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HUMAN CARBON LIFE FOOTPRINT AND CO_2 EMISSIONS PLACED IN THE EARTH ATMOSPHERE

[ADDRESSING CLIMATE CHANGE]

In 2004 total world carbon emissions released into the Earth atmosphere totaled 26.08 billion metric tons. By 2005, the United States alone placed 6 million metric tons of CO_2 in the Earth atmosphere. The worldwide total emissions have not abated since 2005, but continued a worldwide trend of increase to the present. Several ArcGIS Map Visualizations are presented to substantiate the increase of CO_2 emissions from 1980 to 2005. Of the 26.08 billion metric tons of CO_2 emissions released into the atmosphere in 2004, power generation plants and industry accounted for 60 percent; industry, 18.2 percent, and residential 12.6 percent.

By 2005, the U.S. residential sector alone placed 21.1 percent of the 6 million metric tons of CO_2 placed in the atmosphere that year. And since the residential sector largely drives worldwide power generation of energy using fossil fuels, this research provides a mathematical formula-kilowatt-hours times 1.36 equals CO_2 emitted to generate human electricity consumption-that can be used to demonstrate how much CO_2 is placed in the Earth's atmosphere based on the square footage of living space inside a home. Using Kilowatt-hour data for selected square footage of living space in homes in the United States, it will be demonstrated that in order to reverse the human carbon life footprint, a reversal in home construction is necessary to significantly reduce CO_2 emissions placed in the atmosphere. One fact makes clear the urgency of this research; namely, "the average size of a new American home[s] grew 45 percent in 30 years," [increasing from 1,700 square feet in 1976 to 2,469 by 2006].

I. BACKGROUND

The greatest, imminent threat to the sustainability of the Earth processes, including water, energy, atmosphere, land, vegetation, and animal life, is climate change, which is driven by the human carbon footprint. And, if these life-sustaining spheres continue to survive over the long-term, a radical change in worldwide human energy consumption is imperative. According to Fromm, "for the first time in history the physical survival of the human race depends on a radical change of the human heart. However, a change of the human heart is possible only to the extent that drastic economic and social changes occur that give the human heart the chance for change and the courage and vision to achieve it" (Fromm, 1976). It will take drastic economic and social changes in the lifestyles of human beings on all continents to solve the human carbon-induced climate change challenge.

Some of the causes of increase in climatic change have been mainly due to the anthropogenic influence through greenhouse gas emissions (GHG). GHG emissions have increased by 70 percent between 1970 and 2004. Human influenced CO_2 is the most predominant GHG that has been emitted into the atmosphere. Changes in the concentration of carbon dioxide, methane, nitrous oxide, and halocarbons have increased dramatically since 1750. In 2005, the atmospheric concentrations of carbon dioxide and methane far exceeded the natural range over the last 650,000 years. Increase in the CO_2 emissions have resulted from human dependence on fossil fuel use (UNIPCC, 2007). The Intergovernmental Panel on Climate Change (IPPC) also stated in its Climate Change 2007 Synthesis Report that "warming of the climate system is unequivocal… (IPPC, 2007).

Moreover, on all continents and all sea surfaces, there is a noticeable rise in temperature. In fact, eleven of the last twelve years-1995 to 2006-rank among the warmest years on record since 1850 (IPCC, 2007). In short, the IPCC report has thoroughly outlined, in great detail, the increasing adverse impacts CO_2 has on such Earth processes as temperature rise, sea surface temperature, ocean conveyor belt imbalance, ocean acidification, desertification, vegetation change, sea ice melting, water and energy cycle imbalance, and permafrost melting among many others.

Therefore, in order to stimulate momentum toward the drastic economic and social changes necessary to reverse the imbalance CO_2 is having on the water and energy cycle, the following objectives are considered.

II. OBJECTIVES

- To demonstrate CO_2 concentrations in the Earth atmosphere steadily increased worldwide from 1980 to 2005.
- To establish a linkage between CO_2 concentrations in the Earth atmosphere and human consumption of electricity.

To accomplish the above objectives, a twofold methodology will be employed to analyze worldwide carbon data collected from the United States Department of Energy, and electricity consumption data collected from the US Energy Information Administration (EIA). The following hypothesis will be tested based on an analysis of this data:

- That demand for electricity to operate US households, particularly for heating and cooling, contributes significantly to CO_2 concentrations in the Earth atmosphere.
- That industrialized countries, and the United States in particular, through the globalization process, adds to the buildup of CO_2 concentrations in the Earth atmosphere via a process called "Out-sourced CO_2."

