DANGER & OPPORTUNITY: IMPLICATIONS OF CLIMATE CHANGE FOR LOUISIANA

A REPORT FOR THE LOUISIANA STATE LEGISLATURE

TO FULFILL HOUSE CONCURRENT RESOLUTION 74, REGULAR SESSION, 1996

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LEGISLATIVE STUDY GROUP, HCR 74

Mary Tutwiler, Chair

Joey Breaux
Office of Soil & Water Conservation La. Department of Agriculture

Honorable Craig Romero (Designee)

Honorable Lynn Dean
Louisiana State Senate

Honorable N.J. D'Amico (Designee)

Gary Groesch
Alliance for Affordable Energy

Dr. Leonard Bahr
Governor's Office of Coastal Activities

Al Hindrichs
La. Department of Environmental Quality

Linda Baynham
Governor's Office of Coastal Activities

Paula Henderson
National Environmental Trust

Doug Daigle
Coalition to Restore Coastal Louisiana

Brad Spicer
Assistant Commissioner Office of Soil & Water Conservation La. Department of Agriculture & Forestry

Carlton Dufrechou
Lake Pontchartrain Basin Foundation

Susan Vuillemot
La. Environmental Action Network

Dr. Bill Herke
LSU School of Forestry, Wildlife, Fisheries (ret.)

Karen Wimpelberg
League of Women Voters

Dr. Robert Hastings
Southeastern Louisiana University

Dr. Paul Templet
Louisiana State University

Kris Sharma
La. Department of Natural Resources

Jean Westbrook
Women for a Better Louisiana

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Introduction & Overview

1998 should be a wake-up call for Louisiana. Not only did NASA declare it the warmest year on record, but the summer of 1998 was the hottest recorded in Louisiana, and the drought one of the most extreme in the state's history. These events, and their economic and environmental impacts, have provided additional urgency for the issue of global climate change. Whether the weather events of 1998 and the extreme El Niøo that fueled them are part of a larger process of climate change may be an open question. What is clear is that these events demonstrated serious vulnerabilities for Louisiana.

This report is intended as a first step towards a policy on climate change for Louisiana. It discusses specific areas of concern that will require planning and preparation. While the state has been aware of the problem of sea-level rise for some time, knowledge about other projected impacts of climate change is incomplete. Many decisions about how to respond to the threat of climate change will be made at the national and international levels. This report focuses on actions that can be taken in Louisiana which provide tangible economic and environmental benefits for the state.

One of the prime concerns about actions to mitigate climate change stems from their potential economic costs. This report identifies options for climate change mitigation that are cost-effective and offer significant economic opportunities for Louisiana, along with their environmental benefits. Prudent actions in this area can also be prudent investments.

There are a number of uncertainties about the issue of climate change. However, we cannot assume that the window of opportunity for taking effective action will remain open until global climate change is proven beyond doubt. What is required of policy makers is that they undertake prudent actions to protect the public interest.

Background

The United Nations' Intergovernmental Panel on Climate Change 1995 Report (hereafter referred to as the IPCC) is the most comprehensive work to date on the issue of global climate change. The IPCC states that atmospheric levels of greenhouse gases have increased substantially over their pre-industrial levels, and are now at greater concentrations than at any time in the past 160,000 years. Direct and indirect measures of climate data indicate a correlation between greenhouse gas levels and global temperature.

The IPCC concluded that "the balance of evidence suggests a discernible human influence on global climate."

- Global indicators of climate change have been increasing in recent years: Global mean temperature has risen by one degree over the past century, at a rate rapid for the historical record. The warmest years on record have occurred since 1980, with 1995, 1997, and 1998 each reaching record temperatures.
- A rise in global sea level of 4-10 inches over the past century may be related to the rise in global mean temperature and in ocean temperatures.
- A dramatic retreat of glaciers has been observed around the world, in the Antarctic peninsula, the Alps, the Andes, southern Alaska, Greenland, and Glacier National Park in Montana.
- The breakup of major ice shelves and icebergs in Antarctica has been noted by the IPCC and subsequent studies. On October 15, 1998, an iceberg one and one-half times the size of Delaware (1,073 square kilometers) broke off from Antarctica's Ronne Ice Shelf.

Implications for Louisiana

The extreme weather events of 1998 demonstrated serious vulnerabilities for Louisiana to climate change - vulnerabilities for public health and safety, as well as for major sectors of the economy. This report will examine five key areas of risk for Louisiana: extreme weather, public health, agriculture, forestry, and coastal impacts.

Extreme Weather:

Flooding - Louisiana is vulnerable to flooding, especially in the southern part of the state. A series of tropical storms in the fall of 1998 led to almost continuous flooding for coastal parishes. Coastal parishes and greater metropolitan New Orleans are also becoming more vulnerable to damage from hurricanes due to coastal land loss. A related effect of this rising vulnerability and an increase in extreme weather events could be a growing unavailability of private insurance for flood-prone areas.

Public Health:

Vector-Borne Diseases - Louisiana is vulnerable to the spread of vector-borne diseases such as malaria, dengue fever, and encephalitis. Mosquitoes carrying these diseases are already found in the state, and an outbreak of the St. Louis strain of encephalitis affecting 19 people occurred in Jefferson Parish in the late summer of 1998. Warmer temperatures would increase this vulnerability.

Heat waves - The summer of 1998 may have set a record for heat-related deaths (at least 41) in Louisiana in a single year. After a record number of successive days with temperatures over 105 degrees, there were 28 heat-related deaths in the Shreveport-Bossier City area alone, primarily among the vulnerable population of the elderly poor.

Air pollution - Warmer temperatures exacerbate the effects of air pollution, such as ground level ozone. A number of metropolitan areas in Louisiana, such as East Baton Rouge Parish, are already in non-compliance with federal ozone standards. The health effects of these pollutants are well-documented; like heat waves and vector-borne diseases, they also have their initial impacts on at-risk populations such as the poor and elderly.

Water pollution - Louisiana already has serious problems with water quality. In addition to industrial and municipal pollution, the state's waters have suffered from harmful algal blooms, as well as viral and bacterial contamination of shellfish, in recent years. A current scientific hypothesis posits that warmer temperatures have interacted with agricultural runoff to facilitate the outbreaks of pfiesteria experienced in estuarine waters of some Atlantic coast states.

Agriculture:

Drought - The drought of 1998 reduced yields of important crops such as corn, cotton, hay, sorghum, and soybeans. The state was declared an agricultural disaster area by USDA, and total crop losses reached over $450 million. That figure does not include economic effects on local communities or the state economy, nor the social costs of bankruptcy for farmers.

In addition to the drought's effects on agriculture, it impacted parishes and municipal areas that rely on lakes for their water supplies, especially in the western part of the state. An increase in the frequency and severity of droughts would also affect aquifers and groundwater supplies in Louisiana. The proposed Trans-Texas Waterway, which could divert up to half of the flow of the Sabine River to serve metropolitan Houston in an era of decreasing water supply, would heavily impact southwestern Louisiana.

Forestry:

Nearly 50 million pine seedlings, about half the year's crop, were lost in 1998 due to a warm, wet winter that caused a microbe buildup, followed by the spring and summer drought. Mortality rates of seedlings on some private lands reached 70%. Louisiana also experienced eight times as many forest fires as usual. Their impacts were controlled by the effectiveness of the state's fire suppression program.

Coastal Impacts:

Louisiana is highly vulnerable to an acceleration in the rate of global sea-level rise due to climate change. Most of Louisiana's coastal system consists of marshes, which when healthy can adapt to some degree of sea-level rise. Unfortunately, Louisiana's marshes and coastal wetlands are facing collapse due to the interaction of human actions and natural forces. The serious impacts of the state's current coastal land loss problem will have to be addressed in the near term, whereas projected sea-level rise would take place over decades.

The IPCC estimates that if global carbon dioxide emissions were to be maintained at 1994 levels (an unlikely event if current energy trends continue), they would lead to a nearly constant rate of increase in atmospheric concentrations of carbon dioxide for at least two centuries, and roughly double those concentrations by the end of the twenty first century. Without significant steps to reduce greenhouse gas emissions, their atmospheric concentrations will continue to increase past the doubling level.

The IPCC projects that, based on current knowledge and understanding, these kinds of events and the climate trends that fuel them will worsen if global emissions of greenhouse gases continue to increase. This projection, as well as the vulnerabilities described above, provides ample justification for seeking to reduce greenhouse gas emissions.

A "No Regrets" Policy

There are uncertainties in the science of climate change, but we cannot assume that resolving them will occur in time to take effective action to head off and mitigate projected impacts. The key task for public officials is not to debate the certainty of the science involved, but to address the question: what is prudent, responsible policy that best protects the public interest and safety?

To help answer this question, the legislative study group has relied on three guiding principles which, taken together, constitute a "no regrets policy":

"No Regrets" - There are many actions that should be undertaken for reasons unrelated to climate change, but that can also play an important role in mitigating and responding to climate change. Benefits from these actions will be realized whether or not climate change occurs as projected. Restoring Louisiana's coast and promoting the state's natural gas resources fall into this category.

Collateral Benefits - Many actions that reduce greenhouse gases offer other benefits, such as saving money on energy bills, and these other benefits may constitute the prime motivation for undertaking the actions. Returning marginal agricultural lands to productive forestry, and saving consumers and taxpayers money through energy efficiency fall into this category.

Precautionary Principle - This principle justifies taking action in situations of serious risk, even in the face of uncertainty. Major policy actions are rarely, if ever, undertaken with the benefit of perfect knowledge. The natural variability of the climate and the narrowness of society's comfort level are factors that strengthen the reliance on this principle.

Following these principles, the legislative study group has identified a number of actions which can be taken to substantially reduce greenhouse gas emissions in Louisiana, while conveying economic and environmental benefits to the state. Within the energy sector, the primary source of greenhouse gas emissions, three key areas of opportunity exist for Louisiana: increasing energy efficiency, promoting the state's natural gas resources, and upgrading transportation systems to expand mass transit.

