# Real-world Evidence that $CO_2$ Emissions and Fossil Energy Enhance the Human Environment

*A presentation by Dr. Craig D. Idso*
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## *Slide 1*

Good afternoon. I appreciate the opportunity to be here today. I would like to thank the Heartland Institute for organizing this conference and for inviting me to speak. I have titled my presentation "Real-world Evidence that $CO_2$ Emissions and Fossil Energy Enhance the Human Environment." In the next 19 minutes my goal is to provide you with an overview of why fossil fuel use and the ongoing rise in the atmosphere's $CO_2$ content should be *welcomed*, not cursed or feared.

## *Slide 2*

In today's world it's almost impossible to avoid the seemingly daily deluge of pessimism surrounding climate change. Consider, for example, the following news headlines obtained following a quick Internet search:

- The "planet is entering [a] 'new climate regime' with 'extraordinary' heat waves intensified by global warming."
- "Climate change is affecting crop yields and reducing global food supplies"
- "Climate change is making hurricanes more dangerous"
- "Climate change is devastating Central America, driving migrants to the US border"
- "UN report on global warming warns of "climate apartheid"
- "Sanders and Ocasio-Cortez move to declare climate crisis [an] official emergency"

## *Slide 3*

The intended message and unifying thread in each of these so-called journalistic reports is that dangerous climate change, caused by rising levels of atmospheric $CO_2$, is presently occurring to the detriment and peril of humanity and the natural world. And because the combustion of fossil fuels is the principal source behind the $CO_2$ rise, society must abandon all use of fossil fuels. In a nutshell, this is the position and objective of climate activists, who seek to enforce government and private sector efforts to restrict fossil fuel use via tax, caps or fiat limits on $CO_2$ emissions.

### *Slide 4*

Reality, however, paints a much different picture. The *real* story is that there is no upcoming climate catastrophe and $CO_2$ emissions and fossil energy should be *celebrated* for *enhancing* life and *improving* the standard of living for humanity and the natural world, and they will continue to do so as more fossil fuels are used in the future. Consequently, efforts to restrict $CO_2$ emissions or limit fossil energy should be avoided, as such actions will most certainly bring about adverse outcomes and unintended consequences that will harm humanity and nature. In support of this thesis, I will next share four key examples of how $CO_2$ emissions and fossil energy improve human prosperity, followed by an additional set of slides demonstrating how they benefit the natural world.

### *Slide 5*

In this first example focusing on fossil fuel benefits to humanity, per capita $CO_2$ emissions, which are an analog for fossil fuel energy use, are plotted against per capita GDP on a countrywide basis for the year 2016. The basic relationship seen here reveals that countries with lower per capita $CO_2$ emissions have lower values of per capita GDP, whereas countries with higher per capita $CO_2$ emissions have higher per capita GDP. So what does this mean? Well, according to every researcher who has examined the relationship between these two variables, it indicates that fossil energy use is fundamentally linked to economic growth. As countries have embraced and increased their production of fossil energy, their citizens have been amply rewarded with increased economic development and growth. Such fossil fuel-based economic prosperity has been proven over and over again throughout the past century as country after country has moved position along this graph from locations near the bottom left toward the upper right.

### *Slide 6*

A second example of the beneficial link between fossil fuel use and human prosperity is seen in this next slide of per capita countrywide $CO_2$ emissions and percent of each country's population living in extreme poverty, defined as those living on less than $1.90 per day. The take home message of this graph is that higher $CO_2$ emissions are associated with lower levels of extreme poverty. Nations enjoying the lowest percentages of their citizens living in extreme poverty are those that use the highest amounts of fossil energy. Consequently, it can confidently be concluded that abundant access to energy is an essential component to improving a nation's living standards and alleviating its poverty.

## *Slide 7*

A third metric documenting the positive relationship between fossil fuel use and human prosperity is found in trends of global literacy. In this figure, I have plotted two centuries of annual fossil fuel consumption and global literacy data, which show illiteracy declining as a function of fossil fuel consumption. For most of the first hundred years of the record, the vast majority of the population older than 15 was unable to read and write; in 1820 only one out of every ten persons older than 15 years was literate. By 1930 the literate portion of this population jumped to one-third. Fast forward to the present and 4.6 billion out of the 5.4 billion persons on earth today over the age of 15 can read and write. Contrast that to two centuries ago when there were less than 100 million who shared these skills. Thankfully, as nations have utilized fossil energy to industrialize, their populations have spent less time performing labors required of sustenance living and more time in the classroom becoming literate and gaining an education.

