

“The Heat is On: America’s Coasts and the Dangers of Global Warming”

I. Introduction to Global Warming and the IPCC

Global Warming is the warming of the Earth’s atmosphere caused by greenhouse gases such as carbon dioxide, methane, and chloro-floro-carbons (CFC’s). Most scientists today believe that the Earth is experiencing gradual global warming. The leading group examining the impact of global warming is the Intergovernmental Panel on Climate Change (IPCC).

The IPCC consists of scientists from various countries around the world. Membership in the IPCC is open to all members of the United Nations (UN) and the World Meteorological Organization¹. The panel generally meets about once a year, and its findings are distributed throughout the world. The IPCC’s reports on global warming are considered the best resource available today on the science of climate change. The IPCC is split up into three “Working Groups” of scientists that are also assigned to different tasks. Working Group I examines the physical basis for climate change. Working Group II looks at climate change impacts, adaptation and vulnerability, and

¹ <http://www.ipcc.ch/about/about.htm> (accessed April 6, 2005)

finally Working Group III deals with mitigation of climate change². The results obtained by Working Group I are a good introduction into the science of global warming.

Working Group I's results show that greenhouse gases emitted by humans began to have a global impact in the 1850's³. The concentration of greenhouse gases in Earth's atmosphere has increased 30% since the Industrial Revolution. The gases are also increasing in the atmosphere at a rate of 0.4% per year. The gases themselves are structured in such a way that they permit heat to come into the atmosphere, but trap it once it arrives. This trapped heat is what makes the Earth get warmer and warmer. As the concentration of greenhouse gases in Earth's atmosphere increases, it follows naturally that the temperature worldwide will increase as well.

The American coastline is affected by this increase in temperature since the rising heat causes glaciers to melt, permafrost in the Earth's crust to run off into the ocean, and sea ice to thin⁴. The overall sea level will then continually rise over the next century, and the world's landmasses will look very different than they do today.

These massive changes to the Earth's surface have an immense impact that must be dealt with by the world's governments in a manner that is fair to all parties. What are the consequences of global warming? What can we do about it? Who pays for it? These are some of the major questions that I will attempt to answer in the pages that follow.

² <http://www.ipcc.ch/about/chart.htm> (accessed April 6, 2005)

³ http://www.grida.no/climate/ipcc_tar/wg1/044.htm#131 (accessed April 6, 2005)

⁴ http://www.grida.no/climate/ipcc_tar/wg1/063.htm (accessed April 6, 2005)

II. The Effect of Global Warming on the Earth's Oceans

We know that global warming will cause the oceans of the world to rise in the future. The question remains to be asked, "How much will they rise?" Current estimates from the IPCC put that number at between 0.09 and 0.37m over the one hundred year period of 1990 to 2090⁵. The reason for the variance between the numbers lies in three factors: the size of the surface warming, the effectiveness of heat uptake by the ocean for a given warming and the expansion resulting from a given heat uptake⁶.

This degree of variance is part of what makes global warming prevention so difficult. The exact amount of sea level rise is not known, so it becomes difficult to plan exactly what sort of action to take for the future. However, it is clear that action must be taken in some form. Coastal landowners are subject to losing their land completely in certain areas.

In South Carolina, our coast is composed of a very small-grained sand. This sort of material is exactly the type that is so vulnerable to erosion from rising sea levels. It is estimated that South Carolina's coastline will migrate inland 200 feet in the 21st century⁷. This inward migration would combine with the natural erosion that South Carolina already has problems with, and would result in further decimation of the coast.

The effect of a 200-foot movement on South Carolina's beaches would be catastrophic. Former beachfront property would be located underwater. People who own

⁵ http://www.grida.no/climate/ipcc_tar/wg1/429.htm#1151 (accessed April 6, 2005)

⁶ *Id.*

homes on the second row of the beachfront would see their real estate values soar if they were not underwater themselves. Beaches formerly frequented by tourists would no longer exist, and those tourists would move elsewhere. It is possible that the tourists might even move out of state altogether, which would be a crushing blow to our already weak South Carolina economy. Consider these economic facts on South Carolina beaches prepared by a research firm:

South Carolina Coastal Facts⁸:

- Visitor spending on travel and tourism in 1999 was well over \$8.8 billion, with \$6.6 billion coming from out-of-state and international visitors.
- In 1998, coastal tourism had a statewide economic impact that totaled \$7.5 billion in expenditures and output.
- South Carolina beaches generate \$1.54 billion in wages and earnings
- Visitors to the coast spend \$6.5 billion in the state and paid \$500 million in state and local taxes.

It is easy to see from these numbers why South Carolina has a very large economic stake in global warming. However, tourism is not the only way that the state may lose money from the ocean rise. As property is washed away into the ocean, the state loses opportunities for property taxes on the billions of dollars in properties located within the 200-foot zone. It is likely that those coastal properties will be among the most valuable in the entire state due to their formerly excellent location. In addition, the state may be liable for any accretion that occurs in those areas. If the ocean recedes at all, it is

⁷ Dana Beach & Kim Diana Connelly, “A Retrospective on *Lucas v. South Carolina Coastal Council*: Public Policy Implications for the 21st Century.” 12 SEENVLJ 1 at pp. 11-12 citing http://coastal.er.usgs.gov/national_assessment/scarolina (accessed Jan. 30, 2004)

⁸ http://www.netlobby.com/value_of_beaches.htm (accessed April 6, 2005)

a certainty that the former owners will want their property back from the state. This is a tough situation, and South Carolina lawmakers need to act on it before it is too late.