III. METHODOLOGY

ArcGIS 9.3 was used to analyze the world carbon dataset obtained from the U.S. Department of Energy's Energy Information Administration. Carbon dioxide data in millions of metric tons, for all countries and all continents, were placed in a Microsoft Excel spreadsheet and imported into the ArcGIS 9.3 environment. This made it possible to generate a series of map visualizations,

showing worldwide distributions of CO_2 by world regions and individual countries, from 1980 to 2005. To determine to what extent human consumption of electricity in the United States contributed to the increase in the millions of metric tons of CO_2 placed in the Earth atmosphere, several regional datasets-South Atlantic, Middle Atlantic, etc-were obtained from the Energy Information Administration indicating the number of kilowatt hours of electricity consumed by total US households for selected appliances, including heating and cooling. The following model was used to estimate the amount of CO_2 placed in the Earth atmosphere based on total household kilowatt hour consumption.

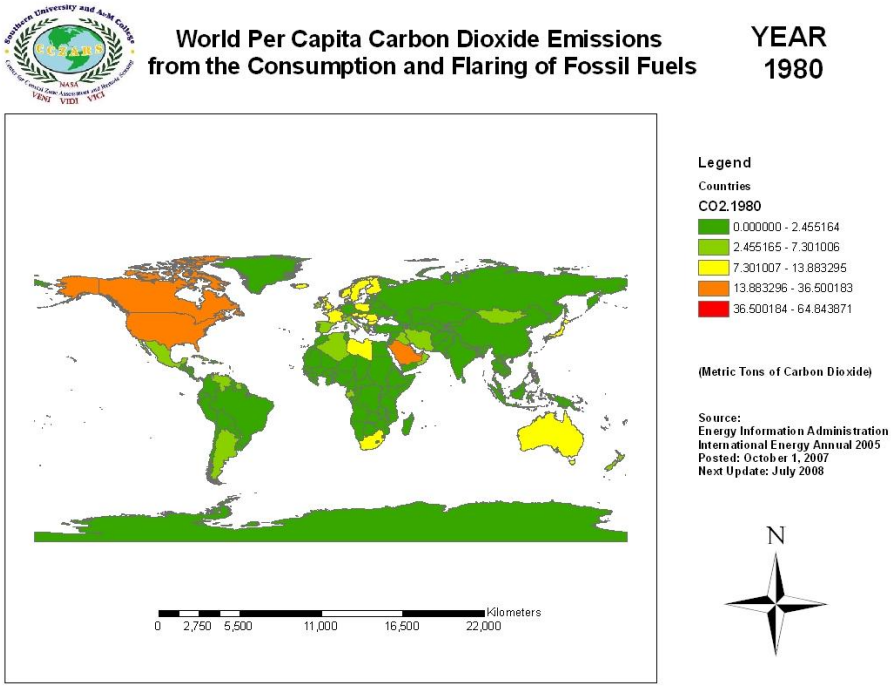
- Estimating Carbon Load: kWhs X 1.36 = lbs of CO_2 (to generate household electricity demand).
- Conversion factor represents an average of power plant fuels.

IV. HUMAN ENERGY CONSUMPTION AND CO_2 LOAD GENERATOR

A. World Distribution of CO_2 Emissions, 1980 to 2005

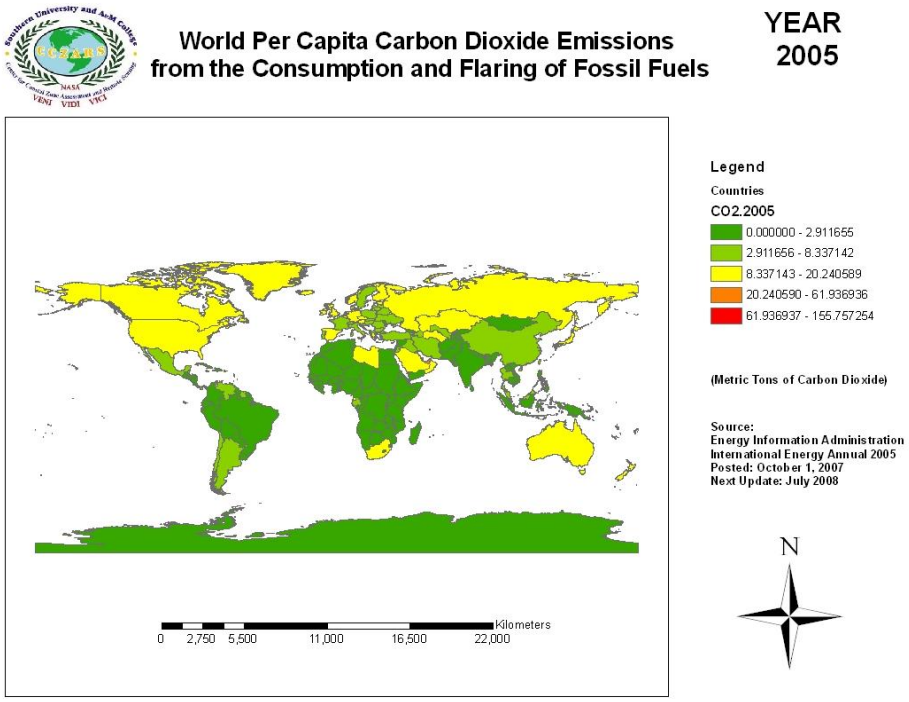
Maps 1.0 and 1.1 shows the world regional distribution of CO_2 placed into the Earth atmosphere between 1980 and 2005. As we see, the United States and Saudi Arabia were the two countries that placed the greatest CO_2 load in the Earth atmosphere in 1980.

