# Warming Bad

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## Science

### Warming’s Real

#### Warming is real – all factors confirm

Muller 7-28-2012

 [Richard, professor of physics at the University of California, Berkeley, and a former MacArthur Foundation fellow, “The Conversion of a Climate-Change Skeptic”, <http://www.nytimes.com/2012/07/30/opinion/the-conversion-of-a-climate-change-skeptic.html?pagewanted=all>, HM]

CALL me a converted skeptic. Three years ago I identified problems in previous climate studies that, in my mind, threw doubt on the very existence of global warming. Last year, following an intensive research effort involving a dozen scientists, I concluded that global warming was real and that the prior estimates of the rate of warming were correct. I’m now going a step further: Humans are almost entirely the cause. My total turnaround, in such a short time, is the result of careful and objective analysis by the Berkeley Earth Surface Temperature project, which I founded with my daughter Elizabeth. Our results show that the average temperature of the earth’s land has risen by two and a half degrees Fahrenheit over the past 250 years, including an increase of one and a half degrees over the most recent 50 years. Moreover, it appears likely that essentially all of this increase results from the human emission of greenhouse gases. These findings are stronger than those of the Intergovernmental Panel on Climate Change [IPCC], the United Nations group that defines the scientific and diplomatic consensus on global warming. In its 2007 report, the I.P.C.C. concluded only that most of the warming of the prior 50 years could be attributed to humans. It was possible, according to the I.P.C.C. consensus statement, that the warming before 1956 could be because of changes in solar activity, and that even a substantial part of the more recent warming could be natural. Our Berkeley Earth approach used sophisticated statistical methods developed largely by our lead scientist, Robert Rohde, which allowed us to determine earth land temperature much further back in time. We carefully studied issues raised by skeptics: biases from urban heating (we duplicated our results using rural data alone), from data selection (prior groups selected fewer than 20 percent of the available temperature stations; we used virtually 100 percent), from poor station quality (we separately analyzed good stations and poor ones) and from human intervention and data adjustment (our work is completely automated and hands-off). In our papers we demonstrate that none of these potentially troublesome effects unduly biased our conclusions. The historic temperature pattern we observed has abrupt dips that match the emissions of known explosive volcanic eruptions; the particulates from such events reflect sunlight, make for beautiful sunsets and cool the earth’s surface for a few years. There are small, rapid variations attributable to El Niño and other ocean currents such as the Gulf Stream; because of such oscillations, the “flattening” of the recent temperature rise that some people claim is not, in our view, statistically significant. What has caused the gradual but systematic rise of two and a half degrees? We tried fitting the shape to simple math functions (exponentials, polynomials), to solar activity and even to rising functions like world population. By far the best match was to the record of atmospheric carbon dioxide (CO2), measured from atmospheric samples and air trapped in polar ice.

#### Scientific consensus is on our side

Lewandowsky and Ashley 2011

[Stephan Lewandowsky, Professor of Cognitive Studies at the University of Western Australia, and Michael Ashley, Professor of Astrophysics at the University of New South Wales, June 24, 2011, “The false, the confused and the mendacious: how the media gets it wrong on climate change,” <http://goo.gl/u3nOC>, HM]

But despite these complexities, some aspects of climate science are thoroughly settled. We know that atmospheric CO2 is increasing due to humans. We know that this CO2, while being just a small fraction of the atmosphere, has an important influence on temperature. We can calculate the effect, and predict what is going to happen to the earth’s climate during our lifetimes, all based on fundamental physics that is as certain as gravity. The consensus opinion of the world’s climate scientists is that climate change is occurring due to human CO2 emissions. The changes are rapid and significant, and the implications for our civilisation may be dire. The chance of these statements being wrong is vanishingly small. Scepticism and denialism Some people will be understandably sceptical about that last statement. But when they read up on the science, and have their questions answered by climate scientists, they come around. These people are true sceptics, and a degree of scepticism is healthy. Other people will disagree with the scientific consensus on climate change, and will challenge the science on internet blogs and opinion pieces in the media, but no matter how many times they are shown to be wrong, they will never change their opinions. These people are deniers. The recent articles in The Conversation have put the deniers under the microscope. Some readers have asked us in the comments to address the scientific questions that the deniers bring up. This has been done. Not once. Not twice. Not ten times. Probably more like 100 or a 1000 times. Denier arguments have been dealt with by scientists, again and again and again. But like zombies, the deniers keep coming back with the same long-falsified and nonsensical arguments. The deniers have seemingly endless enthusiasm to post on blogs, write letters to editors, write opinion pieces for newspapers, and even publish books. What they rarely do is write coherent scientific papers on their theories and submit them to scientific journals. The few published papers that have been sceptical about climate change have not withstood the test of time. The phony debate on climate change So if the evidence is this strong, why is there resistance to action on climate change in Australia? At least two reasons can be cited. First, as The Conversation has revealed, there are a handful of individuals and organisations who, by avoiding peer review, have engineered a phony public debate about the science, when in fact that debate is absent from the one arena where our scientific knowledge is formed. These individuals and organisations have so far largely escaped accountability. But their free ride has come to an end, as the next few weeks on The Conversation will continue to show. The second reason, alas, involves systemic failures by the media. Systemic media failures arise from several presumptions about the way science works, which range from being utterly false to dangerously ill-informed to overtly malicious and mendacious. The false Let’s begin with what is merely false. A tacit presumption of many in the media and the public is that climate science is a brittle house of cards that can be brought down by a single new finding or the discovery of a single error. Nothing could be further from the truth. Climate science is a cumulative enterprise built upon hundreds of years of research. The heat-trapping properties of CO₂ were discovered in the middle of the 19th century, pre-dating even Sherlock Holmes and Queen Victoria.

### A2 Past Tipping Point

#### Not too late – every reduction key

Nuccitelli 12

[Dana, is an environmental scientist at a private environmental consulting firm in the Sacramento, California area. He has a Bachelor's Degree in astrophysics from the University of California at Berkeley, and a Master's Degree in physics from the University of California at Davis. He has been researching climate science, economics, and solutions as a hobby since 2006, and has contributed to Skeptical Science since September, 2010, <http://www.skepticalscience.com/realistically-what-might-future-climate-look-like.html>, HM]

We're not yet committed to surpassing 2°C global warming, but as Watson noted, we are quickly running out of time to realistically give ourselves a chance to stay below that 'danger limit'. However, 2°C is not a do-or-die threshold. Every bit of CO2 emissions we can reduce means that much avoided future warming, which means that much avoided climate change impacts. As Lonnie Thompson noted, the more global warming we manage to mitigate, the less adaption and suffering we will be forced to cope with in the future. Realistically, based on the current political climate (which we will explore in another post next week), limiting global warming to 2°C is probably the best we can do. However, there is a big difference between 2°C and 3°C, between 3°C and 4°C, and anything greater than 4°C can probably accurately be described as catastrophic, since various tipping points are expected to be triggered at this level. Right now, we are on track for the catastrophic consequences (widespread coral mortality, mass extinctions, hundreds of millions of people adversely impacted by droughts, floods, heat waves, etc.). But we're not stuck on that track just yet, and we need to move ourselves as far off of it as possible by reducing our greenhouse gas emissions as soon and as much as possible. There are of course many people who believe that the planet will not warm as much, or that the impacts of the associated climate change will be as bad as the body of scientific evidence suggests. That is certainly a possiblity, and we very much hope that their optimistic view is correct. However, what we have presented here is the best summary of scientific evidence available, and it paints a very bleak picture if we fail to rapidly reduce our greenhouse gas emissions. If we continue forward on our current path, catastrophe is not just a possible outcome, it is the most probable outcome. And an intelligent risk management approach would involve taking steps to prevent a catastrophic scenario if it were a mere possibility, let alone the most probable outcome. This is especially true since the most important component of the solution - carbon pricing - can be implemented at a relatively low cost, and a far lower cost than trying to adapt to the climate change consequences we have discussed here (Figure 4).

#### We can avoid tipping points but action now is key

DNews 2012

(“Politics Is Key to Avoiding Global Warming Catastrophe”, <http://news.discovery.com/earth/politics-is-key-to-avoiding-global-warming-catastrophe-130103.html>, CMR)

Delaying global action on climate change by 20 more years will put the goal of keeping the world relatively cool out of reach forever, no matter how much money humanity later spends to try to solve the problem, a new study finds.¶ Since the 1990s, scientists and international negotiators have aimed to keep global temperatures from warming more than 2 degrees Celsius (3.6 degrees Fahrenheit), but little progress has been made so far in concrete steps toward that goal. The most recent climate talks, in Qatar in December, ended with only modest steps that fail to address growing greenhouse gas emissions, climate scientists said.¶ It's these delays that ultimately make dealing with climate change more expensive and perhaps eventually impossible, according to a study published this week (Jan. 4) in the journal Nature. While it's true there are still uncertainties about how the climate will respond to specific strategies, these uncertainties are nothing compared with potential disaster caused by delay, said study researcher Joeri Rogelj of Switzerland's Institute for Atmospheric and Climate Science in Zurich.¶ "The uncertainties about how the climate system will respond have been previously used as an argument to postpone action until we have learned more," Rogelj told LiveScience. "We show that such a delay strategy is unsupported and that the most important factor for staying below 2 degrees C is the timing of when we start tackling this problem at a global scale."¶ Many researchers have attempted to weigh the costs and benefits of climate-change strategies ranging from a carbon tax on emissions to requirements for sequestering carbon underground rather than releasing it into the atmosphere. What Rogelj and his colleagues did differently was to rank the importance of "the known unknowns." These are the uncertainties that keep scientists from predicting exactly how the future of climate will unravel. They include geophysical uncertainties — how the climate system of our planet will respond to specific strategies — as well as social uncertainties, such as future growth and energy demand. Technological uncertainties include what innovations will be available for lowering emissions. And finally, there are the political uncertainties: When will the world decide to act to prevent further warming? (8 Ways Global Warming Is Already Changing the World)¶ For the first time, Rogelj and his colleagues quantified and ranked the importance of each of these uncertainties. They found that politics dominated.¶ Delay hurts¶ In other words, the timing of climate-change action plays a more important role in keeping the planet from possibly catastrophic warming than social, geophysical or technological hurdles. If humanity delays in taking action, even the best-case social, geophysical and tech scenarios will do little good.¶ "When delaying action by two more decades, chances to stay below 2 degrees C become very low and we find that they cannot be improved later on, no matter how much money we throw at the problem in the future," Rogelj said.¶