Energy Efficiency - There are significant success stories in this area in Louisiana. Among them: public schools in East Baton Rouge Parish saved over $1 million dollars with an energy management program; an energy efficiency program in the New Orleans Utilities Department saved the city over $1 million dollars in 1998; and the state initiated a Commercial Building Energy Conservation Code in 1997.

Tremendous opportunities for increasing energy efficiency (and saving money) exist across all sectors in Louisiana. "Industries for the Future", a new program funded with a grant from the U.S. Department of Energy, offers a significant opportunity for pursuing greenhouse gas emission reductions in the state's industrial sector, while at the same time improving competitiveness in national and international markets. (According to EPA data from 1990, industry accounts for 54% of greenhouse gas emissions in Louisiana.)

Natural gas - Natural gas has the lowest CO_2 emissions per unit of energy of all fossil fuels. Louisiana currently supplies around 25% of the domestic market, and holds 19-20% of domestic U.S. reserves of natural gas. The state also has an extensive infrastructure for processing and distributing natural gas. Policies that promote low-carbon fuels therefore offer important economic opportunities for Louisiana, especially for job creation in the natural gas industry.

Transportation - According to EPA data, Louisiana had the 3rd highest level among states of per capita CO_2 emissions in the transportation sector, which accounts for 25% of emissions in the state. Most of Louisiana's metropolitan areas have lagged behind in investing in public transportation. They also have growing problems with traffic congestion. A number of case studies and examples from across the country indicate that traffic problems, as well as problems for economic development and quality of life that result from traffic congestion, are best addressed through a combination of transportation options, in which mass transit systems such as bus and light rail can play a key role.

Reduction of greenhouse gas emissions will help to reduce the severity and impacts of projected climate change. There are also significant actions that can be taken in the same sectors that climate change puts at risk, such as agriculture, forestry, and our coast, that can help sequester, or store, carbon dioxide that would otherwise be released to the atmosphere:

- Agriculture: A number of studies indicate a tremendous potential for some agricultural practices to sequester atmospheric carbon, while delivering other benefits such as increased soil productivity. These practices should be encouraged with cooperative efforts and incentives (there have been some proposals for tax credits for carbon sequestration for farmers.) The state also needs to develop water use policy and planning to respond to droughts.
- Forestry: Reforestation projects and habitat protection programs offer significant opportunities for carbon sequestration, while delivering other benefits such as flood control, wildlife habitat, and increased landowner income. Urban forestry programs should be expanded to alleviate heat impacts, in addition to the aesthetic and commercial benefits they confer.
- Coastal: Full-scale restoration of Louisiana's coast to a sustainable condition is the state's best defense against accelerated sea-level rise. Reestablishing coastal wetlands can also serve to sequester carbon dioxide.

Louisiana is not only a top energy producing and consuming state, but is also one of the most carbon-intensive states. This means that Louisiana ranks near the top for carbon emissions, primarily from industrial processes, but also from transportation. As such, Louisiana cannot avoid doing its part in national efforts to address the issue of climate change. At the same time, Louisiana has serious vulnerabilities to climate change which would be exacerbated with rising temperatures and an increase in extreme weather events. To do nothing and wait, therefore, is not a tenable position for the state to take. The strength of the actions recom-mended here is that they constitute a "win-win" policy for Louisiana.

Structure of the Report

The report is divided into the following chapters. Chapter 1 reviews the evidence for global climate change summarized by the IPCC. Chapter 2 examines key areas of risk for Louisiana, such as sea-level rise and extreme weather. The sections of this chapter have the following layout:
1. A summary of the IPCC conclusions on each area of risk.
2. A summary of IPCC Recommendations for Action, which tend to be global in focus. 3. Implications for Louisiana, which are regional or local in focus. These include not only projected effects of climate change, but present trends and vulnerabilities which could be exacerbated by climate change.
4. Recommendations for Louisiana, including actions to head off, alleviate, or mitigate climate change as well as adaptive strategies.

Chapter 3 examines ways in which Louisiana can act to reduce its greenhouse gas emissions while expanding its economy, such as improving energy efficiency and promoting the state's natural gas resources. These options offer significant opportunities to both make and save money for Louisiana's citizens, and for the state to proactively adopt policies with its own interests in view. Chapter 4 presents concluding recommendations for state actions and policies.

The HCR 74 Study

Commission In the 1996 Regular Session of the Louisiana legislature, House Concurrent Resolution No.74 (Appendix 1) was introduced by Representatives Murray, Holden, and Rousselle. HCR 74 created a study commission of citizens and experts to do the following:

- review the evidence for global climate change presented by the U.N. Intergovernmental Panel on Climate Change (IPCC);
- examine the mitigation options listed in the IPCC report;
- examine the ways in which policies aimed at reducing carbon dioxide emissions could enhance the economic development of the state of Louisiana;
- make recommendations on prudent actions to protect the health of Louisiana's citizens and natural resources.

HCR 74 was ratified by both legislative branches by large majorities. From the time of original introduction, membership on the commission was open, incorporating members of the legislature, secretaries of two administrative agencies, the commissioner of agriculture, wetland and coastal experts, environmental organizations, and representatives of people who live in coastal communities. No group or organization that requested membership was denied.

The commission adhered strictly to the Louisiana Open Meetings Law for its plenary sessions and committee meetings. The non-governmental members of the commission served without compensation. No budget was provided by the legislature for the work of the commission, but the staff of the legislative committees were generous with in-kind contributions of mailing and copy costs.

As outlined in HCR 74, the commission was initially called together by the chairmen of the Senate and House Natural Resources Committees. At that meeting, the commission appointed a permanent chairperson and a vice-chair, and organized itself into committees to carry out research and compilation of the report. The full text of the report was approved by a majority of the full commission. We attempted to work out differences through consensus where possible, and encouraged minority reports from members with differing view points from those contained in the final report.

History and Role of the IPCC

The Intergovernmental Panel on Climate Change (IPCC) was jointly established by the World Meteorological Organization and the United Nations Environment Programme in 1988, in order to:

- assess available scientific information on climate change;
- assess the environmental and socioeconomic impacts of climate change;
- formulate response strategies.

The IPCC First Assessment Report was completed in August 1990, and served as the basis for negotiating the UN Framework Convention on Climate Change. The IPCC was organized into three main Working Groups with over 2000 authors, contributors, and reviewers from a variety of scientific disciplines representing more than 50 countries.

Working Group I focused on the science of climate change. There were 78 lead authors in 20 countries, over 400 contributing authors from 26 countries who submitted draft text and information, and over 500 reviewers from 40 countries who provided suggestions for changes and improvements.

Working Group II of the IPCC reviewed the state of knowledge concerning the impacts of climate change on physical and ecological systems, human health, and socioeconomic sectors. It also reviewed the available information on the technical and economic feasibility of a range of potential adaptation and mitigation strategies.

Working Group III reviewed the economic and social dimensions of climate change, including impacts on financial institutions such as banks and insurance companies.

In 1992, the IPCC reorganized its Working Groups II and III, and completed a Second Assessment in 1995, updating information on the same range of topics, and including the new subject area of technical issues related to the economic aspects of climate change.

Chapter I: Review of Evidence for Climate Change

The "greenhouse gases" that occur naturally in the atmosphere, such as water vapor, carbon dioxide, and methane, hold part of the sun's radiated heat close to the earth and keep it from being completely reflected back into space. This warming by the natural greenhouse effect makes life possible on earth's surface. Scientists have asked about the results of raising the concentrations of atmospheric greenhouse gases ever since they realized that an increase was occuring because of human activities, such as burning wood and coal.

The IPCC concluded that the balance of evidence suggests a discernible human influence on global climate. Human activities are increasing the atmospheric concentrations of greenhouse gases, such as carbon dioxide and methane, which act to warm the atmosphere.

The amount of carbon dioxide in the atmosphere has increased by more than 25% over the past century. This is due in large part to the burning of fossil fuels and clearing of forests.1 By 1995, atmospheric concentrations of carbon dioxide had reached 360 parts per million (ppm), compared with levels of 280 ppm prior to the beginning of the industrial revolution, circa 1750. Atmospheric concentrations of methane and nitrous oxide have increased by 145% and 15%, due to human activities such as biomass burning, landfills, rice farming, and raising livestock. Concentrations of chlorofluorocarbons (CFC's) and a range of other gases have also increased due to industrial activity.[2]

Many greenhouse gases remain in the atmosphere for long periods of time. Carbon dioxide and nitrous oxide remain for decades to centuries. Carbon dioxide alone accounts for over half of current human greenhouse gas emissions. The IPCC report states that if emissions of carbon dioxide were maintained at 1994 levels, the result would be a nearly constant increase in atmospheric concentrations for at least two centuries. Under this scenario, atmospheric concentrations of carbon dioxide would reach about 550 ppm, or twice the pre-industrial level, by the end of the 21st century.[3]

Continued increases in concentrations of greenhouse gases are projected to lead to regional and global changes in climate and related parameters such as temperature, precipitation, soil moisture, and sea level. [4] The IPCC states that the magnitude and significance of these and other effects of climate change are not yet fully resolved.[5]

The IPCC points out that any human effect on climate will be superimposed on the "background noise" of natural climate variability.[6] Natural variability in climate results from internal fluctuations in the atmosphere, land, and oceans, and from external factors such as solar activity and volcanic eruptions. The IPCC 1995 Report cited significant progress in distinguishing natural and human influences on climate since its earlier report in 1990.[7]

The IPCC identified the following indicators for global climate change:

- Temperature: Global mean surface air temperature has risen by .54 to 1.08 degrees Fahrenheit since the late 19th century. The IPCC states that this increase is "exceedingly rapid" compared with the historical record.[8] Recent years have been among the warmest since instrumental records were kept, with the warmest years on record occurring since 1980. 1995, 1997, and 1998 have since been declared the hottest years on record.[9] Regional changes are most evident, with recent warming being greatest over the mid-latitude continents in winter and spring. Night-time temperatures have generally increased more than daytime ones, possibly as a result of increased cloud cover.[10]
- Sea Level: Global sea level has risen 4-10 inches over the past 100 years. Because water expands as it warms, this rise may be a result of the rise in global mean temperature.[11] Subsurface ocean temperatures have also risen, along with surface temperatures.[12]
- Glaciers: A retreat of glaciers has been measured in many parts of the world, including the Alps, south-central Alaska, and Glacier National Park in Montana.[13] Data subsequent to the 1995 IPCC has shown increased glacier retreat in the Andes and Greenland.[14]
- Ice Sheets: The IPCC noted recent break-ups of several major ice shelves and discharges of large icebergs in Antarctica, and several ice-sheets have broken off subsequent to the IPCC Report.[15]

The IPCC relied on both direct and indirect measures of global climate change. Many observations utilized in attempting to detect climate change were made for other purposes, such as weather forecasting.[16] Direct measures include air temperatures and sea-level. Indirect measures include the retreat of glaciers and sea-ice cover, borehole temperature and pollen readings in polar ice, and examination of tree rings and coral bleaching.[17] Sources of climate information also include instrumental and "paleo-data" (such as that from ice cores), and climate models.

