


Climate Change in North Carolina: Analyses, Implications and Solutions

UNIVERSITY OF NORTH CAROLINA AT PEMBROKE

Report to President Erskine Bowles
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EXECUTIVE SUMMARY

The Earth's global average temperature is rising and as a result its climate is changing. It is accepted in the scientific community and beyond that this change is correlated with and attributable to an increase in the levels of carbon dioxide in the atmosphere. Humans have contributed to this increase in carbon dioxide through fossil fuel consumption.

The people and governments of North Carolina, like all states and nations, have a collective responsibility to do what they can to minimize the predicted impacts of a changing climate on the health and prosperity of people, ecosystems and the interrelationships among them. At the same time, steps must be taken to reduce carbon dioxide emissions and hence the carbon footprint of North Carolina. It is understood that this can be achieved by shifting energy dependency toward renewable and alternative energy sources. Such steps will minimize future effects and/or slow the advance of undesirable change.

It is predicted that coastal North Carolina will be particularly vulnerable to the effects of climate change, which include sea level rise and an increase in the intensity of hurricanes. A consequence of both these changes will be increased coastal erosion (as much as 770 square miles of coastline may be lost) and flooding. Therefore it is predicted that coastal infrastructure, ecosystems and people will suffer. State and county planners need to consider the vulnerability of the coast to increased flooding when building roads, bridges and buildings along the coast. Officials also need to consider ecosystem services (such as clean air, water, and flood control) in their planning such that these services are used and preserved wisely.

Administrators, educators and practitioners working in human health professions need to anticipate possible increases in the frequency of heat stress, food shortages, homelessness, and infectious and waterborne diseases. They also need to be mindful of the associated psychological and emotional effects including Post-Traumatic Stress Disorder, anxiety, depression and indecision. Higher levels of emotional, psychological or physical (e.g. heat) stress among people, especially among the economically disadvantaged, can lead to strained interpersonal relationships and increased frequencies of dispute and violence.

It is predicted that the displacement or extinction of non-human species and the cycles they depend on will be particularly noticeable in coastal and mountainous regions of North Carolina. Among those species threatened by rising sea levels and flooding are fifty-two species that are already federally listed as threatened or endangered. Existing habitats and natural spaces need to be protected. At the same time, degraded and urbanized spaces, such as university campuses, can be modified to provide more green space and habitats. The physical greening of campuses will reduce their carbon footprints.

The cultures and identity of indigenous peoples are directly tied to non-human species and the associated and sacred spaces. Therefore, migration, extinction, or demise of animals or plants or other life forms will compromise the traditional religious practices of Native Americans. This has implications for their constitutional rights and freedoms.

The UNC can and should lead North Carolina in reducing its carbon footprint through innovation, commitment and change among their campuses. Many and widely varying examples of change in policy and practice at both institutional and individual levels are included in this report. Resources for implementation of change are also provided.

The greening of campuses is a growing initiative among many campuses. Huge gains in reducing carbon footprints on campuses can be made when constructing resource- and energy-efficient buildings. Features of green buildings include solar-generated electricity, geothermal heating, grass roofs, collection and use of rainwater, re-claimed and local building products and natural lighting. The UNCP is an expanding campus with a need for more buildings. With a focus on green building design and construction, the UNCP can help the UNC show leadership in the carbon footprint challenge.

PREFACE

Members of the Climate Change Task Force include faculty representatives from the departments of American Indian Studies, Biology, Chemistry and Physics, Geology and Geography, Mathematics, Nursing, Philosophy and Religion, Political Science, and Psychology. We have assumed throughout the process of our deliberations that the phenomenon of climate change is a real and scientifically documented and verifiable one. We agree that climate change is, at least in substantial part, the result of human activity that has paralleled economic growth over the last few hundred years, which has been over the last quarter century accelerated in the non-western, developing areas of the planet.

We have also determined that the impact of climate change to the United States in general and to North Carolina in particular is in all likelihood going to be gradual but increasingly noticeable over the next several decades. It is important to add that this report does not purport to provide a comprehensive list of recommendations. However, the Task Force's expertise of scientific disciplines is applied to examine a variety of issues associated with and anticipated by climate change, including what we regard as plausible outcomes and various ways to avoid or to blunt the least appealing scenarios.

We have endeavored to understand how and to what extent human society will be influenced by and react to the effects of climate change in North Carolina. We look at the various psychological, medical and health, political, biological, and social dimensions. This report is the result of several committee meetings. The recommendations are themselves the product of carefully developed "thought pieces" based on the expertise of the contributors. Each essay is documented and an overall bibliography is available in the report's concluding section. We consider this narrative to be preliminary only. Many of our conclusions are tentative and will require additional examination.

The fact that the report's wording is grounded in objective and scientific scholarship encourages the recommendation that further investigation is both warranted and desirable. While we can accept climate change as an established fact, we remain unable at this point to be completely confident of its full implications for our own and future generations. Climate change has been accepted as a reality by most governments and at all levels. However, what to do about it remains a subject of debate. Clearly, it is not an issue that will go away nor will it be resolved in a speedy fashion. The public and private sectors will have to work collaboratively to assess where we are in the climate change sequence and where to attempt a reversal of its impact. And within the public sector itself there will be a necessity for federal, state, and local governmental authorities and agencies to both cooperate and to determine a division of labor.

Dr. Martin Slann, Dean
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1. THE SCIENCE OF CLIMATE CHANGE

By Dr. Roland Stout, Department of Chemistry and Physics

The scientific community has come to the conclusion that the available data inescapably show that human caused global warming, now generally called climate change, caused in large part by increasing levels of carbon dioxide in our atmosphere, is real and is a threat to humanity.[1] Many of the world's respected scientific organizations support this statement including the American Association of the Advancement of Science (AAAS)[1], the American Chemical Society (ACS)[2], the American Geophysical Union (AGU)[3], the American Meteorological Society (AMS)[4], and the U.S. National Academy of Science along with those of ten other leading national academies of science.[5] The reality of climate change has also been recognized by international governmental organizations.[6, 7]

Over the past few years the term "global warming" has largely been replaced with "climate change", which recognizes that the increased concentration of greenhouse gases causes far more than raised temperatures. The scientific community and other organizations referenced in the paragraph above all use the term climate change, as does most of the current scientific literature on the subject.

While the fact of global climate change is clear, the details of what this will look like locally are still murky. To give just one example, while it is now well known that ice sheets are shrinking[8] and that melting ice sheets will raise ocean levels[9,10] by how much sea level will eventually rise is unknown. It will require continual research to assess how the Earth, its climate and ecosystems are changing as a result of climate change. The ACS put it this way, "We are, in effect, in the midst of a vast experiment with the Earth's climate – with uncertain, but likely quite unpleasant, outcomes."[2]

Climate change is a global phenomenon and must ultimately be addressed globally if we are to have any hope of slowing it or decreasing its overall effects. This said there is still much we can do to mitigate its effects on North Carolina. We are, after all, part of the global community and

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[1] *AAAS, 2007, AAAS Board Statement on Climate Change, American Association for the Advancement of Science,* www.aaas.org/news/press_room/climate_change/mtg_200702/aaas_climate_statement.pdf.

[2] *ACS, 2004, 2008, ACS Statement on Global Climate Change, American Chemical Society, http://portal.acs.org/portal/acs/corg/content?_nfpb=true&_pageLabel=PP_SUPERARTICLE&node_id=1907&use_sec=false&sec_url_var=region1.*

[3] *AGU, 2003, Human Impacts on Climate, American Geophysical Union, http://www.agu.org/sci_soc/policy/positions/climate_change.shtml.*

[4] *AMS, 2007, Climate Change, American Meteorological Society, http://www.ametsoc.org/POLICY/2007climatechange.html.*

[5] *NA, 2005, Joint science academies' statement: Global response to climate change, http://www.nationalacademies.org/onpi/06072005.pdf.*

[6] *IPCC, 2007, Intergovernmental Panel on Climate Change, http://www.ipcc.ch/.*

[7] *UNEP, 2002, Climate Change & the Financial Services Industry, United Nations Environment Programme, July 2002.*

[8] *"Changes in the Velocity and Structure of the Greenland Ice Sheet," Eric Rignot and Pannir Kanagaratnam, Science, 17 February 2006, vol. 311, no. 5763, pp. 986-990.*

[9] *"Recent Sea-Level Contributions of the Antarctic and Greenland Ice Sheets," Andrew Shepherd and Duncan Wingham, Science, 16 March 2007, vol. 315, no. 5818, pp. 1529-1532.*

[10] *"Perspectives on the Arctic's Shrinking Sea-Ice Cover," Mark C Serreze et al., Science, 16 March 2007, vol. 315, no. 5818, pp. 1533-1536.*

we must play our part, along with others, to slow or decrease the effects of climate change. While we can not solve this looming problem ourselves, neither will it be solved if we ignore it whether intentionally or merely by making other choices. To not decide is an implicit decision. In not deciding we simply let climate change, with whatever impacts it has, happen to us. It is better in this case for all concerned to be proactive rather than reactive.