### A2 Alt Causes

#### CO2 is the primary driver of climate change – outweighs all alt causes

Vertessy and Clark3-13**-**2012[Rob, Acting Director of Australian Bureau of Meteorology, and Megan, Chief Executive Officer at the Commonwealth Scientific and Industrial Research Organisation, “State of the Climate 2012”, <http://theconversation.edu.au/state-of-the-climate-2012-5831>]

Carbon dioxide (CO2) emissions account for about 60% of the effect from anthropogenic greenhouse gases on the earth’s energy balance over the past 250 years. These global CO2 emissions are mostly from fossil fuels (more than 85%), land use change, mainly associated with tropical deforestation (less than 10%), and cement production and other industrial processes (about 4%). Australia contributes about 1.3% of the global CO2 emissions. Energy generation continues to climb and is dominated by fossil fuels – suggesting emissions will grow for some time yet. CO2 levels are rising in the atmosphere and ocean. About 50% of the amount of CO2 emitted from fossil fuels, industry, and changes in land-use, stays in the atmosphere. The remainder is taken up by the ocean and land vegetation, in roughly equal parts. The extra carbon dioxide absorbed by the oceans is estimated to have caused about a 30% increase in the level of ocean acidity since pre-industrial times. The sources of the CO2 increase in the atmosphere can be identified from studies of the isotopic composition of atmospheric CO2 and from oxygen (O2) concentration trends in the atmosphere. The observed trends in the isotopic (13C, 14C) composition of CO2 in the atmosphere and the decrease in the concentration of atmospheric O2 confirm that the dominant cause of the observed CO2 increase is the combustion of fossil fuels.

#### Anthropogenic emissions massively outweigh natural emissions.

American Geophysical Union 2011

[ “Volcanic Versus Anthropogenic Carbon Dioxide,” 6/14, http://www.agu.org/pubs/pdf/2011EO240001.pdf]

The projected 2010 anthropogenic CO2 emission rate of 35 gigatons per year is 135 times greater than the 0.26-gigaton-per-year preferred estimate for volcanoes. This ratio of anthropogenic to volcanic CO2 emissions defines the anthropogenic CO2 multiplier (ACM), an index of anthropogenic CO2 ’s dominance over volcanic CO2 emissions. Figure 1 shows the ACM as a time series calculated from time series data on anthropogenic CO2 emissions and Marty and Tolstikhin’s [1998] preferred and plausible range of emission estimates for global volcanic CO2 . The ACM values related to the preferred estimate rise gradually from about 18 in 1900 to roughly 38 in 1950; thereafter they rise rapidly to approximately 135 by 2010. This pattern mimics the pattern of the anthropogenic CO2 emissions time series. It reflects the 650% growth in anthropogenic emissions since 1900, about 550% of which has occurred since 1950. ACM plots related to the preferred estimates of global volcanic CO2 in the four other studies (not shown) exhibit the same pattern but at higher values; e.g., the 2010 ACM values based on their preferred estimates range from 167 to 233, compared to the 135 based on Marty and Tolstikhin’s [1998] preferred estimate.

### A2 Natural Variability

#### Natural variability doesn’t disprove warming – hotter temperatures will continue to be more prevalent with climate change

Hansen 2012

[James, NASA Goddard Institute for Space Studies, “Climate change is here — and worse than we thought”, http://www.washingtonpost.com/opinions/climate-change-is-here--and-worse-than-we-thought/2012/08/03/6ae604c2-dd90-11e1-8e43-4a3c4375504a\_story.html]

These weather events are not simply an example of what climate change could bring. They are caused by climate change. The odds that natural variability created these extremes are minuscule, vanishingly small. To count on those odds would be like quitting your job and playing the lottery every morning to pay the bills. Twenty-four years ago, I introduced the concept of “climate dice” to help distinguish the long-term trend of climate change from the natural variability of day-to-day weather. Some summers are hot, some cool. Some winters brutal, some mild. That’s natural variability. But as the climate warms, natural variability is altered, too. In a normal climate without global warming, two sides of the die would represent cooler-than-normal weather, two sides would be normal weather, and two sides would be warmer-than-normal weather. Rolling the die again and again, or season after season, you would get an equal variation of weather over time. But loading the die with a warming climate changes the odds. You end up with only one side cooler than normal, one side average, and four sides warmer than normal. Even with climate change, you will occasionally see cooler-than-normal summers or a typically cold winter. Don’t let that fool you. Our new peer-reviewed study, published by the National Academy of Sciences, makes clear that while average global temperature has been steadily rising due to a warming climate (up about 1.5 degrees Fahrenheit in the past century), the extremes are actually becoming much more frequent and more intense worldwide. When we plotted the world’s changing temperatures on a bell curve, the extremes of unusually cool and, even more, the extremes of unusually hot are being altered so they are becoming both more common and more severe. The change is so dramatic that one face of the die must now represent extreme weather to illustrate the greater frequency of extremely hot weather events. Such events used to be exceedingly rare. Extremely hot temperatures covered about 0.1 percent to 0.2 percent of the globe in the base period of our study, from 1951 to 1980. In the last three decades, while the average temperature has slowly risen, the extremes have soared and now cover about 10 percent of the globe. This is the world we have changed, and now we have to live in it — the world that caused the 2003 heat wave in Europe that killed more than 50,000 people and the 2011 drought in Texas that caused more than $5 billion in damage. Such events, our data show, will become even more frequent and more severe.

### A2 Negative Feedback – Clouds

#### Cloud effect is net neutral – thin and thick clouds have opposite effects

Baum et. al 2012

[Seth Baum, Research on Environmental Decisions @ Columbia, Chris Karmosky, Geography @ Penn State, Jacob Haqq-Misra, Meteorology and Astrobiology Research Center, June 2012, "Climate Change: Evidence of Human Causes and Arguments for Emissions Reduction," Science and Engineering Ethics 18]

The Role of Cloud Formation Clouds do play an important role in surface air temperatures: water vapor is Earth’s most prevalent greenhouse gas, so increased cloud cover will cause surface warming. However, clouds also reﬂect incoming solar radiation back into space, thereby cooling Earth’s surface. In general, thick clouds, such as the cumulonimbus Evidence of Human Causes and Arguments 397 123clouds found in thunderstorms, tend to have a net cooling effect on Earth’s surface, whereas thin clouds, such as high cirrus clouds, have a net warming effect (Grenci and Nese 2006). Higher global temperatures will cause higher rates of evaporation, bringing more of both thick and thin clouds. Clouds thus constitute an important source of uncertainty in future temperature change.

### A2 Negative Feedback – Carbon Sinks

#### Agricultural sequestration can’t solve warming – droughts offset and sequestration is short-term

EPA 2010

[“Frequent Questions”, http://www.epa.gov/sequestration/faq.html#8]

According to a National Academy of Sciences 2001 report, "Greenhouse gases are accumulating in the Earth's atmosphere as a result of human activities, causing surface air temperatures and subsurface ocean temperatures to rise." In addition to temperature, human-induced climate change may also affect growing seasons, precipitation and the frequency and severity of extreme weather events, such as fire. These changes can influence forests, farming and the health of ecosystems, and thus carbon sequestration. Some argue that rising CO2 levels will enhance sequestration above normal rates due to a fertilization effect. However, the concurrent changes in temperature and precipitation, along with local nutrient availability and harmful air pollutants, complicate this view. Furthermore, recent studies of pine forests fumigated with elevated CO2 levels have shown that this fertilization effect may only be short-lived (Schlesinger and Lichter 2001; Oren et al. 2001). Current projections of business-as-usual U.S. sequestration rates under various climate change scenarios show both increases and decreases in carbon storage depending on various assumptions. To date, few analyses of the potential for additional sequestration over time have considered the future effects of climate change

### A2 Adaptation

#### The rate of climate change prevents adaptation

Romm ’07 [Joseph, Senior Fellow at Center for American Progress, Aug 29, “Hurricane Katrina and the Myth of Global Warming Adaptation,” http://gristmill.grist.org/story/2007/8/29/94352/7786]

If we won't adapt to the realities of having one city below sea level in hurricane alley, what are the chances we are going to adapt to the realities of having all our great Gulf and Atlantic Coast cities at risk for the same fate as New Orleans -- since sea level from climate change will ultimately put many cities, like Miami, below sea level? And just how do you adapt to sea levels rising 6 to 12 inches a decade for centuries, which well may be our fate by 2100 if we don't reverse greenhouse-gas emissions trends soon. Climate change driven by human-caused GHGs is already happening much faster than past climate change from natural causes -- and it is accelerating.

#### Even if adaptation was possible – non-linear impacts disrupt the process

Mazo 2010 [Jeffrey Mazo, Managing Editor, Survival and Research Fellow for Environmental Security and Science Policy at the International Institute for Strategic Studies in London, 3-2010, “Climate Conflict: How global warming threatens security and what to do about it,” pg. 29]

This latter aspect, the rate of change, is a critical factor in terms of adapting to climate change. Although some states and societies will be better able to adapt to change than others, regardless of how resilient a given society is there will always be some point at which its efforts would be overwhelmed by the pace of change. Changes in climate - long-term wind and rainfall patterns, daily and seasonal temperature variations, and so on - will produce physical effects such as droughts, floods and increasing severity of typhoons and hurricanes, and ecological effects such as changes in the geographical range of species (including disease-causing organisms, domesticated crops and crop pests). These physical changes in turn may lead to effects such as disruption of water resources, declining crop yields and food stocks, wildfires, severe disease outbreaks, and an increase in numbers of refugees and internally displaced persons.4

## Impacts

### Warming Outweighs

#### Warming outweighs

#### a. Survival—it’s the only existential risk—collapses global sustainability—outweighs nuclear war

Doebbler 2011.