The IPCC utilized global climate models for the atmosphere and oceans, as well as models for land surface changes, sea ice fluctuations, and other processes.[18] The 1995 IPCC assessment incorporated the influence of human-generated aerosols, particles which tend to cool the atmosphere. The cooling role of aerosols is limited by their short "lifespan" of days to a few years, as opposed to greenhouse gas lifespans of a century or more.

The models predict an increase in global mean temperature of 2-9 degrees Fahrenheit) by the year 2100, and an associated rise in sea level of between 6 and 38 inches.[19] The doubling of atmospheric carbon dioxide has been used as a benchmark in climate change models, but the IPCC pointed out that concentrations of greenhouse gases are not expected to level off at this doubling.[20]

Uncertainties in Climate Change Predictions

The IPCC Report discussed in detail uncertainties that remain in the science of climate change. Some sources of data needed for documenting, detecting, and attributing climate change "are not at present good enough for rigorous conclusions to be reached."[21] There are also uncertainties in understanding long-term climate variability and the response to increasing greenhouse gas concentrations, the cycling of greenhouse gases throug biochemical systems, regional patterns of climate change, and estimation of future greenhouse gas emissions.[22]

There are a number of uncertainties in global climate models, particularly regarding the "feedback systems" associated with clouds, ocean currents, and the carbon cycle.[23] Models and data collection have continued to be refined since the IPCC 1995 Report. Key questions remain about global feedback systems, especially the role of ocean currents in past climate change, and about how to predict their role in future changes. Because of the uncertainties in projections of future climate, the IPCC emphasizes their importance as scenarios to assess possible impacts on the environment and society.[24]

The IPCC makes the important point, however, that uncertainty cuts both ways. Climate change could be less pronounced than expected, or more extreme than current models and projections indicate. Evidence drawn from ice cores indicate that past climate changes were rapid and large, and not associated with any known causes. "Future unexpected, large and rapid climate system changes (as have occurred in the past) are difficult to predict."[2]

Notes

1. Trenberth, et.al, "The Climate System: an overview", p.59, in Climate Change 1995: The Science of Climate Change: Contribution of Working Group I to the Second Assessment Report of the Intergovernmental Panel on Climate Change; Cambridge University Press, 1996. Hereafter referred to as WGI.
2.Climate Change 1995: The Science of Climate Change: Summary for Policymakers and Technical Summary of the Working Group I Report, p.8; Cambridge University Press, 1996. Hereafter referred to as WGI Summary.
3. Ibid.
4. WGI Summary, p.12.
5.Trenberth, et.al, p.59, WGI.
6.WGI Summary, p.10.
7. Technical Summary, p.35, WGI.
8. Trenberth, et.al, p.62, WGI.
9. Goddard Institute for Space Studies, "Global Land-Ocean Temperature Index", National Climatic Data Center, National Oceanic and Atmospheric Administration (NOAA), cited in O'Meara, M., "Global Temperature Reaches Record High", Vital Signs 1998 W.W. Norton & Co. 1998.
10.WGI Summary, p.10. See also, Leary, W.E., "Spring May be Earlier than a Generation Ago," New York Times (hereafter NYT), 7/16/96; Stevens, W.K., "A Greener Green Belt Bears Witness to a Warming Trend", NYT, 4/22/97; Stevens, W.K., "Ever-so-slight rise in temperatures led to a record high in 1997", NYT, 1/9/98; Stevens, W.K., "Global Temperature at a high for the first 5 months of 1998," NYT, 6/8/98.
11. WGI Summary, p.10.
12. Nicholls, et.al, "Observed Climate Variability and Change",p.149-150, WGI; see also, Cane, et.al, "Twentieth-century sea surface temperature trends," Science, v.275, 2/14/97.
13. Warrick, et.al, "Changes in Sea Level", p.371, WGI.
14. O'Meara, op.cit.
15. Ibid., p.374. See also, "Giant iceberg breaks off Antarctica", Science-News, v.147, 4/29/95; "Rapid collapse of northern Larsen Ice Shelf," Science, v.271, 2/9/96; "Antarctic warmth kills ice shelves," Science-News, v.149, 2/17/96; "Catastrophic Melting of Ice Sheet is Possible, Studies Hint", NYT, 7/7/98; "Researchers Find Signs of Warming in Arctic Air, Ice, and Water", NYT, 10/20/98; "Antarctic Ice Shelves See Another Big Breakup", WorldWatch, vol.12, no.1, Jan/Feb 1999.
16. Trenberth, et.al, p.61, WGI.
17. Nicholls, et.al, p.149, WGI.
18. Ibid., p.62; See also, Hasslemann, K., "Are we seeing global warming?", Science, v.276, 5/9/97.
19. WGI Summary, p.45-46.
20. Trenberth, et.al, p.64, WGI.
21. Nicholls, p.141, WGI.
22. WGI Summary, p.13. See also, Wood, A.R., "Cloud Cover: Deficiencies in data concern climatologists", Sunday Advocate. 12/29/96.
23. Gates, et.al, "Climate Models - Evaluation", p.274, WGI.
24. Trenberth, p.64, WGI.
25. WGI Summary, p.13 & p.51. See also, Stevens, W.K., "If Climate Changes, It May Change Quickly", NYT, 1/27/98.

Chapter II: Areas of Risk from Climate Change

The legislative study group identified several key areas of risk for Louisiana from projected climate change: extreme weather, human health, agriculture, forestry, and coastal impacts.

Section One - Extreme Weather Events

- Summary of IPCC Report and other global indicators

Climate change is projected to cause an increase in climate variability, with a resulting increase in extreme weather events. Warmer temperatures are expected to lead to more extreme hydrological cycles. Frequency and severity of droughts and floods are projected to increase for some regions and decrease for others. Some climate models indicate an increase in the intensity of precipitation and occurrence of heavy rain events.[1]

The IPCC Report stated that while there is insufficient data to reach general conclusions on how climate variability or weather extremes are changing on a global level, there is clear evidence of changes in extremes and variability on a regional level.[2] There has been a decrease in precipitation in tropical regions, while a significant trend of increased heavy rain events is evident in the U.S., especially during the warm season.[3] Several studies subsequent to the IPCC Report have found an increase in droughts, unusual wet periods, and intense storms in the last few decades.[4] Although the causes of these trends are uncertain, they are consistent with climate models developed by the IPCC.

The IPCC states that the persistent 1990-95 "warm-phase" El Niøo event in the Pacific Ocean was unusual based on records of the last 120 years.[5] The 1997-98 El Niøo was one of the most intense on record, causing severe winter storms on the Atlantic and Pacific coasts, and an unusually warm and wet winter and spring in the south and interior U.S., followed by a summer marked by drought and heat waves in many parts of the country.[6] A key question is whether the persistence and intensity of the latest El Niøo is part of a larger process of climate change.[7]

- IPCC Recommendations

The IPCC recommended taking a regional focus in looking at possible impacts of an increase in extreme weather events, since regional differences can be substantial.[8] Most societies have developed strategies to cope with only a limited range of climatic events, and are unprepared for adaptating to projected changes, especially on the local level.[9] "Adaptation to changing temperatures involves adjustments in health care, heating and cooling facilities, and household activities. Improvements to infrastructure, including urban buildings and construction as well as water control and storage systems [will] also be needed."[10]

The IPCC emphasized the importance of planning, as opposed to an ad hoc approach. Planning for land use, particularly in flood plains and coastal zones, was identified as essential for preventing increased risk to property values. "Long-term planning should consider particularly the risk of major inundation... This is an increasing risk as population and investment move to coastal areas or river plains, and will be compounded by sea-level rise..."[11] "Effective coastal zone management and land-use regulation can help direct population shifts away from vulnerable locations such as flood plains [and] low-lying coastlines."[12]

Working Group III of the IPCC developed assessments of some of the costs of climate change by estimating damages from events such as floods and wind storms, and developed ways to assess cost-benefit ratios of mitigation and adaptation options in light of the damage costs.[13]

- Implications for Louisiana

Key risks to Louisiana from extreme weather include heat waves, floods, and increased intensity of hurricanes. While hot temperatures are nothing new to Louisiana, the state is still vulnerable to damage from prolonged heat waves and droughts. The summer of 1998 was the hottest on record in Louisiana,[14] with the heat and drought causing severe damage to Louisiana agriculture and forestry (see Chapters 3 and 4.)

