The World is in Overshoot, Will We Let it Collapse? Erosion Loops in our Biosphere and the Role of Effective Policy as a Counteractive Measure

Ana P. Diaz*

ABSTRACT

Based on the analysis of the book "Limits to Growth: The 30-Year Update" by Meadows et. al (2004) which suggests our world is heading towards overshoot and collapse, this paper looks at the role of several erosion loops (soil depletion, and social instability) and gathers data that support the overshoot and collapse claim, and the impacts of increasing fossil fuel prices on the economy. Also, based on previous international accords in order to ameliorate the impact of the human population and its consumption to the environment and their success/ failure, the study analyzes the possibility of relying on policy-making as an effective and timely method to counteract the effects of a growing population and a diminishing resource base.

INTRODUCTION

Every day, our biosphere degrades as it bears the toll of growing human population and its sustenance needs. Before, when relative scarcity was the lens through which the economics profession approached the allocation problem, we had found ways to breach the seemingly restricted amount of capital that was at our disposition by becoming more efficient in production. Hence, we incurred in specialization by trading with other nations, and technological developments. Despite the scarcity approach, the Earth has still been bountiful regardless of how "unlimited" we considered our wants to be. Since the advent of the three-field-crop rotating system, the industrial revolution, and the discovery of hydrocarbons, our capitalistic society has been able to spring forward and go from sustaining a population of roughly one billion people in 1800, to somewhat above seven billion. These advances considerably amplified our carrying capacity (otherwise known as the amount of resources available for a population to sustain itself) and a new society developed. We were able to become more materialistically driven than we had in previous agricultural settings, or during our hunter-gatherer times[1], thus creating the ethos of the *homo economicus*.

Climate change, hunger, social unrest, and other phenomena that are taking place in our world right now point to the fact that the Earth has been taken advantage of for its generosity. The Earth gave us a hand and we took her whole arm, and now we are seeing and feeling the consequences on a global

*Department of Economics and Management (BA program), class of 2012, Wells College, Aurora, NY 13026. (correspondence via e-mail adiaz@wells.edu)

scale, through hunger, political conflict, and diseases, to name a few. Nature always prevails at least in the long run, for as a species we are still subject to the same survival tests as other living organisms. Anyone with an elementary background in college-level ecology would know, populations that exceed their carrying capacity sooner or later are brought under control. That we have managed to escape this fate for the longest time due to the increased (and cheap) energy brought about by hydrocarbons does not mean the situation will not catch up to us. It does mean, to our own disadvantage, that the fall that will bring us under our carrying capacity will be far greater than any the human race has ever experienced before. Since the 1970s, when the authors of *Limits to Growth* (Meadows et al, 2004) warned us of the consequences of our actions if business as usual continued, people have been working to change the way we behave towards our planet. However, publicity for this topic withered away, as the claims made by the authors in the 1980s and 1990s seemed ridiculous and contradictory with the recovering economy.

This time, nonetheless, we are experiencing the whiplash of our foolishness and hubris. Like the eye of the hurricane, those years only served to distract us away from the issues at hand and make us believe that it had all been a bad scare by some crazy tree-loving scientists, themselves unknowledgeable about the magic of the market. This trend has slowed down recently. Ecological concerns have gained much terrain in the political realm than that which they had 10 or 20 years ago, when the Kyoto Protocol was signed by countries in a (rather weak) effort to reduce carbon dioxide emissions. Despite the eye-opening data, skeptics of climate change are still among us (!), and most governments are still idle bystanders when it comes to taking action, for fear of letting their populations' expectations of growth and economic success be marred by the quest to save the earth we live in, and preserve the resources we use to ensure our sustenance. Governments around the world, and especially important actors such as the United States and China, have not led the world to a consensus in order to orderly cushion our collapse.

Emphasis should be put on cushioning our collapse and not straying us away from it. Lester Brown reminds us, in his book *World on the Edge*, previous complex societies collapsed after they had severely affected the environment that they lived in. He finds examples in the Mayans, the Romans and the Sumerians, who all suffered from an ecological crisis alongside the other individual factors that lead to their demise. This same phenomenon has started to show in our own society. Whether you chose to acknowledge this view at pessimistic or realistic, if we continue business as usual and don't stand up to the material changes that are happening around us by re-shaping our paradigm about economic activity, contemporary society's return to our original carrying capacity will be considered a major catastrophe.