[Curtis, International Human Rights Lawyer. Two threats to our existence. Ahram Weekly. July 2011. <http://weekly.ahram.org.eg/2011/1055/envrnmnt.htm>, CMR]

**No other threat** -- **including war**, **nuclear disasters**, **rogue regimes**, **terrorism**, or the fiscal irresponsibility of governments -- is reliably predicted to cause **so much harm to** so many people on earth, and indeed to **the earth itself.** The **I**nternational **P**anel on **C**limate **C**hange, which won the Nobel Prize for its evaluation of thousands of research studies to provide us accurate information on climate change, has predicted that under the current scenario of "business-as-usual", temperatures could rise by as much as **10 degrees** Celsius in some parts of the world. This would have horrendous consequences for the most vulnerable people in the world. Consequences that the past spokesman of 136 developing countries, Lumumba Diaping, described as the equivalent of sending hundreds of millions of Africans to the furnace. Yet for more than two decades, states have failed to take adequate action to either prevent climate change or to deal with its consequences. A major reason for this is that many wealthy industrialised countries view climate change as at worst an inconvenience, or at best even a potential market condition from which they can profit at the expense of developing countries. Indeed, history has shown them that because of their significantly higher levels of population they have grown rich and been able to enslave, exploit and marginalise their neighbours in developing countries. They continue in this vein.

#### Science proves—it causes extinction and outweighs nuclear war

Deibel 2007

[Terry L. Deibel, professor of IR @ National War College, 2007, Foreign Affairs Strategy, Conclusion: American Foreign Affairs Strategy Today, CMR]

Droughts, floods, and violent storms Consensus Disease and Illness 26% of GDP—Economy Thermohaline circulation collapse Runaway green house warming Positive Feedback, H2O vapor More true than Nuclear Winter Finally, there is one major existential threat to American security (as well as prosperity) of a nonviolent nature, which, though far in the future, demands urgent action. It is the threat of global warming to the stability of the climate upon which all earthly life depends. Scientists worldwide have been observing the gathering of this threat for three decades now, and what was once a mere possibility has passed through probability to near certainty. Indeed not one of more than 900 articles on climate change published in refereed scientific journals from 1993 to 2003 doubted that anthropogenic warming is occurring. “In legitimate scientific circles,” writes Elizabeth Kolbert, “it is virtually impossible to find evidence of disagreement over the fundamentals of global warming.” Evidence from a vast international scientific monitoring effort accumulates almost weekly, as this sample of newspaper reports shows: an international panel predicts “brutal droughts, floods and violent storms across the planet over the next century”; climate change could “literally alter ocean currents, wipe away huge portions of Alpine Snowcaps and aid the spread of cholera and malaria”; “glaciers in the Antarctic and in Greenland are melting much faster than expected, and…worldwide, plants are blooming several days earlier than a decade ago”; “rising sea temperatures have been accompanied by a significant global increase in the most destructive hurricanes”; “NASA scientists have concluded from direct temperature measurements that 2005 was the hottest year on record, with 1998 a close second”; “Earth’s warming climate is estimated to contribute to more than 150,000 deaths and 5 million illnesses each year” as disease spreads; “widespread bleaching from Texas to Trinidad…killed broad swaths of corals” due to a 2-degree rise in sea temperatures. “The world is slowly disintegrating,” concluded Inuit hunter Noah Metuq, who lives 30 miles from the Arctic Circle. “They call it climate change…but we just call it breaking up.” From the founding of the first cities some 6,000 years ago until the beginning of the industrial revolution, carbon dioxide levels in the atmosphere remained relatively constant at about 280 parts per million (ppm). At present they are accelerating toward 400 ppm, and by 2050 they will reach 500 ppm, about double pre-industrial levels. Unfortunately, atmospheric CO2 lasts about a century, so there is no way immediately to reduce levels, only to slow their increase, we are thus in for significant global warming; the only debate is how much and how serious the effects will be. As the newspaper stories quoted above show, we are already experiencing the effects of 1-2 degree warming in more violent storms, spread of disease, mass die offs of plants and animals, species extinction, and threatened inundation of low-lying countries like the Pacific nation of Kiribati and the Netherlands at a warming of 5 degrees or less the Greenland and West Antarctic ice sheets could disintegrate, leading to a sea level of rise of 20 feet that would cover North Carolina’s outer banks, swamp the southern third of Florida, and inundate Manhattan up to the middle of Greenwich Village. Another catastrophic effect would be the collapse of the Atlantic thermohaline circulation that keeps the winter weather in Europe far warmer than its latitude would otherwise allow. Economist William Cline once estimated the damage to the United States alone from moderate levels of warming at 1-6 percent of GDP annually; severe warming could cost 13-26 percent of GDP. But the most frightening scenario is runaway greenhouse warming, based on positive feedback from the buildup of water vapor in the atmosphere that is both caused by and causes hotter surface temperatures. Past ice age transitions, associated with only 5-10 degree changes in average global temperatures, took place in just decades, even though no one was then pouring ever-increasing amounts of carbon into the atmosphere. Faced with this specter, the best one can conclude is that “humankind’s continuing enhancement of the natural greenhouse effect is akin to playing Russian roulette with the earth’s climate and humanity’s life support system. At worst, says physics professor Marty Hoffert of New York University, “we’re just going to burn everything up; we’re going to heat the atmosphere to the temperature it was in the Cretaceous when there were crocodiles at the poles, and then everything will collapse.” During the Cold War, astronomer Carl Sagan popularized a theory of nuclear winter to describe how a thermonuclear war between the Untied States and the Soviet Union would not only destroy both countries but possible end life on this planet. Global warming is the post-Cold War era’s equivalent of nuclear winter at least as serious and considerably better supported scientifically. Over the long run it puts dangers form terrorism and traditional military challenges to shame. It is a threat not only to the security and prosperity to the United States, but potentially to the continued existence of life on this planet.

#### Only scenario for nuclear war—no restraint

Dyer 2009

[Gwynne, MA in Military History and PhD in Middle Eastern History former @ [Senior Lecturer](file:///C%3A%5Cwiki%5CSenior_Lecturer) in War Studies at the [Royal Military Academy Sandhurst](file:///C%3A%5Cwiki%5CRoyal_Military_Academy_Sandhurst), Climate Wars]

THIS BOOK IS AN ATTEMPT, peering through a glass darkly, to understand the politics and the strategies of the potentially apocalyptic crisis that looks set to occupy most of the twenty­first century. There are now many books available that deal with the science of climate change and some that suggest pos­sible approaches to getting the problem under control, but there are few that venture very far into the grim detail of how real countries experiencing very different and, in some cases, overwhelming pressures as global warming proceeds, are likely to respond to the changes. Yet we all know that it's mostly politics, national and international, that will decide the outcomes. Two things in particular persuaded me that it was time to write this book. One was the realization that the first and most important impact of climate change on human civiliza­tion will be an **acute** and **permanent** crisis of food supply. Eating regularly is a non-negotiable activity, and countries that cannot feed their people are **unlikely to be "reasonable"** about it. Not all of them will be in what we used to call the "Third World" -the developing countries of Asia, Africa and Latin America. The other thing that finally got the donkey's attention was a dawning awareness that, in a number of the great pow­ers, climate change scenarios are already playing a **large** and **increasing role** in the military planning process. Rationally, you would expect this to be the case, because each country pays its professional military establishment to identify and counter "threats" to its security, but the implications of their scenarios are still alarming. There is a probability of wars, including even **nuclear wars,** if temperatures rise two to three degrees Celsius. Once that happens, all hope of international cooperation to curb emissions and stop the warming goes out the window.

#### Scope – causes war and magnifies all impacts—biod, food security, prolif, econ

Renner 2010

[Michael, Senior researcher at Worldwatch Institute and director of the Institute's Global Security Project, Jan/Feb, “CLIMATE WARMING DEMANDS FRESH THINKING ABOUT SECURITY POLICY.”, Ebsco]

Climate change may very well be the biggest challenge our civilization has ever faced. Left unaddressed, the effects on natural systems, biodiversity, food security, and habitability will likely be calamitous and the economic penalties severe. And in the absence of increased cooperation, runaway climate change may well trigger a whole new age of conflict. We live, after all, in a world marked by profound inequalities, unresolved grievances, and tremendous disparities of power. Ruled by competitive nation-states and rootless global corporations, our planet bristles with arms of all calibers. Under such circumstances, the additional stress imposed by climate change could have tremendous repercussions for human well-being, safety, and security. Nations around the world, but particularly the weakest countries and communities, confront a multitude of pressures. Many face a debilitating combination of rising competition for resources, severe environmental breakdown, the resurgence of infectious diseases, poverty and growing wealth disparities, demographic pressures, and joblessness and livelihood insecurity. Climate change is certain to intensify many, if not all, of these challenges. More frequent and intense droughts, floods, and storms will play havoc with harvests and weaken food security. Extreme weather events, sea-level rise, and spreading disease vectors could conceivably undermine the long-term habitability of some areas. Together with reduced economic viability, the result could be escalating social discontent and large-scale involuntary population movements, severely testing national and international institutions. Possible conflict constellations revolve around resource access, natural disaster impacts, and refugee and migrant flows (see figure b

### Impact – General Extinction

#### Makes multiple short-term and long-term crises inevitable

Hansen 5-9-2012

[James, professor in the Department of Earth and Environmental Sciences at Columbia University and at Columbia’s Earth Institute, and director of the NASA Goddard Institute for Space Studies, “Game Over for the Climate”, http://www.nytimes.com/2012/05/10/opinion/game-over-for-the-climate.html]

