

**The Reality of Global Warming (Climate Change)  
and its Potential Impact on North Carolina:**  
UNC Asheville Response

September, 2008

Report for President Erskine Bowles, University North Carolina and  
Senator Marc Basnight, President Pro Tem North Carolina Senate

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## **Executive Summary**

Senator Marc Basnight asked UNC President Erskine Bowles to seek guidance from the very best scientists on each UNC campus to answer two primary questions:

- What is the reality of global warming?
- What could be the potential effects on North Carolina?

**The reality of global warming** - In Asheville, we are fortunate to be the home of National Oceanographic and Atmospheric Administration's (NOAA's) National Climatic Data Center (NCDC). NCDC hosts all of our nation's weather and climate data, as well as a large number of its prominent Climate Scientists. NCDC is home to nine Nobel Laureates, and UNC Asheville has a direct tie to a tenth – Dr. Lenny Bernstein is the project manager for our new Climate Change and Society Masters program. This group of people won the Nobel Prize for their role in writing the Intergovernmental Panel on Climate Change (IPCC) report on Climate Change and Global Warming. UNC Asheville has a very close working relationship with NCDC which is enhanced by our co-location in Asheville. Examples of a UNC Asheville-NCDC collaborations include a Memorandum of Agreement, grants, UNC Asheville employee at NCDC, guest lecturers from NCDC on campus, students and interns. This relationship gives us the ability to address Climate Change issues from a position of both academic and practical strength. We believe that the scientific data is clear and overwhelming. **The climate is changing and the globe is warming at a rate faster than has been seen in recorded history.**

**Potential effects on the State of North Carolina** – Although the data shows that the planet is warming, the effects and severity of Climate Change are not the same everywhere. Each region will experience different impacts. The primary effects we will see in North Carolina include:

- Extreme weather – precipitation will be less frequent, but more intense when it arrives. In other words, the recent reality of drought punctuated by severe hurricane damage in North Carolina will continue.
- Hotter days and nights, extending into longer heat waves, will continue to increase.
- This combination of drought and heat will lead to a greater chance of wildfires. This fact, coupled with more people living at the “forest/urban” interface, will put more people's lives and property at risk.
- Coastal sea level will continue to rise due to thermal expansion of water when heated and increased sea volume due to melting ice. This fact, coupled with the recurrence of major hurricanes will have a large effect on eastern North Carolina.
- All of these facts will mean a much greater impact on state energy issues, water resources, land use, transportation and emergency response. These are all “big ticket” economic issues that our state and its citizens must be prepared to deal with.

**What North Carolina needs in order to address Climate Change** - The real issue is “How can our UNC Campuses help North Carolina build climate literacy and support group decision making to meet this challenge?” Recent studies show that people are beginning to accept the reality of Climate Change on a global scale, but do not know what to do locally or regionally. People will contribute to the debate (and find the solutions) only if they can understand the issue and how it ties to their own experience and knowledge. UNC can assist in the following four-step process:

1. **Provide a trusted source of information on Climate Change** – This includes not only basic climate data at the appropriate scale, but also discussing uncertainties with related

Climate Change data in a sufficient fashion for making informed and reasoned decisions on a local and regional basis. This includes tools to integrate Climate Change data with other societal data sets in order to help people relate to the information and make the best value decisions. Through this process, North Carolinians will be able to comprehend and connect to the local impact on themselves and their region.

2. **Build Climate Change Literacy through Education and Outreach.** When dealing with the issue of global warming (i.e. Climate Change), we must first deal with people's view of reality. People have always viewed climate as a constant – (just as they have done with the perceived realities of plentiful water resources, cheap energy and plentiful land.) There must be continued education and communication to build climate literacy and convince people that they must confront the new realities of a changing climate.
3. **Continue research related to Climate Change and its impacts** – UNC should continue to put resources into Climate Change research, focusing especially on reducing current uncertainties and directing research at the topics that clearly impact our state.
4. **Develop decision support tools** - This includes a process that will allow transfer of Climate Change knowledge into actions and policies that are relevant to specific sectors of the economy, and focus on reducing loss of life, personal injury and property damage. People will only take action if they see that there is a “value driven” decision point, and they understand how to deal with uncertainty related to this decision. Values have not only economic costs, but social costs as well. If individuals, and communities, must consider Climate Change when making personal and business decisions, they must have decision support tools that are accessible and reliable.