## *Slide 8*

As a final example to illustrate just one more of the many human benefits of fossil fuel use, this next slide plots the two hundred year trend of human life expectancy and fossil fuel consumption, revealing a high degree of correlation among the two records. Two hundred years ago, the average life expectancy of a child born was a mere 29 years. Health care was relatively non-existent and 43% of the world's newborns died before reaching their 5$^{th}$ birthday. Thereafter, things began to change, though slowly at first. Society began to use fossil fuels on a much larger scale and industrialize. Rising energy production brought economic prosperity and literacy, which helped reduce poverty. Housing and sanitation improved. People ate more and they ate healthier, nutritious foods. A more educated population coupled with fast-developing societies provided fertile ground for key scientific breakthroughs in modern medicine that both saved and prolonged lives.

During the 19$^{th}$ century life expectancy changed but little. Then, as fossil energy consumption really took off, so did human longevity, with global life expectancy *doubling* in value over the next ten decades, reaching 72 years today. The real significance of this monumental accomplishment in human achievement, however, is *not* in the doubling of life expectancy in and of itself, but in *the number of persons who are experiencing it*.

### *Slide 9*

Consider, for example, that in 1820 the world population was only 1.06 billion, whereas today it is 7.38 billion. By multiplying the population in each of these years by the corresponding average lifespan at that time, we find that the number of total human life years supported by the planet in 1820 amounted to 30.7 billion, whereas today it is a much larger 527 billion. Thus, thanks in large measure to benefits from enhanced fossil energy use, our planet now supports an increase in total human life years that is *17-fold larger* than it was just two centuries ago! Such improvements are astounding and will likely only be enhanced in the years and decades to come as energy remains accessible, affordable and plentiful.

### *Slide 10*

Beyond these four key metrics, there are numerous other examples of humanity benefiting from fossil energy use, including productivity enhancements, the improvement and expansion of goods and services, and the development of new inventions and innovations. Think about cell phones, air travel, the Internet, CT scans and a host of other innovations. These products or benefits could not have possibly existed years ago. They only exist today thanks to decades of technological and economic progress made possible by fossil energy use.

### *Slide 11*

Now, as alluded to in the beginning of my talk, aside from producing very real and quantifiable benefits for human prosperity, fossil energy has also improved the natural world. Such benefits to nature generally have their origin in, or are linked to, the carbon dioxide concentration of the atmosphere, which has increased during the Modern Era primarily in response to humanity's combustion of fossil fuels.

### *Slide 12*

Among the most commonly recognized of these $CO_2$-induced benefits to the natural world is an increase in plant productivity and growth. This occurs because carbon dioxide is the primary raw material or "food" utilized by the vast majority of plants to produce the organic matter out of which they construct their tissues, which matter subsequently becomes the ultimate source of food for nearly all animals and humans. And, as has been demonstrated in literally *thousands* of laboratory and field experiments conducted on hundreds of different plant species, the more $CO_2$ there is in the air, the better plants grow. And the better plants grow, the more food there is available to sustain the entire biosphere.

### *Slide 13*

Typically, a 300-ppm increase in the air's $CO_2$ content is sufficient to raise the productivity of most herbaceous plants by about one-third and most woody plants by around 50%, which stimulation is generally manifested by an increase in the number of branches and tillers, more and thicker leaves, more extensive root systems, and more flowers and fruit. To place these growth enhancements within a proper temporal perspective, consider that humanity has *already* raised the $CO_2$ concentration of the atmosphere by 130 ppm, or 45%, and that by the end of this century it will have risen by *another* 200 to 500 ppm. What does this current and future growth-enhancing benefit of atmospheric $CO_2$ enrichment portend for the biosphere?

### *Slide 14*

One obvious consequence is greater crop productivity, and many researchers have acknowledged the yield-enhancing benefits of the historical and still-ongoing rise in the air's $CO_2$ content on past, present and future crop yields. In this regard, in my own studies of the subject I have calculated that the benefits of $CO_2$ on agriculture are so important that without them, world food supply will fall short of world food demand by mid-century.

### *Slide 15*

I have also calculated the direct monetary benefits of atmospheric $CO_2$ enrichment on both historic and future global crop production. Over the past five decades that benefit amounted to over $3.2 trillion. And projecting the monetary value of this positive externality forward in time reveals it will bestow an additional $9.8 trillion on crop production by mid-century.

### *Slide 16*

A second major biological benefit stemming from the modern rise of atmospheric $CO_2$ is increased plant water use efficiency. Plant water use efficiency is the amount of biomass produced by a plant per unit of water lost via transpiration. What we find here is that plants exposed to elevated levels of atmospheric $CO_2$ generally do not open their leaf stomatal pores as wide as they do at lower $CO_2$ concentrations. The result is a reduction in most plants' rates of water loss by transpiration; and the amount of carbon they gain per unit of water lost – or *water-use efficiency* – therefore typically rises for a doubling of $CO_2$ on the order of 70 to 100%. Thus, at higher atmospheric $CO_2$ concentrations, it has been observed that plants need less water to produce the same – or an even *greater* – amount of biomass.

