Aspects of Climate Change Induced by Human Activities: Impact on Global Natural Disaster Mortality

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Abstract

Some scientists believe that global warming and the consequent climate change are inevitable results of slight deviations of the earth's movement around its axis; a greater majority of scientists stipulate that a greater bulk of the reason for global warming and climate change is accounted for by human activities that destroy the natural environment. The present study looks into the chain of events that lead to natural disasters with specific focus on quantifying the human contribution to these catastrophes. The centroid regression approach identifies the categories of countries that contribute most to the world's CO2 emissions and determines the relationship among natural resource depletion (% forest area) and CO2 emission and forest land area. The fitted curve states that the CO2 emissions increases as the square of the fossil fuel usage by the countries so that those nations, particularly those belonging to the high and very high HDI which are highly developed, contribute tremendously to the level of CO2 emissions across the globe. The impact of human exploitative activities on the accelerated CO2 accumulation in the atmosphere led to natural disasters spawned by rising global temperatures increasing natural disaster mortality.

Keywords: fossil fuel, renewable energy, CO2 emission, forest area, climate change, global warming, natural disaster mortality

1.0 Introduction

Scientists believe that global warming threatens the planet in a new and unexpected way as evidenced by triggering earthquakes, tsunamis, avalanches and volcanic eruptions. Reports by international groups of researchers showed that climate change, caused by rising outputs of carbon dioxide from vehicles, factories and power stations, will not only affect the atmosphere and the sea but will alter the geology of the Earth (McGuire, 2009). Recent events in the Philippines have likewise lend credence to these forecasts with the world's strongest super typhoon hitting Central Visayas in the same location still reeling from the havoc created by a magnitude 7.2 earthquake in less than a month's time. While some scientists believe that global warming and the consequent climate change are inevitable results of slight deviations of the earth's movement around its axis, a greater majority of scientists stipulate that a greater bulk of the reason for global warming and climate change is accounted for by human activities that destroy the natural environment. The present study looks into the chain of events that lead to natural disasters with specific focus on quantifying the human contribution to these catastrophes.

Van Aalst (2006) opined that human emissions

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of greenhouse gases are already changing the climate. Several trends in weather extremes are sufficiently clear to inform risk- reduction efforts. In many instances, however, the potential increases in extreme events due to climate change come on top of alarming rises in vulnerability. Hence, the additional risks due to climate change should not be analyzed or treated in isolation, but instead integrated into broader efforts to reduce the risk of natural disasters. The emission of green house gases result to rising global temperature (hence, global warming) which in turn precipitate weather extremes. Of all the greenhouse gases, carbon dioxide accounts for the greatest bulk in the earth's atmosphere. Carbon dioxide emissions come from industrial operations, motorized vehicles, factories, and other human activities necessary to support the needs of an ever-growing population. Developed and industrialized nations are the greatest producers of greenhouse gases. In an effort to strike a balance between development and environmental conservation, developed , developing and underdeveloped nations agreed to jointly address the issue of carbon emissions through diplomatic instruments e.g. Kyoto Protocol, Washington Protocol and Rio de Janeiro Protocol, where underdeveloped and developing nations serve as carbon sinks through a "carbon trading" mechanism. These protocols have raised several climate change and environmental ethics issues: how does one account for loss of human lives vis-a-viz continued carbon emission?

Ethical debates emanating from international efforts to curb continued carbon emission will continue with no foreseeable conclusion unless quantitative evidences are presented. This research is an attempt in this direction.

2.0 Conceptual Framework

The major consequences of global warming are the drastic ecological and social changes caused by the rise in global temperatures. There is a scientific consensus that climate change is occurring, and that human activities are the primary driver (Joint Statement of 18 Scientific Organizations (2007)). Evidence of climate change includes the instrumental temperature record, rising sea levels, and decreased snow cover in the Northern Hemisphere (IPCC, 2007). According to the Intergovernmental Panel on Climate Change (IPCC), most of the observed increase in global average temperatures since the mid-20th century is very likely due to the observed increase in human greenhouse gas concentrations.

Projections of future climate change suggest further global warming, sea-level rising, and increase in the frequency and severity of some extreme weather events. Parties to the United Nations Framework Convention on Climate Change (UNFCCC) have agreed to "stabilize greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system."(UNFCC, 2009).

