources, the quality of our water resources, and food production all depend on climatic factors; overall human health, sea level rise and the world's coastal communities are just a few more examples of how modern society is fundamentally integrated to the climate system. Climate change is the central environmental challenge of the future. And while we might already be irreversibly committed to climate change, society will be presented with many opportunities to reduce the severity of those ultimate impacts and to slow the rate of those changes.

## CHAPTER 6

# THE DEPLETION OF VITAL RESOURCES AND THE GROWING THREAT OF CONFLICT

### Up For Grabs

In the early centuries of human civilization, the pursuit of vital natural resources were stimulating factors that enabled conquering forces to explore new frontiers and project power beyond their lands. As ancient Rome continually added new colonies, central Italy required an ever-increasing amount of food and materials to satisfy and sustain the expanding Roman population. Later, in the fifteenth century, the European empires sent fleets of sailing ships to resource-rich foreign territories of Africa, Asia, and the Americas in search of gold, silver, spices, furs, timber, and a variety of other commodities for their homeland. As recently as the twentieth century, the world experienced the genocidal rise of fascism in the 1930s and witnessed the collapse of the Soviet Union in 1991. During this period, concerns over resources were eclipsed by ideological strife as the principle cause of international conflict. But today the importance of natural resources has reasserted itself; in the coming decades, the rapid depletion of these materials will take center stage in world affairs and will most likely lead to various forms of international conflict (Klare 2012, 15).

The unsustainable consumption of natural resources is not just a continuation of previous behavior; instead, it now represents a truly unprecedented and shortsighted push to relentlessly extract the planet's depleting supply of vital resources. In the early years of colonization and resource utilization, empires were bound by several factors that prevented global hegemony. Today, that is no longer the case. Technological advancements in everything from transportation to military weaponry have enabled countries to project power on a global scale and in a variety of ways. Unlike ancient civilizations, there are no other, as-yet-undetected frontiers lying beyond those that are now being exploited. Virtually all accessible resource zones are now in production; except for the extreme and inhospitable locations such as the Arctic, the Congo, the ocean bottom, and unyielding rock formations, there is no place left to go (Klare 2012, 15-6).

For this reason, economies and human society in general are headed for a shock of epic proportions. Klare goes on to argue that the ongoing invasion of the Earth's final frontiers has unique significance:

*What we expropriate from these areas represents all that remains of the planet's once abundant resource bounty. In all likelihood, we are looking at the last oil fields, the last uranium deposits, the last copper mines, and the last reserves of many other vital resources. These materials will not all disappear at once, of course, and some as-yet-undeveloped reserves may prove more prolific than expected. Gradually, though, we will see the complete disappearance of many key resources upon which modern industrial civilization has long relied (Klare 2012, 16).*

And this is just the beginning. As the rapid consumption of materials builds momentum, it will intrude with greater intensity into world affairs, endangering the existence of animal species,

local communities, giant corporations, and entire nations (Klare 2012, 210). As it is currently constituted, the global economy needs to constantly absorb a growing supply of assorted critical resources in order to continue expanding. But the unrelenting acquisition of these materials will increasingly threaten the long-term security and stability of modern human society and the natural world.

The current trajectory of worldwide consumption will not only lead to the eventual depletion of familiar resources like oil and copper that are likely to be exhausted in this final drive. Over the next several decades, the demand for exotic materials that are needed for specialty purposes, including the chromium used in making stainless steel and the cobalt required for high-strength alloys, is expected to rise even further. Demand is also outpacing the supply of the “rare earth elements,” such as dysprosium, lanthanum, neodymium, and terbium—all essential ingredients in the production of superconductors and hybrid car motors (Klare 2012, 16). Similarly, environmental concerns and rising gasoline prices have made “plug-in” hybrids and all-electric cars an increasingly more popular alternative to conventional options. As a result, the demand for lithium, an ultra-lightweight metal used in advanced battery designs, has gone up substantially. The remaining deposits of these rare earth elements, lithium, and other exotic materials which are vital to the technological development of modern society, will come under growing pressure as existing mines are fully depleted and global demand continues to increase at high rates.