**At UNC Asheville, we are not only studying Climate Change, we are taking action.**

UNC Asheville is working with our community; we are already partnering with NOAA's NCDC and our local city and county governments on all of the topics mentioned above.

Specifically, we are:

- o Creating outreach and education products and rapidly testing their effectiveness in building climate literacy, and integrating the information into useful decision support tools.
- o Expanding our research on Climate Change related issues.
- o Creating a new graduate program, “Climate Change and Society” to provide trained professionals to address this issue on a deeper and broader scale, adding the urgently needed social science component to understanding Climate Change (sociology, psychology, land use planning, economics, government & policy implications, etc).

## Setting the stage - The reality of global warming

Global warming is one aspect of Climate Change. To understand Climate Change, we must first differentiate 'weather' from 'climate.' Robert Heinlein did a pretty good job explaining the difference – "Climate is what you expect, but weather is what you get." More precisely, the definition of climate is the atmospheric conditions (weather variables) averaged over a long period of time and over a large area.

Earth's climate has changed in the past, is currently changing, and is expected to change in the future. However, current scientific consensus is that the natural processes driving Earth's long-term Climate Changes cannot entirely explain the rapid changes experienced in recent decades, nor can they reliably predict those changes projected for coming decades. There is growing evidence that indicates human activities are impacting the climate system. The uncertainty arises when we have to quantify man's contribution, and project these trends into the future and make predictions.

To adjust for this uncertainty in future models, we can apply the concept of confidence factors. The IPCC (Intergovernmental Panel on Climate Change) has defined terms to indicate the assessed likelihood, using expert judgment for an outcome or a result. Absolute certainty regarding Climate Change consequences is impossible to achieve. There are too many variables in climate science and in future human political and economic development decisions to make certainty statements with 100% confidence, and therefore IPCC projections are scenario-based and are typically expressed in ranges. The IPCC definitions are:

- Virtually Certain > 99% probability of occurrence
- Extremely Likely > 95%
- Very Likely > 90%
- Likely > 66%

Scott Shuford, working for the Environmental Quality Institute (EQI) at UNC Asheville this past year through a NOAA grant, has done a good job summarizing the IPCC findings. Scott is a professional city planner, and he has prepared a study called "Climate Change Handbook for Planners." In it, Scott provides this perspective: "In April, 2007, the IPCC reached definite consensus that there is a significant human-induced contribution to Climate Change and that this human component is currently the single greatest contributor to worldwide Climate Change. Consensus was also reached that Climate Change impacts are going to be extensive and will continue to increase for at least this entire century regardless of the scale and expedience of human intervention."

This very strong statement has been echoed in many presentations by scientists from NCDC during the past two years. These scientists include the nine Nobel Laureates who were awarded this distinction for preparing the IPCC report on Global Climate Change and its impacts. Although it would take many pages to list all of their findings, a very good overview was provided by Dr. Tom Karl, Director of NCDC, in a talk he gave to the American Garden Club in September 2007. His main points, tied to the "uncertainty vocabulary" include:

- Most of North America is experiencing more unusually hot days and nights – this trend is **very likely** to continue
- Heat waves will **likely** become more frequent, longer lasting and more intense

- Precipitation will **likely** be less frequent, but more intense – extreme precipitation episodes (heavy downpours) have become more frequent and intense in recent decades over most of North America
- It is **likely** that increasing temperatures and associated evaporation are already contributing to droughts that are longer and more intense
- These extremes can have positive and negative effects, but on balance, systems have adapted to the historical range of extremes, so events outside this range are expected to have negative impacts.
- Changes in extremes will further challenge the ability of society to cope with Global Warming.