Observations reveal that there have been changes in weather. As climate changes, the probabilities of certain types of weather events are also affected. For instance, changes have been observed in the amount, intensity, frequency, and type of precipitation. Widespread increases in heavy precipitation have occurred, even in places where total rain amounts have decreased. With medium confidence, IPCC (2012) concluded that human influences had contributed to an increase in heavy precipitation events at the global scale. Projections of future changes in precipitation show overall increases in the global average, but with substantial shifts in where and how precipitation in rainfall in the subtropics, and an increase in precipitation in sub-polar latitudes and some equatorial regions. In

other words, regions which are dry on the onset will in general become even drier, while regions that are currently wet will in general become even wetter. This projection is not applicable to every locale, and in some cases can be modified by local conditions.

Since the 1950s, it is very likely that the number of cold days and nights have decreased globally. There have been other changes in climate extremes, e.g., floods and tropical cyclones, but these variations are more difficult to identify. As previously stated, human influences emerge to have contributed to some of the observed changes.

Expected climate change will be very likely associated with more very hot days and fewer very cold days. The frequency, length and intensity of heat waves will very likely to increase over most land regions. It is likely that the typical maximum wind speed of tropical cyclones will increase, though there may also be fewer cyclones. More regions may experience more extreme droughts, including southern Europe and the Mediterranean region, central Europe, central North America, Central America and Mexico, Northwest Brazil, and Southern Africa. Heavier rainfall might contribute to increase in local flooding in some catchments or regions. In coastal regions, it will very likely contribute to extremes in the rising of sea levels.

The impacts of tremendous events on the environment and human society will diverge. Some impacts will be favorable e.g., fewer cold extremes will probably lead to fewer cold deaths. Overall, however, impacts will probably be mostly harmful.

On the other hand, the function of the oceans in global warming is a complex one. The oceans serve as a sink for carbon dioxide, taking up a considerable quantity that would otherwise remain in the atmosphere, but increased levels of CO2 have led to ocean acidification. Furthermore, as the temperature of the oceans increases, they become less able to absorb excess CO2. The ocean has also acted as a sink in absorbing extra heat from the atmosphere. Consequently, the increase in ocean heat content is much larger than any other accumulated energy in the Earth's heat balance over the two periods 1961 to 2003 and 1993 to 2003, and accounts for more than 90% of the potential increase in heat content of the Earth system during these periods.

Global warming is predicted to have a number of effects on the oceans. Continuing dismal effects can include rising sea levels due to thermal expansion and melting of glaciers and ice sheets, and warming of the ocean surface, leading to augmented temperature stratification. Other possible effects include large-scale disturbances in the ocean circulation.

3.0 Methodology

We made use of data obtained from the data base of the IPCC (2009) readily available from the internet. The variables considered pertained to: the primary energy supply (fossil or renewable), total CO2 emission, natural resource depletion, impacts (deaths due to natural disaster) across countries with : very high Human Development Index (HDI), high HDI, medium HDI and low HDI.

The relationship between the primary energy supply used by different countries and their corresponding CO2 emissions was obtained. Fitting a regression curve on these two variables for a given category (say high HDI countries) usually hides the overall global relationship between the two variables. Given this, we estimated the mean energy usage (fossil or renewable) and the mean CO2 emissions per category. This method will smooth out the ruggedness that tends to obscure the relationship. The regression curve is fitted that passes through the four (4) centroids.

The centroid regression approach identifies the categories of countries that contribute most to

the world's CO2 emissions. It may be recalled that CO2 is a primary greenhouse gas that causes rise in global temperature. Global warming, in turn, precipitates extreme weather conditions such as cyclones, hurricanes and typhoons.

The same centroid regression approach was then performed for determining the relationship between natural resource depletion (% forest area) and CO2 emission.

Finally, we estimated the impact of unfettered CO2 emission to the damage brought about by natural disasters to the nations in various categories.