Canada’s tar sands, deposits of sand saturated with bitumen, contain twice the amount of carbon dioxide emitted by global oil use in our entire history. If we were to fully exploit this new oil source, and continue to burn our conventional oil, gas and coal supplies, concentrations of carbon dioxide in the atmosphere eventually would reach levels higher than in the Pliocene era, more than 2.5 million years ago, when sea level was at least 50 feet higher than it is now. That level of heat-trapping gases would assure that the disintegration of the ice sheets would accelerate out of control. Sea levels would rise and destroy coastal cities. Global temperatures would become intolerable. Twenty to 50 percent of the planet’s species would be driven to extinction. Civilization would be at risk. That is the long-term outlook. But near-term, things will be bad enough. Over the next several decades, the Western United States and the semi-arid region from North Dakota to Texas will develop semi-permanent drought, with rain, when it does come, occurring in extreme events with heavy flooding. Economic losses would be incalculable. More and more of the Midwest would be a dust bowl. California’s Central Valley could no longer be irrigated. Food prices would rise to unprecedented levels. If this sounds apocalyptic, it is. This is why we need to reduce emissions dramatically. President Obama has the power not only to deny tar sands oil additional access to Gulf Coast refining, which Canada desires in part for export markets, but also to encourage economic incentives to leave tar sands and other dirty fuels in the ground. The global warming signal is now louder than the noise of random weather, as I predicted would happen by now in the journal Science in 1981. Extremely hot summers have increased noticeably. We can say with high confidence that the recent heat waves in Texas and Russia, and the one in Europe in 2003, which killed tens of thousands, were not natural events — they were caused by human-induced climate change. We have known since the 1800s that carbon dioxide traps heat in the atmosphere. The right amount keeps the climate conducive to human life. But add too much, as we are doing now, and temperatures will inevitably rise too high. This is not the result of natural variability, as some argue. The earth is currently in the part of its long-term orbit cycle where temperatures would normally be cooling. But they are rising — and it’s because we are forcing them higher with fossil fuel emissions.

#### Positive feedbacks make it the most likely scenario for extinction

Ahmed 2010

[Nafeez Ahmed, Executive Director of the Institute for Policy Research and Development, professor of International Relations and globalization at Brunel University and the University of Sussex, Spring/Summer 2010, “Globalizing Insecurity: The Convergence of Interdependent Ecological, Energy, and Economic Crises,” Spotlight on Security, Volume 5, Issue 2, online]

Perhaps the most notorious indicator is anthropogenic global warming. The landmark 2007 Fourth Assessment Report of the UN Intergovernmental Panel on Climate Change (IPCC) – which warned that at then-current rates of increase of fossil fuel emissions, the earth’s global average temperature would likely rise by 6°C by the end of the 21st century creating a largely uninhabitable planet – was a wake-up call to the international community.[v] Despite the pretensions of ‘climate sceptics,’ the peer-reviewed scientific literature has continued to produce evidence that the IPCC’s original scenarios were wrong – not because they were too alarmist, but on the contrary, because they were far too conservative. According to a paper in the Proceedings of the National Academy of Sciences, current CO2 emissions are worse than all six scenarios contemplated by the IPCC. This implies that the IPCC’s worst-case six-degree scenario severely underestimates the most probable climate trajectory under current rates of emissions.[vi] It is often presumed that a 2°C rise in global average temperatures under an atmospheric concentration of greenhouse gasses at 400 parts per million (ppm) constitutes a safe upper limit – beyond which further global warming could trigger rapid and abrupt climate changes that, in turn, could tip the whole earth climate system into a process of irreversible, runaway warming.[vii] Unfortunately, we are already well past this limit, with the level of greenhouse gasses as of mid-2005 constituting 445 ppm.[viii] Worse still, cutting-edge scientific data suggests that the safe upper limit is in fact far lower. James Hansen, director of the NASA Goddard Institute for Space Studies, argues that the absolute upper limit for CO2 emissions is 350 ppm: “If the present overshoot of this target CO2 is not brief, there is a possibility of seeding irreversible catastrophic effects.”[ix] A wealth of scientific studies has attempted to explore the role of positive-feedback mechanisms between different climate sub-systems, the operation of which could intensify the warming process. Emissions beyond 350 ppm over decades are likely to lead to the total loss of Arctic sea-ice in the summer triggering magnified absorption of sun radiation, accelerating warming; the melting of Arctic permafrost triggering massive methane injections into the atmosphere, accelerating warming; the loss of half the Amazon rainforest triggering the momentous release of billions of tonnes of stored carbon, accelerating warming; and increased microbial activity in the earth’s soil leading to further huge releases of stored carbon, accelerating warming; to name just a few. Each of these feedback sub-systems alone is sufficient by itself to lead to irreversible, catastrophic effects that could tip the whole earth climate system over the edge.[x] Recent studies now estimate that the continuation of business-as-usual would lead to global warming of three to four degrees Celsius before 2060 with multiple irreversible, catastrophic impacts; and six, even as high as eight, degrees by the end of the century – a situation endangering the survival of all life on earth.[xi]

### Impact – Ocean Acidification

**Unchecked C02 levels acidifies the oceans – kills all marine life**

**Koebler 8/1**/12 – science and technology reporter for U.S. News & World Report (Jason, “NOAA: Oceans' Reefs at Risk From Carbon Emissions”, http://www.usnews.com/news/articles/2012/08/01/noaa-oceans-reefs-at-risk-from-carbon-emissions, CMR)

Not all carbon emissions find their way into Earth's atmosphere—about half of it is absorbed by vegetation and the world's oceans. On the one hand, that helps limit carbon's climate-changing effects. But on the other, it can deliver what a National Oceanic and Atmospheric Administration scientist calls a "double whammy" to the oceans.¶ That's because carbon dioxide (CO2) is a weak acid, and when it's absorbed by water, it contributes to ocean acidification, which can kill **coral reefs** and **shellfish**, wreaking havoc on undersea plant and animal life.¶ As humans have increased their carbon emissions over the past 100 years, vegetation and the world's surface oceans have been working overtime to absorb about half of it, about the same proportion as 50 years ago, according to the study, published Wednesday in Nature.¶ "Humanity is getting an assist on climate change from natural systems, otherwise the carbon dioxide in the atmosphere would be twice as high," says Pieter Tans, one of the study's authors. "But CO2 is an acid and the amounts [being absorbed by the ocean] are **so massive** that I don't see how we can remedy coming acidification."¶ Reforestation in parts of North America and China and deforestation slowdowns in other parts of the world have allowed plants to bear some of the burden, but he says the ocean is working overtime to pull in more carbon than ever before.¶ But even though Earth is absorbing a similar proportion of carbon as it was 50 years ago, overall human emissions have **greatly increased**, meaning sea temperatures are rising even as they acidify. According to a Scripps Institution of Oceanography study released earlier this year, ocean temperatures have increased by about half a degree over the past 100 years; many scientists say that increase has been responsible for an increase in the **severity** and **frequency** of hurricanes.¶ "Sea temperature change comes from climate change, but they're also acidifying," Tans says. "The oceans get a double whammy."¶ While increasing carbon emissions may take longer to wreak havoc on the world's climate, it could deal a **death blow** to vulnerable coral reefs, which shelter millions of plant and animal species, Tans says.¶ "Acidification is a concern for sea life—for the atmosphere, it's a good thing our oceans are absorbing so much carbon, but as the oceans acidify, it'll affect [coral reefs and shellfish], and **work its way up the food chain**," he says. "At some point, [reefs] are endangered. We're not too far away from that."¶

**Extinction**

Kristof 6 (NICHOLAS D. KRISTOF, American journalist, author, op-ed columnist, and a winner of two Pulitzer Prizes, “Scandal Below the Surface”, Oct 31, 2006, http://select.nytimes.com/2006/10/31/opinion/31kristof.html?\_r=1, CMR)

If you think of the earth’s surface as a great beaker, then it’s filled mostly with ocean water. It is slightly alkaline, and that’s what creates a hospitable home for fish, coral reefs and plankton — and indirectly, higher up the food chain, for us. But scientists have discovered that the carbon dioxide (CO2) we’re spewing into the air doesn’t just heat up the atmosphere and lead to rising seas. Much of that carbon is absorbed by the oceans, and there it produces carbonic acid — the same stuff found in soda pop. That makes oceans a bit more acidic, impairing the ability of certain shellfish to produce shells, which, like coral reefs, are made of calcium carbonate. A recent article in Scientific American explained the indignity of being a dissolving mollusk in an acidic ocean: “Drop a piece of chalk (calcium carbonate) into a glass of vinegar (a mild acid) if you need a demonstration of the general worry: the chalk will begin dissolving immediately.” The more acidic waters may spell the end, at least in higher latitudes, of some of the tiniest variations of shellfish — certain plankton and tiny snails called pteropods. This would **disrupt the food chain,** possibly killing off many whales and fish, and rippling up all the way to humans. We stand, so to speak, on the shoulders of plankton. “There have been a couple of very big events in geological history where the carbon cycle changed dramatically,” said Scott Doney, senior scientist at the Woods Hole Oceanographic Institution in Massachusetts. One was an abrupt warming that took place 55 million years ago in conjunction with acidification of the oceans and **mass extinctions**. Most scientists don’t believe we’re headed toward a man-made variant on that episode — not **yet**, at any rate. But many worry that we’re hurtling into unknown dangers. “Whether in 20 years or 100 years, I think marine ecosystems are going to be dramatically different by the end of this century, and that’ll lead to **extinction events**,” Mr. Doney added. “This is the only habitable planet we have,” he said. “The damage we do is going to be felt by **all the generations to come.”** So that should be one of the great political issues for this century — the vandalism we’re committing to our planet because of our refusal to curb greenhouse gases. Yet the subject is barely debated in this campaign. Changes in ocean chemistry are only one among many damaging consequences of carbon emissions. Evidence is also growing about the more familiar dangers: melting glaciers, changing rainfall patterns, rising seas and more powerful hurricanes. Last year, the World Health Organization released a study indicating that climate change results in an extra 150,000 deaths and five million sicknesses each year, by causing the spread of malaria, diarrhea, malnutrition and other ailments. A report prepared for the British government and published yesterday, the Stern Review on the Economics of Climate Change, warned that inaction “could create risks of major disruption to economic and social activity, on a scale similar to those associated with the great wars and the economic depression of the first half of the 20th century.” If emissions are not curbed, climate change will cut 5 percent to 20 percent of global G.D.P. each year, declared the mammoth report. “In contrast,” it said, “the costs of action — reducing greenhouse gas emissions to avoid the worst impacts of climate change — can be limited to around 1 percent of global G.D.P. each year.” Some analysts put the costs of action higher, but most agree that it makes sense to invest far more in alternative energy sources, both to wean ourselves of oil and to reduce the strain on our planet. We know what is needed: a carbon tax or cap-and-trade system, a post-Kyoto accord on emissions cutbacks, and major research on alternative energy sources. But as The Times’s Andrew Revkin noted yesterday, spending on energy research and development has fallen by more than half, after inflation, since 1979.