In their book *Limits to Growth: The 30-Year Update*, Meadows *et. al*, (2004) pose four possible scenarios that show the relationship of the human population with its carrying capacity, the complex resource base the human population uses (described below). After discussing all four models, the authors boil it down to two realistic scenarios for the future of humanity and its resource base: the overshoot and oscillation scenario, and the overshoot and collapse scenario. The World3 Model runs point in the direction of an overshoot scenario, and it is my contention that we might be leaning towards a collapse rather than an oscillating relationship between population and carrying capacity.

In an exponentially growing economy like ours, its expansion creates stresses within the environment in which it is encapsulated. These stresses act out as part of negative feedback loops, trying to bring the economy back into alignment with the constraints of the system. They are signals that the economy is putting too much pressure on its resource base. When ignored, these stresses become the sure precursors of erosion loops. One of the stresses mentioned in Meadows et al (2004) is an increase in the energy investment that it takes to develop a new hectare of farmland. Although I am positive more stresses are taking place on the earth because of our abuses, contributing to more erosion loops, I have decided to center on this particular one, given that as Lester Brown has mentioned, the ability to procure sustenance is has been every civilization's weakest link.

The discussion given to this paper is carried out in the following order. First, I discuss the World3 Model and its relevant components. Following, I describe the impacts of falling soil yields on the financial sector, and the consequences on social stability. Third, I look at the pros and cons of policymaking as a strategy for a cushioned transit to a less energy-intensive economy. The last section is a conclusion.

THE WORLD3 MODEL, A ROLLER COASTER BETWEEN SKYROCKETING GROWTH, NATURAL RESOURCE PEAKS, AND EROSION LOOPS

The World3 model was created by the authors of *Limits to Growth* in an attempt to get to broad predictions about "how the expanding global population and material economy interact with and adapt to the earth's limited carrying capacity over the coming decades" (Meadows et al, 2004, p. 137). It is a mathematical model, and utilizes differential equations to show a simplified interaction between different sets of feedback loops of stocks, such as industrial capital, population, pollution, and cultivated land, to name a few. As all these feedback loops interact together[2], the model focuses on the time that it takes for events to take place, the delays in flows and the slow unfolding of physical processes (Meadows et al 2004, p. 133).[3]

THE FOUR SCENARIOS

To understand the claim that currently our economy is heading towards the overshoot and collapse scenario, I would advise the reader to refer to the summary of the scenarios presented by the authors of *Limits to Growth* (Meadows et al, 2004, p. 158). The authors, after running World3 several times, concluded that we are far beyond our excess capacity at this point, and that stresses are already being felt all over the globe. The scenario I am concerned with, overshoot and collapse, is characterized by population levels significantly exceeding their carrying capacity, to the point where the carrying capacity is permanently damaged. This leads to a permanent diminishing of the resource base available to the population. The unavailability of resources then leads to a quick and sharp decrease in population, eventually leveling off over time to find itself within its carrying capacity. Granted, this is true if the situation of the planet continues as it is, with humanity deploring resources at an increasing rate and no policy actions taken to shift our consumption and waste patterns. On the other hand, the overshoot and

oscillation scenario, as Meadows et al. (2004) state, “can occur only if the environment suffers insignificant damage during periods of overload or can repair itself quickly enough to recover fully during periods of underload”. Insignificant damage due to changes in the exploitation of the carrying capacity is closely tied with timely policy action, and these occurrences are but few, as will be discussed further on.

EROSION LOOPS—THE BLACK SHEEP WITHIN POSITIVE FEEDBACK LOOPS

In order to better elucidate how erosion loops work, a brief explanation of what feedback loops are, coupled with exponential growth is needed. Feedback loops are a method utilized by those who work with systems dynamics. They represent different processes and the stocks within them. Positive feedback loops are self-reinforcing loops that generate exponential growth or exponential decay. Negative feedback loops, on the other hand, are goal-seeking loops that reverse the direction of change or try to pull the system back into equilibrium (Meadows et al 2004, p. 143).