It is expected that climate change will have a number of effects, some of which are listed in Table 1 below. What is not known is how significant these effects will be to our state's social, cultural, economic, and environmental systems, or how committed our state and its leaders will be to making the hard choices needed to face these effects.

Table 1. Anticipated Effects of Climate Change

i. Ice sheets and glaciers will melt world wide[11]
ii. Sea levels will rise globally[9, 11]
iii. The global average temperature will rise but local temperatures may either rise or fall[12]
iv. The ranges of various plants and animals will move north and up in elevation[13]
v. Extinctions of plants and animals will accelerate in specific ranges or even globally[14,15]
vi. Rainfall patterns will change[16]
vii. Extreme weather events will increase in both number and intensity, including
    - Hurricanes[17,18]
    - Thunderstorms and tornados
    - Blizzards
    - Wild fires[19]
    - Droughts and floods
viii. Ocean oxygenation[20] and biodiversity will change, affecting various fisheries
ix. The ozone layer will be further disrupted[21]

What we do not yet know is exactly how and how strongly these possible effects will impact the citizens of North Carolina. We will need more and continual research to measure both these

[11] *"Climate Change: Losing Greenland," A Witze, Nature, 17 April 2008, vol. 452, no. 7189, pp. 798-802.*
[12] *"Stable Carbon Cycle-Climate Relationship During the Late Pleistocene," Urs Siegenthaler et al., Science, 25 November 2005, vol. 310, no. 5752, pp. 1313-1317.*
[13] *"Drought Sensitivity Shapes Species Distribution Patterns in Tropical Rainforests," Nature, 3 May 2007, vol. 447, no. 7140, pp. 80-82.*
[14] *"Attributing Physical and Biological Impacts to Anthropogenic Climate Change," C Rosenzweig et al., Nature, 15 May 2008, vol. 453, no. 7193, pp. 353-357.*
[15] *"Widespread Amphibian Extinctions from Epidemic Disease Driven by Global Warming," JA Pounds et al., Nature, 2006, vol. 439, pp. 161-167.*
[16] *"Detection of Human Influence on Twentieth-Century Precipitation Trends," XB Zhang et al., Nature, 26 July 2007, vol. 448, no. 7152, pp. 461-465.*
[17] *Hurricanes, Climate, and Katrina, A special collection from Science Online.*
[18] *"Effect of Remote Sea Temperature Change of Tropical Cyclone Potential Intensity," GA Vecchi and BJ Soden, Nature, 13 December 2007, vol. 450, no. 7172, pp. 1066-1070.*
[19] *"Warming and Earlier Spring Increase Western U.S. Forest Wildfire Activity," Anthony L Westerling et al., Science, 18 August 2006, vol. 313, no. 5789, pp. 940-943.*
[20] *"Expanding Oxygen-Minimum Zones in the Tropical Oceans," Lothar Stramma et al., Science, 2 May 2008, vol. 320, no. 5876, pp. 655-658.*
[21] *"From Ocean to Stratosphere," R Deckert and M Dameris, Science, 3 October 2008, vol. 322, no. 5898, pp. 53-55*

effects and their impacts on the people of our state. These are largely knowable if we do the work to measure them.

We must also prioritize the impacts to decide how to spend our resources to provide the best response we can. This prioritization will likely be contentious, as the various effects of climate change will impact different population groups to a different extent. Residents of our barrier islands may view rising sea levels as most significant, while farmers in the piedmont may see rainfall and temperature changes to be more significant. Making these decisions will be easier if we educate ourselves so that we all better understand the impacts on different areas of North Carolina. Education about climate change and its impacts on us will become easier as we gather more information, again suggesting that sustained research will be beneficial.

Carbon Footprint

It is now generally accepted that the globe is warming due to the increased concentration of greenhouse gases in our atmosphere. There are a number of greenhouse gases, but carbon dioxide is present in the highest concentration and provides the greatest contribution to global warming. Carbon dioxide levels are known to have varied widely over the Earth's history as a result of natural phenomena as shown in Figure 1 below.

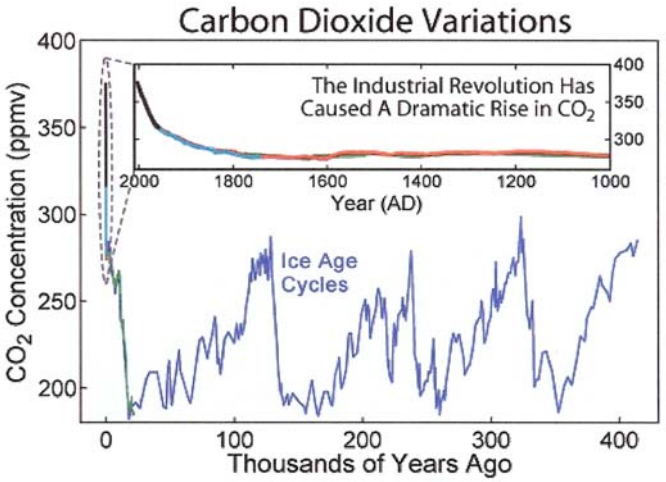

Figure 1. This figure shows the carbon dioxide variation over the past 400 thousand years. These cycles are mostly the result of changes in the Earth's orbit, which drives changes in the degree of global glaciation. Ice core data show similar oscillations going back 650,000 years.[12]

The inset graph expands the last 1000 years, which show that carbon dioxide levels have increased by a factor of 2 over the recent past and are now the highest levels in the last 650,000 years.[12]

Image credit: "Dragons flight" at Wikipedia.org

There are some who claim that natural phenomena are causing the dramatic increase seen in the last 250 years as well. However, careful research shows that the very recent increase in carbon dioxide levels tracks very well with the increased burning of fossil fuels[22], beginning with coal during the industrial revolution. The scientific consensus is that this recent increase is predominantly human caused.[1-7]

The question for us today is, what can we do to at least reduce the rate of increase of carbon dioxide concentrations, or even reverse it? A carbon footprint is a measure of the impact our activities have on the amount of greenhouse gases produced in our day-to-day activities through burning fossil fuels for electricity, heating and transportation etc. For example, activities

[22] *"Contributions to Accelerating Atmospheric CO_2 Growth from Economic Activity, Carbon Intensity, and Efficiency of Natural Sinks," JG Canadell et al., Proceedings of the Natural Academy of Science, 20 November 2007, vol. 104, no. 47, pp. 18866-18870.*

that burn fossil fuels increase our carbon footprint and those that use renewable resources decrease it. But it goes deeper than this. Using products and consuming foods that are produced far from us increase the fossil fuels used to transport these goods to us, while consuming locally uses less fuel for transportation. Similarly, switching from other fuels to electricity, which is predominantly produced in coal fired power plants, can actually increase our carbon footprint. In 2006, North Carolina generated 63.7% of its electrical energy from fossil fuels, which is lower than the national average (72.3%) for the same year.[23] A significant amount (35.4%) of North Carolina's electricity was generated from nuclear power and, while not a fossil fuel, has its own set of environmental issues.

[23] *http:/www.eia.doe.gov/cneaf/electricity/epa/generation_state.xls*

2. CLIMATE CHANGE AND OUR HEALTH

By Dr. Barbara B. Synowiez, Department of Nursing

The World Health Organization (WHO) estimates that climate change is currently responsible for a minimum of 150,000 extra human deaths each year and expects that number could double by 2030. Unfortunately a disproportionate part of the burden is going to fall on vulnerable populations such as children, the elderly, those with chronic health conditions, and the poor (Gorman 2006).