### Impact – Food

#### Even a small rise in global temperature would lead to mass starvation despite CO2 fertilization resulting in extinction

Robert Strom, Professor Emeritus of planetary sciences in the Department of Planetary Sciences at the University of Arizona, 2007(studied climate change for 15 years, the former Director of the Space Imagery Center, a NASA Regional Planetary Image Facility, “Hot House”, SpringerLink, p. 211-216)

THE future consequences of global warming are the least known aspect of the problem. They are based on highly complex computer models that rely on inputs that are sometimes not well known or factors that may be completely unforeseen. Most models assume certain scenarios concerning the rise in greenhouse gases. Some assume that we continue to release them at the current rate of increase while others assume that we curtail greenhouse gas release to one degree or another. Furthermore, we are in completely unknown territory. The current greenhouse gas content of the atmosphere has not been as high in at least the past 650,000 years, and the rise in temperature has not been as rapid since civilization began some 10,000 years ago. What lies ahead for us is not completely understood, but it certainly will not be good, and it could be catastrophic. We know that relatively minor climatic events have had strong adverse effects on humanity, and some of these were mentioned in previous chapters. A recent example is the strong El Nin~o event of 1997-1998 that caused weather damage around the world totaling $100 billion: major flooding events in China, massive fires in Borneo and the Amazon jungle, and extreme drought in Mexico and Central America. That event was nothing compared to what lies in store for us in the future if we do nothing to curb global warming. We currently face the greatest threat to humanity since civilization began. This is the crucial, central question, but it is very difficult to answer (Mastrandea and Schneider, 2004). An even more important question is: "At what temperature and environmental conditions is a threshold crossed that leads to an abrupt and catastrophic climate change?'' It is not possible to answer that question now, but we must be aware that in our ignorance it could happen in the not too distant future. At least the question of a critical temperature is possible to estimate from studies in the current science literature. This has been done by the Potsdam Institute for Climate Impact Research, Germany's leading climate change research institute (Hare, 2005). According to this study, global warming impacts multiply and accelerate rapidly as the average global temperature rises. We are certainly beginning to see that now. According to the study, as the average global temperature anomaly rises to 1 °C within the next 25 years (it is already 0.6'C in the Northern Hemisphere), some specialized ecosystems become very stressed, and in some developing countries food production will begin a serious decline, water shortage problems will worsen, and there will be net losses in the gross domestic product (GDP). At least one study finds that because of the time lags between changes in radiative forcing we are in for a 1 °C increase before equilibrating even if the radiative forcing is fixed at today's level (Wetherald et al., 2001). It is apparently when the temperature anomaly reaches 2 °C that serious effects will start to come rapidly and with brute force (International Climate Change Taskforce, 2005). At the current rate of increase this is expected to happen sometime in the middle of this century. At that point there is nothing to do but try to adapt to the changes. Besides the loss of animal and plant species and the rapid exacerbation of our present problems, there are likely to be large numbers of hungry, diseased and starving people, and at least 1.5 billion people facing severe water shortages. GDP losses will be significant and the spread of diseases will be widespread (see below). We are only about 30 years away from the 440 ppm CO2 level where the eventual 2'C global average temperature is probable. When the temperature reaches 3 'C above today's level, the effects appear to become absolutely critical. At the current rate of greenhouse gas emission, that point is expected to be reached in the second half of the century. For example, it is expected that the Amazon rainforest will become irreversibly damaged leading to its collapse, and that the complete destruction of coral reefs will be widespread. As these things are already happening, this picture may be optimistic. As for humans, there will be widespread hunger and starvation with up to 5.5 billion people living in regions with large crop losses and another 3 billion people with serious water shortages. If the Amazon rainforest collapses due to severe drought it would result in decreased uptake of CO2 from the soil and vegetation of about 270 billion tons, resulting in an enormous increase in the atmospheric level of CO2. This, of course, would lead to even hotter temperatures with catastrophic results for civilization. A Regional Climate Change Index has been established that estimates the impact of global warming on various regions of the world (Giorgi, 2006). The index is based on four variables that include changes in surface temperature and precipitation in 2080-2099 compared to the period 1960-1979. **All regions of the world are affected** significantly, but some regions are much more vulnerable than others. The biggest impacts occur in the Mediterranean and northeastern European regions, followed by high-latitude Northern Hemisphere regions and Central America. Central America is the most affected tropical region followed by southern equatorial Africa and southeast Asia. Other prominent mid-latitude regions very vulnerable to global warming are eastern North America and central Asia. It is entirely obvious that we must start curtailing greenhouse gas emissions now, not 5 or 10 or 20 years from now. Keeping the global average temperature anomaly under 2'C will not be easy according to a recent report (Scientific Expert Group Report on Climate Change, 2007). It will require a rapid worldwide reduction in methane, and global CO2 emissions must level off to a concentration not much greater than the present amount by about 2020. Emissions would then have to decline to about a third of that level by 2100. Delaying action will only insure a grim future for our children and grandchildren. If the current generation does not drastically reduce its greenhouse gas emission, then, unfortunately, our grandchildren will get what we deserve. There are three consequences that have not been discussed in previous chapters but could have devastating impacts on humans: food production, health, and the economy. In a sense, all of these topics are interrelated, because they affect each other. Food Production Agriculture is critical to the survival of civilization. Crops feed not only us but also the domestic animals we use for food. Any disruption in food production means a disruption of the economy, government, and health. The increase in CO2 will result in some growth of crops, and rising temperatures will open new areas to crop production at higher latitudes and over longer growing seasons; however, the overall result will be decreased crop production in most parts of the world. A 1993 study of the effects of a doubling of CO2 (550 ppm) above pre-industrial levels shows that there will be substantial decreases in the world food supply (Rosenzweig et al., 1993). In their research they studied the effects of global warming on four crops (wheat, rice, protein feed, and coarse grain) using four scenarios involving various adaptations of crops to temperature change and CO2 abundance. They found that the amount of world food reduction ranged from 1 to 27%. However, the optimistic value of 1% is almost certainly much too low, because it assumed that the amount of degradation would be offset by more growth from "CO2 fertilization." We now know that this is not the case, as explained below and in Chapter 7. The most probable value is a worldwide food reduction between 16 and 27%. These scenarios are based on temperature and CO2 rises that may be too low, as discussed in Chapter 7. However, even a decrease in world food production of 16% would lead to large-scale starvation in many regions of the world. Large-scale experiments called Free-Air Concentration Enrichment have shown that the effects of higher CO2 levels on crop growth is about 50% less than experiments in enclosure studies (Long et al., 2006). This shows that the projections that conclude that rising CO2 will fully offset the losses due to higher temperatures are wrong. The downside of climate change will far outweigh the benefits of increased CO2 and longer growing seasons. One researcher (Prof. Long) from the University of Illinois put it this way: Growing crops much closer to real conditions has shown that increased levels of carbon dioxide in the atmosphere will have roughly half the beneficial effects previously hoped for in the event of climate change. In addition, ground-level ozone, which is also predicted to rise but has not been extensively studied before, has been shown to result in a loss of photosynthesis and 20 per cent reduction in crop yield. Both these results show that we need to seriously re-examine our predictions for future global food production, as they are likely to be far lower than previously estimated. Also, studies in Britain and Denmark show that only a few days of hot temperatures can severely reduce the yield of major food crops such as wheat, soy beans, rice, and groundnuts if they coincide with the flowering of these crops. This suggests that there are certain thresholds above which crops become very vulnerable to climate change. The European heat wave in the summer of 2003 provided a large-scale experiment on the behavior of crops to increased temperatures. Scientists from several European research institutes and universities found that the growth of plants during the heat wave was reduced by nearly a third (Ciais et al., 2005). In Italy, the growth of corn dropped by about 36% while oak and pine had a growth reduction of 30%. In the affected areas of the mid- west and California the summer heat wave of 2006 resulted in a 35% loss of crops, and in California a 15% decline in dairy production due to the heat-caused death of dairy cattle. It has been projected that a 2 °C rise in local temperature will result in a $92 million loss to agriculture in the Yakima Valley of Washington due to the reduction of the snow pack. A 4'C increase will result in a loss of about $163 million. For the first time, the world's grain harvests have fallen below the consumption level for the past four years according to the Earth Policy Institute (Brown, 2003). Furthermore, the shortfall in grain production increased each year, from 16 million tons in 2000 to 93 million tons in 2003. These studies were done in industrialized nations where agricultural practices are the best in the world. In developing nations the impact will be much more severe. It is here that the impact of global warming on crops and domestic animals will be most felt. In general, the world's most crucial staple food crops could fall by as much as one-third because of resistance to flowering and setting of seeds due to rising temperatures. Crop ecologists believe that many crops grown in the tropics are **near, or** at, their thermal limits**. Already** research **in the Philippines** has linked higher night-time temperatures to a reduction in rice yield. It is estimated that for rice, wheat, and corn, the grain yields are likely to decline by 10% for every local 1 °C increase in temperature. With a decreasing availability of food, malnutrition will become more frequent accompanied by damage to the immune system. This will result in a greater susceptibility to spreading diseases. For an extreme rise in global temperature (> 6 'C), it is likely that worldwide crop failures will lead to mass starvation, and political and economic chaos with all their ramifications for civilization.