4.0 Results and Discussions

Table 1 displays the basic statistics obtained for three variables: use of fossil fuel, use of renewable energy sources and CO2 emissions in megatons

Figure 1 shows the scatteplot of the centroid of fossil fuel against the centroids of the CO2 emissions across the different HDI categories. The scatterplot suggests a quadratic curve sloping

HDI Category	Fossil Fuel (% of total)	Renewable Energy (% of total)	CO2 emission (mT)
Very High	78.31 (sd:18.90)	13.14 (sd:15.82)	150.20 (sd: 189.8)
High	83.60 (sd:16.23)	13.80 (sd:15.68)	111.00 (sd:147.0)
Medium	69.15 (sd: 24.98)	32.35 (sd:33.22)	72.80 (sd:117.80)
Low	30.14 (sd: 23.51)	69.48 (sd: 23.83)	19.52 (sd: 61.90)

Table 1: Basic Statistics for Primary Energy Supply and CO2 Emission by Category

Tabular values show that the standard deviations for the CO2 emissions are generally larger than their means which indicate a very wide spread in terms of the distribution of CO2 emissions by the nations per category. That is, various countries found in each category of nations have widely differing CO2 emissions relative to the average. In fact, this is an indication that the CO2 emissions can be properly modeled by a fractal distribution (see Padua et al. (2012)).

Tabular values likewise indicate that countries belonging to the high and very high Human Development Indices have generally higher CO2 emissions. In fact, they produce more than double the CO2 emissions of medium HDI countries. This fact is a reflection of the reality that countries belonging to the high HDI category are highly industrialized and have more cars per capita than the other countries in the lower HDI category.

In contrast, countries belonging to the lower HDI category tend to utilize renewable energy sources. In fact, these countries registered five times bigger utilization of renewable (green) energy sources than those countries that are more economically developed and belonging to the high to very high HDI category.

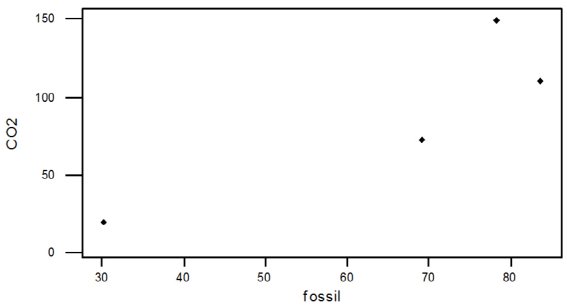

Figure 1: Scatterplot of the centroids of fossil fuel and CO2 emissions

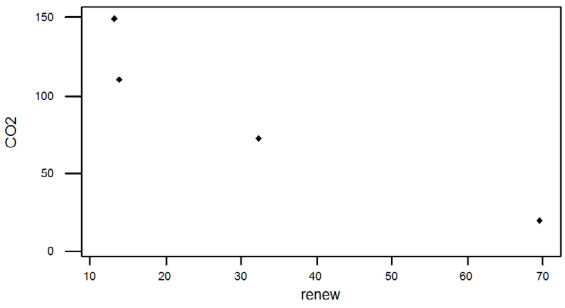

Figure 2: Scatterplot of renewable energy source against CO2 emission

upwards. The best quadratic function that fits the observations is given below:

The regression equation is
CO2 = 1.6 + 0.0185 fossil squared

Predictor	Coef	SECoef	T	P
Constant	1.56	35.02	0.04	0.969
fossils	0.018462	0.006673	2.77	0.110

S = 31.07 R-Sq = 79.3% R-Sq(adj) = 68.9%

The fitted curve states that the CO2 emissions increases as the square of the fossil fuel usage by the countries so that those nations, particularly those belonging to the high and very high HDI which are highly developed, contribute tremendously to the level of CO2 emissions across the globe. The marginal rate of contribution of fossil fuel utilization to the CO2 emission can be computed from the derivative:

d(CO2)/d(fossil) = 0.037*fossil fuel

which means that for each unit increase in the fossil fuel utilization, approximately 3.7% of a megaton of CO2 is added to the global emission (or 37,000 kilos of CO2 are added).

The scatterplot in Figure 2 illustrates downward sloping straight line relationship between the use of renewable energy sources of the nations and their CO2 emission. The linear regression curve is given below:

The regression equation is CO2 = 152 - 1.99 renew

Predictor	Coef	SE Coef	T	P
Constant	152.47	19.58	7.79	0.016
renew	-1.9907	0.4959	-4.01	0.057

S = 22.68 R-Sq = 89.0% R-Sq(adj) = 83.4%

The use of renewable energy (green energy) appears to drastically reduce CO2 emission by the countries. In fact, for each unit of green energy utilization, CO2 emission is reduced by 1.99 megaton. Browsing through the green energy utilization of the countries, we find that medium HDI countries and low HDI countries contribute the most to the minimization of carbon emissions across the globe.