This problem does not affect only South Carolina, obviously, and our lawmakers may decide to look at other states' plans before taking action. The states most affected are those on the Atlantic and Gulf Coasts. The sediment composition of these coasts is what makes them so vulnerable. Erosion is already a problem in these areas, and rising sea levels will only accelerate the damage. "Over the last 100 years, 70% of the world's sandy shorelines have been retreating, 20-30% have been stable, and about 10% have been advancing"⁹. It seems likely that many beaches in the immediate vicinity of the South Carolina coast will fall into this 70% category. Many leaders from the surrounding states will have to work together to solve the erosion problems if goals are to be accomplished. All of the Atlantic beaches are connected by the ocean's currents, so sand taken from one state may end up in another state. It will be important to look past these boundaries when dealing with erosion problems.

Wave height is another effect of rising sea levels that accelerates the erosion process. In the North Atlantic, waves have gotten larger and larger over the last few decades⁹. However, the reason for the size of the waves is unknown at the present time⁹. In any event, the bigger waves will not only accelerate erosion, but they will also eliminate many of nature's natural barriers against the sea, such as sand dunes. Without these dunes for protection, the rows of beachfront houses will be pounded into submission by the crashing waves.

⁹ http://www.grida.no/climate/ipcc_tar/wg2/293.htm#642 (accessed April 8, 2005)

III. Mitigation

A. Insurance

With all of this talk of impending doom, the question remains: “What can we do about it?” The first possible step is to provide insurance for homeowners who wish to purchase it. The insurance industry is somewhat wary of insuring against global warming, but I believe that insurance is needed in coastal areas that may suffer in the future. In his 1992 Article, “Beyond Rio: Insuring Against Global Warming”, Christopher Stone says that the biggest reason that the insurance industry is against global warming policies is because “it is almost fatuous to worry about how people will live ninety years from now.”¹⁰ Granted, things have changed slightly since Stone’s 1992 paper in regard to global warming, but his theories about the insurance industry are still valid. He ponders, “How accurately could those living in 1900 have predicted and provided for the problems that face us?”¹¹. That maxim may seem reasonable at first glance, but it seems to me that we can plan the protection of the future with at least moderate success today.

That protection is exactly what insurance is all about. We do not know for certain that the sea levels will rise to a point where every house with two-hundred feet of the current Atlantic coast will be underwater. We can, however, provide for that possibility through insurance and understanding. I propose a federal flood insurance program for

¹⁰ Christopher D. Stone, “Beyond Rio: Insuring Against Global Warming.” 86 AMJIL 445 at p.447.

¹¹ *Id.* At 448.

America's coasts much in the same way that federal flood insurance currently protects homeowners that live in designated flood plains. My proposed program is different from current legislation, because current programs only provide protection of up to \$250,000 on residential homes.¹² Coastal property in the United States is so valuable that \$250,000 will not protect a great deal of homes in South Carolina or any other state for that matter. This situation will only get worse over the next few years as the population of the United States continues to rise, and undeveloped coastal land continues to get scarce.

President Truman attempted to establish the National Flood Insurance program in 1951 after massive flooding in Kansas and Missouri¹³. The National Flood Plain Act became law in 1968 after flood losses were increasing, "largely as a result of the accelerating development of, and concentration of population in, areas of flood and mudslide hazards."¹⁴

The situation of today's global warming danger seems very similar to the flood plain problems of over fifty years ago. The population on the coast is booming, and it seems that some sort of federal program should be implemented to help the potentially afflicted members of America's coast. This program could be supplemented through private insurance policies for homeowners who demand more protection. Americans certainly are not adverse to paying insurance premiums. The insurance industry represents 9% of the United States' GDP, and this means that the average annual

¹² http://www.fema.gov/nfip/c_cov.shtm (Accessed May 19, 2005)

¹³ Steven E. Ehlmann, "Conflict at the Confluence: The Struggle Over Federal Flood Plain Management." 74 N.D. L. Rev. 61 at p. 65

¹⁴ *Id.*

insurance premium is \$2,600 per capita for U.S. citizens¹⁵. There is some serious money to be made in coastal insurance for the insurance industry, and they need to be made aware of it. Federal Flood Insurance only covers up to \$250,000 for residential property, so the insurance companies can protect the remaining value in the house. Commercial property is only protected for up to \$500,000, and it is clear that many properties are worth significantly more than that¹⁶. The insurance companies can add significantly to their holdings by insuring commercial property for amounts above \$500,000 and insuring residential property for amounts greater than \$250,000. An added benefit for the insurance companies is that the Federal government will cover the first \$250,000 or \$500,000 of damage depending on the type of property involved.

The industry will no doubt be frightened by the potential monetary claims that homeowners may have, but the claims can be offset by federal spending on the project. The insurance industry already offers life insurance, which is 100% guaranteed to be paid out at some point if the premiums are paid, so why not offer to protect a person's most important physical possession?

The insurance actuaries could sit down and crunch the numbers to arrive at a premium value that is beneficial to both the insurance companies and the homeowner. The insurance policy could cover the amount of value that is lost for each piece of property that is taken away by rising seas. One problem would be what to do with the land if the waters begin to accrete later. Who would get the accreted land, the insurance

¹⁵ http://www.grida.no/climate/ipcc_tar/wg2/579.htm#15271 (Accessed April 9, 2005)

company or the homeowner? My solution to this would be that title to accreted lands should pass to the insurance company once a claim has been paid for that particular tract. This is similar to what is done with insurance companies that pay money after a car accident. The companies are assigned the insured's claim from the accident and are free to fight for the money in court. Assigning the accreted land to the insurance companies gives them an additional way to make money from the protections they offer to homeowners, and will serve as an additional tool to get the companies involved.