## A2 DAs

### 2AC CO2 Ag

#### 1. Warming kills agriculture

#### A. Drought

Pappas 7-25-2012

[Stephanie, LiveScience Senior Writer, “Ongoing Drought Hits Crops Hard”, http://www.livescience.com/21845-ongoing-drought-crop-prices.html]

"Global warming helps make droughts hotter and drier than they would be without human influence," said Heidi Cullen, the chief climatologist for Climate Central, a non-profit organization dedicated to communicating the science of climate change. Cullen and Stanford University food security expert David Lobell spoke to the media on Wednesday about the effect of the current drought on agriculture. The price of corn has risen by 50 percent, to $8 a bushel, from where it was last month. And a U.S. Department of Agriculture report released today suggests that consumers can expect to see the price of meat and dairy products rise as feed for livestock becomes more expensive. "It's not really going to affect the price of a loaf of bread or a corn muffin directly, but it will affect the price of meat," Lobell said. "The real impact you see is in the countries where they really rely on raw corn and wheat for a larger part of their diet." Drought worldwide Sixty-three percent of the area of the lower 48 U.S. states is in moderate to exceptional drought, Cullen said, but the weather and agriculture story is really a global one. Low rainfall in Australia, a late, weak monsoon in India, heat waves in Europe and a La Niña drought in Brazil have all impacted growing seasons, she said. U.S. agriculture is important globally, because America produces much of the world's grain. According to the Environmental Protection Agency, the United States produced 10 billion of the world's 23 billion bushels of corn in 2000. The U.S. produces 13 percent of the world's wheat and more than 50 percent of its soybeans. A combination of factors has led to what climatologists and meteorologists call a "flash drought" in much of the United States, including the agricultural center of the Corn Belt, Cullen said. [Worst Droughts in U.S. History] La Niña, a climate pattern that pushes storm tracks north, set up this southern drought with dry conditions, Cullen said. Oppressively hot conditions in June and July followed, breaking records and sealing the deal for drought. "Large portions of the Corn Belt need at least a foot of rain to effectively end the drought," Cullen said. Drought and food security To make matters worse, the drought hits at a time of tight demand worldwide, Lobell said. The last major drought in 1988 didn't affect food prices very much, he said. But now, with ethanol production eating up 40 percent of U.S. corn and demand for meat growing worldwide, the market is tight. The United States has been spared much of the heat seen in Europe and Russia in recent years, but this year could mark the end of that good luck. Droughts happen naturally, Cullen said, but climate change increases their likelihood, and exacerbates their severity. Climate models suggest that a warming world will bring more drought to the Mediterranean, central North America, the U.S. Southwest and southern Africa, she said.

#### B. Temperature

Hatfield 2011

[J.L. Hatfield, Laboratory Director, National Laboratory for Agriculture and the Environment; K.J. Boote, Agronomy Department, University of Florida; B.A. Kimball, USDA-ARS, U.S. Arid-Land Agricultural Research Center; L.H. Ziska, USDA Crop Systems and Global Change Laboratory; R.C. Izaurralde, Joint Global Change Research Institute, Pacific Northwest National Laboratory, University of Maryland; D.R. Ort, USDA/ARS, Photosynthesis Research Unit, University of Illinois; A. M. Thomson, Joint Global Change Research Institute, Pacific Northwest National Laboratory, University of Maryland; David W. Wolfe, Department of Horticulture, Cornell University, 2011, “Climate Impacts on Agriculture: Implications for Crop Production,” Agronomy Journal, Volume 103, Issue 2]

Crop species respond differently to temperature throughout their life cycles. Each species has a defined range of maximum and minimum temperatures within which growth occurs and an opti- mum temperature at which plant growth progresses at its fastest rate (Table 2). Growth rates slow as temperature increases above the optimum and cease when plants are exposed to their maximum (ceiling) temperature. Vegetative development (node and leaf appearance rate) hastens as temperatures increase up to the species optimum temperature. Vegetative development usually has a higher optimum temperature than reproductive development. Progression of a crop through phenological phases is accelerated by increasing temperatures up to the species-dependent optimum temperature. There are differences among annual (nonperennial) crop species in their cardinal temperature values as shown in Table 2. Values reported in Table 2 represent conditions in which temperature is the only limiting variable. It is important to realize that plant temperatures can be quite different than air temperatures and can be warmer than air under water stressed conditions or cooler than air under adequate soil water conditions. A recent review by Hatfield et al. (2004) provides a summary of the current use of plant temperatures to quantify water stress in plants. Plant temperatures are measured with either attached thermometers to the leaf that are difficult to maintain or with relatively expensive infrared thermometers, and therefore plant temperatures have been observed much less often than air temperatures. Consequently, evaluations of plant responses to changes in temperature have been focused on air temperature rather than plant or canopy temperatures, including the values given in Table 2. Exposure to higher temperatures causes faster development in nonperennial crops, which does not translate into an optimum for maximum production because the shorter life cycle means smaller plants, a shortened reproductive phase duration, and reduced yield potential because of reduced cumulative light interception during the growing season. Observations across species have shown optimum temperatures for yield are generally lower than the optimum temperature for leaf appearance rate, vegetative growth, or reproductive progression (Table 2). Yield may be impacted when temperatures fall below or above specific thresholds at critical times during development. The duration of the crop life cycle is determined by temperature and the location of specific cultivars to given production zones is a reflection of their specific temperature response. Another factor that has a major role in life cycle progression in many crops, especially for soybean, is the daylength sensitivity. One of the critical phenological stages for high temperature impacts is the reproductive stage because of the effect on pollen viability, fertilization, and grain or fruit formation. Yield potential will be affected by chronic exposures to high temperatures during the pollination stage of initial grain or fruit set. Temperature extremes during the reproductive stage of development can produce some of the largest impacts on crop production. Schlenker and Roberts (2009) have emphasized the importance of considering the nonlinearity of temperature effects on yield (the slope of the decline in yields above the optimum temperature is often steeper than the incline below it) in projecting climate change impacts. Temperature effects on individual species are discussed in the following section.

#### 2. These factors outweigh CO2 benefits

Hatfield 2011

[J.L. Hatfield, Laboratory Director, National Laboratory for Agriculture and the Environment; K.J. Boote, Agronomy Department, University of Florida; B.A. Kimball, USDA-ARS, U.S. Arid-Land Agricultural Research Center; L.H. Ziska, USDA Crop Systems and Global Change Laboratory; R.C. Izaurralde, Joint Global Change Research Institute, Pacific Northwest National Laboratory, University of Maryland; D.R. Ort, USDA/ARS, Photosynthesis Research Unit, University of Illinois; A. M. Thomson, Joint Global Change Research Institute, Pacific Northwest National Laboratory, University of Maryland; David W. Wolfe, Department of Horticulture, Cornell University, 2011, “Climate Impacts on Agriculture: Implications for Crop Production,” Agronomy Journal, Volume 103, Issue 2]

Climate change, either as increasing trends in temperature, CO2, precipitation (decreasing as well as increasing), and/or O3, will have impacts on agricultural systems. Production of annual and perennial crops will be affected by changes in the absolute values of these climatic variables and/or increased variation. Episodic temperature changes exceeding the thresholds during the pollination stage of development could be quite damaging to crop production because of the sensitivity of crop plants to temperature extremes during this growth stage. These changes coupled with variable precipitation that places the plant under conditions of water stress would exacerbate the temperature effects. Warmer temperatures during the night, especially during the reproductive period, will reduce fruit or grain size because the rapid rate of development and increased respiration rates. A recent analysis by Ko et al. (2010), using the CERES–Wheat 4.0 module in the RZWQM2 model, evaluated the interactions of increasing CO2 obtained from a FACE experiment along with temperature, water, and N. They found the effects of water and N were greater than CO2 effects on biomass and yield and that temperature effects offset the CO2 effects. These results further confirm the concept that there are counterbalancing effects from different cli- mate variables and that development of adaptation or mitigation strategies will have to account for the combined effects of climate variables on crop growth, development, and yield. In an effort to examine potential solutions to low yields in sub-Saharan Africa, Laux et al. (2010) evaluated planting dates under climate change scenarios to evaluate the effect of increasing CO2 and higher temperature on groundnut (peanut) and maize. They found the positive effect of CO2 would offset the temperature response in the next 10 to 20 yr but would be overcome by higher temperatures by 2080. Changing planting dates were beneficial for the driest locations because of the more effective use of precipitation and avoidance of high temperature stresses. Both of these types of analyses will have to be conducted to evaluate potential adapta- tion strategies for all cropping regions. Increases in CO2 concentrations offer positive impacts to plant growth and increased WUE. However, these positive impacts may not fully mitigate crop losses associated with heat stress, increases in evaporative demand, and/or decreases in water availability in some regions. The episodic variation in extremes may become the larger impact on plant growth and yield. To counteract these effects will require management systems that offer the largest degree of resilience to climatic stresses as possible. This will include the development of man- agement systems for rainfed environments that can store the maximum amount of water in the soil profile and reduce water stress on the plant during critical growth periods.

#### 3. Other limiting factors prevent yield increases – nutrients, fisheries, pollination

Whitesell 2011

[William, Director of Policy Research at the Center for Clean Air Policy in Washington, DC, “Climate Policy Foundations: Science and Economics with Lessons from Monetary Regulation”, p. 97]

In many regions, however, water and nutrients are the limiting factors for plant growth, not CO2 and temperature. In areas where climate change lowers the rate of precipitation or reduces the availability of melted snow from mountains in critical growing seasons, crop yields will fall. In addition, too much warmth can retard the growth of plants. As noted earlier, photosynthesis is impared at temperatures above 35C (95F) and shuts down completely above 40C (Brown, 2008). At such temperatures, the key staple food crops, corn and rice, lose the ability to develop pollen. To some extend farmers may be able to alleviate such effects by switching crops and altering the times for planting and harvesting. The IPCC (2007) judged that yields would generally rise with a warming of 1C to3C, except in tropical areas. For a temperature increase of more than 3C above the 1980-1999 global average of 14.25C, however, agricultural output would generally fall, even in some high-latitude regions. Food supplies could also be impaired by lower yields from fishing. Marine life will be harmed, not only by rising temperatures, but also by a relative increase in acidity because of the ocean’s absorption of CO2, as discussed later. Finally, if the overturning circulation of the ocean slows, the reduced upwelling would mean fewer nutrients brought to the surface and therefore lower productivity for the world’s fisheries.