### **Potential effects of global warming on North Carolina and the various regions of our State**

Based on the experts' confidence factors, we now have probabilities to manage. Those probabilities will need to be considered when looking at how North Carolina is going to adapt to Climate Change and mitigate its future impacts. The following brief description lists the areas that these discussions will need to focus upon. Note that the first major points address weather and natural phenomena tied to Climate Change, and the subsequent points address effects on the State that are related, but not obviously tied to climate.

1. **Increased precipitation tied to extreme weather events** – This is probably the primary impact affecting the entire State. North Carolina already leads the nation in the billions of dollars of damage due to extreme weather events. With the Climate Change projections, and the growing population in our State, it is **likely** that we will have even more lives lost and property damaged tied to these events. Increased precipitation means more flooding and associated landslides. We cannot directly relate recent disasters to Climate Change, but they do give us a benchmark for the impact that extreme weather has on North Carolina. During the floods of 2004 caused by remnants of Hurricanes Francis and Ivan, Western North Carolina experienced 13 deaths and over \$200 million in damage. These numbers are small compared to similar events during Hurricane Floyd in 1999.
2. **Coastal Sea Level Rise** – The entire coast of North Carolina (from the Outer Banks to the major ports including Wilmington and the large military installations including Camp LeJeune) average an elevation of only a few feet above sea level. Much of our coastline will **likely** be inundated when global sea levels rise, and the projections range from a few feet in the next 20 years to much more in this century. Equally unfortunate is the fact that some of this inundation will not be gradual. Sea level rise, coupled with recurring strong hurricanes, will mean that major storms are **likely** to completely erode large stretches of barrier islands and other coastal features that currently provide protection from storm surge.
3. **Drought** – An increase in precipitation from extreme weather events would suggest a corresponding decrease in drought, but that is not the case. Recent history in Western North Carolina is an excellent example. During the years 2001-2004, there was below average rainfall. This cycle was broken by the huge amounts of rainfall during Hurricanes Frances and Ivan (18 inches of rain in one location due to just Hurricane Frances). Since that time, the Western part of the State has again experienced severe drought. 2007 was bad, and 2008 has proved even worse. The French Broad River was at its lowest recorded level in history in early August, 2008. This “feast or famine” cycle makes it very difficult to balance optimal water resource usage with flood mitigation. It is **very likely** that North Carolina will experience more droughts in the future. Even if these extremes in precipitation were not tied to Climate Change, we need to plan for their continued occurrence.