The insurance industry also could gain a potential windfall from the global warming crisis. While global warming does appear to be more likely than not at this point, the possibility remains that the sea levels may not rise a significant amount in the foreseeable future. The IPCC itself addressed this topic with a workshop and a subsequent report¹⁷. The report has a tremendous amount of very interesting information on how exactly science treats uncertainty. The IPCC reveals in its report that scientists and policymakers have vastly different objectives when it comes to evaluating risk. The IPCC concluded that

The policymaker's view of uncertainty focuses on: valuation of outcomes, whether or not there are conflicting objectives, and assessments of priorities and interests. The risk assessor's view is generally quite different and emphasizes cumulative model uncertainties and the robustness of conclusions to changes in assumptions made. Thus the scientific assessment of uncertainties has to feed into a wide range of both qualitative and quantitative approaches¹⁸.

¹⁶ http://www.fema.gov/nfip/c_cov.shtm (Accessed May 19, 2005)

¹⁷ http://ipcc-wg1.ucar.edu/meeting/URW/product/URW_Report_v2.pdf (Accessed April 11, 2005)

¹⁸ *Id.* at p. 10

What this statement means is that the IPCC's report is structured in such a way that it can be beneficial to many parties, including insurance companies looking for answers about global warming and for scientists seeking further aid in their research. Insurance companies will only make changes to their coverage plan if the changes prove to be economically efficient. The data must be so overwhelming in order for the insurance company to change its strategy behind coverage. This means that the "robustness of conclusions" method used by insurance companies looks at the big picture with regard to profits rather than the small problems that may affect certain homeowners. For example, if a certain insurance plan is working effectively, then the insurance company will not change that plan absent some large problems with the scheme.

One final and important idea that comes from the IPCC's uncertainty report is that reinsurance companies are making money off of the risks that insurance companies do not want to cover in full¹⁹. These companies act as a last resort to a homeowner who cannot get coverage through normal insurance means. A reinsurance company basically agrees to cover the homeowner against catastrophic damage that would be nearly impossible for the homeowner to get otherwise. The reinsurance industry "is generally focused on catastrophic property losses and has to manage a balanced portfolio of business through detailed analysis of risk in complex situations across many countries"²⁰. These companies are very knowledgeable about what exactly uncertainty means in a scientific sense, and what they are willing to insure. Reinsurance companies basically

¹⁹ *Id.* at p. 11

help spread the cost away from insurance companies, and are accurately described as “insurance for insurance companies.”²¹ They allow insurance companies to take on risks that normally would be outside the realm of coverage.

The IPCC goes into great detail about what uncertainty is in scientific terms, but their best explanation is that common words cannot be used to describe uncertainty²².

In Section 2.5 of the uncertainty report, Morgan wisely states:

This leads to the subjective view of probability as a statement of the degree of belief that a person has, that a specified event will occur given all the relevant information currently known by that person. Such subjective probabilities have wider utility and are more relevant to the climate change context²³.

This basically means that terms such as “likely” or “very likely” have no place in the scientific world. Another means is necessary to convey the probability that an event will take place in the future. A recognized way of dealing with this is to use standardized terms such as *likely* or *very likely* that are defined in terms of a probabilistic scale²⁴. This means that a universal scale is put in place where “likely” means 60% or more, “unlikely” means 40% or less, and the gaps are filled in with other values. The IPCC and the scientific community do not yet have a table where the exact percentages of probability are set. This is a concern, and one that needs to be addressed in the future. The insurance and reinsurance industries can benefit greatly from an IPCC system that uses common language terms, and is also tied to specific scientific probabilities.

²⁰ *Id.*

²¹ http://community.reinsurance.org/ScriptContent/index_fundamentals.cfm (Accessed May 20, 2005)

²² http://ipcc-wg1.ucar.edu/meeting/URW/product/URW_Report_v2.pdf (Accessed April 11, 2005)

²³ *Id.* at p. 12

²⁴ *Id.*

Hopefully, the IPCC can improve on this aspect of its research in the future, in order to better educate the insurance laymen who rely on IPCC research for their livelihoods. Better communication of IPCC results equals better insurance coverage and rates for all homeowners who may be affected by global warming.

B. Extreme Storm Monitoring and Detection

A major theory that is now being studied intensely is the idea that extreme weather events will occur more frequently due to global warming²⁵. Scientists know that “Changes or fluctuations in atmospheric and oceanic circulation are important elements of climate. Such circulation changes are the main cause of variations in climate elements on a regional scale, sometimes mediated by parallel changes in the land surface”²⁶. This statement means that atmosphere temperature change affects the temperature of the ocean itself, which sets off a domino effect that changes the world’s climate.

When the ocean’s temperature rises, it causes the currents to flow differently than they normally would. These currents are important, because they determine in large part how the Earth’s winds will move²⁷. These winds may sometimes move in ways that cause extreme weather patterns, such as hurricanes. The IPCC looked at several studies in determining their analysis of what exactly will happen with extreme weather events in the future. One of the most relevant studies to South Carolina and the Atlantic Coast of

²⁵ http://www.grida.no/climate/ipcc_tar/wg1/091.htm (Accessed April 19, 2005)

²⁶ *Id.*

²⁷ http://www.grida.no/climate/ipcc_tar/wg1/091.htm (Accessed April 19, 2005)

the United States is the study of the dominant circulation variability over the North Atlantic, known as the North Atlantic Oscillation (NAO).²⁸

This study is not indicative of exactly how the extreme weather events in South Carolina will change over the next few decades, but rather that the events will change in an unpredictable fashion²⁹. According to the scale used for the study, a positive NAO value means that strong westerly winds are blowing across the Atlantic, and that North American winter temperatures will be significantly colder than the winter temperatures in Europe, Siberia, and Eastern Asia³⁰. A negative NAO value means the exact opposite, and the colder temperatures will shift away from North America to the other continents on the other side of the Atlantic. According to the IPCC, “A sharp reversal is evident in the NAO index starting around 1970 from a negative towards a positive phase. Since about 1985, the NAO has tended to remain in a strong positive phase, though with substantial interannual variability”³¹. This change in wind patterns over the Atlantic has a substantial effect on the climates of both North America and Europe. The effect is that winters may shift radically from being rather mild to suddenly being downright frigid the very next year. Normally these types of temperature shifts occur over an extended period of time, but global warming has the potential to speed them up radically.