Exponential growth is the driving force behind feedback loops. The difference between exponential growth and linear growth is the amount of growth in a given period. For things that grow linearly, the amount changing every period is constant. On the other hand, things that grow exponentially will have an increasing amount each period that depends on the accumulation of the factor in question. Exponential growth frequently happens in populations. For example, the positive feedback loop for populations is birthrates, while the negative feedback loop is deaths per year (or life expectancy). The more people there are on the planet, the more births there are going to be. However, deaths per year regulate how many people there will be on the planet. Within the World3 Model, feedback loops for industrial capital, agriculture and pollution are considered as well (Meadows et al 2004, p. 144).

There is one clear reason as to why most of the thousands of runs of the World3 model return overshoot and collapse scenarios: the presence of erosion loops in the system. Erosion loops indicate stress on a system, for the positive feedback loops’ reinforcing effects are not being counteracted adequately by negative feedback loops. One of the erosion loops modeled in World3 is the intensive work of the land, which produces more food in the short term at the expense of the soil and its maintenance in the long-term (Meadows et al 2004, p. 165). Thus, the negative feedback loop that would keep population in check, the lack of available food by regular solar flow means, is overpowered by the positive feedback loop of increased food availability through industrial outputs for agricultural inputs, such as fertilizers. That leads to industrial output pollution, which in turn causes stress on the environment, coupled with the unavailability of the soil to recover itself properly for better crop yield. Eventually, as food supplied declines and demand increases, more fertilizer is added to the soil, reinforcing the process of the positive feedback loop.

The most successful element to aid the multiple negative feedback loops that try and bring humanity under its carrying capacity to cushion collapse would be effective policy-making, incentivized by concerned and active citizens (Heinberg, 2005, p. 243). If for each sector that is suffering from stresses that are creating erosion loops, governments worldwide could develop and implement policies to

incentivize the private sector and consumers into protecting our resources, we would stand a chance to regenerate the earth's carrying capacity[4]. This, topic, however, will be dealt with later in the paper.

THE LAND PRODUCTIVITY EROSION LOOP: THE "WEAK LINK"

Liebig's Law stresses that a reaction or the growth of a system is limited by its least abundant factor. The human population, as any other population on this planet, is circumscribed by the amount of food and sustenance that it can procure for itself. As I mentioned above, one of the erosion loops present in World3 has to do with land productivity and investment on soil maintenance. As Malthus would argue in his Theory of Rent, increased population growth rates involve exploiting land more intensively and extensively due to diminishing marginal returns on the land or less productivity of the soil (Hunt, 2002, pp. 95-96). This presupposes that more energy (in the form of fertilizers, pesticides, mechanical harvesting, pumps for irrigation, etc.) would have to be invested in the growing of food to keep feeding the population[5]. We can see this phenomenon happening already. An analysis of data provided by the United Nation's FAO (Food and Agricultural Organization) shows that world consumption of fertilizers increased greatly in the past four decades: From a little over 30 million tons consumed in 1961, to more than 140 million tons in 2002 (FAOSTAT, 2004). Thus, world agricultural yield has increased from over 13 thousand Hg/Ha (Hectograms per Hectare) in 1961 to a little over 35 thousand Hg/Ha in 2009, and the area harvested increased by over 50 million hectares in that same period. That stated, the increase in fertilizer use would indicate, as Malthus pointed out, that as populations increased, lesser quality soil is worked (represented by the additional 50 million hectares harvested). Similarly, world fertilizer use per capita increased from one-hundredth of a ton in 1961 to a little more over two-hundredths of a ton in 2009, and world agricultural yield per hectare per capita in the same period of time decreased from around 0.4E-06 to 0.5E-06 (FAOSTAT 2004, US CENSUS BUREAU 2011). As lesser quality soils are used, we resort to more fertilizers and more land, both of which experience diminishing marginal returns over time.

An important element to take into account here is that we have not yet reached, much less gone beyond, a tipping point where the amount of energy we put into growing things would make no difference in yield, at least for a while. Soil continues to be productive, albeit at a decreasing rate. However, what this does indicate is that *ceteris paribus*, soil productivity is bound to collapse. We will eventually run out of cheap energy to throw into the soil[6], as EROI for oil extraction has been declining in the past several years, and soil productivity levels without its miracle nutrient source will rapidly fall to their natural rate (maybe even less), as will its process of regeneration. Fallback to pre-industrial revolution agricultural levels will occur as we run out of these additives coming from the cheap energy derived from the easily accessible portion of the fossil fuels that are now massively exploited. Absolute soil fertility decreases and decline in agricultural yield will lead to war, famine and disease as the human population continues to grow, dramatic decreases in human population, and thus, the overshoot collapse scenario described my Meadows et al will realize itself.