4. **Wildfires** – North Carolina prides itself on the natural resource and national treasure provided by its abundant forests. These forests provide not only a great environmental resource, but also a great quality of life for those North Carolinians who live close to and in the forest landscape. Over the past few decades, this quality-of-life driver has greatly increased the number of people living in what is called the “forest/urban interface.” As drought conditions increase, so does the stress on the forest and the higher risk of wildfires. In the past, we have thought of large forest fires, and associated loss of people’s homes, as being a Western United States phenomenon. The recent fires in Eastern and Western North Carolina show us that this is a growing issue for our State, and will become more severe as Climate Change progresses. This issue shows that Climate Change does not bring with it a singular impact; it is inextricably tied to issues such as a change of the natural landscape (land use). Industries and dwellings tied to this changing landscape, which include more than just forests and farms, must be accounted for when addressing this issue.
5. **Resource impact** – We are already experiencing water resource issues in the State due to prolonged drought. With much of the State not having deep aquifers that can be tapped with wells, we rely on our fresh water from the natural water cycle of precipitation and run-off feeding reservoirs that have been constructed in our watersheds. As the natural cycle of precipitation is affected by drought, and higher evaporation occurs due to the increased heat, we will experience more serious water shortages in the future. This is especially true when we look at the anticipated population growth for our State. As we switch to cleaner energy sources to mitigate the greenhouse effect, we will be improving our air quality. This situation will also improve as we find more efficient transportation choices.
6. **Disaster and Emergency Response** – Our State already must sustain a large emergency response infrastructure based on the severe storm history we have experienced. With more floods, severe weather, ice storms, drought and wildfires predicted due to Climate Change, we will have to train and support a greater emergency response workforce.
7. **Energy needs, use, and sources** – Much of the discussion around mitigation of global warming deals with converting any carbon-based energy source to alternatives. Although this will be costly in the short term, our State’s economy should benefit in the long term. North Carolina had a \$15 billion deficit in 2006 due to our reliance on imported oil, natural gas and coal. As we convert to wind, biomass, geothermal, solar and other alternative energy sources, we will become more self-reliant and also create local jobs to support these industries. Regarding mitigation, it will require increasing energy to cool our homes and businesses. In addition, the United States Geological Survey water report in 2000 showed that we use over 80% of our fresh water to cool power plants, more than for farm irrigation or municipal drinking water. If the droughts continue and possibly worsen, this will be a major issue to contend with.
8. **Transportation** – Our State spans 560 miles, and our transportation needs are varied and growing. Conversion to alternative energy sources related to transportation is a difficult task, due to our extreme reliance on automobiles for personal transport and large trucks for hauling most of our commerce. Climate Change adaptation and mitigation will require us to think about alternative transportation scenarios, and will probably impact our land use decisions as well. More dense metropolitan areas and locating people’s residences closer to their work will require a substantial shift from our current reality of commuting long distances from rural/suburban homes to commercial centers.
9. **Equity implications on the poorest and most vulnerable citizens** – Given the inadequacy of capacity, economic strength, resilience, and institutional capabilities characterizing some of our poorer communities, the impact of Climate Change may bring a further decline in economic conditions and increased risks to health, food security, etc. Individually, climate change will impact economically challenged citizens the hardest. Their ability to adapt to, or move from hard climatic conditions is the most limited among North Carolina’s populace.

## **Creating the Tools to Address Climate Change – UNC Asheville’s Approach**

When we start to look at these potential impacts on North Carolina, a key question is, “How we are going to respond to this challenge?” We need strategies not only to adapt to Climate Change, but also to mitigate global warming.

This short report will not attempt to provide solutions. Only policy makers and an informed, concerned and motivated citizenry can meet this challenge. But policy makers and their constituencies need support, and the UNC system is already starting to respond to that need.

**The first step** is to **provide a trusted source of information** on the topic of Climate Change. On a national and international level, the IPCC report is fairly exhaustive and covers most of the key topics. However, this report lacks a transmission device that can make the data understandable to a broad cross-section of society, and provide the information at a regional scale so it can be personalized.

- This report and its companions from the other campuses can start the framework for providing that trusted source of information on Climate Change specific to North Carolina. Many campuses, non-profits and community organizations are also working on similar tools. These need to be integrated and coordinated to insure a consistent message and direct application to a variety of sectors.
- As previously mentioned, a good example of personalizing Climate Change data to a specific audience is the upcoming UNC Asheville release of a "Climate Change Handbook for Planners" (in association with NOAA's NCDC). This handbook is authored by Scott Shuford, a professional city planner who has worked in numerous areas of the country. His expertise in planning issues, coupled with being able to work with the climate scientists at NCDC for the past year, has produced a handbook that takes Climate Change issues and relates them to a planning audience.

**The second step** is to **build climate literacy and environmental literacy through education**. This is a very large task, but we at UNC Asheville are already well on our way to providing useful tools and curricula.

- The integrated world view upon which a liberal arts foundation stands is key to educating policy makers and their constituency. UNC Asheville’s undergraduate liberal arts curriculum provides its students with not only the literacy in these key topics, but also tools to advance beyond knowledge toward application. UNC Asheville received a NOAA grant to promote climate education, research and outreach. Through this grant, faculty and students work jointly to address the societal aspects of climate and Climate Change.
- The UNC campuses, through the University’s long-range plan, UNC Tomorrow, are cooperating to provide a common framework for teaching environmental literacy across the campuses. A recent UNC Tomorrow videoconference on 21<sup>st</sup> Century Skills and Global Readiness featured a presentation by two UNC Asheville professors, who were asked to share UNC Asheville’s approach to environmental literacy as a model for the 16 campuses.