A major side effect of the shift in winds over the Atlantic is that pockets of low pressure may develop in detrimental areas. The IPCC states that, “The changes in

²⁸ http://www.grida.no/climate/ipcc_tar/wg1/086.htm (Accessed April 19, 2005)

²⁹ *Id.*

³⁰ *Id.*

³¹ *Id.*

atmospheric circulation over the Atlantic are also connected with much of the observed pressure fall over the Arctic in recent years”³². These pressure changes can have an adverse effect on glaciers and ice that are located in the polar regions. “Associated precipitation increases have resulted in the notable advance of some Scandinavian glaciers (Hagen et al., 1995), while decreases to the south of about 50oN have contributed to the further retreat of Alpine glaciers (Frank, 1997)”³³. These glaciers are vital to overall sea level, since they would raise the sea level of the Earth by approximately 0.5 m if they all were to melt³⁴.

Another climate system besides the NAO that has gained a great deal of notoriety from the media in recent years is the El Niño-Southern Oscillation (ENSO). ENSO originates in the tropical Pacific ocean, but it is a system that has a large impact on global climate³⁵. The ENSO system is best explained by the scientists who studied it:

ENSO is generated by ocean-atmosphere interactions internal to the tropical Pacific and overlying atmosphere. Positive temperature anomalies in the eastern equatorial Pacific (characteristic of an El Niño event) reduce the normally large sea surface temperature difference across the tropical Pacific. As a consequence, the trade winds weaken, the Southern Oscillation index (defined as the sea level pressure difference between Tahiti and Darwin) becomes anomalously negative, and sea level falls in the west and rises in the east by as much as 25 cm as warm waters extend eastward along the equator. At the same time, these weakened trades reduce the upwelling of cold water in the eastern equatorial Pacific, thereby strengthening the initial positive temperature anomaly.³⁶

³² *Id.*

³³ *Id.*

³⁴ http://www.grida.no/climate/ipcc_tar/wg1/413.htm (Accessed April 19, 2005)

³⁵ http://www.grida.no/climate/ipcc_tar/wg1/303.htm (Accessed April 19, 2005)

³⁶ *Id.*

What this means in layman's terms is that ENSO has an effect on all of the regional climate systems that surround it. The warming of Pacific waters and the "and the associated latent heat release alters the heating patterns of the atmosphere which forces large-scale waves in the atmosphere"³⁷. The waves are radiations of energy that result from the buildup of heat in the atmosphere. These waves extend to surrounding systems and may cause jet streams and storm tracks from other regions to change. The main reason that ENSO is important to scientists who are studying it is because it does tend to considerably alter the tracks of tropical storms and cyclones.

These extreme weather events are a significant concern to the scientific community. One common misconception is that global warming will alter the number or intensity of hurricanes and tropical storms. The IPCC, however, is not exactly sure what will happen to extreme weather events if the temperature increases. The IPCC says that "while increases in sea surface temperatures favour more and stronger tropical cyclones, increased isolated convection stabilises the tropical troposphere and this in turn suppresses organised convection making it less favourable for vigorous tropical cyclones to develop"³⁸. These two factors tend to cancel each other out and will not necessarily lead to more powerful or more frequent tropical storms and hurricanes. The Atlantic coast of America will actually benefit from increased ENSO activity due to the fact that "During an El Niño, for example, the incidence of hurricanes typically decreases in the Atlantic and far western Pacific and Australian regions, but increases in the central and

³⁷ *Id.*

eastern Pacific”³⁹ South Carolina should be safe from increased activity, but the United States needs to take action to prepare the Pacific coast from the possible threat of ENSO activity due to global warming.

The best way to prepare the Pacific coast for increased extreme weather activity is to educate lawmakers from the region on potential disaster relief efforts such as what the government does in Florida after a damaging hurricane. A damaging tropical storm could devastate Hawaii, for example, and federal funding needs to work immediately to assist those in need. A major problem with these programs is that the public believes they are funding projects that they have no interest in. It is difficult to convince the majority of Americans that we need to save the Hawaiian coast when a Hawaiian vacation is seen as something that only a certain few can afford. Marc Poirier addresses this topic on point in his article in the Rutgers Law Review:

The problem of beachfront property use, disaster aid and other subsidies must be distinguished from the situation of disaster aid and other subsidies where a broader segment of the population bears an approximately equal risk and chips in to help whoever actually turns out to have had bad luck -- for example, non-coastal hurricane damage and relief.⁴⁰

Poirier contends that coastal real estate owners get the benefit of federal subsidies that normal landowners would not. He says that inland landowners only get federal money when a tornado, mudslide or other random event happens to them. The perception among many people is that coastal landowners tend to be wealthy, and they do not need

³⁸ http://www.grida.no/climate/ipcc_tar/wg1/305.htm (Accessed April 19, 2005)

³⁹ *Id.*

⁴⁰ Marc R. Poirier, “Takings and Natural Hazards Policy: Public Choice on the Beachfront”. 46 Rutgers L. Rev. 243 at p. 265.

additional funds from people who do not get any money from the government themselves. Poirier says the argument over federal money between coastal dwellers and non-coastal dwellers boils down to the fact that “the difference (in the parties) could be described as the public's interest in the beach versus the beachfront owners' interest in beach real estate.”⁴¹ People who visit beaches for fun and recreation will still be able to do those things after a natural disaster hits the coast. The real problem is convincing people who use beaches for fishing, swimming, and sunbathing that the beaches are worth saving for other reasons.