Another source of concern for Louisiana comes from changes in the hydro-logical cycle projected to result from climate change. There are some indications that such changes may already be underway. An examination of state precipitation records by Dr. Robert Muller of the Louisiana Office of State Climatology has shown an increase in precipitation in the state of 15-20% over the last century.[15] In more recent decades, there has also been an increase in extreme rain events, defined by Dr. Muller as having at least 6 inches of rainfall during no more than 3 consecutive days. For the five year period ending with 1995, there were an unprecedented ten such events, or two per year on average.

A rise in the number of extreme rain events brings the risk of increased flooding, especially in low-lying areas that are already vulnerable. In May 1995 (one of the hottest, wettest years experienced in Louisiana) a record two-day rainstorm overwhelmed the drainage pump system in New Orleans and caused severe flooding.[16] The same storm dumped 24 inches of rain in two days over St. Tammany Parish, causing widespread flooding. Risks are high in many parts of southern Louisiana: 42% of the land in East Baton Rouge Parish, 70% of Ascension Parish, and 75% of Livingston Parish have the potential to be inundated in a designated "100-year flood."[17]

Projected increases in precipitation in the Mississippi River Valley could also result in higher river levels and more frequent floods. Some models predict that a doubling of atmospheric greenhouse gas levels would increase freshwater discharge from the Mississippi River to the Gulf by 20%.[18] This could necessitate substantial re-engineering of the levee system along the river. High water levels on the Mississippi in the spring of 1997 strained the levee system and necessitated the opening of the Bonnet Carre Spillway and the closing of several flood gates in Morgan City.[19]

There is still uncertainty about whether projected climate change will increase the number of hurricanes for the Gulf Coast, but it is clear that the state's vulnerability to hurricane damage is steadily increasing as the buffer of barrier islands and coastal wetlands is lost. In the past few years, even relatively small hurricanes which have not made landfall in Louisiana have caused serious coastal flooding.[20] In fact, smaller storms that only "brush" the coast can be extremely dangerous. In late summer 1998, a series of tropical storms that hit Louisiana in quick succession (Earl, Frances, Hermine), followed by Hurricane Georges, led to continual flooding in all coastal parishes and the north shore of Lake Pontchartrain. Nineteen parishes required federal disaster assistance.[21]

Louisiana already leads the nation in property damage caused by floods.[22] Most flood insurance policy holders in the state live in parishes defined by the Federal Emergency Management Agency (FEMA) as "Coastal Special Flood Hazard Areas."[23] In 1996, the Allstate and State Farm companies announced that they would freeze the amount of property insurance they sell in south Louisiana parishes.[24] If precipitation levels, flood frequency and storm intensity continue to increase, greater assumption of flood and storm damage insurance liability by the public is likely.

- Recommendations for Louisiana

Louisiana's ability to respond effectively to an increase in extreme weather caused by climate change will depend on two kinds of planning: 1) emergency and disaster planning, and 2) land use planning. The storms of 1998 dramatize the growing vulnerability of coastal and other low-lying areas, including metropolitan New Orleans, which narrowly avoided a direct hit by Hurricane Georges. The American Red Cross had already decided two years earlier to no longer operate hurricane evacuation shelters south of Interstates 10 and 12, since these areas have been designated as inundation zones for Category 4 hurricanes.[25] Louisiana will have to continue to develop and improve its emergency and disaster planning capabilities.

The second kind of planning involves land use. Controlling development in flood plains and stemming the loss of interior wetlands can reduce vulnerability to both current and future flooding. Development and drainage systems can be planned around wetlands and natural drainage systems. Louisiana is currently reassessing the value of its coastal wetlands in terms of their role in storm protection and water purification. The function that interior wetlands make to flood control (as well as for water recharging and filtering) should be incorporated into economic assessments of their value as well. The public funds being expended to deal with flooding and drainage issues in parts of the Amite and Comite River Basins that were allowed to be developed are another reminder that preventative actions are less expensive than mitigation.[26]

The projected increase in extreme weather events from climate change also makes it clear that prudent policy requires combining both kinds of planning. This approach informed the Atchafalaya Basin Master Plan completed by the state in 1998.[27] By restricting development in the Atchafalaya Basin and making retention of its wetlands functions a priority, the Master Plan sought to accomplish several goals at once. Not only would the values and benefits of wildlife, recreation, and tourism be enhanced, but the crucial function of the Atchafalaya as a floodplain would be ensured so that the basin can accomodate the eventual "Project Flood" (a flow estimated by the US Army Corps of Engineers at 1.5 million cubic feet of water per second).

- Addendum: The Role of Insurance

An additional indicator of trends in weather extremes comes from the insurance industry, which has recorded a fourfold increase in annual weather disasters since the 1960s.[28] At least one "billion dollar storm" occurred every year worldwide from 1987 to 1993, and weather disasters between 1988 and 1998 cost the U.S. over $150 billion.[29] The annual insured cost of major windstorms worldwide increased progressively from $500 million in the 1960s to over $11 billion in the early 1990s.[30] These costs partly reflect socio-economic changes, such as population increases in many coastal areas.

Hurricane Andrew (1992) acted as a bellwether for the insurance industry. Prior to Andrew, many insurance experts thought that property damage from a serious storm would never exceed $8 billion, but the price tag for Andrew reached $15.5 billion. In the aftermath, insurers began to reassess loss estimates and to use computer models to pinpoint high risk areas.[31] The insurance industry has called for more planning to mitigate projected damages from climate change, and is also funding research into past climate changes in an attempt to anticipate future storm cycles, including studies at Louisiana State University.[32] A greater frequency of extreme weather events carries the risk of higher insurance premiums and withdrawal of coverage in vulnerable areas.[33]

The IPCC noted that insurers have traditionally anticipated increased risk by restricting coverage, transferring risk, or raising premiums. Now, however, a new, preventative outlook is emerging.[34] The Federal Emergency Management Agency (FEMA) has made floodplain management a central part of Project Impact, a new initiative designed to shift focus from simply responding to disasters to taking action beforehand to help reduce potential damage.[35] Among the elements of Project Impact:

- Withdrawing flood insurance availability for owners who refuse to elevate or accept a buyout for their home after having filed two or more claims totalling more than their home's value;
- Charging people who live in high risk areas fair market rates (as opposed to lower, subsidized federal rates) for insurance;
- Protecting floodplains and wetlands against development;
- Insuring all public buildings to 80% of their replacement value within the next two years in return for mitigation incentives.

The IPCC pointed out that because of its experience with issues of weather impacts, the insurance industry can help public authorities improve their response to property damage from climate change. This can be done through mapping potential hazards, putting physical protections in place, improving construction designs and processes in new buildings, and retrofitting old ones.[36] The IPCC recommended that all parties in the property market - owners and occupiers, architects and builders, insurers and regulatory authorities -

be educated about the potential effects of climate change and the means available to combat its impacts, so that disaster plans can be prepared at all levels.[37]

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Section Two: Impacts on Human Health

(This chapter reviewed by Louisiana Department of Health & Hospitals)

- Summary of IPCC Report

The IPCC concluded that the disturbance of physical systems and ecosystems brought on by climate change will pose significant threats to human health.[1] Among the more serious threats are:

- Extreme heat
- Extreme Weather Events and Variability
- Vector-Borne Diseases
- Water-Borne and Food-Borne Diseases
- Effects on Agricultural Productivity
- Effects on Food Supplies
- Impacts on Respiratory Disorders from Air Pollution
- Skin Cancers, Cataracts, Altered Immune Functions
- UV-B Radiation

The IPCC states that the anticipated health impacts of climate change are on the scale of whole communities or populations. This makes climate change a public health, rather than personal health, issue.[2] On the global level, the ability to predict regional differences in health effects of climate change is still limited, but human populations differ widely in their environmental circumstances, social resources, preexisting health status, and their vulnerability to climate-induced stresses.

The IPCC identified a number of ways in which climate change could contribute to or influence risks to public health:

- An increase in frequency or severity of heat waves would cause an increase in mortality and illness.
- More frequent extreme weather events would increase rates of death, injury, and infectious disease.
- Warmer weather could increase the geographic distribution of vector organisms for infectious diseases. Changes in life-cycle dynamics of vector and infective parasites would also increase the potential transmission of vector-borne diseases.[3] The IPCC makes two important points about vector-borne diseases:

- Because vector control methods exist for many of these diseases, more developed countries should be able to minimize their impact.
- Quicker turnover of the parasite life-cycle at higher temperatures, however, could increase their likelihood of evolving greater resistance to drugs and other control methods. "Many of the health impacts of climate change would occur via processes that are relatively unfamiliar to public-health science. [They] would arise via the indirect and often delayed effects of disturbances to natural systems and their associated ecological relationships."[4]
- A crucial factor in the potential spread of both infectious and vector-borne diseases is the effect of climate change on the bioclimatic thresholds which usually constrain them. There is generally a range of climatic conditions which act as upper and lower thresholds for the viability of infectious disease pathogens, insect pests, and organisms that spread vector-borne diseases. Changes in the distribution of organisms that spread vector-borne diseases like malaria would occur if climate change causes their present geographic range to shift.
- The IPCC points out that "vector-borne diseases (VBDs) are now relatively rare in most developed countries; however, it has been predicted that various VBDs might enter or increase in incidence in the U.S. because of higher temperatures."[5] In addition, "climate change-related increases in malaria incidence... would occur primarily in tropical, subtropical, and less well protected temperate-zone populations currently at the margins of endemic areas."[6] Along with malaria, Venezuelan equine encephalitis, dengue, and leishmaniasis could expand in the southern United States. Species such as the dengue-transmitting mosquito are well established in the United States, and may move further north if temperatures rise.
- IPCC Recommendations

  The IPCC acknowledges that there is unavoidable uncertainty and complexity in forecasting health impacts of global climate change. Environmental management, public health monitoring, protective technical measures, and improved primary health for vulnerable populations are important strategies for dealing with threats to human health on the global level. Two specific areas of recommended study are the health impacts of heat waves in conjunction with air pollution, and the relation between climatic impacts on ecosystems and vector-borne diseases.[7]

- Implications for Louisiana

Projected climate changes could result in Louisiana facing health threats in four key areas: heat waves, air pollution, water pollution, and vector-borne diseases.