Impacts of Climate Change on Our Health

According to the CDC Director, Julie Gerberding (2007), even though many organizations are working to address climate change, the public health effects of climate change have not been a major focus; thus, climate change is considered a serious public health concern. Some of the major impacts of climate change on our health include:

1. Heat Stress and Direct Thermal Injury – Scientists project an increase in frequency of hot days, hot nights, and heat waves. "Low estimates suggest that annual temperatures in the Southeast will increase by 4.1ºF over the next century, unless actions are taken to reduce emissions of global warming pollutants, while high estimates suggest the temperature rise could be 10ºF. A temperature rise of 4ºF would make the climate of central North Carolina similar to that of central Florida" (Munger and Shore 2005). "Heat waves up the ante for power outages. With an increasing aging population in the US, this increases the risks for higher mortality as the elderly are more vulnerable to dying from much hotter temperatures than those to which they might be accustomed. By 2030, nearly two-thirds of the population is expected to live in urban areas. The combination of longer stretches of scorching days and increasing urbanization means ripe conditions for illness or death from heat.
   Long periods of hot weather push up electricity demand, straining the power grid and increasing the likelihood of blackouts. The elderly and infirm are particularly vulnerable. Without power to run air conditioners or elevators, people who have limited mobility or are in poor health may suffer or die in overheated apartments" (Environmental Defense Fund 2008a, pp. 2-3).

2. Extreme Weather Events – Nearly half the U.S. population lives in coastal areas; thus, extreme weather events such as hurricanes and floods can have major health effects. "The health effects of extreme weather events range from loss of life and acute trauma, to indirect effects such as loss of home, large-scale population displacement, damage to sanitation infrastructure (drinking water and sewage systems), interruption of food production, damage to the health care infrastructure, and psychological problems such as post-traumatic stress disorder. Displacement of members of the population often results in disruption of health care which is a major concern for those with chronic diseases" (Gerberding 2007, p. 2). Carbon monoxide poisoning is also of concern when people use portable generators in response to power outages during extreme weather events. After Hurricane Charley in 2004, it is estimated that 167 Florida residents died of carbon monoxide poisoning (Environmental Defense Fund 2008a).

3. Air Pollution-Related Health Effects – "Of particular concern is the impact of increased temperature and UV radiation on ozone smog formation especially during the summer months. As a primary ingredient of smog, ground-level ozone is of concern. It can irritate the

respiratory system, reduce lung function, aggravate asthma, and inflame and damage cells that line the lungs. In addition, it may also cause permanent lung damage and aggravate chronic lung diseases" (Gerberding 2007, p.2). Hospital admissions and emergency room visits for respiratory illnesses rise during periods of high smog levels. "This represents a large health threat to the 6.5 million U.S. children with asthma and to those at risk of developing asthma as the number of "code orange" and "code red" ozone days increase. Studies clearly show that childhood exposure to specific air pollutants is related to decreased lung growth and permanent decrements in pulmonary functions as well as increases in respiratory infection, asthma, infant mortality and all age mortality, miscarriages, preterm delivery and low birth weight" (Shea and Balk 2007, p. 4).

4. Allergic Diseases – "Studies have shown that plants such as ragweed and poison ivy grow faster and produce more allergens under conditions of high carbon dioxide and warm weather" (Gerberding 2007, p.2). Thus, asthma and allergies are likely to increase regionally as the world gets warmer. Allergy season will also start earlier and end later, thanks to the lengthened growing season.

5. Water- and Food-borne Infectious Diseases – "Changes in precipitation, temperature, humidity, and water salinity have been show to affect the quality of water used for drinking, recreation, and commercial use" (Gerberding 2007, p. 2). "Sixty-eight percent of outbreaks of waterborne illness in the U.S. over the past 45 years have been associated with rainfall above the 80th percentile" (Shea and Balk 2007, p. 5). "The most common [illness] is diarrhea from drinking contaminated water. Heavy rainfall may overload and contaminate drinking water treatment systems leading to illness from such organisms as Cryptosporidium and Giardia. Storm water runoff from heavy precipitation can increase fecal bacterial counts in coastal waters due to the washing of waste and chemicals into rivers and oceans. Runoff can cause coliform bacteria outbreaks and algae blooms that prevent people from swimming or eating fish from those waters" (Environmental Defense Fund 2008a, p.3).

6. Vector-borne Diseases – "Patterns of vector-borne illness are expected to change. Insects and rodents respond quickly to changes in temperature and moisture by migrating and reproducing more rapidly. Temperature increases accelerate the vector's life cycle and shorten the incubation of parasites living in the vector. Warmer weather and failure of winter kills will prolong the transmission season and change the range of vectors, resulting in more illness" (Shea and Balk 2007, p.5).

7. Food Scarcity – Food production, especially cereal crops, may be affected by climate change both directly and indirectly. Climate change may lead to scarcity of some foods, increase food prices, and threaten access to food for vulnerable Americans, which could lead to malnutrition and hunger in both children and adults.

8. Mental Health Problems – It is projected that some folks "may suffer anxiety, depression, post-traumatic stress related to climate changes"; these conditions will "have significant effects on health and well-being" (Gerberding 2007, p.3). "For example, over 38 percent of the people who came to an interim Emergency Department in New Orleans after Hurricane Katrina were later diagnosed with Post-Traumatic Stress Disorder (PTSD)" (Environmental Defense Fund 2008a, p.2).

9. Long-term Impacts of Chronic Diseases and Other Health Effects – "Children are at greater risk of worsening asthma, allergies, and certain infectious diseases, and the elderly are at higher risk for health effects due to heat waves, extreme weather events, and exacerbations

of chronic disease. People of lower socioeconomic status are particularly vulnerable to extreme weather events. Members of racial and ethnic minority groups suffer particularly from air pollution as well as inadequate health care access, while athletes and those who work outdoors are more at risk from air pollution, heat, and certain infectious diseases" (Gerberding 2007, p.4).

Making a Difference

According to the World Health Organization (2008), there are two basic ways that we can deal with the health problems of climate change: mitigation and adaptation. "Mitigation is any action taken to permanently eliminate or reduce the long-term risk to human life, property, and function from the hazards of climate change. Adaptation is an adjustment in behavior that responds to actual or expected climatic effects. Various types of adaptation include anticipatory and reactive adaptation, public and private adaptation, and autonomous and planned adaptation" (WHO 2008, p.22). Both mitigation and adaptation are needed now to combat the effects of climate change on our health.

Public Health Preparedness for Climate Change

According to the Centers for Disease Control and Prevention (2007), public health principles can be used to combat the effects of climate change on our health. Several priorities have been identified:

1. Developing response plans for heat waves

2. Monitoring and preventing health threats – Vulnerability assessments that identify the most vulnerable populations with the most significant health disparities and identify their risks for particular exposures

3. Researching possible relationships between climate change and health outcomes

4. Ensuring a skilled, competent public health workforce – Training the public health community to respond to threats associated with climate change

5. Informing and educating people regarding health issues

    a) Development and implementation of health and risk communications targeting the most vulnerable population groups. Effective communication can alert the public to health risks associated with climate change, avoid inappropriate responses, and encourage constructive protective behaviors.

    b) Development of early warning systems focusing on vulnerable communities

6. Linking people to needed personal health services

3. GEOLOGICAL AND BIOLOGICAL EFFECTS

Geological Concerns for North Carolina

By Dr. Martin B. Farley, Department of Geology and Geography

North Carolina's current physical environment is dynamic and changes in response to natural processes and forcing mechanisms as diverse as river migration, tropical and mid-latitude storms, and El Niño climate events. Changes in the physical environment impact the biosphere and human populations. Examples of these changes include shoreline migration and floods. [See Riggs and Ames (2003) for a discussion of coastal dynamics.]

North Carolina would benefit from improving our ability to cope with today's dynamism. Anthropogenic climate change will make North Carolina's environment even more dynamic in ways that will be both easy and difficult to predict precisely. Even with uncertainty, we can change to make North Carolina less vulnerable to current changes in the physical environment. This will also lessen our vulnerability to changes created by climate change. Much of society's planning occurs incorrectly, as if the natural environment is static and our actions have no feedback on the natural system. We need to do a better job of compensating for the obvious consequences of society's activities, such as how land development makes flooding worse and puts more structures in harm's way in the 100-year floodplain.

Two approaches are: 1) accepting the inevitability of shoreline changes today and making our structures (e.g., buildings, roads, and bridges) along ocean and estuary shores more adaptable will reduce the impact of climate change (e.g., sea level rise) on those structures in the future, and 2) improving the health of rural, low income North Carolina communities today will make them more resilient in the face of future environmental changes.