The best way to get someone's attention about a certain issue is to speak directly to their pocketbook. The beaches are a vital source of revenue for all of the coastal states. Increased spending on recreation by out of state tourists is an excellent way to keep state taxes low or to increase spending on needy public projects such as education, police, or public roads. Landowners that are not on the coast need to be aware that the state as a whole can gain a significant profit from out of state sources. Increased hurricanes and cyclones would certainly put a significant damper on money that coastal states count on for a significant portion of their budgets each year. Hawaii, for example, would be a much less attractive vacation destination if tourists were aware that cyclones could whip through the islands at any time. Much of the Hawaiian islands would also lose their natural beauty from the new barrage of storms that would be sure to come. These violent and extremely powerful storms would be unlike any the Pacific has ever

⁴¹ *Id.* at p. 266.

seen. Many of the native flora and fauna would possibly be killed immediately due to their lack of natural defenses against such storms. This would destroy a great deal of the biodiversity that Hawaii is so famous for, and would make the situation on the islands even bleaker.

The other major weather patterns besides hurricanes that may increase in intensity due to global warming are regional storms such as tornadoes and thunderstorms⁴². South Carolina in particular is very vulnerable to these types of storms. A study relied upon by the IPCC in their analysis of extreme climate events showed that “with a 1°C increase in global wet-bulb temperature there is a 40% increase in lightning activity, with larger increases over the Northern Hemisphere land areas (56%)”⁴³. Wet-bulb temperature is very similar to the heat-index that most of us are familiar with. Wet-bulb temperature is measured with a thermometer that is wrapped in muslin, which is kept moist with distilled water⁴⁴. The temperature goes down as the water evaporates, so high humidity in the air will keep the thermometer cool⁴⁵. Wet-bulb temperature will always be cooler than the air surrounding it.

This information means that we can expect lightning strikes to increase as global warming raises the wet-bulb temperature of the planet. The IPCC also relied upon several studies on hail, tornadoes, and severe thunderstorms in their analysis of global

⁴² http://www.grida.no/climate/ipcc_tar/wg1/092.htm#2734 (Accessed April 20, 2005)

⁴³ *Id.*

⁴⁴ <http://www.bom.gov.au/climate/glossary/wetbulb.shtml> (Accessed April 20, 2005)

⁴⁵ *Id.*

warming⁴⁶. These storms are particularly relevant to South Carolina, because our state is very susceptible to these types of weather. One major problem for the scientists researching these phenomena is that “statistics of relatively rare events are not stable at single stations, observational practices can be subjective and change over time, and the metadata outlining these practices are often not readily available to researchers”⁴⁷. This means that these smaller types of storms are so difficult to measure that the data collected can be very inaccurate. The IPCC says that, “because of the inherent difficulty in working with these data, there have been relatively few large-scale analyses of changes and variations in these events”⁴⁸.

Even with the fact that relatively few data sets are available on severe local weather, the IPCC feels confident in its conclusion that “despite an increase in minimum temperature of more than 1°C since 1900 and an increase in tropospheric water vapour over the United States since 1973 (when records are deemed reliable), no systematic increase in hail or thunder days was found”⁴⁹. This is significant, because it shows the random nature of local weather events is not necessarily affected by temperature. In that regard, it appears that no additional mitigation steps are necessary to prevent hail and thunderstorm damage. The events are just too random to predict in the future.

Tornadoes in fact may become a problem in the United States due in part to the rising temperatures. Research shows that “since 1920, the number of tornadoes reported

⁴⁶ http://www.grida.no/climate/ipcc_tar/wg1/092.htm#2734 (Accessed April 20, 2005)

⁴⁷ *Id.*

⁴⁸ *Id.*

⁴⁹ *Id.*

annually in the United States has increased by an order of magnitude, but this increase reflects greater effectiveness in collecting tornado reports”⁵⁰. This statement says that scientists may feel that tornadoes are becoming more common, but it probably is more a case of early weather history not being recorded very well. One interesting note is that “severe” tornadoes are actually decreasing. The IPCC says that “the data set of “significant” tornado days developed by Grazulis (1993) shows a slow increase in number of days with significant tornadoes from the early 1920s through the 1960s, followed by a decrease since that time⁵¹.

In summary, it does not appear that extreme storms will necessarily have a huge impact on America’s coasts due to global warming. The IPCC sums the situation up perfectly in a report:

There is little sign of long-term changes in tropical storm intensity and frequency, but inter-decadal variations are pronounced. Owing to incomplete data and relatively few analyses, we are uncertain as to whether there has been any large-scale, long-term increase in the Northern Hemisphere extra-tropical cyclone intensity and frequency though some, sometimes strong, multi-decadal variations and recent increases were identified in several regions. Limited evidence exists for a decrease in cyclone frequency in the Southern Hemisphere since the early 1970s, but there has been a paucity of analyses and data. Recent analyses of changes in severe local weather (tornadoes, thunder days, lightning and hail) in a few selected regions provide no compelling evidence for widespread systematic long-term changes⁵².

This information basically means that the coasts of the United States are safe at the present time from hurricanes, tornadoes, thunderstorms and hailstorms. The only major

⁵⁰ *Id.*

⁵¹ *Id.*

changes that we can expect in the future are that these storms will shift from one area to another due to the NAO and ENSO climate systems. I propose that the United States government put together a team to investigate the NAO and ENSO systems effectively. The government currently has programs to track general climate, such as the National Climatic Data Center (NCDC), but a specialized team for the NAO and ENSO systems as they relate to warming in the United States would be very helpful⁵³. These climate systems control the climate for basically the entire country, and they also interact with other systems around the world. The world's climate is very dependent on each of the different regions to make up a larger whole. The whole piece is much more complex than the sum of the individual parts. The United States could possibly get help for funding from leaders of other nations in order to monitor the activity of the various climate systems more effectively. This research could be vital to preserving the climate of the Earth as we know it.