Heat Waves - The summer of 1998 caused a high number of heat-related deaths in Louisiana.[8] At least 41 such deaths were recorded by August. Northwest Louisiana was especially hard hit. Following a record number of successive days with temperatures of 105 degrees (F) or more, there were an estimated 28 heat-related deaths in the Shreveport-Bossier City area. The usual number of such deaths in that area is approximately three per year.[9] Weather patterns in the area closely paralleled those in Texas, which recorded over 100 heat-related deaths for the summer.

These deaths demonstrated the vulnerability of certain populations, such as the poor and elderly, to extreme heat conditions. A number of those who died in the Shreveport area were elderly residents of houses and apartments where inside temperatures reached between 100 and 120 degrees (F).[10] FEMA states that urban areas are at greater risk from the effects of prolonged heat waves than rural areas.[11] This heightened risk stems in part from the concentrated populations and intensified heat effects in urban areas, a combination that contributed to the deaths of over 700 people in the Chicago heat wave of July 1995.[12]

Air pollution - Another heightened risk in urban areas comes from the effects of higher temperatures on pollen counts and airborne pollutants such as hydrocarbons and ozone.[13] Ozone pollution in particular is worsened by hotter conditions. Ozone damages lung tissue and can aggravate asthma and lung disease, and even modest exposure can affect healthy individuals. Several areas in Louisiana, such as Baton Rouge and several surrounding parishes, are currently in non-compliance with federal standards for ground level ozone.[14] Baton Rouge is grouped with far larger metropolitan areas, such as Los Angeles and Houston, for the severity of its ozone problem.

Water pollution - Higher temperatures also exacerbate the effects of water pollution. Louisiana already has problems with water quality. A 1998 assessment of state watersheds tested 212 waterbody "subsegments" and found that 32 (15%) had good water quality, 59 had fair water quality, 49 had poor water quality, and 72 were designated as "threatened" (an additional 264 subsegments lacked sufficient data to make a designat-ion.)[15] Future warming could combine with local pollution to pose increased threats to health.

Warmer waters have the potential to increase the duration and extent of harmful algal blooms. These blooms can damage habitat and shellfish nurseries. They can also be toxic to humans. Along Louisiana's coast, viral and bacterial contamination of shellfish has caused illness several times in the past few years. Thus far Louisiana's estuaries have not experienced outbreaks of pfiesteria like those along the Atlantic coast.[16]

Climate change could lead to another water quality problem to which Louisiana would be especially vulnerable: "A rising sea level would lift the water table in low-lying land near the coast, releasing contaminants from dump sites and viruses and bacteria from septic systems into drainage systems and waterways. Such contaminants would enter estuarine and inshore food chains and pose a hazard for human communities."[17]

Vector-borne diseases - The potential for a resurgence of vector-borne diseases in Louisiana remains a concern for public health officials.[18] One of the co-authors of the IPCC chapter on human health, Dr. Jonathan Patz, led a seminar on health effects of climate change at the Tulane-Xavier Center for Bioenvironmental Research in May 1996. Dr. Patz stated that climate change is likely to produce an increase in southern Louisiana of mosquito-borne diseases such as dengue fever, encephalitis, malaria, and yellow fever.[19]

Given their historic record of outbreaks of malaria and yellow fever, New Orleans and southern parts of the state are at particular risk from increases in temperature, precipitation, and humidity. As an example of this risk, an outbreak of St. Louis encephalitis occurred in late summer 1998 in which nineteen persons were infected - 13 in East Jefferson Parish, 5 in Lafayette, and 1 in St. Tammany Parish.[20] Mosquitoes carrying encephalitis, present in most southern parishes, were found in St. John the Baptist Parish.[21] Eastern equine encephalitis was also detected in test chickens in Orleans Parish.[22] Mosquito populations in Calcasieu and Vermillion Parishes were also especially high as a result of Tropical Storm Frances.[23]

Local health officials said that the 1998 outbreak was unusual because, prior to Frances, the heat and drought of the summer had actually reduced mosquito populations.[24] In addition to the prompt response of state and parish health offices, heavy floods that flushed standing water out of the New Orleans area were credited with helping to cut down the St. Louis encephalitis outbreak.[25] Ed Bordes, Director of the New Orleans Mosquito Control Board, has pointed out that as climate warms, the "window of opportunity" to control mosquito populations narrows, because mosquitoes then manifest shorter lifespans with higher reproductive rates. Vulnerable populations, such as the urban poor, are often outside during high activity periods for mosquitoes.[26]

- Recommendations for Louisiana

Louisiana's long history of controlling mosquito-borne disease, along with other successful public health efforts, makes us more prepared to address this problem than some other states. However, the encephalitis outbreak in 1998, along with recent increases in instances of malaria and dengue fever in Texas, and an outbreak of Eastern equine encephalitis in Miami in 1997, make it clear that we are in a vulnerable situation. Similarly, issues of water quality, air pollution, and public health that are already with us will be worsened should warmer temperatures and increased precipitation result from climate change.

There are important precedents and opportunities for comprehensively addressing water pollution in Louisiana. The federal Clean Water Action Plan launched in 1998 directs state and federal agencies to work together with local governments and the public to produce Unified Watershed Assessments.[27] In Louisiana this assessment is being undertaken by the Department of Environmental Quality (DEQ) and the Natural Resources Conservation Service (NRCS) of the U.S. Department of Agriculture. DEQ and NRCS will work with Soil and Water Conservation Districts and other units of local government to identify and address water quality problems within watersheds and drainage basins.

Addressing issues of water quality is also an integral part of the Comprehensive Conservation and Management Plan (CCMP) developed by the Barataria-Terrebonne National Estuary Program. The CCMP will work to address bacterial and toxic contaminants, oil and produced water spills, sewage pollution, agricultural runoff, storm water management, contaminated sediments, and toxic phytoplankton blooms within the Barataria and Terrebonne basins.[28]

The US Environmental Protection Agency has noted that "many of the impacts of climate change on health could be avoided through the maintenance of strong public health programs to monitor, quarantine, and treat the spread of infectious diseases and to respond to other health emergencies as they occur."[29] Planning for protecting public health from projected effects of climate change should become state policy.

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Section Three: Impacts on Agriculture
(This section reviewed by La. Department of Agriculture & Forestry)

- Summary of IPCC Report

The IPCC reported that substantial progress has been made since their 1990 assessment on understanding anticipated impacts of climate change on agriculture.[1] The report concluded that global agricultural production could be maintained in the face of climate change predicted to occur over the next century. Regionally, however, effects of climate change on crop yields and productivity are predicted to vary widely.

The IPCC identified three main negative impacts of climate change on agriculture: Weather - Consistency and availability of moisture is critical to crops. Climate change is expected to intensify the hydrological cycle, bringing higher levels of precipitation, evaporation, and humidity. Higher temperatures also cause increased water demand in crops.

Weeds - The "fertilization effect" of increased carbon dioxide will also benefit weeds, accelerating their expansion into higher latitudes, and impacting efforts to control them.

Insects - Climate change will affect the distribution and degree of infestation of insect pests, through direct effects on their life cycles and by indirect climatic effects on their hosts, predators, competitors, and pathogens. Warming trends could facilitate higher winter survival for insect populations and favor earlier northward migrations in the spring.[2]

Patterns of agricultural production are predicted to change in a number of regions, along with changes in soils in some climatic zones. These could include loss of organic matter, leaching of soil nutrients, and increased salinization and erosion. Some of these changes could be reversed or managed by crop rotation, conservation tillage, and improved nutrient management.[3]

Experiments have also shown beneficial effects of elevated carbon dioxide concentrations for some crops, especially annuals.[4] This "fertilizing effect" also depends on available nutrients, temperatures, precipitation, and other environmental factors. The IPCC stated that fewer experiments have been done for perennial, especially woody species, and that many crop species have not been tested for response to elevated levels of carbon dioxide.

Thus far, climate change has generally not been among the top priorities for agricultural policymakers. Climate change, however, could affect "the cost and likelihood of achieving other policy priorities, [such as] assuring regional and national economic and social development, increasing farm income and the viability of rural communities, reducing or reversing land degradation and soil loss [that occurs] through erosion."[5]

The IPCC stated that there are a number of uncertainties about the ability of agricultural systems to adapt to climate change, as well as uncertainty as to whether "the rate of change of climate and required adaptations would add significantly to the disruption likely due to future changes in economic conditions, population, technology, and resource availabilities."[6] Vulnerability of agricultural systems to climate change depends not only on their physical and biological responses, but also on their socio-economic characteristics. Low-income populations that depend on isolated agri-cultural systems are especially vulnerable.

Differences in agricultural systems, as well as in climates, resources, and economic characteristics across and within countries, may be more important in determining the effects of climate change than the changes themselves. The IPCC states that "the broader impacts of climate change on world markets, on hunger, and on resource degradation will depend on how agriculture meets the demands of a growing population and threats of future resource degradation."[7]

- IPCC Recommendations

The IPCC concluded that in addition to the pursuit of sustainable agricultural practices, research will play a key role in the ability of agriculture to respond to climate change.

Among the research needs identified by the IPCC are:

- the development and broad application of integrated agricultural modeling efforts and approaches applicable at the regional scale;
- the evaluation of climate variability and its effects on crop yields and markets.[8]

The IPCC noted that while changes in the geographic distribution and vigor of weeds, insects, and pathogen-mediated plant diseases are likely to significantly affect agriculture in the wake of climate change, potential changes in crop losses due to climatically driven changes in pests have not been included in most agricultural impact studies.[9]

- Implications for Louisiana

The effects of climate change on crops and livestock should be of concern to Louisiana, where agricultural enterprises were worth almost $10 billion in 1997.[10] About 25 percent of acres farmed in the state are irrigated, and a number of key crops, such as cotton, soybeans, and corn, are vulnerable to the effects of droughts and extreme weather events.