#### 4. CO2 emissions independently cause extinction

Romm 3-2-2012

[Joe, is a Fellow at American Progress and is the editor of Climate Progress, “Science: Ocean Acidifying So Fast It Threatens Humanity’s Ability to Feed Itself,” http://thinkprogress.org/romm/2012/03/02/436193/science-ocean-acidifying-so-fast-it-threatens-humanity-ability-to-feed-itself/?utm\_source=feedburner&utm\_medium=email&utm\_campaign=Feed%3A+climateprogre]

The world’s oceans may be turning acidic faster today from human carbon emissions than they did during four major extinctions in the last 300 million years, when natural pulses of carbon sent global temperatures soaring, says a new study in Science. The study is the first of its kind to survey the geologic record for evidence of ocean acidification over this vast time period. “What we’re doing today really stands out,” said lead author Bärbel Hönisch, a paleoceanographer at Columbia University’s Lamont-Doherty Earth Observatory. “We know that life during past ocean acidification events was not wiped out—new species evolved to replace those that died off. But if industrial carbon emissions continue at the current pace, we may lose organisms we care about—coral reefs, oysters, salmon.” That’s the news release from a major 21-author Science paper, “The Geological Record of Ocean Acidification” (subs. req’d). We knew from a 2010 Nature Geoscience study that the oceans are now acidifying 10 times faster today than 55 million years ago when a mass extinction of marine species occurred. But this study looked back over 300 million and found that “the unprecedented rapidity of CO2 release currently taking place” has put marine life at risk in a frighteningly unique way: … the current rate of (mainly fossil fuel) CO2 release stands out as capable of driving a combination and magnitude of ocean geochemical changes potentially unparalleled in at least the last ~300 My of Earth history, raising the possibility that **we are entering an unknown territory** of marine ecosystem change. That is to say, it’s not just that acidifying oceans spell marine biological meltdown “by end of century” as a 2010 Geological Society study put it. We are also warming the ocean and decreasing dissolved oxygen concentration. **That is a recipe for mass extinction**. A 2009 Nature Geoscience study found that ocean dead zones “devoid of fish and seafood” are poised to expand and “remain for thousands of years.“ And remember, we just learned from a 2012 new Nature Climate Change study that carbon dioxide is “driving fish crazy” and threatening their survival. Here’s more on the new study: The oceans act like a sponge to draw down excess carbon dioxide from the air; the gas reacts with seawater to form carbonic acid, which over time is neutralized by fossil carbonate shells on the seafloor. But if CO2 goes into the oceans too quickly, it can deplete the carbonate ions that corals, mollusks and some plankton need for reef and shell-building.

### EXT 1 – Warming = Drought

#### Warming devastates agriculture via drought

Chou 7-24-2012

[Ben, NRDC, “Another Record-breaking Drought: A Sign of Things to Come?”, http://switchboard.nrdc.org/blogs/bchou/another\_record-breaking\_drough.html]

These record-breaking drought conditions are causing widespread devastation to agricultural crops and livestock, have led to water restrictions in afflicted communities, and have impacted commerce on the Mississippi River. Nebraska has even ordered some farmers to stop irrigating crops because surface water supplies are too low. In fact, the U.S. Department of Agriculture has declared almost 1,300 counties in 29 states as disaster areas, making farmers in these counties eligible for low-interest emergency loans. As crop yields dwindle from the dry conditions, prices for corn, soybeans, and food are rising. Corn is the main ingredient in feed for cattle, chicken, and pigs so increases in the cost of animal feed will subsequently result in higher prices for meat. Increases in the prices of other commodities, like wheat and soybeans, also will likely be passed on to consumers. All told, this drought could have a $50 billion economic impact. According to recent research, we should get used to drier conditions as climate change drives temperatures higher. Scientists have concluded that conditions that led to the devastating 2011 drought in Texas are distinctly more probable now than they were just 40 to 50 years ago. In addition, rapid warming since the 1970s due to greenhouse gas emissions has significantly contributed to the widespread drying observed worldwide. And higher temperatures in the future are only expected to lead to continued drying over much of the world, including most of the U.S.

#### Warming-induced droughts kill crops

Walsh 1-24-2012

[Bryan, TIME, “Climate Change and Farming: How Not to Go Hungry in a Warmer World”, http://www.time.com/time/health/article/0,8599,2105169,00.html]

That's why the threat that climate change could mess with agriculture is so scary — and why experts are worried that we're not stepping up to the challenge. In last week's Science, an international group of leading investigators — led by John Beddington, the chief science adviser for the British government — published a call urging policymakers to ensure that agriculture becomes a more vital part of global action against climate change. "Global agriculture must produce more food to feed a growing population," they write. "Yet scientific assessments point to climate change as a growing threat to agricultural yields and food security." In other words, the potential risks to farming are one more reason we need to reduce carbon emissions soon — and the fact that the climate is already changing, and will continue to change, means that we also need to start adapting agriculture to a warmer world immediately. How exactly could climate change diminish our ability to feed ourselves? Warming alone could do it, with already hot and dry parts of the world — like the American Southwest or the Horn of Africa — predicted to become hotter and drier still. The catastrophic droughts that have gripped Texas and East Africa — leading to a devastating famine in the latter case — this past summer are likely signs of things to come. (And it's not just climate change that should cause us worry there: both regions have a history of megadroughts in the geologic past, before they were widely settled by human beings, which means even the norm may be drier than we think.) While additional carbon in the air may help some plants, warmer temperatures can also retard growth, so extreme heat could lead to greater crop loss.

### EXT 2 – Warming OW Fertilization

#### Effects of warming outweigh marginal CO2 benefits

Field 2011

[Christopher, PhD in Biology from Stanford, Director, Department of Global Ecology Carnegie Institution for Science, 3-8-2011, “CLIMATE SCIENCE AND EPA'S GREENHOUSE GAS REGULATIONS,” CQ Congressional Testimony, Lexis]

Globally and in the US, advancements in agriculture are among the crowning accomplishments of human ingenuity. Especially over the last century, yields have increased dramatically ( Lobell et al. 2009 ), more than keeping pace with the growth of human population. One recent analysis concludes that agricultural intensification since 1961 has increased yields so much that the area in crops has not needed to change, even as demand has soared ( Burney et al. 2010 ). As a consequence, intensification of agriculture has prevented deforestation that otherwise would have emitted 161 billion tons of carbon to the atmosphere. Over recent decades, yields of most major crops have increased at 1-2% per year ( Lobell and Field 2007 ), but an increasing body of evidence indicates that obtaining these yield increases is becoming more and more difficult, as climate change acts to resist or reverse yield increases from improvements in management and breeding. Using global records of yield trends in the world's six major food crops since 1961, my colleague David Lobell and I ( Lobell and Field 2007 ) concluded that, at the global scale, effects of warming are already visible, with global yields of wheat, corn, and barley reduced since 1981 by 40 million tons per year below the levels that would occur without the warming. As of 2002 (the last year analyzed in the study), this represents an economic loss of approximately $5 billion per year. In the United States, the observed temperature sensitivity of three major crops is even more striking. Based on a careful county-by county analysis of patterns of climate and yields of corn, soybeans, and cotton, Schlenker and Roberts ( Schlenker and Roberts 2009 ) concluded that observed yields from all farms and farmers are relatively insensitive to temperature up to a threshold but fall rapidly as temperatures rise above the threshold. For farms in the United States, the temperature threshold is 84F for corn, 86F for soybeans, and 90F for cotton. For corn, a single day at 104F instead of 84F reduces observed yields by about 7%. These temperature sensitivities are based on observed responses, including data from all of the US counties that grow cotton and all of the Eastern counties that grow corn or soybeans. These are not simulated responses. They are observed in the aggregate yields of thousands of farms in thousands of locations. The temperature sensitivity observed by Schlenker and Roberts ( Schlenker and Roberts 2009 ) suggests a challenging future for US agriculture. Unless we can develop varieties with improved heat tolerance, modest warming (based on the IPCC B1 scenario) by the end of the 21st century will reduce yields by 30-46%. With a high estimate of climate change (based on the IPCC A1FI scenario), the loss of yield is 63-82%. These three major crops, in some ways the core of US agriculture, are exquisitely sensitive to warming. This result is very clear. We may be able to breed warming tolerant varieties, and it is possible that some of the yield losses due to warming will be compensated by positive responses to elevated atmospheric CO2 ( Long et al. 2006 ), but we will be trying to improve yields in a setting where warming is like an anchor pulling us back.