### Harder To Come By

In February 2005, the chairman and CEO of Chevron, David O’Reilly, startled attendees at an annual oil-industry conference in Houston when he stated that their industry had reached an

epochal turning point. After over a hundred years of easily accessible petroleum that consistently kept pace with the world's growing demand, he said, "Oil is no longer in plentiful supply. The time when we could count on cheap oil and even cheap natural gas is clearly ending.... The era of easy oil is over (Klare 2012, 210)."

Upon additional review, O'Reilly's speech was less about enlightenment than it was about lobbying the government for more favorable policies and a further loosening of environmental restrictions. Nonetheless, his assessment of global energy trends has been repeatedly cited as an explanation for dwindling supplies of fossil fuels and rising energy prices (Klare 2012, 210-1).

The rapid loss of resources has also been driven by the sudden emergence of powerful new competitors with booming economies. Until fairly recently, only countries such as the United States, Japan, Germany, Britain, and France had the means to relentlessly pursue energy and mineral resources anywhere in the world. These nations were able to basically control the global commodity markets and establish industrial-scale resource ventures in parts of the Third World—Africa, Latin America, and the Middle East. But recently, Asian dynamos like China, India, South Korea, and Taiwan have experienced significant economic gains which have enabled these states to consume evermore resources and expand their presence around the globe. China, for instance, has become the world's largest consumer of coal, iron, copper, and aluminum ore, and the second largest consumer of petroleum (Klare 2012, 17). For the most part, the consumption patterns of these newly industrialized economies coincide with the behavioral patterns of the older industrial powers. The only real distinction is timing; the newly developed countries are entering the global economic system when the Earth is already under tremendous stress from all fronts.

The impact of the conversion from “easy oil” to tougher and unconventional substitutes is partly financial. For example, Saudi Arabia became the world’s leading oil provider by tapping its vast reserves of easily accessible, high-grade light oil. But as growing energy demands deplete the world’s remaining fields of “easy oil,” the Saudis are now looking at a less desirable alternative: the billions of barrels of heavy oil trapped beneath the surface (Klare 2012, 211). Compared to “easy oil,” these unconventional sources of energy are not only more environmentally risky, more costly, more energy-intensive (utilization process), and of a lesser quality, they are indicative of an unsustainable way of life.

As easily accessible reserves of energy sources and vital materials vanish, the cost of basic commodities will increase, leading to great hardship for the poor and requiring lifestyle adjustments—oftentimes quite significant ones—from those who have become accustomed to abundance. Rising gasoline prices, for instance, has begun to alter the discretionary driving habits of many Americans who are on a tight budget. These inflated energy costs have also disrupted suburban commerce and tourism-related industries. In addition, a number of homeowners have been forced to lower the temperature on their thermostats and have had to spend more money on energy-saving insulation as a result of higher heating oil prices. Aging gas guzzlers are being replaced by smaller, more fuel-efficient vehicles; new homes are now smaller on average than the homes that were constructed over the last several decades. Newly erected factories, schools, stores, and office buildings are similarly being outfitted with energy efficiency in mind to a much higher degree than ever before (Klare 2012, 213).

According to Klare, skyrocketing commodity prices are among the most visible effects of the end of “easy” resources, and virtually everyone in the world will be impacted by these developments in some way (Klare 2012, 214). In a world transitioning away from “easy”

materials, individuals will not be the only ones struggling to hold on to what little will be left; one can expect powerful corporations and opportunistic nation-states to compete ferociously for the last of the Earth's easy-to-access, high-quality resources.

