Circular Retribution
The Effects of Climate Change on U.S. and Global Economy

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Until just recently, the pretext to all problems was "global warming." ("Why is it raining?" "It's because of global warming.") Then the economy plummeted: a massive national debt, a huge trade deficit, weak job growth, and suddenly the focal point of all problems is "the economy." One (idiom) is exchanged for another yet the two are closely linked. Consider the effect that global warming has on the economy. We are accustomed to thinking of the environment as an infinite well of resources that exists for the benefit of our economic growth and so we take from it at will. Yet the climatic changes that ensue create natural disasters and debilitate the economy: the damages incurred reduce the initial growth created from environmental resources. The two are essentially linked in a mutually induced cycle that fluctuates between economic growth and decline. It is not surprising that both issues, the economy and the effects of global warming, have risen to the fore of global political concern and action. The increase in natural disasters, namely hurricanes as devastating as Katrina and the decimation of the agricultural industry, clearly demonstrates the powerful effects that climate change has on the global economy. However, we can change this development by switching to solar and hydrogen systems as primary sources of energy. We can effectively reduce the variable of economic damage induced by climate change and thereby build a foundation not only for a healthier planet, but also for a better and more stable economy.

The global greenhouse effect is the primary contributor to the increase in the Earth's mean surface temperature, and thus the main contributor to climate change. Greenhouse gases such as carbon dioxide, methane and chlorofluorocarbons collect in the atmosphere and act much like an insulating blanket, trapping heat and preventing the radiation of light back into space. The burning of fossil fuels, such as coal and oil, and deforestation all contribute to the increase in these green house gases. There is no doubt that quantifying climate change based solely on the increase in these gases is difficult. Much controversy surrounds the various estimates that have been made with respect to the specific increase in CO_2 levels over time. However, recent studies conducted by the Intergovernmental Panel on Climate Change (IPPC) decrease the uncertainty of predicting the result of future emission scenarios. The IPPC asserts that the doubling of CO_2 emissions will increase the global mean surface temperature by 3°C yearly.[1] The IPCC determined that mean surface temperatures have increased by 0.74°C ± 0.18°C over the last one hundred years and that the last decade experienced the warmest temperatures on record. The planet is getting warmer and with increasing evidence, humans are substantially to blame for it.[2]

A catholic and detrimental shift in the climate is the product of increasing global temperatures. This shift is manifested in the increased intensity of tropical cyclone activity, which leads to devastating hurricanes, and increased occurrence and duration of extreme draughts, which greatly reduces agricultural output and global food supply.

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The agricultural industry, more so than any other major industry, is severely impacted by climate change. The yearly output and food supply is a direct product of fluctuations in temperature and precipitation. Climate change is a permanent trend, one that can be seen only by analyzing the change in soil temperature and its effect on crop output over many years. Such a study reveals that temperatures, especially for inland areas, will increase dramatically. Such an increase will place a higher demand for water to irrigate the land, a need that will prove costly as higher temperature will slowly deplete the soil water. The scarcity of water will be profound and the need extreme.

The general trend for precipitation variability is related to the increase in mean temperature. In fact, there exists a direct relationship between the two: According to a recent study by U.C. Berkeley, the global mean precipitation has increased at a rate of 6.7 ± 3.5% per °C between 1987 and 2006.[3] However more startling and consequential is the degree of variability of rainfall, which recent studies suggest has increased dramatically.[3] Periods of extreme drought follow periods of extreme rain. Instead of revitalizing the earth after long periods of dry weather, the massive inundation that follows only leads to runoff, landslides and the further destruction of already vulnerable crops. Drought is the most severe problem, as it diminishes plant vigor, and alters the soil's carbon to nitrogen ratio, which relates to its growth and mineral distribution. More importantly, however, warm weather and lack of precipitation couples the promotion of insect populations with the lowering of plant resistance. Thus, plants are often killed by nematodes, insects and fungal pathogens.[4] How do farmers accommodate these conditions? They spray their crops with insecticides, which are often damaging to the soil and rob it of its valuable minerals, and they build expensive irrigation systems and levees which are supposed to provide water in times of drought and prevent flooding in times of rain. The increase in these extreme weather conditions, which are precipitated by a general increase in temperature and ensuing change in climate patterns, are making agriculture a very vulnerable industry.