Biological Diversity and Ecosystems: Present and Future Potential Impacts

By Dr. Lisa Kelly, Department of Biology

Global climate change is affecting many organisms. In a recent review on the subject, Parmesan (2006) offers several lines of evidence [this paragraph] and writes, "… the direct impacts of anthropogenic climate change have been documented on every continent, in every ocean, and in most major taxonomic groups." Geographic ranges of organisms in the Northern Hemisphere have shifted northward or upward in elevation (i.e., six kilometers north or six meters upward per decade). As one example, the sachem skipper butterfly of California now occurs 676 kilometers (420 miles) farther north in Washington state. Changes in the timing of important life history events (e.g., egg laying by birds and first flights for butterflies) have accelerated by approximately two-to-five days per decade for all species studied. Not all species are responding at the same pace, however, and the activities of some closely interacting species are no longer in synchrony. Declines of polar sea ice are threatening a host of animals, including polar bears, krill, penguins, and ringed seals. Along the western coast of the United States, changes in the composition of marine fish are occurring as northern-ranged species are being replaced by southern-ranged species.

Some species extinctions are linked to climate change. More than one-half of the 110 known species of harlequin frog of Central and South America have disappeared (Pounds et al. 2006). Similarly, entire populations of other amphibians have declined precipitously or disappeared

entirely, while global warming and its favorable effects on a pathogenic fungus have been implicated in many instances (Wake 2007, Whitfield et al. 2007).

Some scientists forecast a dismal outlook for much of the world's biodiversity, predicting as many as 15-37% of species in many regions will go extinct by the year 2050 (Thomas et al. 2004). Accordingly, climate change may be the greatest threat to the world's rich biological diversity in the near future and, coupled with other serious threats, such as habitat loss, the extinction risk can only be exacerbated.

Not all changes from climate change will be harmful; some species will actually benefit (McNulty and Aber 2001). Forests that are adapted to cooler climates will likely migrate north but, at the same time, some forest species (e.g., red spruce) could go extinct (McNulty and Aber 2001). Ranges for southern hardwood and mixed pine forests are likely to expand northward. Under extreme warming, southeastern mixed forests could be replaced by savannas and grasslands (Hansen et al. 2001). Organisms are adapted to historic disturbances (e.g., fires and ice storms), and climate change may alter interactions between species as well as the severity, frequency, timing, and duration of natural disturbances such as fires, insect and pathogen outbreaks, droughts, windstorms, and ice storms (Dale et al. 2001). Windstorms, for instance, may become more frequent, and ice storms could shift northward. The incidence of wildfire in North America has clearly accelerated since 1980 (IPCC 2007).

North Carolina's Fauna and Flora

By Dr. Lisa Kelly

In the wake of human activities, longleaf pine forests and spruce-fir forests persist today on a mere 2% of their historic ranges (Noss et al. 1995); further reductions may ensue as climate changes (Hansen et al. 2001). Numerous species that inhabit these forests are currently threatened and endangered. In low elevations of the Southeast, the diversity of bird and mammal faunal could be reduced by 25% as climate changes (Hansen et al. 2001). Species at risk in North Carolina are concentrated largely in the southern Appalachian Mountains and in coastal areas (Hansen et al. 2001).

Fifty-two species of endangered and threatened species of plants and animals inhabit areas within three meters (10 feet) of mean sea level (Daniels et al. 1993). Among the species that are likely to be at risk from rising sea level include Bachman’s warbler, bald eagle, brown pelican, piping plover, red-cockaded woodpecker, wood stork, American alligator, loggerhead sea turtle, and shortnose sturgeon (Daniels et al. 1993). Coastal regions of North Carolina will be particularly vulnerable from sea level rise, coastal erosion, coastal flooding, loss of wetlands, and increased storm severity (IPCC 2007). The state may lose nearly 2000 kilometers (770 square miles) of coastal areas if sea level rises by 36 centimeters (14 inches) (Munger and Shore 2005), inundating salt marshes, maritime forests, shrub thickets, and floodplain forests, and reducing critical wilderness areas, including the Alligator River National Wildlife Refuge.

Conservation Strategies

By Dr. Lisa Kelly

The rich variety of life on Earth is critical for healthy, functional ecosystems, which provide the natural resources and services on which humans depend, including clean air and water,

decomposition, and food production. Biological diversity is important for its educational value, aesthetics, recreation and entertainment, spiritual enrichment and enlightenment, and for the treasure chest of evolutionary change it represents. Protection of North Carolina's plant and animal life and their natural environments in the face of changing climate will require flexible, adaptive strategies and coordination among scientists and land managers in state and national parks (and other protected areas) throughout the Southeast (Hannah et al. 2002). Populations must be monitored, and existing protected areas should be expanded in size (where feasible), while neighboring areas should be managed for potential, future inclusion in the protected network (Hannah et al. 2002). Degraded habitats should be restored, fragmentation of habitats should be curtailed, and greenhouse emissions should be cut (Brook et al. 2008). Incentives programs, land-use planning and regulation, and management of human population growth are keys to mitigating biodiversity loss (Hansen et al. 2001). A more thorough discussion of global strategies is outlined below.

Northward shifts in geographic ranges in response to global warming have already been noted for numerous species, and this trend is likely to continue (Parmesan 2006). Hence, some parks and natural areas may no longer support rare species and the distinctive fauna and flora (e.g., spruce fir forest and its inhabitants) for which they are known. It is important to place additional lands (including suboptimal habitats) under protection to provide future habitat (Hannah et al. 2002, Boere and Taylor 2004). Lands surrounding protected areas should be left as natural as possible (Hannah et al. 2002), and where human activities are to occur, these should be as environmentally friendly as possible (e.g., agroforestry and forest plantations). North Carolina's "million-acre land conservation" goal is an important step in the right direction (Munger and Shore 2005). Conservation agreements should be struck with landowners of surrounding lands, including in the agreements the option of future use of the land for natural areas (Hannah et al. 2002).

Range shifts and changes in abundance may be pronounced for North Carolina's mountain fauna, given the greater variability in climate associated with rising elevation and relief. Climate change may exacerbate this variability, creating intolerable conditions for some animals, such as salamanders, that are restricted to higher elevations (U.S. EPA 1998, Hannah et al. 2002). Spruce-fir and hemlock forests of the Appalachians Mountains, already in decline from air pollution and damage from exotic insects (i.e., balsam wooly adelgid and hemlock adelgid), may suffer greater stress (Dale et al. 2001) or may disappear entirely as climate change accelerates (U.S. EPA 1998). North Carolina's mountains should be the focus of intense monitoring, research, adaptive management, and protection from intensive development.

Urbanization, the chief cause of deforestation in the South (Conner and Hartsell 2002), will increase as human populations expand. Land conversion and urbanization destroy wildlife habitat and splinter remaining habitats into smaller, isolated fragments that are surrounded by modified landscapes (e.g., cities, highways, and farms). The synergistic effects of habitat fragmentation and climate change will pose serious challenges for the conservation of wildlife and natural communities (Root and Schneider 2006, Brook et al. 2008). As one of the most populous and fastest growing states in the nation, North Carolina will be particularly challenged in this respect. Concerted efforts should be made to reforest landscapes, including abandoned croplands, in order to create new wildlife habitat, enhance ecosystem services, and to sequester carbon dioxide (Bierbaum et al. 2007). The federal Conservation Reserve Program's Longleaf Pine Initiative is currently financing the planting of longleaf pine on thousands of acres of cropland in the Southeast (USDA FSA 2006). Pine plantations and other tree farms, however, are not viable replacements for natural forests (and the greater biodiversity they support) (Hansen et al. 2001). Additional cost-share programs, targeting existing forests, would go

further to encourage restoration and offset development pressures, particularly in the midst of escalating land values. Urban planning can ameliorate habitat loss by incorporating "green spaces" and curbing urban sprawl.

Invasive exotic species (e.g., red imported fire ants and kudzu) pose one of the greatest threats to native species, and invasive species should be monitored and controlled when necessary (Hannah et al. 2002). Because tourists and park visitors may facilitate the spread of invasive species into parks, management plans should prepare for this possibility. For adequate long-range responses to climate change, management plans should include 30-50 year time frames, minimally (Hannah et al. 2002).

International treaties and conventions should be modified to deal with the effects of climate change on wildlife (particularly migratory waterbirds) and their habitats (Boere and Taylor 2004). Further, wetland protection should be included in strategic planning in connection with land use change and with all aspects of coastal development (Boere and Taylor, 2004). The United States already has a "no net loss" policy for wetlands, and this policy must be embraced globally. Wealthier nations, such as the U.S., should assist poorer nations in restoring and conserving habitat for wildlife (Boere and Taylor 2004).

Global climate change is likely to bring more intense hurricanes, greater storm damage, and coastal flooding to North Carolina (Bierbaum et al. 2007). Discouraging new developments on floodplains and on coastal lands of less than one meter above current high tides (Bierbaum et al. 2007) will protect people and their property, and will benefit wildlife and vegetation; marsh and maritime vegetation would encounter fewer barriers in their migration inland in advance of rising sea levels.