### Corporate Muscle

In the future, as global supplies of raw materials dwindle and exploiting the planet's declining resources becomes costlier and more hazardous, only a small number of giant resource firms are likely to subsist. Those that are unable to acquire enough available resources to remain sufficiently profitable will contract, become insolvent, or become absorbed by the more dominant companies (Klare 2012, 214). The same scenario holds true for nation-states; those that are able to establish a more advantageous position in terms of material acquisition with at least intermittent levels of sustainability may continue to experience growth within their borders. On the other hand, countries that do not have the capabilities to exploit and retain vast quantities of vital resources will suffer hardship and decline. In a world of escalating scarcity, therefore, the rivalry among the various powers will become increasingly merciless, incessant, and severe (Klare 2012, 215). The strongest actors will likely do what they feel is required using any and all means necessary to survive, and to eliminate or subdue any threatening competitors.

The corporate crisis that BP found itself immersed in after the Deepwater Horizon catastrophe offers up an early but revealing indication of how these events are likely to develop. Prior to the deepwater blowout, *Fortune* magazine identified BP as the fourth largest publicly owned corporation in the entire world, with 2009 revenues listed at \$367 billion. But once the extent of the damage caused by the spill was gauged, many on Wall Street started to predict that the company would likely not be able to survive the aftermath. Considering that BP was liable

for not only the cleanup costs in the Gulf but was also facing punitive damages on every barrel of oil spilled as a result of its reported negligence—charges that could have possibly reached \$50 billion—a complete liquidation did not appear far-fetched (Klare 2012, 215). As of today, BP has managed to endure, however it is significantly weaker, having no other choice but to sell off a number of its oil and natural gas assets in an attempt to raise cash for numerous claim settlements and lawsuits. Whether or not BP emerges from this episode as an independent major corporation will depend on a number of factors.

In the days following the Deepwater Horizon explosion, many of BP's principal competitors already operating in the Gulf of Mexico offered to assist in the efforts to plug the leaking well. Perhaps because they knew that if public opinion rallied against deep-offshore drilling, the oil industry as a whole would have been negatively impacted. However, once the media became fixated on the oil gusher and Congress started to investigate the matter, they quickly distanced themselves from BP by trying to portray the company as some rogue operator who was guilty of gross negligence. At a June 2010 hearing on the Gulf of Mexico spill, Rex W. Tillerson, the chief executive of ExxonMobil declared that, "We would not have drilled the well the way they did." As John S. Watson, the chairman of Chevron went on to say: "It certainly appears that not all the standards that we would recommend or that we would employ were in place." Also, Marvin E. Odum, the president of Shell stated: "It's not a well that we would have drilled in that mechanical setup (Klare 2012, 215-6)."

Arguably, the executives' grandstanding was a ploy designed to further weaken the already battered BP into submission. At the height of the crisis, several of BP's top competitors were considering the possibility of acquiring the company outright—apparently thinking that the circumstances engulfing BP would force the company into an all-out fire sale. Various reports

would later reveal that ExxonMobil and Royal Dutch Shell both considered proposing a serious deal for the struggling firm, with ExxonMobil actually seeking preliminary approval for this potential buyout from the Obama administration. While ExxonMobil and Shell ultimately did not advance with takeover proceedings, neither company excluded the possibility of a future acquisition, so they remain equipped to snatch BP up if it finds itself in additional financial or legal troubles (Klare 2012, 216).

So far, BP has not been receiving bids at bargain-basement prices from any major oil companies, but BP's plight has been thoroughly exploited by its rivals. In what has been described as a feeding frenzy by savage vultures, competing firms have acquired some of BP's top oil and gas prospects—often at discounted prices considering what they would have commanded if not for BP's urgent need to accumulate vast sums of cash. Over the course of just a few months in 2010, the assets sold by BP were as follows: oil sites in Colombia, an exploration concession in Egypt, hydrocarbon deposits in the United States and Canada, and a majority stake in Pan American Energy, Argentina's second largest energy provider (Klare 2012, 216). BP's divestments netted the company almost \$18 billion—enabling the firm to pay for the cleanup efforts in the Gulf, but stripping it of several billion in potential earnings.

As the global struggle to acquire vital resources intensifies, examples of predatory behavior will become more recurrent and increasingly brutal. With fewer projects offering promising returns and market pressures growing more uncertain, resource firms will begin to feed upon one another to satisfy their endless appetite for crucial assets. It is only a matter of time before the smaller and weaker companies disappear altogether or become consumed by their stronger competitors; only the most adaptable and powerful will endure.