Projected climate change could have mixed effects. With a moderate rise in temperature, production of some crops, such as rice and sweet potatoes, would probably increase. Yields of other crops, such as cotton, soybeans, and corn, would likely remain near present levels or possibly slightly increase. Warmer temperatures could also reduce the production of cold season vegetables in the state, while warm season vegetables (truck crops) could benefit from slightly warmer conditions. While a warmer and wetter climate would probably increase sugarcane yields in the mid to upper elevation range in Louisiana, yields in low lying areas of the extreme south would possibly decrease due to rootstock damage caused by increased soil moisture.[11]

Agriculture in the southern part of the state would probably feel the greatest effects from sea-level rise, which would affect the hydrology of low-lying coastal soils. Rice growers in coastal parishes would be impacted by sea-level rise and increased salinity in groundwater. While warmer temperatures could benefit citrus production in Plaquemines and St. Bernard Parishes, coastal land loss and salt water intrusion are already negatively impacting growers there.[12]

One third of agricultural value in Louisiana comes from livestock. In addition to their vulnerability to drought, livestock can be affected by other weather conditions. Cattle in Vermillion Parish were besieged in September 1998 by swarms of mosquitoes after a prolonged period of rain.[13] The same standing water that hatched the mosquitoes also killed pasture grass, and brackish water threatened rye grass needed for winter pasture. In the future, moderately warmer and wetter conditions could favor an increase in the threat of intestinal parasites for livestock, but could also increase forage production in some parts of the state.

The drought of 1998, called the worst in the state's history, can provide a case study of what happens when climate conditions are not moderate. Crops across the state were affected by prolonged heat and drought conditions through the spring and summer. Officials with the Louisiana Farm Bureau stated that the weather in May and June was the driest since 1919.[14] Governor Foster declared a statewide emergency in August, and USDA officials declared all 64 parishes federal agricultural disaster areas.[15]

As a result of the drought there were significant reductions in yields for a number of important crops in Louisiana.[16] Among those hardest hit were corn, cotton, hay, sorghum, and soybeans. Corn losses from the drought were exacerbated by the spread of the aflatoxin fungus, and totalled $65 million by September.[17] Cotton production was forecast at the lowest levels since 1983,[18] and the cotton crop in Caddo Parish was described as the worst in 30 years[19]. At least $120 million of hay was lost by August, necessitating emergency shipments from other states.[20] Soybean production dropped 44% from 1997, the lowest level in the last 12 years.[21] Total crop losses from the drought in Louisiana had reached $420 million by September.[22] This figure does not include economic effects on local communities or the state economy, or the social costs of bankruptcy for farmers.

The drought's impacts were even more severe in neighboring Texas, where devastation from heat and drought was followed by an upsurge in locust populations which did further damage to crops and other vegetation.[23] These impacts demonstrate that continued increases in atmospheric carbon dioxide levels will not take place in a vacuum, but will be accompanied by weather and biological influences that can erase any beneficial effects.

The drought of 1998 made it clear that agriculture is the sector of Louisiana's economy most immediately vulnerable to climate change.

- Recommendations for Louisiana

Obviously, it would be easier for agriculture in Louisiana to adapt to more gradual, longer term climate change. Some of the changes in soil hydrology could be managed or in some cases reversed by modern conservation practices and by enhancing surface and subsurface drainage to respond to changing conditions. An increase in insect pests would have to be managed through integrated insect management programs. The best response to the threat that rising sea level poses to agriculture in the southern part of the state would seem to be extensive coastal restoration to keep Louisiana's buffer of marshes and wetlands intact.

The vulnerability of the crucial agricultural sector to more abrupt changes can justify actions in other sectors aimed at reducing climate disruption, such as reducing greenhouse gas emissions. The IPCC points out that agricultural practices themselves are a major source of greenhouse gas emissions, being responsible for about 50% of the methane and 70% of the nitrogen oxide generated by human activities.[24]

There have been some proposals for farmers to receive a payment or tax credit for carbon they harvest from the atmosphere and keep in the soil.[25] These credits could serve as an incentive and an additional source of revenue to offset losses in drought and flood years. Recent studies suggest that agriculture can play a very significant role in carbon reduction and stabilization. A 1998 USDA-funded report, The Potential of U.S. Cropland to Sequester Carbon and Mitigate the Greenhouse Effect, concluded that soil restoration and regionally or locally recommended best management practices can reduce greenhouse gas emissions from agricultural activity and make U.S. cropland a major sink for carbon.[26]

The report identified soil, crop, and water management practices that increase productivity while enhancing carbon sequestration in soil:

- crop residue management,
- conservation tillage,
- nutrient management,
- precision farming,
- water management through drainage and irrigation,

- restoration of degraded soils.[27]

These practices are being applied in a growing number of farm operations in Louisiana, and there are significant opportunities for expanding their use.[28] Federal restoration projects, such as the Wetland Reserve Program (WRP) offer another opportunity. Over 200 Louisiana farms are participating in the WRP, with easements exceeding 77,000 acres in 1997.[29]

A coordinated planning effort between state and federal agencies, the private sector, and academic institutions which are carrying out research on the effects of climate change on agriculture will increase Louisiana's ability to adapt and respond to future disruptions.

- **Addendum: Droughts and Water Policy**

Despite its generally wet climate, it is clear that Louisiana is vulnerable to drought. Water resources are affected by changes in humidity, precip-itation, and temperature. Higher temperatures increase evaporation, causing lower river and stream flows and lake levels, as well as a drop in groundwater levels. Greater precipitation, on the other hand, can cause flooding. Louisiana drains the Mississippi and Red Rivers, which have their headwaters far from their mouths, with stream flow affected by conditions outside the state's borders. In the southern part of the state, the flat topography means that groundwater and surface water systems are closely connected, and easily affected by drought.[30]

The western part of the state, which has weather patterns similar to those of east Texas, is more vulnerable to impacts on water use caused by higher temperatures and dry weather. A number of cities and towns in northwest Louisiana depend on lakes, such as Caddo and Cross Lakes, for their primary water source. During the summer of 1998, Shreveport, Bossier City, Vivian, and other municipalities were subjected to serious strains on their water supply as lake levels dropped.[31] Bossier City declared a state of emergency for water use in August, and a city official stated that "the day we reached 108 degrees we were basically out of water."[32]

The drought caused problems for urban water systems, such as increased breaks in water pipes, as well as for rural areas.[33] The lack of rain, coupled with heavy electrical demand, caused a serious drop in the water level at Toledo Bend Reservoir. While the Sabine River Authority sells electricity to customers in central Louisiana (the peak demand period is from May to September), recreational operators on the lake depend on lake levels being high enough to use boat launches.[34] While seasonal lowering of water levels has some benefits for lake ecosystems, they can also cause fish kills and algal blooms.[35]

Drought conditions can also exacerbate preexisting water problems. The Sparta Aquifer, which supplies water for over 790,000 north Louisiana residents (as well as a large portion of southeastern Arkansas), would be put at significant risk by an increase in drought frequency.[36] Local officials in the area have realized that water supply will be a major constraint on economic development. Salt water intrusion into the Chicot Aquifer, a major water source for agriculture in southwest Louisiana, could also increase if droughts become more frequent.[37]

Water policy will clearly require more attention from the state, especially if projected climate change causes an increase in droughts. Texas, a state with large arid regions, is actively pursuing water policy planning. The proposed Trans-Texas Waterway Project would divert up to half of the flow of the Sabine River to metropolitan Houston during times of high water demand.[38] The downstream effects of this diversion on southwestern Louisiana, in particular coastal areas of western Cameron Parish, would be serious even under normal conditions.

Currently, water management is carried out by several agencies in Louisiana. The Department of Natural Resources sponsors a Rural Water Energy Conservation Program.[39] The Office of Emergency Preparedness coordinates the response to droughts and the process for declaration of emergency by municipalities due to low water supplies. The Department of Transportation and Development works with planning for rural water systems, and is updating a 1984 Water Resources Study for the legislature.[40] The Department of Agriculture & Forestry coordinates the state's efforts to address impacts of drought on farming, and is currently leading an effort to develop a statewide drought plan for agriculture. A state-federal Interagency Water Resources Coordinating Committee, established some years ago, could begin comprehensive planning for effects of climate change on water resources in Louisiana.

The National Drought Policy Act, signed by President Clinton in July 1998, will establish a commission to review current federal, state, local, and tribal laws and programs. The commission will recommend steps towards an integrated, coordinated federal drought policy to help prepare for and alleviate adverse agricultural, economic, environmental, and health impacts.[41] Louisiana should ensure that it receives adequate attention from the commission.

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Section Four: Impacts on Forestry

This section reviewed by Louisiana Department of Agriculture & Forestry.

- Summary of IPCC Report

The IPCC identified 3 major ways that climate change could impact the world's forests and forestry industry:

- changes in seasonal climate patterns, which differ with latitude;
- water shortages during the growing season;
- an increase in the rate of climate change and its effects.[1]

In general, trees and forests adapt to specific climate conditions. As climate changes, forest types are likely to change. The IPCC concluded that current projected climate change appears to be too rapid to allow geographic forest species populations to adjust, and that large areas of low-productivity or degraded forest could be present for centuries. "Climate change is expected to occur at a rapid rate relative to the speed at which forest species grow, reproduce, and reestablish themselves."[2]

Overall effects of climate change on forests remain uncertain. A rise in the frequency or intensity of wildfires could come from an increase in drought conditions, while warmer temperatures could exacerbate disease and pest outbreaks, affecting the ability of forests to store carbon.[3]

IPCC simulations for baseline climate change to the year 2050 suggest that boreal and temperate forests will be the most impacted by climate change. "Environmental factors such as future climate change, increases in atmospheric carbon dioxide, increased mobilization of other elements such as nitrogen and sulfur, and other pollutants such as nitrous oxide and tropospheric ozone, are likely to have the greatest impacts on mid- and high-latitude forests..."[4]

The IPCC states, however, that the most significant changes in global forests over the next fifty years are likely to be caused by non-climate effects such as changes in land use. "Increasing human populations, with [increasing] per capita wood use, suggests that the annual need for timber will exceed... annual growth... by the year 2050".[5]

- IPCC Recommendations

The IPCC recommended that, given the current uncertainty over future climates and the subsequent responses of forest ecosystems, "it is prudent to prepare for severe undesirable impacts to ensure that viable and flexible options are implemented to maintain sustainable forest ecosystems."[6] The IPCC concluded that mitigation measures, i.e., trying to reduce the rate or magnitude of environmental changes, entail less risk than adaptation strategies, i.e., trying to minimize forest damage from a changing environment.[7]

Deforestation has been identified as a significant contributing factor to increased levels of carbon dioxide in the atmosphere. Harvesting of forests, especially where replanting does not occur, along with their conversion to agricultural land, releases carbon from trees into the atmosphere through burning and decay. Because of deforestation and forest degradation, the world's forests are now estimated to be a net carbon source.