Climate change may bring more intense precipitation and more extreme weather events, including drought, to North Carolina (U.S. EPA 1998). Drought increases the risk of wildfire, but many species of plants and animals (e.g., inhabitants of longleaf pine forests) are dependent on fire for reproduction and survival. State bans on burning should make exceptions for natural areas that require frequent fire and whose land managers have expertise to conduct prescribed fires safely. Accumulation of heavy fuel loads (e.g., fallen limbs and needles) in the absence of prescribed fires enhances the risk of catastrophic fires.

Protection of North Carolina's plants and animals and their ecosystems require diligence and careful attention to changes in population dynamics and ecosystem functioning in response to changing climatic conditions. Methodologies must be adaptive, entail clear communication across scientific disciplines, and must include sharing of information, assessment tools (including computer models) and technologies. Some topics of future research have already been identified for coping with the combined impacts of climate change, human land use, and other stressors on species and ecosystems (Dale et al. 2001, Hansen et al. 2001). Natural areas protection and the expansion of existing natural areas must be given priority. Further, the United States and other nations must work cooperatively in order to mitigate global climate change.

4. AMERICAN INDIANS IN NORTH CAROLINA AND CLIMATE CHANGE

By Dr. Jay Hansford C. Vest, Department of American Indian Studies

Traditional American Indian religious practices have a goal of harmony with nature, ethical reciprocity in the human species' relationship with the "non-human persons" of nature, and a contributive role in securing affinity between Natives and wild nature.[1] Stating this essential point, Joseph Campbell declared, "Nature religions are not attempts to control nature but to help put yourself in accord with it."[2] There is, indeed, an ecological integration of religious thinking and practice among Natives that constitutes what Ake Hultkrantz called a "cosmotheistic interpretation of nature."[3] As a consequence, the Great Mystery, the sacred, is manifest throughout the natural world. For traditional Natives, there is, accordingly, a sacred unity of nature, humanity and "cosmic breath" or spirit that requires the moral acknowledgement of wild, willful or inspirited, nature. The result of these beliefs is that the spirits of nature are fully integrated into all aspects of social, cultural, and environmental activity and, therefore, manifest nature is of definitive significance in traditional Native American religious practice.[4]

From the afore-going perspective on American Indian religious traditions, we can acknowledge traditional ecosystems have distinctively unique levels of meaning within traditional worldviews. These traditions are distinctive in their site specific attention to local ecology where nature persons or spirits are manifestations of a given ecosystem or habitat. Giving meaning to these localized habitats, traditional cultures illustrate their specific worldview valuations through mythological association, figurative symbolic interpretation, and ritual-religious incorporation. As a result, Native geopiety is distinctly unique as the incorporative ecosystem that sustains it, despite having common worldview attributes with other indigenous traditions around the world.

Moreover, throughout Native America, there are specific ecosystems that are traditionally affirmed via an oral narrative tradition and the concomitant ecological referents of nature. With climate change as induced by global warming derived from human industrial activities, ecosystems are expected to change and, as a result, the change will alter the traditional relationship between sacred narrative and ecological referent, thereby rendering the traditional American Indian religion impotent.

In North Carolina today, there are eight American Indian tribes recognized by the state and one – the Eastern Band of Cherokee – acknowledged by the United States government. Recognition of Indian tribes mandates a fiduciary relationship wherein obligations must be acknowledged and affirmed by the recognizing party. In the case of North Carolina's American Indian tribes, there are treaties engaging the Native people and Great Britain in legal bond dating back to earliest colonial times, as well as the afore-going state and federal tribal recognitions. Commonly initial treaties secured usufructuary rights associated with hunting, fishing, plant and mineral gathering as well as spiritual associations with "nature persons" – traditional species within a given tribal territory unique to a Native people. Protection and conservation of "nature persons" or species inhabiting the ecosystem at the time of treaty engagement is, therefore, mandatory under treaty law, which holds the highest authority in United States jurisprudence. Consequently, traditional species, at the time of these treaties, are to be sustained into perpetuity if said treaties are to remain unbreached and honorable by law. Treaty enforcement, therefore, requires the protection, conservation and continuation of traditional species significant to the Native American usufructuary rights at the time of their engagement.

Furthermore, in its recognition of the eight American Indian tribes, the state of North Carolina is obliged to honor fiduciary relationships with these Indian peoples. Fiduciary principles affirm and include traditional cultural and spiritual practices of these Native Americans. Such rights are further protected by federal statute – American Indian Religious Freedom Act of 1978 – and constitutional decree mandated in the First Amendment protections associated with religious freedom and establishment. As noted earlier, Native religions are nature based and grounded in the ecology of place. As ecosystems are radically changed and transformed as a result of climate change induced by human activity, the traditional religious practices of the American Indians of North Carolina are severely impacted and threatened with extinction. Accordingly, radical ecosystem transformation and climate change accompanied with species extinctions as induced by anthropogenic global warming threaten to breach American Indian treaties, state and federal fiduciary obligations, as well as religious protections as promised by law to the American Indians of North Carolina.

In considering this matter, we might turn to a statement issued by an old Pii'kani elder, – Joe Crowshoe, Sr. – who once remarked, "Out there, the Nature, the landscape will teach you who you are." The power of this wisdom rests in an ecological integrity born of complexities beyond human anthropocentricism and the genesis of humanity. Cautioning the planners of cities and towns, that most prominent sage of the Western tradition, Plato resonates with Crowshoe's advice when he declared that particular locations possess ecological and spiritual qualities that markedly affect human character development. As Plato advised then, "A sagacious legislator will give these facts all consideration a man can, and do his best to adapt his legislation to them."[5]

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[1] *Christopher Vescey, "Environmental Religions," in American Indian Environments: Ecological Issues in Native American History, edited by Christopher Vescey and Robert W. Venables (Syracuse, NY: Syracuse University Press, 1980), pp. 1-37.*

[2] *Joseph Campbell with Bill Moyers, The Power of Myth, Betty Sue Flowers, editor (New York: Doubleday, 1988). pp. 23-24.*

[3] *Ake Hultkrantz, Belief and Worship in Native America, edited by Christopher Vescey (Syracuse, NY: Syracuse University Press, 1981), pp. 117-135. In "Feelings for Nature among North American Indians," Hultkrantz explained this cosmotheistic interpretation of nature as a perspective where, "nature is sacred because it revels, or symbolizes, the Great Mystery," ibid, 128; see also Ake Hultkrantz, The Religions of American Indians, translated by Monica Setterwall (Berkeley, CA: University of California Press, 1970).*

[4] *For further discussion of these matters of American Indian religious traditions and nature, please see Vest, "The Wild and The Tame: Understanding Wilderness and Agriculture in Native America," The National Geographical Journal of India, 39:1-4 (January 1994), pp. 215-229; Vest, "The Badger-Two Medicine Wildlands: Sacred Geography of the Blackfeet," Western Wildlands, 15: 3 (Fall 1989), pp. 30-36; Vest, "The OLD MAN RIVER and the Sacred: A Meditation upon Aputosi Pii'kani Tradition and Environmental Ethics," The Canadian Journal of Native Studies, 25:2 (2005), pp. 571-607; and Vest, "The Landscape of Amotken and Sinchlep: Lolo Peak and the Missoula Valley as Salish Sacred Geography," American Indian Culture and Research Journal, forthcoming (2009), 42 pp.*

[5] *Plato, Laws, V: 747 d-e. See Plato, Collected Dialogues. When considering the problems of anthropocentricism and environmental ethics, see Vest, "The Concept of Wilderness: A Proprietary Right Over the Land?," Western Wildlands, 17: 3 (Summer 1991), pp. 2-6; also helpful, Vest, "WILL-OF-THE-LAND: Wilderness Among Primal Indo-Europeans," Environmental [History] Review, 9: 4 (Winter 1985), pp. 323-329.*

5. THE ETHICAL IMPACT

By Melinda Rosenberg, Department of Philosophy and Religion

North Carolina will be adversely affected by climate change. With increased storm activity, coastal communities will be flooded, perhaps permanently if sea levels continue to rise. This will result in a large growth of displaced persons. Where will these people go? Can we take care of them? Long droughts or extensive flooding will dramatically alter the state's agriculture. Many farmers are already economically underprivileged. Fewer crops will exacerbate this situation. More storm activity may also increase the mosquito population. A rise in mosquito-borne illnesses would surely lead to a public health crisis. The future of North Carolina could be bleak. What obligations, if any, do we have to prevent this state of affairs from happening?