CHEAP ENERGY AND THE FINANCIAL CONSEQUENCES OF FALLING SOIL YIELDS

Cheap energy (or resources), including oil and water, for example, is what has allowed us to develop into such a plentiful society that has defied the scarcity approach advanced by Smith and others. Not only that, but we have been able over the centuries to substitute high energy return on investment fuels for low EROI fuels (e.g. oil and natural gas for coal, coal for wood, wind, animal and human muscle power, since the 1700s. That process has come to an end since the high energy return on investment (EROI) fuels has been depleted. Since the industrial revolution, we have not dealt with absolute scarcity, or in other words, limited means. Economic welfare has been built around economic growth, which has been provided to such a wonderful degree through the use of fossil fuels. The Earth has been generous and given us plenty, and our human genius has allowed us to enhance this bounty. It is in this way that as a species we were able to reach 7 billion people in the world, as of late 2011. Liebig's Law, once again, implies that mentioned before, the only thing that restricts a population's reproduction rate is its carrying capacity, but we increased our carrying capacity as we took control of fossil fuels.

Population is estimated to increase to around 9 million by 2050 and we are not only to provide sustenance but also economic stability for the coming generations. However, with increasing oil prices derived from higher costs of extraction, and the slowdown of economic processes around the globe as shortages in oil become more persistent, this will not be possible. Increases in oil prices will not only cause a decrease in the annual yields of the soil as it become to buy industrial fertilizers, but it will also affect every single aspect of the economy, and thus, the financial system. As Richard Heinberg explains, "Our current financial system was designed during a period of consistent growth in available energy, with its designers operating under the assumption that continued economic growth was both inevitable and desirable," (2005, p. 188) and so the spike in costs of what has been the engine of this unlimited growth will indubitably bring about financial turmoil. Given the above, if what lies ahead of us is a decrease in economic activity as oil becomes scarcer and more expensive; there is very little chance, if any, that the financial system will survive an energy decline in the economy, despite whether it is gradual or rapid. Add to this equation the human element of social instability wrought by precarious economic conditions, and the subsequent unwillingness of investors to put their money where these investments could prove unsuccessful or their profits taken away from them by recently-turned nationalist governments, the panorama for economic stability is grim, especially for poorer nations.

SOCIAL INSTABILITY: THE EROSION LOOP NOT MODELED

The question of cheap energy as a means to sustaining great populations, like the ones we have in societies all over the world today brings us to another erosion loop that was not modeled in World3: social instability (Meadows et al, 2004, p. 166). To go back to the land productivity erosion loop mentioned before, we can connect the fact that people who are not well fed, and see their resource based depleted, resort to violent means to assure a share of the shrinking pie.

Proof of the interconnectedness between erosion loops lies in the recent revolutions taking place in the Middle East, where their people ousted several governments who had been in power for decades. Food prices for cereals and grains had been rising for the past couple years, and for the populations that find themselves highly dependent upon these sources for food, their subsistence was clearly jeopardized. A closer look at the producer price per ton of cereals in these countries provides us with concrete evidence for the revolts, even though we only have figures until 2008 and the revolution took place in early 2011[7]. In Tunisia, in only one year (2007-2008), the price to produce one ton of wheat rose by 31%, and the price to produce one ton of barley or triticale rose by 55.8% (FAOSTAT, 2011). Its 23 year-old government met its end January 14, 2011 under protests of corruption and unemployment by the people[8]. Unemployment (labor wise) presupposes that there are less or no means in the household to support it and its most basic need: food. Coupled with rising prices, and thus decreasing purchasing power, revolution was bound to take place sooner than later. Food production prices in Egypt suffered similar spikes: a ton of Barley produced in 2008 cost 74.2% more than in 2007, and the production of a ton of wheat cost 130% more (FAOSTAT, 2011). The fact that the Egyptian government suffered the same fate as the Tunisian only a month later comes as no surprise. Relating the earlier example of increased use of fertilizer and its rising cost due to higher oil prices with the soaring food prices in the Middle East (and the rest of the world), we see then how the biophysical erosion loop affects the social one.