C. Cost Spreading and Planning

As the oceans rise in level, it seems only natural that certain beaches will become more attractive than others. Areas like Myrtle Beach, which is highly visited now, may suffer millions of dollars in lost tourism money if the beaches recede. It is difficult to convince homeowners, businesses, and lawmakers that changes may occur, especially when those changes happen over the course of many years. The IPCC committee on mitigation wrote a report that deals with this situation directly:

⁵² http://www.grida.no/climate/ipcc_tar/wg1/092.htm#274 (Accessed April 21, 2005)

As discussed in Chapters 8-10, it may be less costly to spread the costs of averting climate change by beginning mitigation efforts early, rather than to wait several decades and take actions after the problem has already advanced much further. Indeed, if postponing mitigation efforts allows irreversible climate impacts to occur, then no future efforts, at any cost, can undo the resultant damage⁵⁴.

This sort of cost spreading approach would be very beneficial to South Carolina. The cost of global warming could be spread out over a long period of time instead of one lump sum. This huge rise in sea level may never actually occur, but we need to be prepared just in case that it does. The IPCC says, "It is generally sensible for a person to purchase fire insurance on his or her house (despite the likelihood a fire will never occur). Likewise, it is rational for nations to insure against potentially serious damages from climate change, despite the significant chance that the most serious scenarios will not materialize⁵⁵. It is evident that cost spreading, insurance, and tourism changes all work together to create a larger framework. South Carolina needs to address each provision in the plan with the idea that all of these areas are codependent on each other. For example, spending money on cost spreading, such as new policies for global warming, right now might make insurance costs less in the future. All of the plans balance out to form the larger goal of a more hospitable coast.

It is interesting to compare the way that South Carolina would prepare for global warming to the way that the average homeowner would theoretically prepare for global warming. Disregarding the fact that most individuals and most state governments do not

⁵³ <http://www.ncdc.noaa.gov/oa/ncdc.html> (Accessed May 20, 2005)

⁵⁴ http://www.grida.no/climate/ipcc_tar/wg3/053.htm#124 (Accessed April 21, 2005)

⁵⁵ *Id.*

have enough foresight to actually plan for possible changes in the sea level, their actual plans would be quite similar in nature. The average prudent homeowner would take out an insurance policy on his or her home, and protect their valuable assets against rising sea level in any way that is cost effective and manageable for him or her. The problem for South Carolina compared to that of the homeowner is simple: How can the state protect intangible assets such as tourism from the rising ocean levels? The answer is that South Carolina has one distinct advantage that individuals do not have, and that is the ability to create policies that materially alter the framework of how life is maintained on the coast.

The largest potential policy changes over the last few years regarding global warming came in the form of the Kyoto Protocol. The IPCC met in Kyoto, Japan in 1997, and came away from the meeting with an idea for a policy on greenhouse gas emissions⁵⁶. The Kyoto protocol called for the United States to cut emissions of greenhouse gases to 7% less than 1990 levels for the years of 2008 through 2012⁵⁷. This plan for emission reductions was thought at the time to be an excellent way to mitigate global warming, but it has proven to be a better example of what not to do when planning for the future. The reason that the Kyoto Protocol was such a monumental failure is that it did not provide regulations that applied to the entire world. Certain developing countries were allowed to continue producing unlimited greenhouse gases. The problem with this is that in 1990, “the industrialized world produced roughly 49% of all carbon

⁵⁶ Bruce Yandle & Stuart Buck, “Bootleggers, Baptists, and the Global Warming Battle.” 26 HVELR 177 at p. 180

⁵⁷ *Id.* at p. 181

dioxide emissions coming from the consumption of fossil fuels in 1990, which then totaled 5.821 billion tons annually. The developing countries and the countries of the former Soviet Union produced the remaining 51%”⁵⁸. This means that even if the industrialized countries cut their emission significantly, the majority of greenhouse gas emissions would remain.

Another problem is that the developing nations would contribute more and more greenhouse gases as they continued to grow. It appears now that the United States and other developed nations will produce significantly less greenhouse gases than nations that are still considered to be in the “development” phase today.⁵⁹ “In other words, forecasts predict that the industrialized world's share of world emissions of carbon dioxide will decrease by 8% over the next twenty years, even without any broad attempts at emissions reductions”⁶⁰. This means that by around 2020, nations that are still considered “developing”, such as India and China will be producing a large amount of greenhouse gases, and will not be required to curb their production at all due to the Kyoto Protocol⁶¹.

Kyoto also allows “credits” to be bought and sold among the various nations⁶². For example, if the United States produced too many greenhouse gases in a given year, it could go to an undeveloped nation and purchase any emissions credits that the nation was willing to give up. This is dangerous, because it defeats the whole purpose of trying to keep emissions as low as possible. The Protocol basically became more of a political

⁵⁸ *Id.* at p. 183

⁵⁹ *Id.*

⁶⁰ *Id.*

⁶¹ *Id.*

process and began to go away from its original purpose, which of course was to protect the environment. Each of the various countries involved in the Protocol began to make personal attacks on each others leaders. The Kyoto Protocol quickly went from a great idea to a classic example of what not to do when planning for global warming.

How can South Carolina and the United States avoid the problems of Kyoto when structuring a plan for global warming? The main concern is that the resolution for dealing with global warming is fair to all of the parties involved. The IPCC's approach when proposing Kyoto is helpful in determining what not to do:

- no large financial transfers or windfall gains;
- no sudden shocks, but a gradual approach consistent with the coping capacity of different countries;
- no financial burden on non-Annex I (Annex I countries are the 36 industrialized countries and economies in transition listed in Annex I of the United Nations Framework Convention on Climate Change⁶³) countries; and
- no restrictions on the space for sustainable development, particularly in the developing countries⁶⁴.