Fossil fuel combustion accounts for most of the man-made greenhouse gas emissions. The United States is currently the largest emitter of greenhouse gases (GHGs). However, greenhouse gas emissions from industrializing nations such, as India and China, have increased immensely. Many solutions can be proposed. We could reduce our reliance on coal for electricity. We could build more nuclear power plants since these plants do not release carbon into the atmosphere. We could pursue renewable energy such as solar and wind power to wean ourselves of hydrocarbons and nuclear energy. We could drive cars that do not run on gasoline, reducing our reliance on crude oil. My purpose here is not to favor one proposal over the other. It is my intention to ascertain why we have an ethical obligation to combat climate change. If we are obligated to reduce the contaminants that contribute to climate change, we can then propose solutions towards moving past our current hydrocarbon economy.

The Earth does need to be warm. Without some warming, human life on Earth would not be possible. However, industrialization has increased the amount of greenhouse gases in the atmosphere. A higher concentration of GHGs will cause more heat to be retained in the atmosphere. More carbon dioxide in the air is especially alarming since it can remain in the atmosphere anywhere from five years to two hundred years. If this trend continues, the Earth will certainly get warmer. We cannot predict exactly what will happen if the surface temperature of the Earth continues to rise. Some predictions are apocalyptic. Some are optimistic, provided we have the technology to combat climate change as the Earth continues to warm. Some people even deny that climate change is man-made. This does not mean that climate change should be ignored until we can move from possible to highly probable conjectures about its existence. If the Earth continues to warm, ice at the poles will melt, causing sea levels to rise. Rising sea levels would certainly jeopardize island nations and nations with generous coastlines. Some of these nations would be unable to handle this crisis. Catastrophic weather could become more common. Catastrophic weather would lead to greater homelessness, crop failure, and loss of life. As Paul Roberts points out, climate change is "not an equal opportunity disaster."[1] The poor would certainly suffer more than the rich. Developed nations would be able to better address the perils of climate change than developing or undeveloped nations. However, Hurricane Katrina reminds us that even a nation like the United States cannot always manage a natural disaster adequately. If the warming of the Earth continues, the number of "climate refugees" may swell, even in wealthy nations. Would I have any obligations towards these refugees? Should I not simply look after myself since I might suffer from the consequences of climate change as well? Furthermore, is it not *my* decision as to how I should respond to this impending crisis?

One principle that is especially pertinent to climate change is indifference. Indifference militates against trust:

> Vulnerable agents – and all human agents are vulnerable – cannot will indifference to others as a universal law because they invariably have plans and projects that they cannot reasonably hope to achieve without others' support. In willing that indifference should become a universal principle, they would (incoherently) will to put at risk help that may be indispensable for others' activities or projects, including their own.

We all have projects that we want to complete. We cannot complete these projects if others are indifferent to our needs. Our own survival is at risk if we are indifferent to the needs of others. If we are indifferent to the fragility of our environment, we will have no obligations to promote the restoration of the environment. This will harm not only those who are palpably vulnerable (e.g., poor residents living in or near coastal areas), the damage done by climate change will harm us as well. If we choose indifference, we have no obligation to mitigate any environmental harm we have caused.

Indifference may not seem as reprehensible as acting on principles of coercion, violence, or deception. It is not that we wish to harm others. It is that we are not particularly troubled by what happens to people on the other side of the world. We may not even care that much about the needy in our own country. We may not care that deeply about any damage done to the environment. What wrongs have I perpetrated? I have not intimidated anyone because of my indifference. I have not murdered anyone because of my indifference. Yet my indifference is just as detrimental. I have obligations to act on principles that can be adopted by all. I have obligations to treat everyone as ends, not as means only. Through indifference, I have failed others and myself. Indifference cannot bind us universally. To do so would put us all at risk since we are mutually dependent upon each other for survival. Through indifference, I have not treated others as ends since I have compromised others to act autonomously.

Some are indifferent to the perils of climate change because they argue that is it not man-made at all. Even those who agree that climate change could be problematic still approach it with indifference. There is always an excuse to be indifferent. There is always an excuse to shirk one's obligations. Approaching these problems with indifference can hardly nurture trustful relationships. Very often, economic reasons are offered as a justification for inaction. It is too expensive to implement clean energy such as solar or wind power. Residents often oppose the construction of solar or wind farms for aesthetic reasons. Utility companies are hesitant to think beyond coal for electricity generation. Coal reserves are plentiful in the United States. Why use other sources of energy when we can exploit our natural resources? Shutting down coal-fired power plants would be unthinkable for many of these utility companies. Automakers are resistant to improving the fuel economy of their vehicles. They have also been lagging in their production of cars that do not run on fossil fuels. Consumers have increased their addiction to crude oil by purchasing light trucks and SUVs. It is only due to the high cost of crude oil that consumers are investigating alternative fuels and vehicles. There is always an excuse for shelving any proactive response to climate change. These are excuses that we cannot continue to make. If we only make reference to our individual wants and needs, we will be derelict in our collective obligations to all in need. We cannot trust or continue to trust others if they do not act in ways that extend and sustain our capacities for autonomous action. Consumers may fulfill their end of the bargain, but others must fulfill their responsibilities as well. Clean and renewable energy must be explored and implemented. Alternatives to fossil fuel vehicles must be produced

and they should be affordable. Public transportation must be upgraded and expanded. It is not just single, anonymous agents who must discharge their obligations. Corporations, state and federal governments must also act in ways that treat every person as an end. We all have stake in this matter.

We too might be in need one day. Wealthy people live along the coastline as well. We can rebuild our homes one or twice, but can we rebuild for the tenth time? Wealthy people can afford the cost of food, even with high inflation. But if our food supply is diminished due to climate-induced crop failures, we all can go hungry or fight for what food is available. If we act with principled autonomy, we are acting on principles to which everyone could consent. We will not act on questionable principles. These are principles that anyone in the kingdom of ends would accept. These are principles which are indicative of values that we all share. This is an age that may leave the Earth in a state that is permanently inhospitable to the survival of human beings. I argue that without principled autonomy, we cannot invest trust in each other to act in ways that could promote survival, and even flourishing, in a damaged environment.

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[1] *Paul Roberts. The End of Oil: On the Edge of a Perilous New World (Houghton Mifflin: NY, 2004) p. 121.*
[2] *O'Neill, Autonomy and Trust, op. cit., p. 88.*

6. THE PSYCHOLOGICAL IMPACT

By Dr. John D. Raacke, Department of Psychology and Counseling

When looking at the psychological impacts of global climate change, there are several avenues that can be addressed. However, some of the more interesting impacts that are relevant to our state fall into three areas: decision-making, aggression, and stress. Although not exhaustive, the list below is representative of some of the impacts climate change can have on the psychological nature of our population.

Decision-Making

A major challenge facing a climate change population is the way that people make decisions about their lives. Although most economists assume that people are rational when making decisions, research has shown they are not. Basically, people tend to use simple decision-making rules when making most purchases. This can lead to irrational decisions. For example, imagine family A needs a new water heater and has a choice between two options. Option A is a standard model that is moderately energy efficient. Whereas, option B is a highly efficient eco-friendly model that costs $300 more initially but will make up that difference in cost on lower energy bills in 12 months. The question becomes, which does the family choose? A rational decision maker would choose option B. Yes, it is a little more up front but money is saved in the long haul.

However, people do not always live in the rational world but rather in the real world. In other words, for most families in our area there is no choice, they choose option A. This is known as satisfying, settling for a satisfactory way to answer a question rather than searching for the ideal method or answer (Simon 1979). Many in our area, who do not have the disposable income to make the rational choice, have to rely on a simple decision making strategy. Therefore, they are using what is known as a "fast and frugal" approach to decision making (Gigerenzer 1996). They make the choice on a simple aspect of a decision, in many cases money. This is a problem that will be faced by people due to global warming. Specifically, much of the eco-friendly or green products that are currently being promoted and sold are not affordable. Because of the lower socioeconomic status of much of southeastern North Carolina, the investment in eco-friendly products is problematic. Plainly, just because it is rational to be green, does not mean that it is practical for most families.