This of course, is not to mention the challenge resource-plentiful but poorer countries will face from richer and more militarily capable countries such as the U.S. and China. China, with its burgeoning economy is already leasing land in countries in Africa to ensure both the yields of the land and mining of minerals. The U.S. has had a resource-dominance policy for years now, both indirectly (through corporate profits) and directly, by ensuring resources through military control and bases all over the world. When food scarcity becomes an even more acute problem, it is these poor nations' peoples which will take the hardest toll. Other, more capable nations will take a hold of their resources one way or another, unless a policy of global food security is undertaken by all parties in an effort to cushion the transition into a less energy intensive economy (Heinberg, 2005, p. 251).

CREATING A PATH TOWARDS THE SOLUTION: PRIVATE ENTERPRISE VS. POLICY-MAKING?

Usually, it is believed effective policy-making and implementation is really the only tool we possess to make change in our communities, countries and the world. While this is not entirely true, it does play a major role in assuring that there is a systematic and leveled approach to combat societal collapse, ensuring that we oscillates back into equilibrium without severely diminishing our carrying capacity. In order to bring about change in our laws in order to reduce our energy consumption, we are going to need more people involved in grassroots organizations that reach out to their politicians and demand that the situation is addressed as soon as possible. If politicians in the international community are coaxed by their active constituents to, instead of offering optimistic but unrealistic goals for the economy, reach an

agreement on how to manage the resource shortage we will face, we will have as a species, a better (and less violent) chance of adapting to the new situation.

In our efforts at global accords, there is both good news and bad news. The good news, is that as a global community, we have been able to reach agreements when the threat to the human population has been imminent. A perfect example is provided by Meadows et al (2004) where they describe the process by which CFCs, chemical compounds which were destroying the Earth's ozone layer, were banned. However, It took the international community several years before the problem of the depleting ozone layer was uncovered in 1974 to when they reached an agreement in 1987 in Montreal and countries started implementing policies. This one of a kind event saved the future of the ozone layer, for the Montreal agreement and its successors impeded CFC concentrations to more than 40 ppb in 2075 (Meadows et al, 2004, p. 195). Concentrations are now more stable and are predicted to stay that way for the coming century.

Unfortunately, the bad news is that this is not always the case, and policy delays are the biggest stumbling rock we face as we try to prevent overshoot and collapse. The latest climate change conferences, where tackling carbon dioxide emissions was the key point in efforts to fight global warming, have advanced very slowly. Since the signing of the Kyoto Protocol in 1992, little progress has been made, .was exempt from limitations and the U.S. never ratified the treaty, these two nations are the world's largest emitters of heat-trapping gases. The last meeting of the UN, which took place in Bangkok only has brought good intentions, but no real agreements[9]. The big difference, it seems, is that CFCs have a more benign substitute, HFCs (the bonding of hydrogen seems to have a smaller impact on ozone depletion) while as of this time there is no viable substitute for fossil fuels. Despite many years of greenwashing most diplomats know this, but refuse to acknowledge the severity of the situation for political reasons. No one wants to be the bringer of bad news, or tell people that the economy is going to shrink and that standards of living are going to have to radically change in order for us to not fall into complete chaos. Similarly, interests from corporations and the financial sector which thrive on relentless growth, and which would in turn be severely downsized (if not liquidated), clash with that of the citizenry and are pressed upon politicians that have strong ties to them due to financial contributions to their campaigns or because they are a part of their "constituency". Overall, painting an optimistic and unrealistic vision of the future and telling people to hope for it is far easier for those in power than to roll their sleeves up and actually start fomenting change before the inevitable future rolls around the corner.

CONCLUSION

The data presented currently support the overshoot and collapse scenario. Evidence is present all over the planet, as erosion loops just as the ones we described exacerbate each other as time goes by and no real change is being made. We are experiencing diminishing crop yields per hectare, producing more social unrest. Unfortunately, at this point policy-makers are in a catch-22, as they see the signs of overshoot affecting their countries, but are unable to switch away from cheap energy sources that keep

their populations happy and fed in the short term. The entrenched paradigm of the *homo economicus,* and what we have known to be telling characteristics of a successful economy (growth and material acquisition) will be difficult to strip away from a societies that have many advantages thanks to the technology fossil fuels have provided us. More so, it will be difficult to tell developing countries that they are to stop that process of developing for growth, and that the goal of more material accumulation and a better standard of living enjoyed by the First world is not feasible for them as well if we wish to be alive in the next couple hundred years. This fact would create intense discontent among these countries, leading in the worst cases to intense international political turmoil and war over the remaining resources. Thus, our efforts since 1949 of creating a global community would most likely be either severely altered or completely destroyed.