This chart of the IPCC's goals shows exactly how a project that looks good on paper can turn out poorly in the real world. It is hard to argue that these four goals are not excellent for the overall well being of the environment. The IPCC proposed these goals to the members of the countries involved, and the first response was a resounding approval. However, when the world's leaders took a better look at exactly what Kyoto called for, the proposal was denounced by the United States and Europe. The reason is

⁶² *Id.* at p. 182

⁶³ <http://www.co2e.com/common/faq.asp?intPageElementID=30120&intCategoryID=93> (Accessed May 20, 2005)

⁶⁴ http://www.grida.no/climate/ipcc_tar/wg3/058.htm (Accessed April 23, 2005)

because Kyoto is slanted towards “non-Annex I” countries, which are essentially developing countries such as India and China. This meant that the United States and Europe would cut emissions drastically, while other countries would be allowed to actually raise their emissions. The end result was that the emission reductions by the current Annex-I countries would be negated by the increased emissions of the non-Annex I countries⁶⁵.

The first step that South Carolina can take to deal with all parties involved fairly is to hold a sort of town-hall type meeting where all of the parties can address their concerns. The coastal landowners, the government, business owners, non-coastal landowners, and any other interested parties can all arrange to have some sort of representation at the meeting. Goals will be discussed, and a budget can be proposed.

The second step would be to get people involved and concerned about the global warming crisis in South Carolina. Outside of nuclear war, there is no other disaster that can come close to global warming in terms of scope and repercussions. It seems that most people today either do not know enough about global warming, or think that it is going to happen so far into the future that it does not matter. This situation is not helped by the media’s constant barrage of reports on the impending doom of the world due to global warming. While it may not be true that the world is coming to an end simply because sea levels rise a few feet, it is a situation that needs to be addressed quickly.

⁶⁵ Yandle & Buck at p. 185.

The third step is that whatever legislation is ultimately decided on must be policed and enforced. The regulations that the legislature approves must be put into use or they will have no effect. It seems that controlling greenhouse gas emission will have little or no effect, since according to Kyoto, it is nearly impossible to get all groups to agree on an emissions standard that is fair for all parties. Instead, South Carolina should seek to establish an insurance program that will supplement any Federal money that the state gets for sea level rise. The main goal of any planning and cost spreading legislation should be to think of ways to encourage people to live on the coast, and insure the people who already live there of their investment. If citizens stop coastal development, then that is a key source of state property tax dollars that will be cut from an already lean budget. The state legislature should work on programs to encourage coastal development, insure coastal owners for their property, and prevent lost tourism dollars from dwindling beach access. Any money spent now on these efforts will pay off down the road, because millions of dollars will not need to be allocated in one large chunk. The money will already be in reserve waiting in case the worst should occur. If the sea level makes no discernable rise, then the state has saved wisely, and can invest the money in more worthwhile projects in the future.

D. Protecting South Carolina's Biodiversity and Natural Landscape

South Carolina has always been known as a hotspot for tourists. Our beaches, barrier islands, and marshes are among the most visited places in the United States. The

main reason that these places are so popular is because of their inherent natural beauty. One major problem that we are sure to face in the next century involves the radical changes that global warming will impose on our coastal landscape. South Carolina faces siltation, species extinction, and a major loss of biodiversity⁶⁶. These losses in biological terms would be tremendous, and further losses would come from millions of lost tourism dollars to the state's economy. This is a problem that must be addressed very quickly, or South Carolina will find itself struggling to play catch up with Mother Nature.

South Carolina does have an informal biodiversity policy in place already, but additional measures are needed to combat global warming. "The legislature has stated that it is state policy to preserve wildlife and natural resources, the coastal zone and the state's river areas. (S.C. Code Ann. §§48-9-20, 48-39-20, 48-39-250, 49-29-30) A variety of programs exist to implement these policies such as coastal zone and beach management plans"⁶⁷. The South Carolina Legislature actually has a somewhat of a mission statement codified in § 48-39-250:

The General Assembly finds that:

- (1) The beach/dune system along the coast of South Carolina is extremely important to the people of this State and serves the following functions:
 - (a) protects life and property by serving as a storm barrier which dissipates wave energy and contributes to shoreline stability in an economical and effective manner;
 - (b) provides the basis for a tourism industry that generates approximately two-thirds of South Carolina's annual tourism industry revenue which constitutes a significant portion of the state's economy. The tourists who come to the South Carolina coast to

⁶⁶ http://www.grida.no/climate/ipcc_tar/wg2/206.htm (Accessed April 25, 2005)

⁶⁷ <http://www.defenders.org/bio-stsc.html> (Accessed April 25, 2005)

enjoy the ocean and dry sand beach contribute significantly to state and local tax revenues;

(c) provides habitat for numerous species of plants and animals, several of which are threatened or endangered. Waters adjacent to the beach/dune system also provide habitat for many other marine species;

(d) provides a natural healthy environment for the citizens of South Carolina to spend leisure time which serves their physical and mental well-being⁶⁸.

This part of the South Carolina Code is a very encouraging sign that the legislature is very aware of the importance of South Carolina's coastal zone. The Code just needs some updates to reflect the potential problems that will surely come as the temperature rises over the next century. One key feature missing from the mission statement is how to protect biodiversity in South Carolina. The statute mentions that the beaches are a natural habitat for many endangered species and must be maintained for that purpose, but global warming will irreparably alter the habitat so that the species are forced to migrate. Habitat maintenance under the global warming scenario is much more difficult than the past methods of limiting development and human encroachment. Habitat maintenance in the 21st century will consist of attempting to make air quality clean, keeping the ocean temperatures down, and allowing for great changes in animal migration patterns. Many states already have systems in place for massive migration patterns such as salmon, but these patterns will likely change as the climate changes and states need to be aware of them.

It also seems that states will have to lead the way in global warming policy making, since the Kyoto Protocol fell through for the Federal government. The United

States has been slow to adopt any further national policies on global warming at all.