## The Interests of Nations

Like the large resource companies, the world's major powers will also see no other option but to aggressively pursue the most essential resources available in order to maintain some level of economic activity. Although nations, unlike corporations, are not likely to be directly attacked and absorbed by their rivals, they are destined to fight for advantageous political and economic positioning. As the world's most powerful actors consume everything in sight, countries that succeed in securing resources that are of vital interest to their state will elevate their standing on the world stage, while those that fail to do so will experience decline within their international boundaries.

Of course, the fight to control natural resources has been a source of conflict that has long shaped human history. According to Klare, ancient dynasties routinely waged wars to secure larger agricultural territories; while European colonial empires fought one another in order to increase their resource-rich outposts abroad (Klare 2012, 218-9). Therefore, one could argue that the violent struggle over resources is just a continuation of an age-old conflict. One large distinguishing factor however, is the number of powerful contenders that currently exist or are in the process of emerging. These modern-day challengers possess advanced capabilities and are harboring expanding populations that have acquired an insatiable taste for consumer goods. As the higher quality and easily accessible sources of supply face inevitable exhaustion, the world will also be contending with a shrinking number of new reservoirs waiting on the horizon. With more nations and more people experiencing economic growth, there will be significantly more people living off of the same dwindling supply.

Even in countries like Canada and the United States, which have long relied on private industry to acquire valuable resources, government agencies are now assuming a greater role in stockpiling vital materials from deposits located around the world. In the Arctic for example, governments are sending assessment teams to conduct official surveys of their maritime territories in an attempt to lay claim to unexplored stretches of submerged continental shelf. In countries such as China and India, the task of providing their own citizenry with sufficient quantities of raw materials—and thus building off of their countries' economic momentum—is viewed as a critical component of governing.

The level of state involvement in resource exploitation activities varies from country to country. In China, authorities have been investing heavily in the procurement of adequate supplies in critical natural resources for many years now. With these growing national funds at their disposal, China has been offering huge loans to foreign governments and their state-owned companies as leverage for acquiring much needed material exports (Klare 2012, 219). A number of other countries can be seen taking the same approach as China's leaders have taken. With time, every industrialized power will do more to secure their future than just simply reallocating public funds.

### Looming Conflict

Financial maneuvering and intense diplomatic negotiations will probably account for most of the direct government involvement in the future. In their quest for natural resources, governments have already begun forging strategic alliances between their own national firms and the state-run companies of their major suppliers. As such state-backed merger operations begin

to multiply, government policies—rather than market forces—will assume a much larger role in dividing the world’s remaining assets (Klare 2012, 220).

Once the development of the world’s final reserves begins, their depletion could occur very rapidly—producing a sharp decrease in the global distribution of many of the planet’s vital resources. Under these conditions, it is logical to think that various consuming powers will begin to employ more forceful means in the hunt for scarce materials. In all likelihood, nations in possession of significant resource deposits will start to acquire more weapons, military training, technical assistance, and intelligence support from countries that are in need of materials and want to establish closer ties (Klare 2012, 221). It is also reasonable to assume that combat forces will be deployed abroad to protect the resources of its allies: these sites may include key ports, pipelines, refineries, and various other installations of great value. These actions do not necessarily represent overt provocations; nevertheless, large-scale mobilizations and a heightened state of readiness exponentially increase the threat of war.

Indeed, there is already an increasing amount of military activity taking place in key-resource supplying locations, especially throughout Africa and Central Asia. In both of these regions, the United States and China are developing closer strategic ties with various countries. The United States for instance, has established deeper relations with Nigeria, the Republic of Georgia, and the Persian Gulf Kingdoms; while China has been getting more involved with Sudan, Zimbabwe, and the Central Asian republics. These strategic involvements have largely consisted of military aid in the form of: weaponry, military advisors, instructors, and technicians. An even more significant development, Washington and Beijing have both created new organizations to facilitate the delivery of military assistance and to coordinate any future military intervention in these regions (Klare 2012, 221). In 1996, the Shanghai Cooperation Organization

(SCO) was introduced by China, with the intention of providing regional security in Central Asia, while in 2007 the United States established the Africa Command (Africom). According to Klare, while neither of these organizations is explicitly devoted to securing vital materials, both of these entities have made energy security one of their top priorities (Klare 2012, 221).