The above prospect looks grim, no doubt, and one can somewhat sympathize with these world leaders and their fear of what taking action would ensue in the international community. Nonetheless, paying attention and acting on the ecological needs of our planet despite of the political, social and economic turmoil that those actions might bring is necessary. There is no easy way to go back within our carrying capacity, and most likely we will not find more cheap energy to sustain or overconsumption lifestyle. We need effective action to be taken by the international community, just as they did to tackle the problem of the ozone layer hole in the 1980's. Changes *can* be made, industries *can* shift to other practices and economies actually do survive, albeit in a different fashion. The faster we take action and compromise with ourselves and our neighbors to understand what a less intensive economy entails and how to live within it; the inevitable transition away from fossil fuels will be more bearable and less violent.

ENDNOTES

1. A discussion of how needs were met by hunter-gather societies, and their complete disregard fo material possessions due to the hindrance they posed on mobility can be found in a great book by Marshall Sahlins (1972) *Stone Age Economics*.
2. A diagram of how the stocks and their feedback loops interact together can be found in pages 144-145 (Meadows et al 2004).
3. If the reader were interested in understanding the model's intricacies, I would highly recommend they read chapter 4 of *Limits to Growth*.
4. Meadows et al (2004) refer to the case of CFCs and how the international community was able to protect the ozone layer from suffering more degradation, after the hole in Australia was discovered and the effects of it were laid out to be extremely harmful for life on Earth as we know it.
5. Malthus wrote at a time were fertilizers were not in use, so he did not know how fertilizers could enhance natural soil productivity and curb diminishing marginal returns for a while. This fact, however, is inconsequential as nature also catches up with fertilizers, and there are also diminishing marginal returns to the use of fertilizers in the soil.

6. Fertilizer nutrients are in their majority derived from oil, whose price has fluctuated with the years, mostly due to politics, such as the OPEC's oil embargo in the 1970's. However, as the era of peak oil approaches, oil's price will progressively increase due to greater extraction and refining costs. Not only is oil a non-renewable resource, but the best quality oil is used up first, which leaves us diminishing marginal returns and the certainty that at some point it will not be profitable to employ it to enhance agricultural product.
7. There is indication that prices did not drop substantially from 2008-2011, given that rising global food prices are still of much concern for the UN (see "World Food Situation" at www.fao.org.) Moreover, the fact that revolution actually took place a year and a half later should be indication enough that change for the better did not happen.
8. Elaine Ganley and Bouazza Ben Bouazza. "Tunisians drive leader from power in mass uprising". 14 January 2011. The Boston Globe. http://timelines.boston.com/2011/1/14/tunisian-government-ousted (last accessed April 13, 2011)
9. United Nations Framework Convention on Climate Change. *UN Climate Change Chief urges countries to push ahead with their work in 2011 as countries agree agenda for 2011.* Bangkok, April 8, 2011. http://unfccc.int/files/press/press_releases_advisories/application/pdf/pr20110408 bkk_close.pdf (last accessed April 15th, 2011)

REFERENCES

Brown, Lester R. 2011. "World on the Edge: How to Prevent Environmental and Economic Collapse." Earth Policy Institute.

FAOSTAT. faostat.fao.org. (Last Accessed April 13, 2011)

Ganley, Elaine and Ben Bouazza. "Tunisians drive leader from power in mass uprising." 14 January 2011. The Boston Globe http://timelines.boston.com/2011/1/14/tunisian-government-ousted

Heinberg, Richard. "The Party's Over: Oil, War and the Fate of Industrial Societies." New Society Publishers, 2005.

Hunt, E.K. 2002. "History of Economic Thought: A Critical Perspective." 2nd Edition. Arnonk, New York: M.E. Sharpe

Meadows, Donella, Randers Jorgen and Dennis Meadows. 2004. "Limits to Growth: The 30-Year Update." White River Junction, VT: Chelsea Green Publishing Co.

United Nations Framework Convention on Climate Change. 2012 "UN Climate Change Chief urges countries to push ahead with their work in 2011 as countries agree agenda for 2011." Bangkok, April 8, 2011 http://unfccc.int/

U.S. Census Bureau International Database www.census.gov (last accessed January 20, 2012)