MAP 1.0



Source: Lionel D. Lyles

MAP 1.1



Source: Lionel D. Lyles

Interestingly, by 2005, it seems the United States significantly reduced its CO_2 placed in the Earth atmosphere. And, China seems to have caught up with the United States, regarding CO_2 emissions. In fact, this observation is misleading. Given the current globalization trend, which symbolizes industries' search for cheaper places to manufacture commodities, the United States, for example, is a driver of much of the massive buildup of carbon emissions currently placed in the atmosphere by China. Accordingly, Funk stated the following:

"A 2005 study by Bin Shui and Robert Harris of Colorado's National Center for Atmospheric Research determined that from 1997 to 2003, China-U.S. trade increased global CO^2 emissions by 720 million metric tons. Some 7 to 14 percent of China's emissions resulted from exports to American customers; had the goods been produced here, our national CO^2 emissions would be up to 6 percent higher, and the U.S. would still be the top greenhouse emitter in the world. Simply put, this is our pollution too-we've just

outsourced it to China" (Funk, 2007).

Moreover, in 1990, U.S. direct investments abroad was $616,655,000,000; by 2004, it rose to $2,367,386,000,000 (Statistical Abstract of the United States, 2005). The value of established businesses abroad was $7.3 billion by 2004. Capital outflows in manufacturing were $54.2 billion in 2004. And, U.S. direct investment in China in 1990 was $354 billion; by 2004, this figure increased to $15.4 trillion! The United States is a co-facilitator of China's rapid upsurge in CO_2 emissions between 1980 and 2005. Before we proceed to an analysis of U.S. kilowatt hour consumption by American households, it is timely to mention here that oil and gas production in the Arctic Region, along with household consumption of electricity, is responsible for the rise in CO_2 emissions in Greenland in particular. In 2005, Greenland produced 300 million kWhs of electricity, and consumed 279 million kWhs; regarding electricity production, 100% are produced using fossil fuel (World Factbook, 2008). The CO_2 by-product contributes directly to the rapid melting of Greenland.

B. Selected U. S. Household Kilowatt hours Consumption

Fialka and Rogers gave a breakdown of U.S. CO_2 emissions by sector for 2005: industrial: 28.3%; transportation: 32.9%; residential: 21.1%; and commercial: 17.7% (Fialka and Rogers, 2007). During 2005, the latter placed 5,945.3 million metric tons of CO_2 in the Earth atmosphere. In 2001, "electricity consumption by 107 million U.S. households…totaled 1,140 billion kWh. The most significant end uses were central air-conditioning and refrigerators, each of which accounted for about 14 percent of the U.S. total" (EIA, 2005). This demand continues to be driven by the American consumers' preference for bigger homes. According to the National Geographic Changing Climate Special Report, "the average size of new American homes grew 45 percent in 30 years, from 1,700 square feet of living space in 1976 to 2,469 by 2006" (Nijhuis, 2008). Using the kWh model outlined above, let us take a closer look at the amount of CO_2 American households placed in the Earth atmosphere by 2001.

C. Carbon Load Estimation, 2001

Although 2001 U.S. household electricity consumption is the latest year available, the Energy Information Administration (EIA) stated "retail sales of electricity to the residential sector totaled 1.3 trillion kilowatt-hours (kWh) in 2003 and increased use of electricity accounts for 68 percent of the projected increase in residential delivered energy use between 2003 and 2025" (EIA, 2005). Table 1.0 shows the total amount of CO_2 placed in the Earth atmosphere by all U.S. households during 2001.