Arguably, one of the most potentially contentious sites of the future will be in the East and South China Seas, which are believed to contain considerable quantities of oil and natural gas. Presently, China maintains that a majority share of these waters lie within its territorial boundaries; Japan on the other hand, claims that a significant portion of the East China Sea is sovereign Japanese territory, and countries such as Vietnam, the Philippines, Malaysia, and Brunei similarly argue that a large swath of the South China Sea belongs to them. Development of these offshore oil and gas deposits could provide all of these neighboring states with a valuable source of fuel, but none of them will be able to proceed until the location of maritime boundaries can be agreed upon. All of the countries involved have deployed air and naval forces in the contested waters, which has led to various incidents of provocation like seizing fishing boats or aiming guns at one another's ships and planes (Klare 2012, 223). The United States, which maintains a number of security alliances with neighboring powers, has also deployed a greater number of military assets to the region. With such activity expected to persist and eventually intensify, it is not difficult to see how a minor occurrence—perhaps, a collision between two warships, accidental or otherwise—could escalate into a more large-scale crisis (Klare 2012, 223-4).

Recently, there have been a number of examples that are indicative of just how easily such a scenario could potentially develop. One occurrence that took place not too long ago happened on March 8, 2009, when a flotilla of small Chinese ships obstructed an American naval

surveillance vessel, the *Impeccable*, in China's southern waters. The *Impeccable* was towing underwater sonar cables, presumably for the purpose of submarine detection; the Chinese ships made an effort to sever those cables and tried to block the American vessel from leaving the area, prompting President Obama to immediately deploy a guided missile destroyer toward the site (Klare 2012, 224). Ultimately, the *Impeccable* was able to evade the Chinese dragnet without any assistance and no shots were fired, however, the incident was broadly seen as a precursor to more volatile encounters at sea, possibly leading to violent conflict (Klare 2012, 224).

Only eighteen months after the *Impeccable* episode, an incident involving a Chinese fishing trawler and two Japanese coast guard vessels unfolded in the East China Sea. The Chinese fishing trawler was detained after his ship collided with the Japanese coast guard vessels. The event and detainment of the trawler captain, Zhan Qixiong, led China to indefinitely suspend its rare earth deliveries to Japan. While the trawler captain claimed that he was acting alone when he deliberately resisted Japanese efforts to deter his approach towards the disputed Senkaku islands (claimed by both China and Japan), many analysts believe that his actions are part of a larger effort by China to assert its claim of sovereignty over the entire region (Klare 2012, 225). The rising tensions between China and Japan are particularly concerning to American officials due to the fact that a treaty obliges the United States to come to the defense of Japan in case of an attack; senior US officials immediately held emergency meetings with their Japanese counterparts in order to discuss ways to diffuse the situation (Klare 2012, 225). As of today, it appears that these incidents have not permanently damaged long-term relations between the countries involved. However, one could make the argument that these occurrences not only signify a pattern of Chinese aggressiveness in the area, but represent the future behavior of many world powers.

There is no way to predict when, or whether, such provocations will eventually escalate into some sort of armed conflict. What has become increasingly evident, however, is that all key parties to the territorial disputes in the East and South China Seas are beginning to understand what is at stake—valuable offshore resource deposits. As a result, these neighboring rivals are prepared to mobilize their combat forces in order to assert their sovereignty claims, even if it risks further escalation. And while it can be argued that none of these countries want to engage in armed combat with one another, it can also be argued that these nations are unlikely to exercise restraint. Klare goes on to conclude:

*If, in some future confrontation, commanders on the scene do not refrain from using live ammunition, and senior government officials then fail to order an immediate cease-fire, a larger outbreak of violence could conceivably follow. Many wars have erupted that way in the past, and there is no reason to assume the same cannot occur again.... As the global struggle over scarce resources intensifies, such risks will only become more common. Similar aggressive posturing by rival claimants, as we have seen, has also been occurring in the Arctic, the Falkland Islands region, and the Celebes Sea off Malaysia and Indonesia.... With government officials...under increasing pressure to protect and expand their countries' resource reserves, the potential for overreaction and miscalculation—and possibly full-scale war—is bound to grow (Klare 2012, 226-7).*

## CHAPTER 7

### CONCLUSION

In sum, modern society's present course will inevitably lead to the destabilization of the world's interconnected systems, which will undoubtedly result in widespread conflict, social disorder, and human misery. For my conclusion, I utilize the subsequent quotation from *The End of Growth: Adapting to Our New Economic Reality*, which makes the following assessment:

*Our collective global conversation about the economy needs to change. We need to be thinking and talking about how to adapt to the end of growth. I don't know how to help catalyze that conversation without first pointing out some inconvenient facts—starting with the fact that our economy currently is set up to fail under the kinds of circumstances that are unfolding around us (resource depletion and catastrophic environmental decline). If political leaders and voices in the major media are unwilling to consider the possibility that growth is ending, then at least this information should be available to receptive individuals and communities so they can prepare themselves for what is coming.... Even so, there is irony and risk. The strategies that individuals should be pursuing to prepare for the end of growth (disengaging from consumerism, getting out of debt, becoming more self-sufficient) are things that—if everyone did them—would keep*

*the economy from recovering and would push us further into recession. When the short-term interests of the economy conflict with the long-term interests of communities, a majority of individuals, and the natural world, we have a dilemma on our hands. In some respects, it is not an entirely new one (this conflict was implicit in Marx's critique of capitalism), but it is becoming acute and more difficult to hide. Resolving the conflict in favor of the economy is no solution when individuals, communities, and nature are imperiled to the point that economic growth cannot continue in any case—which is exactly the situation we face. Resolving the conflict entirely in favor of individuals is no solution if this results in a substantial reduction in the integrity of the social bonds the economy knits together: that is, if we are reduced to a random collection of seven billion humans, each scrambling for survival in the absence of functioning currencies and governments. In that case, the result would be universal chaos, confusion, and suffering. Somehow we have to prepare individually for the ending of growth (a process likely to be accompanied by economic and political upheavals) while at the same time preserving and building social cohesion and laying the groundwork for a new economy that can function in a post-growth, post-fossil fuel environment. It's a tall order, but nothing less will do (Heinberg 2011, 267-8).*

In closing, the salient truth about life in the coming decades is that it will become increasingly and intensely local as well as smaller in scale. The speed in which globalization transitions into localization will depend on the steadiness of the distribution of available cheap energy supplies as the global contest for fossil fuels expands and intensifies. According to Kunstler, the scale and complexity of all human enterprises will contract in concert with dwindling energy supplies; the most technologically complex systems will be particularly

susceptible to dysfunction and collapse—including national and state governments (Kunstler 2005, 239). Complex systems that revolve around far-flung resource supply chains and long-range transport will become increasingly vulnerable to fossil fuel shortages. Consequently, food production will emerge as an issue of utmost urgency.

In the not-too-distant future, the US economy will be required by circumstances to downsize, localize, and focus most of its efforts on agricultural development. Kunstler states his case in the following way:

*To put it simply, Americans have been eating oil and natural gas for the past century, at an ever-accelerating pace. Without the massive “inputs” of cheap gasoline and diesel fuel for machines, irrigation, and trucking, or petroleum-based herbicides and pesticides, or fertilizers made out of natural gas, Americans will be compelled to radically reorganize the way food is produced, or starve (Kunstler 2005, 239).*

According to Klare, greater efficiency standards will become especially critical in the early transition period, when public and private spheres are inevitably forced to replace finite natural resources with renewable substitutes, particularly in energy and transportation applications. Increased levels of efficiency also affords the sole option for feeding the growing global population: only by elevating crop yields while lessening inputs of water, oil, fertilizers, pesticides, and other materials can the world optimistically expect to avoid a series of devastating famines (Klare 2012, 228-9).