States such as Pennsylvania have already started symposiums on what their state can do to protect the environment, and South Carolina should follow suit with a similar program. An excerpt from the Pennsylvania program is a good model for South Carolina to follow in the future:

But there is little executive or legislative effort on the horizon to achieve significant reductions in greenhouse gas emissions or adapt to climate change. As a result, the primary opportunities that Pennsylvania has to address this issue are those that it creates for itself. This is not to deny the attractiveness of a serious national effort. But waiting for that effort makes little sense given the problems that Pennsylvania will need to address. Indeed, it can be argued that the experience of Pennsylvania and other states in addressing climate change will make federal legislation more likely. The experience and knowledge that Pennsylvania gains will provide a more realistic basis for understanding the effects of a serious national effort to address climate change. It is also possible that conflicting or inconsistent state laws would prompt national legislation to achieve consistency⁶⁹.

I think that the approach proposed by Pennsylvania scholars would be an ideal solution for South Carolina. Our legislature could adopt novel approaches to temperature rise and biodiversity issues, and we could be considered a national leader and pioneer in global warming policymaking. We could set out our plans for the future instead of relying on the federal government's direction, which seems to be severely lacking in regard to this issue.

⁶⁸ SC Code 1976 § 48-39-250

⁶⁹ John C. Dernbach, "Toward a Climate Change Strategy for Pennsylvania." 12 PENNSELR 181 at p. 196

The South Carolina Legislature could start by reading the IPCC's report on the anticipated drop in biodiversity due to global warming⁷⁰. According to the IPCC:

The most significant processes are habitat loss and fragmentation (or reconnection, in the case of freshwater bodies); introduction of exotic species (invasives); and direct effects on reproduction, dominance, and survival through chemical and mechanical treatments. In a few cases, there might be an increase in local biodiversity, but this usually is a result of species introductions, and the longer term consequences of these changes are hard to foresee⁷¹.

This statement means that overall biodiversity in South Carolina is predicted to decrease because of warming of the coastal ocean and fresh waters. Biodiversity needs to be maintained in order for a habitat to be healthy. Congress took the first step towards protection and proposed the National Biological Diversity, Conservation, and Environmental Research Act in order to protect biodiversity, but it was never passed⁷². The Act defined biodiversity as "the full range of variability among living organisms and the natural communities in which they occur."⁷³ This Act would have protected habitats and engendered species from both land use pressures and pollution⁷⁴. Instead we have the Federal Clean Water Act and the Endangered Species Act to pick up where the proposed National Biological Diversity, Conservation, and Environmental Research Act left off. For South Carolina to be successful in the future, I recommend that we look to the original intent of the National Biological Diversity, Conservation, and

⁷⁰ http://www.grida.no/climate/ipcc_tar/wg2/206.htm (Accessed April 28, 2005)

⁷¹ *Id.*

⁷² J.B. Ruhl, "Biodiversity, Conservation, and the Ever Expanding Web of Federal Laws Regulating Non-Federal Lands: Time for Something Completely Different?" 66 UCOLR 555 at p. 570.

⁷³ *Id.*

Environmental Research Act proposed by Congress. We could be an innovator in the sense that our laws offer more protection of biodiversity than those of surrounding states.

The reasons for protecting biodiversity are simple and easy to understand. There are both genetic and ecological reasons for biodiversity legislation. The genetic component is essential, because many latent genetic defects occur in mating between animals that have similar genetic dispositions. It would be essentially the same problem that occurs when a brother and sister mate. The offspring are subject to recessive genetic diseases that only occur in a certain population of animals. As the genetic code of the animals gets more and more similar, the percentage of probability that a recessive genetic defect will occur increases exponentially. Thus, the protection of genetic diversity between animals is absolutely critical to the survival of many species⁷⁵. As animals begin to die off from disease due to inbreeding, the ecological pressures on a particular species will begin to mount as well⁷⁶.

Those ecological pressures are fairly straightforward as well. Coastal habitats are balanced in a way that prevents dominance by one particular species. Nature provides that each member of the habitat occupy a precise niche that functions for the benefit of the greater whole. A good example is that if a certain type of fish in a particular area becomes too prevalent, then that fish's predators will become more prevalent as well due

⁷⁴ *Id.*

⁷⁵ http://www.grida.no/climate/ipcc_tar/wg2/206.htm (Accessed April 28, 2005)

⁷⁶ *Id.*

to the abundance of food. The predators will thrive until the fish has been put back down to a normal population size, and then the predator population will shrink back to normal due to a lack of food. It is a precise relationship that is easily changed by forced migration, introduction of new species, and habitat fragmentation. Global warming causes all these potential problems, and therefore it is a significant threat to ecological biodiversity. Certain species will no doubt go extinct due to the fact that the predator/prey relationship is thrown out of balance in certain habitats.

IV. Conclusions

South Carolina has a long way to go before it is fully prepared for the possible repercussions of global warming. There have been no significant steps laid out by our legislature to address the problem. Over the next ten to fifteen years, we as a state need to decide how exactly we are going to combat the many problems of global warming. The warming may never occur at all, but if it does we need to be prepared for that possibility. There is nothing wrong with preparing for the worst and hoping for the best, and I think that is the best approach to take in this situation. The best-case scenario is that the Earth warms a fraction of a degree over the next century, and our environment suffers no appreciable damage. The worst-case scenario, however, is second only to nuclear war in the possible destruction of Earth's natural environment. Imagine that the beautiful Charleston Battery begins to slowly be destroyed by the rising seas or that our coastal ecosystems are wrecked by forced migration, decreased biodiversity, and fragmented habitation. Both of these tragic scenarios are within the realm of possibility

due to global warming, and we need to have a plan of action to mitigate them or to stop them completely. The first steps I recommend toward achieving that goal begin with insurance planning, extreme storm detection, cost spreading, and biodiversity protection.