The agricultural industry comprises approximately 1.2% of the U.S. GDP.[5] A decline in the productivity of this sector of the economy due to weather conditions may not appear alarming, as it certainly will not directly and individually plunge the economy into recession. However, the agricultural industry has vast implications not only on the country's trade deficit but also, on a more global scale, on the world's food supply. Although agricultural products comprise only a minute part of the country's GDP, the United States, along with China and India, creates the greatest agricultural output in the world, in excess of $100 billion.[6] Thus, the

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United States plays an important role in the control of the global food supply, as its export of agricultural products increased steadily in the last two decades. Between 1990 and 2008, the export of bulk products including wheat, rice, beans, feed grains, cotton and linters, and tobacco rose from $21.03 billion to $50.57 billion: a $30 billion increase.[7] While the USD exports have more than doubled, the output, paradoxically has slowed. In the last decade, the growth rate has slowed from 2.24% annual increase in the nineties to a meager 0.39%.[8] This deceleration in growth in the last decade coincides with the record setting temperature increases of the same years. As mentioned earlier, the last ten years experienced the hottest mean temperatures on record and not surprisingly, have precipitated unprecedented periods of drought. This has decreased the global food supply. Warmer temperatures and water shortages will force farmers to fallow their lands leading to a decrease of up to 36% of available farmland and a loss of $6 billion of output in the western part of the United States alone. The agricultural sector will experience losses and the U.S. and global economy will suffer for it.[9]


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However, the agricultural sector is not the only factor that has impacted the economy as a result of climactic changes. The frequency of extreme events, especially intense tropical cyclone activity, has increased dramatically since the 1970's.[10] Further, the strength of these destructive tropical storms has increased as more hurricanes reach categories 4 and 5. This trend culminated in the record breaking 2005 season, where tropical storm, especially in the Southwest Pacific Ocean but also in the North Atlantic reached devastating strength and created great destruction and havoc.

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A tropical storm builds from heat released from water vapor condensation at high altitudes. As air rises and condenses, it creates a low pressure system and strong winds arise. With stronger winds, more surface water evaporation occurs, the air rises, condenses and the storm increases in strength. Water temperature has to reach at least 26.5°C in order for evaporation to be high enough to create this low pressure system. Ocean temperatures just like mean surface temperatures show a steady increase over the last century. Between 1951 and 1993, the temperature of the California Current increased by 1.2-1.6°C.[12] This increase may seem insignificant but it is the crucial difference that allows the formation of a storm. Further, the higher ocean temperature allows the storms, once it forms, to increase in strength more

rapidly, as water evaporates more readily, and the latent heat of the atmosphere increases. More heat creates more condensation, more pressure and stronger winds: in short all the requirements for destruction.

Tropical storms and floods associated with them comprise 62% of global damage incurred by extreme events.[13] When these storms hit land, they cause massive destruction to infrastructure and industries in the affected area, not to mention the death and displacement of sometimes millions of people. An entire labor market can be wiped out. Hurricane Katrina, which hit New Orleans on August 29, 2005, is a useful case to consider in studying the vast economic ramifications that a tropical storm can have. According to a study published by Marshall University, which analyzed the damage to the counties affected by the storm, the total damage cost was $156 billion.[14] This statistic, however, only takes into consideration the direct damage to infrastructure, commercial structures, commercial equipment, residential structures, commercial revenues, electric utility, highway, and sewer systems. Relief efforts for displaced residents further compound the total cost. Important oil fields were destroyed, and the United States experienced a dramatic increase in the cost of oil immediately after the storm.

It remains unclear how much Katrina will cost the United States when rebuilding of the area is finally complete, but a general trend already shows an increasing price tag for extreme events such as Katrina. Every year, the government increases its budget spending on the relief and reconstruction of areas affected by massive flooding. In the 1950's the government spent a mere inflation-adjusted $340 million in disaster relief, compared to $25 billion in the 1990's.[15] The economic impact is staggering.

Given the alarming trends that are forming, why is it that we continue to abuse our environment? It seems that we are playing a circular game of retribution with the environment. We use oil as our primary source of fuel to run our cars and factories: it runs our economic machine. Unfortunately that same fuel releases harmful greenhouse gases into the atmosphere leading to global warming. With an increase in mean surface and ocean temperatures, we create tropical storms and droughts which damage those same industries that we used the oil to supply. The economic growth is thereby reduced. In effect, the environment punishes us for punishing it: an eye for an eye.

Yet, we know that we are stuck in this cycle and that our economic growth depends on the sustainability of the environment. Ironically, the Gulf oil states have taken an initiative in seeking clean energy alternatives. Despite sitting on a monopoly of global oil supply, Saudi Arabia, Qatar, and the United Arab Emirates recognize that oil is a finite resource. They plan for the future by distributing billion dollar research funds to universities around the world. Recently, Saudi Arabia's state owned University of Science and Technology gave a $25 million grant to Stanford University to further the research in solar power. The goal is to make solar power competitive with coal.[16] The sun is the most obvious source of clean energy and advancement in the use of photovoltaic cells and solar thermal systems have been made to harness that energy.

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An initial concern that the energy spent in the implementation of new energy systems would exceed the benefit of them was refuted by a study that analyzed the benefit from switching to photovoltaic cells systems and wind energy. The energy payback for PV cells is believed to be 3-4 years. Wind energy systems are even more efficient, believed to pay back the initial energy input within 3-4 months.[17] As production of these systems becomes more energy and cost efficient the output and benefit will increase as well. The government has shown its intent and commitment to funding this green revolution by proposing a $780 million green stimulus package.[18]

Climate change and the economy are closely inter-

related and we are finally gathering belief in the idea that by creating a healthier planet, we can simultaneously build the foundation for a more efficient and sustainable economy.

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