According to Kunstler, suburbia is best understood as the greatest misallocation of resources in human history. More than half the US population resides in the suburbs. And the economy of recent decades is based largely on its construction and its vast assortment of

services. Kunstler goes on to claim that the entire system will cease to function without liberal and reliable supplies of cheap oil and natural gas (Kunstler 2005, 248).

Currently, the world's dependence on fossil fuels and other finite materials is far too great to expect a sudden reversal in consumption patterns. Nevertheless, as resources continue to dwindle and their prices persistently rise, any substantial delay in establishing entirely new economic and societal structures will prove costly due to the magnitude of the implementation and the fact that it will be a lengthy and volatile process. Even if the transition begins today, developing all the necessary technologies will most certainly be enormously complex and extremely expensive (Klare 2012, 228).

During the early years of the twenty-first century, countries that are able and willing to build next generation nuclear power plants may mitigate the decline of complex global systems in the midst of a post-cheap oil crash. However, it is also true that in addition to the administrative hurdles associated with the logistical challenges of a full-fledged nuclear program, an underlying oil economy would be required to construct and operate a comprehensive system of nuclear reactors (Kunstler 2005, 267-8). As of today, nuclear power plants fundamentally rely on cheap oil and gas for all the procedures of construction, maintenance, and extracting and processing nuclear fuels (Kunstler 2005, 2).

Many leading figures in the American government have been vocal proponents of transformative energy policies that will sustain some form of the US economy and societal functions into the future. Energy Secretary Steven Chu for instance, has characterized China's green-energy program as a modern-day "Sputnik moment" for the United States. According to a recent report by the American Energy Innovation Council (AEIC), an assembly of prominent US

business executives came to the conclusion that “in energy...America has failed the grade, and is paying a heavy price for its failure (Klare 2012, 232).”

In order to rectify America’s energy policy inadequacies, the AEIC and other participants involved in the debate are calling on policymakers in Washington to considerably enlarge its investment in alternative energy systems. The AEIC’s study advocates spending \$16 billion per year on clean energy research, which is more than three times the \$5 billion presently allotted. In November 2010, President Obama’s Council of Advisors on Science and Technology, a blue-ribbon panel of scientists and corporate officials headed by presidential science adviser John P. Holdren, offered a proposal containing aspects that resembled the features advanced in the AEIC’s report. For example, the Holdren panel advised an annual budget of \$16 billion for research on clean energy; it also suggested that the president launch a Quadrennial Energy Review process, parallel to the Pentagon’s Quadrennial Defense Review, to evaluate America’s energy challenges and pinpoint crucial areas that will necessitate special attention in the near-term (Klare 2012, 232-3).

A present-day assessment of the federal government, however, reveals a toxic and dysfunctional political climate that makes the passage of efficacious legislation seem highly unlikely at the moment. Any substantial growth in federal expenditures on renewable energy projects appears to have little chance of garnering congressional approval, especially in the Republican-led House of Representatives, where an anti-spending platform has metastasized into a full-fledged do-nothing agenda. Likewise, one can expect there to be absolutely no movement in Congress with regard to the recommended expansion of the federal bureaucracy that would be tasked with overseeing America’s energy projects. Indeed, venture capitalists and private companies will invest their own funds into new energy initiatives; nonetheless, these investments

alone will most certainly fall short of the minimum target that the President's Council of Advisers identified as essential for continued American leadership in clean energy design. And without sufficient investment, the council projects, America is destined to become a "technology taker" instead of a technology maker, "with the implied economic and leadership consequences (Klare 2012, 233)."

Finally, the end of our perpetual economic growth system does not necessarily mean society has reached the end of qualitative improvements in human life. Heinberg concludes that for future generations to endure and thrive, civilizations have to function within the Earth's budget of sustainably extractable resources. And while we may not know in detail what a desirable post-growth economy will eventually look like, we know enough to begin paving a new way forward (Heinberg 2011, 20-1).