### *Slide 17*

With smaller stomatal openings, plants exposed to elevated levels of atmospheric $CO_2$ tend to become less susceptible to drought, losing less water to the air via transpiration. As such, this benefit is enabling them to grow and reproduce where it has previously been too dry for them to exist. Consequently, Earth's terrestrial vegetation is becoming more robust in arid and droughty regions as the air's $CO_2$ concentration rises, and is beginning to win back lands previously lost to desertification. Simultaneously, the greater vegetative cover of the land produced by this phenomenon is helping to reduce the adverse effects of soil erosion caused by the ravages of wind and rain.

### *Slide 18*

A third major benefit of the ongoing rise of atmospheric $CO_2$ is an amelioration of environmental stresses and resource limitations. Here, atmospheric $CO_2$ has been shown to help reduce the detrimental effects caused by stresses of high soil salinity, high air temperature, low light intensity and low levels of soil fertility. Elevated levels of $CO_2$ have additionally been demonstrated to reduce the severity of low temperature stress, oxidative stress, and the stress of herbivory. What is more, the *percentage* growth enhancement produced by an increase in the air's $CO_2$ content is often *greater* under stressful and resource-limited conditions than it is when growing conditions are optimal.

### *Slide 19*

Consequently, in light of the plant productivity gains that result from the *aerial fertilization effect* of the ongoing rise in atmospheric $CO_2$, plus its *transpiration-reducing effect* that boosts plant water use efficiency, along with its *stress-alleviating effect* that lessens the negative growth impacts of resource limitations and environmental constraints, the world's vegetation possesses an *ideal mix of abilities* to reap *tremendous* growth-related benefits in the years and decades to come.

### *Slide 20*

And based on a multitude of real-world observations *that future is **now*** -- as evidence for this great *greening of the Earth*, as it is often called, is witnessed in satellite measurements across the globe, indicating that the terrestrial biosphere is already experiencing an incredible stimulation of growth, due in large measure to the approximate 45% increase in atmospheric $CO_2$ that has occurred since the beginning of the Industrial Revolution.

### *Slide 21*

Unfortunately, we do not have time to further explore these and other important benefits that fossil fuel use and $CO_2$ emissions have initiated and continue to sustain. Nevertheless, such benefits to the human environment, which includes both humanity and the natural world, are undeniable. Without adequate supplies of low-cost centralized energy, few, if any, of the major technological and innovative advancements of the past two centuries that have enhanced and prolonged human life could have occurred. Additionally, without the increased $CO_2$ emissions from fossil fuel use over the past two centuries, Earth's terrestrial biosphere would be nowhere near as vigorous or productive as it is today. Rather, it would be devoid of the growth-enhancing, water-saving and stress-alleviating benefits it has reaped in managed and unmanaged ecosystems from rising levels of atmospheric $CO_2$ since the Industrial Revolution began.

### *Slide 22*

When considering and accounting for such positive improvements, plus the fact that *none* of the apocalyptic predictions of climate catastrophe are coming true, it becomes scientifically and morally indefensible to demonize fossil energy and claim $CO_2$ emissions are a current threat to human health and welfare. *More*, not less, fossil energy is needed to enhance the future human environment, and that is the critical message that must be shared from the rooftops to scientists, activists, policy makers, educators and the general public.

### *Slide 23*

To help in this regard, the non-profit organization that I chair, the Center for the Study of Carbon Dioxide and Global Change, has formed a new *Institute for the Human Environment*, which I am unveiling to you here publicly today. I am joined in this effort by longtime friend and fossil energy expert and advocate, Fred Palmer, who holds extensive legal and regulatory knowledge and experience on state and US energy and environmental policy.

The primary goal of our Institute is to bring the critical facts I have shared with you here today to light so as to reverse the 2009 Endangerment Finding and, where possible, to also engage at the State level in order to reverse policies aimed at eliminating fossil energy production. By so doing we aim to restore critical policy balance that is needed to allow the continued enhancement of the human environment and we hope you will join with us in that effort.

## *Slide 24*

The message of our Institute is simple: (1) atmospheric $CO_2$ is an aerial *fertilizer*, not an airborne pollutant, (2) fossil energy *enhances* civilization and the human experience, it doesn't diminish it, and (3) more, not less, fossil energy is needed to enhance and protect the human environment.

Protecting the human environment not only includes safeguarding the natural environment, but also defending a fundamental right of society to utilize and transform the natural environment so as to sustain and enhance the quality of human life. It is unfortunate that governments have abandoned this balanced approach to protecting the human environment in recent years. Far too many regulations and laws have tilted the scales toward safeguarding the natural environment at the *expense* of humanity and it is time for that to change.

Thank you.