- UNC Asheville is also working with NC State to design a "Climate Change and Society" Masters Program. This program will begin in the fall of 2009 and will focus on training graduates in the decision making tools necessary to address the exact issues covered in this report. Asheville's local economic development group, called the Asheville Hub, provided county funding of \$20,000 to do the initial planning for this masters program. UNC General Administration has provided another \$80,000 to complete the planning process.

UNC Asheville has started prototyping this "Climate Change and Society" degree program by offering two classes in its Master of Liberal Arts program. The campus offered a masters-level class last fall semester called "Climate and Culture" that had many guest speakers from NCDC. Through this class, as well as studying similar programs on other campuses and working with many climate scientists nationwide, the proposed curriculum for the degree is nearing completion. Classes will include not only climate science, but also tools in integrating climate data with other societal data sets, decision making with uncertainty, and environmental ethics.

The breadth of input we have had in developing this new program has been far reaching. It is not only inter-institutional, but we have had broad community participation that includes NOAA's NCDC, Oak Ridge National Laboratory, expertise from NC State and UNC Chapel Hill (particularly the State Climate Office and Regional Climate Center) and many others. In addition, a doctoral student has conducted research of government/private industry/non-profits to determine internship/research/employment opportunities.

**The third step** is to **continue with research** – The UNC Asheville Atmospheric Science Department has been conducting research related to Climate Change and its impact on North Carolina for many years. Current research includes examining cool season precipitation impacts in Western North Carolina and studying the Pigeon River Basin to examine the hydrology of warm season (rain) events for mountainous terrain. Next year, UNC Asheville professors and their students will be observing the Tar and Neuse River Basins and building up a longer-term database for investigating near-term and long-term changes in the weather of Western North Carolina. This type of research must continue to lessen the uncertainty with the climate models and their associated future scenarios.

**The fourth step** is to **develop decision support tools for our State and local communities tied to Climate Change** – Research has to step off of the campuses and make itself available for use by the communities and State they serve. These must be real tools that planners and decision makers can use to integrate data on Climate Change with the other "new realities" of energy, water resources, and competitive land use. The Renaissance Computing Institute (RENCI) for the State of North Carolina has been applying leading edge computing technologies to address weather and climate issues with specific emphasis on disaster mitigation and emergency response. Locally, RENCI at UNC Asheville has been creating Decision Support Tools to aid Buncombe County and the City of Asheville. The main emphasis has been through the City and County's Flood Damage Reduction Task Force. The task force was formed to study the effects of flooding from the 2004 hurricanes in Western North Carolina and create a plan on how to mitigate future flood damage. The mission statement for this group gives a good understanding of the challenge of integrating Climate Change data with other value drivers: "... to establish a regional approach in developing a long-range plan based on best practices models to protect our floodplains/floodways and manage our watershed." The task force recognized that our community will not be able to control the weather and climate that causes flooding in our region.

Instead, our community must plan to decrease the impact of flooding on our regions' people and their property by proactive land use choices and planning. Finally, the mitigation plan must take the entire community into account -- we all share the benefits of living here, and we must also share in the responsibility for maintaining it.

Lessons learned from this flood mitigation are being expanded to address other topics related to integrating Climate Change with other societal values and data sets. Examples include emergency management training not only for shorter-term issues such as severe weather, but also longer term trends in weather so that they might effectively plan how they will use their resources in the coming decades (for example, less snow removal equipment, but more planning for floods).RENCI is currently working with the State of North Carolina, the Federal Emergency Management Administration (FEMA), and the Department of Homeland Security to create a multi-hazard risk tool to integrate many of the hazards mentioned before, including floods, landslides, drought and wildfire.