#### Warming kills agriculture – CO2 can’t offset

German Advisory Council on Global Change 2008

[CLIMATE CHANGE AS A SECURITY RISK, Accessed via Google books]

Climate change and the increasing concentration of CO2 in the atmosphere affect terrestrial vegetation in a variety of very different ways. Increasing atmospheric CO2 concentrations can directly impact on the productivity and water use of vegetation (Körner, 2006). The rise in air temperature, too, affects productivity, but it also has an impact on biological diversity and species distribution. Changes in precipitation, and thereby in water availability, influence both productivity and species distribution (Kaiser, 2001). Vegetation responds to extreme events, e.g. extreme temperatures, major or rapid fluctuations in temperature, or extreme wind speeds (Potter et al., 2005; reviews: see e.g. Peñuelas and Filella, 2001; Walther et al., 2002). As plants require CO2 for photosynthesis, it was initially assumed that, physiologically, an increase in atmospheric CO2 concentration would have a major, direct positive effect on carbon fixation (the CO2 fertilization effect; see e.g. Cure and Acock, 1986; Stockle et al., 1992). While numerous greenhouse-based experiments in the 1980s confirmed the fertilizing effect of increased CO2 concentrations on crop growth (Cure and Acock, 1986), in the open field, plants adapt to the higher CO2 concentrations. The opening of leaf stomata, plants’ mechanism for gas exchange of CO2 and water with the atmosphere, is restricted to reduce water loss. Production increases thus tend to be lower, generally below 30 per cent (Körner, 2006). Experimental application of CO2 gas to crops in open-field production has shown, for example, that grain yields increase by a mere 11 per cent on average instead of the expected 23–25 per cent (Long et al., 2006). The fertilizer effect appears to be much weaker than hitherto assumed in the case of rice, wheat and soybeans, and there is little or no effect on millet and maize. These findings are borne out in the case of woodlands too (Norby et al., 2005; Asshoff et al., 2006). Consequently, in global terms, the CO2 fertilizer effect will compensate to a much lesser extent than previously assumed for the declines in crop yields that are expected as a result of rising temperatures (and concomitant increase in transpiration losses) and decreasing soil moisture (Parry et al., 2004). The fertilizer effect, moreover, may be completely absent in the event of major climate change. Vegetation distribution also changes in response to changes in temperature and precipitation. An insitu shift in vegetation may occur if previously nondominant or subdominant species in a plant community become dominant as a result of the altered environmental conditions, or if species from other ecosystems migrate into the plant community. These two mechanisms presumably also overlap and interact; first, a shift in the species composition within a plant community takes place, permitting alien species to take on a significant functional role in this plant community (Neilson et al., 2005). Bio-geographical vegetation modelling can demonstrate, for example, that exotic alien species may come to dominate the ecosystems of Mediterranean islands in the future (Gritti et al., 2006). Vulnerable species could thus be suppressed or even face extinction (Kienast et al., 1998; Thuiller et al., 2005). This was the mechanism behind the disappearance of some southern ecotypes of widespread Euro-Siberian species from the Mediterranean flora in the period from 1886–2001. Thomas et al. (2004) conjecture that by 2050 some 15– 28 per cent of plant species could face risk of extinction due to climate change, but also due to changes in land use. Based on modelling calculations, it seems unlikely that biomes as a whole will shift as a consequence of climatic changes (IPCC, 2001). Vegetation models show, however, that in the event of an average temperature rise of 3 °C, around one-fifth of the Earth’s ecosystems will change, although major variations are to be expected from region to region (Fig. 5.2-3). Expansion of tropical forests and savannahs will remain relatively constant in the event of an increase of 1–3 °C in the air temperature (Leemans and Eickhout, 2004). The negative impact of climate change is more likely to be a result of the increasing water deficit. African tropical forests may respond more sensitively than savannahs to changes in precipitation, because not only do they depend more heavily on the amount of precipitation, but also on the time of year that the precipitation occurs (Hély et al., 2006). Simulations relating to biodiversity in the Amazon rainforest, too, show that by 2095 climate change induced habitat modification could be so extensive as to threaten the survival of 43 per cent of rainforest Climate impacts upon human well-being and society 5.2 67 Ice Tundra Boreal forest Temperate forest Temperate grassland Desert Tropical forest No change Savannas, scrubland Figure 5.2-3 Terrestrial ecosystems that will be affected by changes in the event of a global average temperature increase of 3 °C (based on HADCM-GCM). Source: Leemans and Eickhout, 2004 plant species (Miles et al., 2004). The hardest-hit area in this regard is likely to be north-western Amazonia, because it is here that the most significant changes in precipitation and its seasonal distribution are anticipated (Section 5.3.4). Species in temperate and boreal forests face a greater degree of change if the atmospheric temperature increases, and they will shift towards the poles. It is expected that the surface area of temperate forests will increase on average, while the tundra is likely to shrink considerably as a result of boreal forest expansion (Leemans and Eickhout, 2004). A meta-analysis of data from various studies on species distribution shows that, on average, the occurrence of the bird, insect and plant species investigated will shift more than 6km polewards and 6m upwards in altitude per decade (Parmesan and Yohe, 2003). Climate change also affects seasonal events such as plant flowering and bird breeding. Even today, the phenological onset of spring in temperate latitudes has already shifted forwards by around 5 days per decade (Root et al., 2003). In Europe, spring is starting earlier by an average of 2.5 days every decade, while the rise in temperature is having a greater impact on the phenological onset of spring in warmer countries (Menzel et al., 2006). plant species (Miles et al., 2004). The hardest-hit area in this regard is likely to be north-western Amazonia, because it is here that the most significant changes in precipitation and its seasonal distribution are anticipated (Section 5.3.4). In addition to the impact of climate change on vegetation, environmental changes also occur as a result of land use, and these are no less relevant than direct climate-induced changes (MA, 2005a). Alteration of physical and chemical processes in the soil due to human activities, whether in the past or ongoing, may be significant and sometimes irreversible, often resulting in a deterioration in soil characteristics (Fig. 5.2-4). Inadequate data are available for estimating future soil degradation. Baseline data at global level are patchy or out of date. The best global data on soil degradation are from the GLASOD study carried out between 1990 and 1992 (Oldeman et al., 1991; Oldeman, 1992; WBGU, 1995). Many of the processes that are connected to or triggered by changes in land use are not yet (adequately) represented in global models linking materials cycles to global climate (e.g. agricultural use, urbanization, disruption of natural and semi-natural ecosystems and soils). As a result of this flawed information base, it is almost impossible to make any reliable forecasts regarding future land cover and use. The sections below therefore rely on status-quo data (e.g. Oldeman et al., 1991; Oldeman, 1992; MA, 2005a) or only consider demographic developments up to approximately 2025 (Wodinski, 2006). Erosion by wind and water is already a major problem, and one that will be aggravated by rising temperatures and a resulting increase in aridity. Where land use has eliminated the dense vegetation cover, thus exposing the soil directly to the effects of the weather, e.g. following forest clearing or overgrazing, desiccation facilitates rapid erosion of the surface layer of soil. With loss of the fertile topsoil, including as a result of landslides that occur due to lack of vegetation cover, nutrients vital for plant growth are lost, and this in turn leads to reduced agricultural productivity. Often, this process of erosion also entails compaction and encrustation of the soil surface. This further reduces the water-carrying capacity of the soil and accelerates soil degradation even more (Schlesinger et al., 1990; Oldeman et al., 1991; Oldeman, 1992). For this reason, erosion is given particular attention as a factor when considering climate change. Wind erosion is already a typical phenomenon in semi-arid and arid zones. It occurs on the fringes on most deserts, where the sparse plant cover is highly sensitive to overgrazing and arable soils are particularly prone to desiccation (e.g. the Sahel region). But the west coast of South America, the Mediterranean region, the Middle East, India and north-eastern China are also affected by wind erosion (USDA, 1998). It can therefore be assumed that susceptibility to soil degradation due to erosion will increase further in future in tandem with higher air temperatures worldwide.

### EXT 3 – Other Factors Offset

#### Turn – pollution leads to ozone – tanks ag – outweighs any benefit from CO2

Monbiot 2007

[George, Professor @ Oxford Brookes University, Heat: How to Stop the Planet from Burning, pg. 7]

But now, I am sorry to say, it seems that I might have been right, though for the wrong reasons. In late 2005, a study published in the Philosophical Transactions of the Royal Society alleged that the yield predictions for temperate countries were 'over optimistic'. The authors had blown carbon dioxide and ozone, in concentrations roughly equivalent to those expected later this century, over crops in the open air. They discovered that the plants didn't respond as they were supposed to: the extra carbon dioxide did not fertilize them as much as the researchers predicted, and the ozone reduced their yields by 20 per cent." Ozone levels are rising in the rich nations by between 1 and 2 per cent a year, as a result of sunlight interacting with pollution from cars, planes and power stations. The levels happen to be highest in the places where crop yields were expected to rise: western Europe, the midwest and eastern US and eastern China. The expected ozone increase in China will cause maize, rice and soybean production to fall by over 30 per cent by 2020, These reductions in yield, if real, arc enough to cancel out the effects of both higher temperatures and higher carbon dioxide concentrations.

#### Turn – weeds – Co2 leads to weeds – tanks agriculture

Ziska 2007

[Lewis Ziska, PhD, Principal investigator at United States Department of Agriculture
Agricultural Research Service Alternate Crop and Systems Lab. “Climate change impact on weeds” http://www.climateandfarming.org/pdfs/FactSheets/III.1Weeds.pdf]

Weeds have a greater genetic diversity than crops. Consequently, if a resource (light, water, nutrients or carbon dioxide) changes within the environment, it is more likely that weeds will show a greater growth and reproductive response. It can be argued that many weed species have the C4 photosynthetic pathway and therefore will show a smaller response to atmospheric CO2 relative to C3 crops. However, this argument does not consider the range of available C3 and C4 weeds present in any agronomic environment. That is, at present, the U.S. has a total of 46 major crops; but, over 410 “troublesome” weed species (both C3 and C4) associated with those crops (Bridges 1992). Hence, if a C4 weed species does not respond, it is likely that a C3 weed species will. In addition, many growers recognize that the worst weeds for a given crop are similar in growth habit or photosynthetic pathway; indeed, they are often the same uncultivated or “wild” species, e.g. oat and wild oat, sorghum and shattercane, rice and red rice. To date, for all weed/crop competition studies where the photosynthetic pathway is the same, weed growth is favored as CO2 is increased (Table 1, Ziska and Runion, In Press). In addition to agronomic weeds, there is an additional category of plants that are considered “noxious” or “invasive” weeds. These are plants, usually non-native whose introduction results in wide-spread economic or environmental consequences (e.g. kudzu). Many of these weeds reproduce by vegetative means (roots, stolons, etc.) and recent evidence indicates that as a group, these weeds may show a strong response to recent increases in atmospheric CO2 (Ziska and George 2004). How rising CO2 would contribute to the success of these weeds in situ however, is still unclear. Overall, the data that are available on the response of weeds and changes in weed ecology are limited. Additional details, particularly with respect to interactions with other environmental variables (e.g. nutrient availability, precipitation and temperature) are also needed.