The IPCC stated, however, that "there is potential to lessen projected carbon emissions by protecting and conserving carbon pools in existing forests; to create carbon sinks by expanding carbon storage capacities by increasing the area and carbon density of native forests, plantations, and agroforests." [8] In some areas, "the use of modern forestry practices to reduce harvest impacts on ecosystems, combined with substitution of non-timber products for forest products could reduce climate impacts significantly".[9]

The IPCC identified three categories of forestry practices that promote sustainable management of forests and at the same time conserve and sequester (store) carbon:

- Management for conservation of existing carbon pools in forests by slowing deforestation, changing harvest regimes, and protecting forests from other human disturbances;
- Management for expanding carbon storage by increasing the area and carbon density in forests;
- Management to substitute forest biomass products for fossil-fuel based products.[10]

- Implications for Louisiana

The effects of projected climate change on Louisiana's forests should be a key concern, since timber has been the state's largest agricultural crop for a number of years, and 14 million acres of commercial forests fuel over half the state's land-based economy.[11]

There have been several studies of possible impacts on a regional level. A report for the U.S. Office of Technology Assessment, Preparing For An Uncertain Climate (1993), lists several risks to southern forests from climate change:

- forests in coastal regions of the southeast may be at risk from damaging wind storms, sea-level rise, flooding and saltwater intrusion;
- valuable forestland of the southeast from South Carolina to the Gulf Coast could become marginal for timber production due to temperature extremes;
- prolonged warm weather and drought stress favor expansion of bark beetles;
- warmer and moister weather favors fungal diseases such as fusiform rust;
- changes in precipitation and altered hydrology from climate change could bring new physical stresses to bottomland hardwoods.[12]

With moderate changes in climate, the extent and diversity of forested areas in Louisiana could change little, or decline to a minor extent. In some areas, a warmer, wetter climate would favor an increase in upland hardwood species, and forest understory vegetation could become more dense. With drier conditions, pine forests could increase in some areas.

Cypress and tupelo trees which dominate forests in southern Louisiana would possibly decline if a rise in sea level significantly alters soil hydrology regimes. Cypress trees in some areas are already being stressed by higher water levels, as well as suffering from the interaction of flooding with defoliation by the fruittree leafroller, an insect pest.[13] Pine stands at lower elevations in St. Tammany and Tangipahoa Parishes could also suffer from a moderate to substantial rise in sea level.

The most pronounced negative effects of climate change on the state's forests would probably come from increases in diseases, pests, and fires.

Prolonged periods of warm, wet weather could lead to more outbreaks of diseases. Prolonged periods of hot, dry weather can reduce survivability of tree seedlings and increase insect activity. With greater extremes of hot and dry weather, wildfires could also increase.

A number of these negative factors combined to impact forestry in Louisiana in 1998, as a result of weather patterns influenced by the El Niøo event. An unusually warm and wet winter caused a microbe buildup in the soil which stressed roots of newly planted seedlings. The added stress of the record drought which followed in the spring and summer resulted in loss of nearly 50 million pine seedlings, about half of the year's crop.[14] Mortality rates of seedlings on private land reached 70% in some areas,[15] and trees were stressed across the state, resulting in high levels of bark beetle activity.[16]

Louisiana also experienced eight times as many fires as usual during the 1998 drought, including one 2,000 acre fire near Shreveport.[17]The effectiveness of the state's fire suppression program prevented fires of greater magnitude during a period when other states and regions experienced catastrophic forest fires, partly as a result of El Niøo. Florida suffered its worst fires in 50 years, with at least 2,000 separate fires on over 500,000 acres.[18] Over 13,000 fires burned at least a million acres in Mexico.[19]

- Recommendations for Louisiana

Like the rest of the state's agricultural sector, forestry in Louisiana is clearly vulnerable to serious negative impacts from projected climate change. Here, too, this vulnerability of a key sector of the economy would seem to justify pursuing reductions of greenhouse gas emissions across sectors as a way to mitigate climate change. As with crop agriculture, forestry itself offers significant opportunities for carbon sequestration.

Normal climate patterns have given Louisiana optimum growing conditions for forestry. Some studies estimate that one acre of trees can remove four tons of carbon dioxide annually, as well as produce enough oxygen for over 1000 people.[20] The state has recognized the need for reforestation after a decade of record timber harvests. The Forest Productivity Program was approved by the legislature to encourage landowners to replant harvested timber acreage.[21] The USDA Forestry Incentives Program also offers incentives to landowners to share tree planting and forest management expenses.

While timber harvests and the clearing of forests release substantial amounts of carbon, reforestation of marginal agricultural land offers some of the best opportunities for net gains in carbon sequestration. Conversion of land from agricultural use to forestry typically results in a doubling of soil organic carbon.[22] Louisiana is already a leader in the USDA Conservation Reserve Program (CRP), with 1,800 contracts and over 148,000 acres registered in 1997.[23]

A number of projects are underway to create new market opportunities for carbon sequestration through reforestation. In a market for carbon sequestration, emitters of new carbon could offset their increases by paying landowners who either protect forests on their land or reforest harvested areas, creating carbon sequestration credits.[24] A growing number of utilities are investing in reforestation and forest protection to offset their greenhouse gas emissions.[25] Over 600 electric utilities have joined the U.S. Department of Energy in a voluntary effort to reduce carbon emissions.

One such project has been undertaken by the UtiliTree Carbon Company, a non-profit initiative by 40 U.S. electric companies, including Entergy Services, in partnership with the School of Forestry at Louisiana Tech University. This project is investigating the feasibility of restoring bottomland hardwood forests on marginal farmland in Catahoula Parish. The goal is for the bottomland hardwood forest to sequester 47,000 tons of carbon (593 tons per acre) by the end of a 70 year growing period.[26]

The Business Council for Sustainable Development for the Gulf of Mexico (BCSD) is promoting the economic, environmental, and societal benefits of reforesting lands in the Mississippi Alluvial Valley, especially in areas where frequent flooding has made farmland unproductive.[27] The BCSD believes that current market forces in the Delta have created a unique window of opportunity for landowners to achieve both economic rewards and practice environmental stewardship. The goal of the project, which would involve public, private, and academic participation, is the voluntary conversion of one million acres of marginal cropland in the Mississippi Delta over the next 20 years.

Similar public-private partnerships are being undertaken in Louisiana to improve and increase wildlife habitat. The U.S. Fish & Wildlife Service is purchasing 16,000 acres of farmland in Morehouse Parish to add to the Upper Ouachita National Wildlife Refuge. Together with the Louisiana Chapter of the National Wild Turkey Federation, they are working to reforest the lower two-thirds of the tract. This project will be the largest single restoration of bottomland hardwood forests in the U.S. to date.[28]

These reforestation projects offer an excellent example of the collateral benefits of climate change mitigation. Increased flooding in the Mississippi Valley has been linked in part to the loss of 80% of its bottomland hardwood forest, largely to agriculture.[29] Some of the lands that were cleared are unproductive due to frequent flooding, and federal programs no longer encourage conversion of forest land to agriculture. Restoring bottomland hardwood forests in these areas would allow society to benefit from their role in flood prevention, erosion control, and wildlife habitat, while landowners can benefit from sustainable timber harvests on land that formerly provided little income.[30]

Forests are interconnected with other natural systems, and their health impacts those systems and their ability to respond to climate change. A number of studies have shown how loss of riparian or stream-side shading vegetation has had significant effects on water temperatures in freshwater ecosystems.[31] This reinforces the importance of utilizing best management practices (BMPs) in timber operations as a means of minimizing future impacts on landscapes and ecosystems from climate change.

- Addendum: Urban Forestry

Another mitigation option with wide collateral benefits is the development of urban forestry programs. Cities produce an "urban heat island" effect, in large part because materials like concrete and asphalt store more heat, and cool more slowly at night than vegetated areas. The temperatures of buildings, parking lots, roads, and other built structures and surfaces can be 20 to 40 degrees (F) higher than green spaces.[32]

Trees help to counteract the urban heat island effect, and some studies have found that individual trees can reduce the solar energy in their shade by 90%.[33] Reducing air temperatures can help air quality as well since many pollutants increase as temperatures rise. A study of pollution removal by trees around the metropolitan Chicago area found that they removed an estimated 6,145 tons of pollution, with an estimated value of $1 million for city trees and $9.2 million for trees in outlying areas.[34]

While trees can release volatile organic compounds that contribute to formation of ozone, their role in reducing temperature acts to lower ozone levels. A computer simulation for Atlanta showed that a 20% loss in the area's urban forest could lead to a 14% increase in ozone concentrations.[35] Since air pollution is more concentrated in urban areas, wooded areas and green open spaces provide personal health benefits as well.[36]

Urban trees provide other economic benefits. Properly placed, they can reduce energy use in buildings by shading during the summer and blocking winds during the winter.[37] Some studies show benefits for retail and rental properties, and USDA Forest Service studies have shown that healthy, mature trees can add an average of 10% to property values.[38]

These collateral benefits - aesthetic, economic, and environmental - are fueling urban forestry programs in many areas. They will continue to grow in importance, since 3 out of 4 Americans now live in urban areas, which are expanding at a rate of 3,500 acres daily.[39] The LDAF Urban Forestry Program, which promotes urban forest management in all Louisiana communities, reports that currently at least 15 cities in the state have been designated as "Tree City USA" communities. Several larger cities have urban forestry programs, with active citizen volunteer organizations such as Baton Rouge Green and Shreveport Green.[40]

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Section Five: Coastal Impacts

- Summary of the IPCC Report

One of the principal impacts of projected climate change is an accelerated rise in global sea level, primarily from increased melting of glacial and polar ice and thermal expansion of ocean water caused by rising temperatures.