Finally, UNC Asheville is partnering with the local business community through the Asheville Hub (Economic Development Collaborative Group) on the Asheville Climate Initiative. The Hub is an economic, cultural, community and sustainability effort that has unified leaders and citizens around strategies for leveraging our competitive assets and improving our region. The Climate Initiative focuses on how these community assets can be leveraged to not only address Climate Change issues, but to grow jobs as well.

### **Summary**

UNC Asheville's response to Climate Change and its impacts on our state aligns with UNC Asheville's institutional mission which states that our students are prepared "to take their places as contributing citizens of a changing society and with the UNC mission – we are actively pursuing teaching, research and public service while dealing with climate change, perhaps one of the most serious long-term environmental problem the world faces. UNC Asheville's response to Climate Change will leverage existing research expertise to address this critical environmental and sustainability issue, will create a mechanism for applying research and scholarship to addressing climate change adaptation and mitigation, and enhance our capacity and commitment to respond to and lead economic transformation and community development.

## Selected References and web links

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## **Climate Change Expertise at UNC Asheville**

An Appendix to “The Reality of Global Warming (Climate Change)  
and its Potential Impacts on North Carolina”

At UNC Asheville, we have no faculty with direct expertise in global climate change. However, we have established excellent experience from a UNC Tomorrow Perspective. Over the past several years, UNC Asheville has been working with NOAA’s NCDC through an MOA on the topic of Climate Change and Society. Through this relationship, several members of our faculty and staff have been working with the country’s top researchers related to Climate Change.

The authors of this paper serve as community collaborators through a number of grant funded activities that are related to climate change. The authors are shown in bold, with associated relationships. The list is not exhaustive, but does show the breadth of talent that UNC Asheville utilizes in our community.

**Mr. James Fox** – Director, UNC Asheville’s National Environmental Modeling and Analysis Center (NEMAC) and Renaissance Computing Institute (RENCI) at UNC Asheville

- One UNC Asheville staff Research Scientist, Dr. Mark Phillips, through RENCI funding works fulltime at NOAA’s National Climatic Data Center (NCDC) and interacts with numerous climate change experts daily
- Through US Forest Service funding, NEMAC is creating climate change tools for regional forest managers and others
- Through NCDC funding, NEMAC creates outreach and education tools on climate change related issues. NEMAC also works with local city and county decision makers on integrating climate change tools into their value nodes.
- Additional NEMAC Research Scientists include Ms. Karin Lichtenstein, Dr. Todd Pierce and Mr. Greg Dobson

**Dr. Gerard Voos** - Associate Director of Master of Liberal Arts Program, Program Director of UNC Asheville’s Environmental Quality Institute

- Project Manager for NCDC funded Climate Education, Research and Outreach (CERO) grant. Through this grant, Dr. Voos worked with Mr. Scott Shuford to write and publish “Climate Change Handbook for Planners”. This handbook takes climate change issues and relates them to county, city and regional planning issues.

- Taught “Climate and Culture” a Master of Liberal Arts class last year. This class brought in Climate Change experts from NCDC and the Asheville community, including Nobel Laureates for Climate Change, Drs. David Easterling and Leonard Bernstein.

**Dr. Sandra Byrd**, Assistant Provost for Graduate and Continuing Education, Associate Professor of Education

- Leads effort in the new “Climate Change and Society” Masters Degree program, a joint degree between UNC Asheville and North Carolina State. Her Project Manager is Dr. Leonard Bernstein, who is also a Nobel Laureate for Climate Change.
- Coordinates with Dr. Fred Semazzi at North Carolina State. Dr. Semazzi is developing a course for the Masters Program.

**Dr. Douglas Miller**, Chair UNC Asheville’s Atmospheric Science Department,

- Associate Professor, specialty in Numerical Modeling and Mesoscale Prediction
- Other members of the department and their specialties
  - Dr. Alex Huang (Remote Sensing, Computer Applications)
  - Dr. Chris Hennon (Tropical Meteorology, Remote Sensing). Dr. Hennon is working with Dr. Semazzi on developing the curriculum for the Climate Change and Society Masters Degree Program
  - Dr. Christopher Godfrey (Land Surface Modeling, Instrumentation)