Violence

One of the major concerns of global warming is prolonged increases in higher temperature. With the increases in temperature due to global warming, the *heat hypothesis* may become a major factor in our world. The *heat hypothesis* states that hot temperatures increase aggressive motivation and (under some circumstances) aggressive behavior. Simply, research has shown that during periods of increased temperature, there are strong correlations with increased levels of aggression (Barron and Bell 1976). Generally, these increases in aggression are a result of mis-interpretation of social interactions towards a hostile end. Increases in heat make people uncomfortable, and this level of unease results in individuals reacting more strongly to hostile affect (i.e., feelings of anger). It is this increased effect on hostile feelings that often escalates minor scuffles toward a more violent end. These violent incidences could therefore lead to

increases in violent crimes as well as arrests, thereby leading to increased strain on our social systems of justice (Anderson 2001).

Stress

The physiological impacts of stress are well documented. In terms of physiology, stress is the response of the body to any demand made upon it. The financial hardships of living in a global warming world, such as living green and increased energy costs, can be correlated with decreased levels of life satisfaction and higher levels of stress in people (Chou and Chi 2002). Although short-term stress can have a number of positive benefits, research shows that long-term stress increases cortisol, which reduces synthesis of proteins, including proteins of the immune system. These increases in stress can then lead to greater likelihood of illness and medical complication. Specifically, research has shown that prolonged stressful experiences lasting more than a month can lead to increased risk of illness. For a population, this can have several harmful side effects such as increased medical visits as well as increased medical expenses.

7. CLIMATE CHANGE SOLUTIONS

Avoiding Regressive Economic Impacts on Rural North Carolinians

By Dr. Martin Farley

Many plans for reducing greenhouse gas emissions use carbon tax or cap-and-trade systems for reducing emissions by raising the cost of fossil fuels. Such systems are economically regressive because poor households spend a larger fraction of their income on energy than do richer households. We need to compensate for this obvious economic impact of desirable policies lest it create disproportionate impacts on lower income, especially rural households in North Carolina. Otherwise, this could make adaptations (e.g., avoiding adverse health outcomes) by these populations difficult.

Solutions for the UNC System: Accounting for Efficiency Improvements

By Drs. Martin Farley and Lisa Kelly

Reducing consumption of fossil fuels is an important step to mitigate carbon dioxide release to the atmosphere. Many efficiency improvements, such as in building heating and cooling, require a larger capital outlay up front to realize savings in operating expenses over time. Because of the official separation of capital and operating expenses in accounting for UNC and businesses (and informally by households), these improvements are not implemented even though the annual ROI (return on investment) is high, even higher than the expected stock market returns. See the Lawrence Berkeley National Laboratory website (http://hes.lbl.gov) for details for households; Rocky Mountain Institute (http://www.rmi.org) also has advice for households, but specializes in energy efficiency for organizations. UNC can contribute by creating a mechanism within the system's budget to allow recognition of operating savings for efficiency when making capital investments such as building construction and renovation.

North Carolina requires new buildings on college campuses to achieve 20-30% greater energy and water efficiencies than required by earlier minimum standards (Eagan et al. 2008). Thus, campuses are compelled by law to reduce their carbon footprints. Furthermore, President Erskine Bowles should sign onto the American College and University Presidents Climate Commitment, as have more than 580 college and university presidents (Julian Keniry, National Wildlife Federation, personal communication). This would require President Bowles to inventory emissions and to take initiatives that would make the UNC system carbon neutral.

An Opportunity for UNCP to Lead in Energy Efficiency: GREEN BUILDINGS

By Dr. Patricia Sellers, Department of Biology

Reducing energy use by focusing on energy efficiency ultimately translates into a lower carbon footprint. The University of North Carolina at Pembroke is in a good position to respond to the need for greater energy efficiency within the UNC system because it is an expanding campus with a need for more buildings. With a focus on GREEN BUILDING design for new buildings, the UNCP can help the UNC system to reduce its carbon footprint in a direct, positive and creative way.

GREEN BUILDINGS are those that are designed to make use of alternative energy sources (biofuel, wind, solar, geothermal), green (grass) roofs, high efficiency insulation, flushless composting toilets, and reclaimed construction resources. GREEN BUILDINGS are cost-effective in the long-term.

GREEN CAMPUSES promote many environmental and climate-change initiatives beyond green buildings. Examples are many and include recycling programs, naturalization of green space, pesticide-free campus care, use of porous pavement, incentives for buying locally, cycle-to-campus initiatives, and the greening of purchasing policies. A green initiative already taking place at the UNCP is the *Biofuels Project*, which focuses research in the production of biodiesel and ethanol (http://www.uncp.edu/biofuels/).

Many campuses across the United States and Canada have green initiatives in terms of policy and practice. Far fewer have GREEN BUILDINGS. Examples of GREEN BUILDINGS include:

- The Adam Lewis Center for Environmental Studies at Oberlin College (Oberlin, OH) has 60 kW worth of solar panels on its roof, supplying much of the building's energy needs (http://www.oberlin.edu/ajlc/systems_energy_1.html). It also features engineered wetlands to treat and recycle the building's wastewater system. (www.oberlin.edu/ajlc/systems_lm_1.html)

- The new (2008) computer science building at York University (Toronto, Canada) relies on heat stratification to create air flow, concrete to store energy, natural lighting and a grass roof. These and other features have reduced heating and cooling costs by two thirds (http://www.yorku.ca/ycom/gazette/past/archive/2002/032002/current.htm).

- Warren Wilson College (Asheville, NC) currently has three buildings on its campus that feature green design and technologies. One is the Eco-Dorm, which is a residence that uses water pre-heated by the sun for personal use and in-floor radiant heat, grey water recycling, solar-generated electricity and composting toilets. The Eco-Dorm is 67% more energy efficient because of its green features. Another is the Orr Cottage, which was built using local mountain stone and wood from the forest of the College and was building according to *Leadership in Energy and Environmental Design* certification. (www.warren-wilson.edu).

In addition to the campuses listed above, UNC can find examples and resources at the *Greenbuild International Conference and Expo* 2008, which is taking place in Boston, MA, in November. In addition, *The Kendell Foundation* is one of the few examples of a large trust that awards grants to non-profit institutions for projects that promote energy efficiency, climate policy, energy efficiency awareness and planning (http://www.kendall.org/).

Steps Towards the "Greening" of the UNCP Campus

By Drs. Roland Stout and Lisa Kelly

1. Establish a permanent climate change committee, with membership from faculty, staff, and students

2. Educate the campus community about climate change – An example may be borrowed from Western Carolina University. By way of its conservation energy plan (WHEE Save),

Western Carolina is educating faculty, staff, and students about the impacts of energy consumption on both the economy and the environment.

Curricula in the natural and social sciences can be modified to incorporate human impacts on the environment, sustainable development, and research and service learning opportunities that provide positive outcomes for society (Eagan et al. 2008).

3. Audit energy consumption and waste on campus – Eagan et al. (2008) recommend the Clean Air-Cool Planet emissions inventory, which is free and online (www.cleanair-cool planet.org/toolkit) and which has been used by several campuses already.

4. Create and implement an action plan to address climate change, to include goals for reducing GHG emissions and to include specific projects for reducing the campus' ecological footprint (Eagan et al. 2008). Examples of specific projects are listed as items #5-9 below.

5. Reduce transportation and its energy consumption
   a. Reducing the driving of students, staff and faculty would likely have the largest impact on the campus' carbon footprint. Strategies that would help include:
      - Forbid freshmen from driving on campus (as is done on other UNC campuses)
      - Make the campus a walking campus
      - Develop a community-wide mass transit system that would include the entire campus, student dorms and apartment complexes, and local shopping areas
      - Encourage faculty and staff to carpool or to drive more fuel-efficient vehicles. Might parking fees be based on a vehicle's carbon footprint?
   b. Ramp up the production of biodiesel on campus, and offer biodiesel for sale to faculty and staff who can burn it in the vehicles they normally drive to campus
   c. Run ALL motor pool vehicles on battery power (the power source with the lowest carbon footprint) or biodiesel (which is approximately carbon neutral) (E85 would also be a good choice but it is not available in our area.)
   d. Investigate the possibility of commuter train transportation between Fayetteville and Pembroke. The rising cost of gasoline will likely make train transportation more appealing to commuters and, while an earlier effort to route a commuter train through Pembroke was not supported by the community, educational efforts focusing on the consequences of climate change may win community support.
   e. Purchase locally produced products whenever possible, saving the fuel needed for transportation