Table 1.0

Total U.S. Household Electricity Consumption and CO_2 Load Emitted, 2001

End Use/Appl	Households/*	kWh/HH	CO_2 Load(lbs)	Tot. CO_2(lbs)	CO_2-Tons
Total HH	107.0	10,656	14,492	1,550,644	775.3
Central Air	57.5	2,796	3,803	218,673	109.3
Heating Sys.	30.9	3,524	4,793	148,104	74.1
Clothes Dryer	61.1	1,079	1,467	89,634	45
Freezer	34.2	1,150	1,564	53,489	27
Pool/Hot tub	3.3	2,300	3,128	10,322	5.2
TOTAL		**10,849**		**520,222**	**261**

Source: Energy Information Administration, "End-Use Consumption of Electricity 2001," Department of Energy Report, 2005, http://www.eia.doe.gov, May 23, 2008, P.1 and 2.

End-Use/Appliances; Households/*(millions); CO_2 Load (lbs) Estimated; Total CO_2 (lbs) generated to produce electricity demand; CO_2-Tons (emitted into Earth Atmosphere.

As the above Table indicates, the 107 million U.S. households generated 1.6 million pounds (Estimated) of CO_2, or 775.3 tons in 2001, which were a by-product of the burning of fossil fuels necessary to meet the electricity demand of the identified households. Table 1.1 highlights the situation for the South Atlantic Households.

Table 1.1

South Atlantic Electricity Consumption and CO_2 Load Emitted, 2001

End Use/Appl	Households/*	kWh/HH	CO_2 Load(lbs)	Tot. CO_2(lbs)	CO_2-Tons
Total HH	20.3	13,763	18,718	379,969	190
Central Air	16.1	3,467	4,715	75,913	38
Heating Sys.	11.0	2,576	3,503	38,537	19.3
Clothes Dryer	14.1	1,065	1,448	20,422	10.2
Freezer	6.6	1,218	1,657	10,936	5.5
Pool/Hot tub	0.5	2,300	3,128	15,640	8
TOTAL		**10,626**		**161,448**	**81**

Source: Energy Information Administration, "South Atlantic Household Electricity Report," Department of Energy Report, 2006, http://www.eia.doe.gov, May 23, 2008, PP. 1 and 2.

End-use/Appliances; Households/*(millions); Co_2 Load (lbs) Estimated; Total CO_2 (lbs) generated to produce electricity demand; CO_2-Tons (emitted into Earth Atmosphere.

This trend of U.S. household end-use consumption and CO_2 emissions is evident in all regions. For example, the 14.8 million U.S. households in the Middle Atlantic Region consumed 7,799 kWhs of electricity per household in 2001, and the latter demand produced 10,607 pounds of CO_2, per household, or 156,984 pounds-78.5 tons-for the whole region. The West North Central Region consumed 10,930 kWhs of electricity per household, which resulted in 14,865 pounds of CO_2, and 110,000 pounds-55 tons-for the whole region (EIA, 2001). What do these results means?

VI. CONCLUSION

Regarding the U.S. residential sector, the producers of electricity, and homeowners who use electricity, are primary drivers of the production and emission of increasing CO_2 concentrations into the Earth atmosphere. Together, the electricity demand to operate central air and heating systems (CA&HA) in American households contribute the largest amount of CO_2 emissions in the Earth atmosphere. Aggregately, CA&HS accounts for 70.0 percent of all CO_2 emissions compared to all other household appliances. And, if the square footage of living space (SFLS) keeps increasing, CA&HS production of CO_2 will exceed its present 70.0 percent emission rate.

Fortunately, SFLS is driven by freedom of choice related to modern household construction. As such, people worldwide can *consciously choose to reduce their SFLS*. Such action can immediately impact global warming without any government action required.

Through formal re-education, we have an opportunity to make a conscious connection between kWh consumption and CO_2 emission. Homeowners can jumpstart CO_2 emission reduction by examining their monthly electricity bill, where applicable. Using the proposed model to calculate estimated CO_2 production, it is possible for a layperson to begin reducing CO_2 emissions today. Where can government play a role?

Government can pass legislation to establish SFLS limits. This act can offer guidance to banking and architecture institutions. Such limits can become part of the home loan approval process. Regarding buildings, the latter consumes 48.0 percent of energy consumption, and 76.0 percent of all power plant-generated electricity is used *just to operate buildings*. Saving our Earth is a human choice.

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