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HDI Category	Forest Area (% of land area)	Total CO2 emission (mT)	Number of deaths due to natural disasters (annual average per million people)
Very High	35.05 (sd: 19.37)	150.20 (sd: 189.8)	7.69 (sd: 11.09)
High	33.16 (sd: 20.52)	111.00 (sd:147.0)	2.95 (sd: 8.49)
Medium	32.53 (sd: 26.79)	72.80 (sd: 117.80)	2.93 (sd: 3.69)

Table 2: Basic Statistics for Forest Area and Total CO2 Emission by HDI Category

Entries in Table 2 indicate that the forest cover of nations in high to very high HDI categories is generally higher than the forest areas of the countries in the lower categories. All over the world, however, less than half of the forest areas remain intact. The forces of modernization and urbanization encroach into the remaining primary forest covers in several nations; the rate of encroachment is obviously faster in the developing and underdeveloped nations as evidenced by smaller percentages of forest areas in the medium and low HDI categories. In contrast, mere developed nations have sophisticated urbanization plans that include a clear resolve to preserve their remaining forested areas.

Countries like the Philippines, with developing economies exploit their forests for logs, timbers and other forest products despite laws and statutes that prohibit logging. In Southern Philippines for instance, vast tracts of forest areas give way to more profitable mining operations. These human exploitative activities are more clearly demonstrated in nations whose economies depend on agriculture, mining, and wood production.

Collectively, all these human exploitative activities result to a surplus of CO2 because the carbon requirement of plants in both terrestrial and marine environments is exceeded by the rates of carbon emission and forest degradation. Consequently, the accumulation of CO2 in the atmosphere induces the inevitable "green- house effect" leading to global warming.

Equation (2) shows the relationship between CO2 emission and percentage of forest covers using the centroid regression:

$$CO2 = - 542 + 19.5 \text{ forest cover} \qquad (2)$$

The regression fit is counter-intuitive in the sense that as the percentage of forest covers increases, the rate of CO2 emissions correspondingly increases. The equation is "actually" describing the phenomenon that as national development intensifies (hence, greater CO2 emissions), rational plans for forest conservation and reforestation are similarly put in place. More forested areas do not induce significantly greater CO2 emissions.

IMPACTS

The phenomenon of global warming, as evidenced by several scientific studies, is real and appears to be irreversible. Rise in global temperature foretells of natural disasters e.g cyclones, hurricanes, typhoons, floods, volcanic

eruptions, earthquakes and tsunamis, which nations all over the world are experiencing. Table 2 illustrates the dire consequences of man's unfettered CO2 emission. Countries belonging to higher and very high HDI registered a total of over 11 deaths per million people (i.e around 110,000 deaths per year) compared to 13 deaths per million (i.e around 130,000 deaths per year).

Over a ten-year period, since the phenomenon of natural disasters have become more frequent, the low and the medium HDI countries suffered a loss of no less than 1.3 million lives. This staggering revelation illustrates that climate change-induced disasters cost the lives of men and women for exceeding any of the known plagues on earth; exceeding even the infamous Bubonic plague in the 1800's. What is ever more dismal is the prospect of continuing such scourge well into the first half of the 21st century.

Ethical Issues

Climate and environment ethics issues have surfed of late. More than 80 % of the CO2 emissions emanate from highly to very highly developed nations, yet the developing and underdeveloped nations equally endure the loss if lives of their citizens due to natural disasters. Can these poorer nations ask for "compensation" from the world's CO2 polluters? If so, how does one quantify the loss of a single human life?

On the other hand, the more developed nations can equally accuse the less developed nations of wanton destruction of forest areas which is also a primary causative factor in the increased atmospheric CO2 accumulation. Can these nations rightly ask for compensation, too?

5.0 Conclusion

The impact of human exploitative activities on the accelerated CO2 accumulation in the atmosphere led to natural disasters spawned by rising global temperatures. Loss of lives and deaths from these natural disasters have forced climate and environmental ethics issues to be raised in the global community of nations.

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