6. Reduce energy consumption in buildings – The greatest contributors to the carbon footprint of most colleges and universities are buildings, contributing to 70-90% of the carbon dioxide emissions (Eagan et al. 2008). This largely comes from electricity usage and heating/cooling plants. (A large proportion of the UNCP community drives to campus, however, which means that carbon dioxide emissions from vehicles may well equal or exceed that of electricity usage in campus buildings.)
   a. Plan all new buildings according to GREEN BUILDING practices, compliant with *Silver Leadership in Energy and Environmental Design (LEED)* certification. Catawba College's Center for the Environment is a model for green construction. The 21,000 square-foot building uses natural lighting and a geo-exchange system to cool and heat the facility.
   b. Convert existing buildings' HVAC systems to geothermal heat pumps
   c. Heat and cool buildings less (turn down/up the thermostat)

d. Purchase and use only the most efficient (e.g., Energy Star) appliances
e. Consider solar solution systems in building designs (e.g., put photovoltaic panels on roofs to produce at least a part of the electricity from sunlight rather then fossil fuels)
f. Invest in alternative energies such as solar and wind power
g. Replace incandescent light bulbs with compact fluorescent light bulbs. White Light Emitting Diodes (LEDs) have been developed and are a probably a few years away from being routinely available for indoor lighting applications. Current models are roughly as energy efficient as compact fluorescent lamps and efficiencies are on the increase. Their useful lifetime is longer than even high efficiency fluorescent bulbs but their initial cost is still rather high. When high efficiency, white LED lights are routinely available and cost effective, the UNCP ought to consider replacing all indoor lighting with LED systems.
h. Install motion detectors that switch off lights in unused rooms, hallways, and stairs
i. Consider on-demand water heaters located near the end use rather than building-wide hot water.
j. Reduce energy consumption outdoors – Play football, soccer, softball and baseball games during the day, and don't use lighting; do not burn the outside lights on campus at night, or not all night.

7. Reduce waste and consumption
   a. Recycle – Initiate a campus-wide recycling program for paper, glass, plastic bottles, cardboard, aluminum, and other materials. Several universities have engaged in competitions to see which campus could recycle the most materials.
   b. Consume less
      - Use both sides of paper
      - Have the print shop cut scrap paper into quarters and bind them into scratch pads. (This both helps recycle paper and reduces the number of scratch pads we would need to purchase and have shipped to us, saving energy normally used in production and transportation.)
      - Purchase and use more products made from recycled materials
      - Replace styrofoam cups or food containers with compostable materials
      - Stop providing bottled water and encourage refilling other containers with water
      - Use less plastics in general
      - Use less packaging on campus, and purchase products with less packaging
   c. Reduce water consumption by replacing inefficient toilets with water saver models.

8. Reduce environmental impacts
   a. Reduce stormwater runoff – UNC-Chapel Hill has undertaken a billion-dollar construction plan that includes designs that do not contribute to stormwater runoff. Innovative designs include green roofs, as on the Ram's Head recreation center, and the replacement of conventional parking lots with porous pavement. A large capacity cistern on campus collects rain water, which is used to irrigate campus grounds. More information is available at <http://www.sierraclub.org/>.
   b. Prepare for extreme weather events – A warming climate will increase the frequency of intense rainfalls (and flash flooding) in some parts of the world (U.S. EPA 1998). Over the last century, the amount of precipitation in south-central North Carolina increased by about 5% (Karl et al. 1996 in U.S. EPA 1998), and precipitation is expected to increase by 5-30% over the next century (IPCC data given in U.S. EPA 1998). To prevent campus flooding, therefore, it will be important to maintain roadside ditches, monitor stormwater drains for debris, and, as much as possible, replace impervious concrete surfaces with pervious materials. Runoff of oils, fertilizers, pesticides, and toxic compounds can harm

aquatic life and contribute to algal blooms that subsequently create anoxic conditions and fish kills. Runoff can be reduced by establishing rain gardens in strategic locations on campus. Fertilizers and pesticides should be avoided or used sparingly, away from ditches and bodies of water, and should be biodegradable.

9. Plant more native vegetation and restore/preserve natural habitats
   a. Sequester carbon dioxide by planting native trees. Existing forested areas on campus should be preserved, and natural vegetation should be restored.
   b. Plant shade trees near buildings and along popular paths on campus to help cool buildings during summer and to provide relief for pedestrians. A policy can be established to replant trees lost to construction. Native trees (e.g., longleaf pine) and other vegetation that are resistant to drought should be selected.
   c. Reduce mowing – Mow the lawns less frequently, or reduce the amount of lawn needed to be cut, by replacing grasses with shrubs and other greenery. Collect and compost grass clippings and leaves, and use the resulting compost for fertilizer (thereby replacing at least some of the artificial fertilizers used)
   d. Plant perennials rather than annuals

10. Organize stakeholder meetings between academia, the business community, and the private sector

11. Initiate a dialogue about the environmental/societal impacts of unfettered human population growth

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APPENDIX A: THE POWER OF U.S. CITIZENS AND NORTH CAROLINIANS TO MAKE A DIFFERENCE

By Dr. Barbara Synowiez

Examples of personal actions that can be taken by all of us now to help reduce the adverse health impacts from climate change include:

1. Writing legislators to support national action to cap global warming pollution

2. Working with employers to:

    - Go "green" in existing classroom/office spaces and new facilities, under or planned for construction, to mitigate the impacts of climate change on health
    - Support flexible work schedules/telework/telecommuting
    - Conduct energy audits of buildings
    - Increase the reuse of paper and double-sided printing
    - Establish recycling with each building for paper, cans, bottles, and electronics
    - Establish green work groups to develop green objectives in strategic plans (APHA 2008)

3. Developing climate-friendly lifestyles (Environmental Defense Fund 2008b, Shea and Balk 2007, pp. 18-19):

    - Use muscle power rather than gasoline when we can --- by commuting by foot or bike, using push mowers, combining errands when driving.
    - Skip bottled water, carry tap water - According to the 2007 Pacific Institute's fact sheet, manufacturing the 30-plus billion plastic water bottles we bought in 2006:
        Required the equivalent of more than 17 million barrels of oil — enough to fuel more than one million vehicles for a year
        Produced more than 2.5 million tons of carbon dioxide
        Used three times the amount of water in the bottle

7. Choose foods wisely

    - Eat less meat (eat low on the food chain) – Researchers at the University of Chicago have calculated that if every American had one meat-free meal per week, it would be the same as taking more than 5 million cars off our roads. Having one meat-free day per week would be the same as taking 8 million cars off American roads.
    - Buy foods grown locally
    - Choose less processed foods
    - Avoid heavily packaged foods and buy in bulk
    - Buy organic foods
    - Support local agriculture to grow organic

8. Reduce! Reuse! Recycle!

    - Bring a cloth bag to the supermarket instead of having groceries bagged in paper or plastic.
    - Reuse products whenever you can

- Pack your lunches in reusable containers instead of in paper and plastic bags; use a steel thermos for your homemade beverages or tap water.
- Use recycled paper – Producing new paper, glass, and metal products from recycled materials saves 70 to 90 percent of the energy and pollution, including carbon dioxide that would result if the product came from virgin materials. Recycling a stack of newspapers only 4 feet high will save a good-sized tree (Shea and Balk 2007).

9. Focus on energy efficiency

- Replace incandescent light bulbs with compact fluorescent bulbs
- Focus on the bulbs that burn the longest each day. Compact fluorescents produce the same amount of light as normal bulbs, but use about a quarter of the electricity and last ten times longer. In addition to making the air cleaner and curbing global warming, the step saves money on electricity bills and the cost of replacement bulbs. Look for the Energy Star label.
- Turn off lights and TV when leaving an empty room
- Set computers to use existing features to automatically shift to lower power states or to turn off after extended periods of inactivity
- Caulk and weather-strip doorways and windows. Adjust your thermostat; for each degree lower on your thermostat in the winter, energy bills are cut by 3 percent.
- Close windows when the heat or air conditioners are turned on
- Ask a utility company to do a free energy audit of one's home
- Run the dishwasher only when it's full
- Buy energy-efficient electronics and appliances
- Replacing an old refrigerator or an air conditioner with an energy-efficient model will save money on electricity bill and cut global warming pollution. Look for the Energy Star label on new appliances or visit their website at http://www.energystar.gov to find the most energy-efficient products.

10. Save water

- Installing low-flow showerheads and faucets will save water without decreasing performance.
- Turning down the hot water heater to 120°F will result in hot water costs going down as much as 50%. This has the added benefit of being a safer temperature to prevent accidental hot water burns, especially in infants and young children.

11. Drive smart

- To burn less gasoline, make sure the car stays well-tuned and has properly inflated tires. If a new car is needed, consider buying an energy-efficient hybrid.

12. Plant greenery (e.g., trees will absorb CO_2, and decrease summer air-conditioning bills)