Instead of racing to extract whatever remains of the Earth's vital resources, major political and corporate powers could engage in a *race to adapt*: a contest to become among the first to incorporate new materials, methods, and devices that will enable the world to free itself from finite resource supplies. Because no matter how much corporate or government officials might wish to deny it, sooner or later, all countries will be forced to adjust to a life of extreme resource scarcity—and those that are able to make this transition early on will reap significant advantages. Klare makes the claim that, "The race to adapt will reward the governments, companies, and communities that take the lead in developing efficient, environmentally friendly industrial processes and transportation systems, and it will punish those that persist in clinging to existing habits (Klare 2012, 227)." In the end, mastery of the new technologies will enable public and private interests to survive a future with dwindling resource supplies.

It is absolutely essential that we learn how the human condition in a non-growing economy can actually be fulfilling, interesting, and secure. The absence of a perpetual economic growth system should not be viewed as the end of change or improvement. Within a non-growing or equilibrium economy, societal norms that are widely viewed as desirable can still persist in the form of practical skills, artistic expression, and even technological advancements. According to Heinberg, various historians and social scientists would argue that life in an equilibrium economy can be superior to life in a rapidly expanding economy. And while it is true that perpetual growth creates opportunities for some, it also tends to be a boom-and-bust, zero-sum game with big winners and big losers. Heinberg believes that within a non-growing economy it is possible to maximize beneficial components and diminish factors leading to societal decay, but this approach will necessitate pursuing suitable goals: rather than *more*, we must strive for *better*; instead of promoting the acceleration of economic activity for its own sake, we must place greater focus on that which increases quality of life without emboldening consumption (Heinberg 2011, 21). Consequently, it has been suggested that in order to jump-start this transition we must begin by reinventing and redefining *growth* itself.

The transition to a no-growth economy (or one in which growth is defined in a fundamentally different way) is inescapable, but the conversion process will be much smoother if we start designing and preparing for this changeover rather than simply watching in dismay as institutions we have become dependent upon begin to collapse, and then attempt to improvise a last-minute survival strategy in their absence (Heinberg 2011, 21).

Basically, we must implement a desirable “new normal” that fits the natural limitations imposed by depleting renewable and nonrenewable resources. Perpetuating the “*old normal*” is no longer a viable option; if we fail to establish new goals for ourselves and if we do not

adequately plan the transitional process from a growth-based economy to a healthy equilibrium economy, we will end up with a “new normal” that we will find much less appealing. In fact, we are already beginning to witness this in the forms of persistent high unemployment, a widening gap between rich and poor, and ever more recurring and worsening environmental crises—all of which point to a profound distress that is simultaneously impacting our global systems (Heinberg 2011, 22).

In my opinion, I believe that if given enough time, science and technology can solve almost all of our problems and elevate the human condition to heights that imaginative people everywhere have only been able to dream of thus far. Underneath all of the human suffering taking place throughout the world, there are innovative minds and an assortment of brilliant scientists from every field figuring out new ways to advance modern society and protect our vital systems for future generations.

Today, we are seeing revolutionary developments taking place in medicine, computers, artificial intelligence, nanotechnology, energy production, and astronautics. In the near-term, scientists are hoping to develop advanced clean-energy systems that are not only environmentally sustainable, but viable alternatives to fossil fuels. This could potentially pave the way for innovative solutions to the world’s water, food, and climate quandaries.

In the end, the challenges we all face are very real and should be concerning to everyone that wants to pass a better world along to future generations. In the United States, political dysfunction may be one the greatest threats to societal advancement and citizens should not take these unfortunate developments lightly. In order for scientific and technological advancements to be fully realized, governments and private industries must continue to invest in these promising

projects. Finally, I think that the transitional process will most likely be a turbulent one; however, I believe that we are capable of creating an incredibly advanced, more harmonious society that future generations could look back on and be proud of.

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