The IPCC emphasizes two points: 1) current best estimates indicate a rate of sea-level rise that is from two to five times the rate experienced over the last 100 years; 2) model projections show that sea level will continue to rise beyond the year 2100 due to lags in the response time of the climate system, even when an assumed stabilization of global greenhouse gas emissions is factored in.[1]

The IPCC notes that estimates of future rates of sea-level rise are imprecise because of uncertainties in projections of climate change and because of the multiple factors that influence sea level. These factors include:

- Ocean thermal expansion;
- Effects of reduction in volumes of polar ice sheets and mountain glaciers;
- Dynamic effects resulting from ocean circulation;
- Wind and weather patterns;
- Differences in regional ocean density.[2]

Especially vulnerable are coastal wetlands, which are already being lost at an increasingly rapid rate worldwide. These losses are closely connected with human activities. Deltaic coasts in many areas are already suffering from subsidence, saltwater intrusion, deteriorating water quality, and decreased biological production.[3]

The interface between human infrastructure and settlements and coastal ecosystems is especially significant. The projected level of sea-level rise would have negative impacts on a number of economic sectors, including tourism, fisheries, communities, and financial services, as well as human health and the quality and supply of freshwater.[4]

Potential effects of climate change on coastal areas identified by the IPCC include:

- Increased precipitation, with excessive runoff and high river flows, coupled with atmospheric deposition from land-based activities would lead to greater loading of pollutants in coastal waters, with adverse impacts on fisheries, recreation, and tourism.
- Increased frequency of tropical storms and hurricanes would have adverse impacts on offshore oil and gas activities in certain locations and on marine transportation. Increased costs would result from the need to expand dredging operations to keep major ports open in certain locations.
- Fisheries productivity could decline for some species and increase for others, but in both cases the effects are predicted to be dwarfed by overfishing, marine pollution, and habitat destruction that is already occurring.[5]
- In recent decades, many coastal areas have been heavily modified and intensively developed, which has significantly increased their vulnerability to natural coastal dynamics and to the anticipated impacts of global climate change. The IPCC report cites a number of studies showing that over-exploitation of resources, pollution, urbanization, and sediment starvation have already had the following effects on coastal systems:
- accumulation of contaminants in coastal areas;
- rapid decline of habitats and natural resources;
- increased erosion;
- decreased resilience of these systems for coping with natural climate variability;
- reduction of natural capability to adapt to changes in climate and sea-level.[6]

- IPCC Recommendations

Recognizing that suitable options for response to sea-level rise will vary among and within countries, the IPCC Report described three general response strategies: planned retreat, accommodation, and protection.[7]

.Planned retreat implies the gradual evacuation of coastal areas as they become inundated, while strategic retreat involves prevention of major development in coastal areas projected to be impacted by sea-level rise. Accommodation can involve adaptive responses to sea-level rise, such as elevation of threatened buildings, modification of drainage systems, and changes in land use. Protection utilizes defensive measures to maintain shorelines by building or strengthening protective structures such as levees or by artificially nourishing beaches and dunes.

The first two responses, retreat and accommodation, are intended for situations in which increased land loss and coastal flooding will result in the loss of some coastal functions and values. Retreat and accommodation attempt to maintain something of the dynamic nature of coastal eco-systems by allowing them to adapt in a more or less natural manner. The protection response could itself result in the loss of natural functions and values if, for example, wetlands are impounded by protective levees.

The IPCC identified integrated coastal zone management as a key tool for coastal planning under varying conditions. Integrated coastal zone management is described as a continuous and evolutionary process that identifies and implements options to attain sustainable development and adaptation to climate change in coastal zones.[8]

The IPCC defined sustainable development in coastal zones as development that "enables the coastal system to self-organize - that is, to perform all its potential functions without adversely affecting other natural or human systems."[9] Several constraints on the successful implementation of integrated coastal zone management and sustainable development are also identified: technology and human resources capability, financial limitations, cultural and social acceptability, and limitations of political and legal frameworks.[10]

- Implications for Louisiana

All states with low-lying coasts are vulnerable to accelerated sea-level rise, but Louisiana's coast is much more so because of the subsidence of the Mississippi River delta. Until humans intervened, the surface elevation of the broad delta complex had kept pace with rising sea level for several thousand years, largely because the river built delta lobes and nourished wetland vegetation. The rates of natural subsidence and sea-level rise along the Louisiana coast have been exacerbated by human modifications, primarily levees which have isolated the Mississippi River from a delta complex that depends on an annual flooding cycle.[11] These modifications cut off the delta-building process of the river. Louisiana's coastal system has also been heavily impacted by channels dug for navigation and mineral extraction, which have allowed high-salinity Gulf waters to migrate inland. Many of the trends described by the IPCC, such as increased erosion and decreased resilience of natural systems, can be clearly seen on Louisiana's coast. Over a million acres of coastal land have been lost since the 1930s, and between 25 and 35 square miles continue to be lost each year.[12] Louisiana's coastal ecosystems are threatened with systemic collapse.

Louisiana is clearly the state most at risk from further sea-level rise.[13] Absent major intervention, a continuation of current trends is projected to cause loss of more than 400,000 acres over the next 50 years.[14] This is a conservative estimate, since it presumes a continuation of what has been observed over the past 50 years, without factoring in acceleration of sea-level rise from climate change.[15]

Effects of Accelerated Sea Level Rise:

The overall effect of an additional rise in sea level from climate change would likely be an intensification of those impacts predicted to result from current land loss: Decline of estuarine fisheries: Louisiana's coastal fishery is the most productive in the lower 48 states, providing 25-30% of the nation's total catch.[16] Nearly all of the top commercial species caught on Louisiana's coast use estuarine marshes at some stage of their life cycle. It has been estimated that projected losses of 20% of existing marsh by 2050 would cost annually at least $520 million for commercial fisheries and $189 million for recreational fisheries.[17]

Loss of protective storm buffers: The state's shoreline is sparsely inhabited, with only Grand Isle and coastal communities in Cameron Parish directly exposed to the Gulf. However, numerous inland communities and cities depend on coastal marshes and barrier islands for storm protection, including Houma, Lake Charles, Morgan City, and metropolitan New Orleans, with its population of 1.5 million living at or below sea level. These cities are at growing risk from hurricanes as coastal wetlands disappear.[18]

Risks to infrastructure: Louisiana's coastal zone is a key area for national and global commerce, with investments in infrastructure estimated at $100 billion.[19] This includes important ship channels such as the Gulf Intracoastal Waterway, major ports such as Lake Charles and New Orleans, roads, and oil and gas pipelines and facilities.[20] Most of this infrastructure was designed to function behind a buffer of protective wetlands, not for full exposure to the Gulf.

The prospect of continued land loss combined with sea-level rise raises the issue of retreat from the coast. The last line of defense would probably be a system of hurricane protection levees in coastal parishes. The current levee system was also designed to function behind a wetland buffer instead of facing tide and storm surge from open water. Upgrading these levee systems to function as effective sea-walls could easily cost billions.[21] Falling property values and declining economic activity in coastal areas due to continued land loss would make funding problematic.

Abandonment of coastal towns and communities: Retreat from the coast would raise the problem of relocation of inhabitants. The costs of retreat would include lost incomes, relocation and adjustment expenses, and losses in quality of life. Along with financial costs would come social and cultural costs. As one study concluded, "It is almost impossible to quantify the value of a loss of lifestyle, and loss of family and social ties which will inevitably come as wetlands disappear and prompt people to relocate."[22]

Pollution: Another cost of inundation would arise from the many sites and facilities in coastal parishes that contain toxic and harmful materials, such as industrial plants, hazardous waste pits, injection wells, and garbage dumps. Inactive and abandoned hazardous waste sites are known to exist in Grand Chenier, Grand Isle, Bayou Cocodrie, and Port Sulphur. Hazardous waste sites are also located in coastal communities such as Bourg, Cameron, Chauvin, Cocodrie, Cutoff, Grand Bois, Larose, and Venice, and in inland towns such as Abbeville, Belle Chase, Berwick, Chalmette, Gibson, Houma, Morgan City and Thibodaux.[23] Failure to clean up and secure these sites prior to inundation would result in contamination of coastal bays, waterways, and remaining fishery habitats.

Extreme Weather: Projected climate change carries the risk of increased incidence of extreme weather events, such as severe droughts that could further stress coastal ecosystems, or strong storm surges that could overwhelm levees and destroy coastal communities, infrastructure, and interior freshwater marshes. Extreme droughts can cause saltwater "wedges" to move upriver (such as occurred in 1988), threatening drinking water supplies. Heavy rain events can increase the flow volume in the Mississippi and Atchafalaya Rivers, threatening navigation and flood protection structures.[24]

Hypoxia: The combined discharge of these two rivers accounts for 98% of the total freshwater inflow to the northern Gulf of Mexico. Excess nutrients carried in the rivers, in particular nitrogen, is blamed for an annual hypoxic (low oxygen) zone off the Louisiana coast that can reach 6,000 square miles in years with heavy floods.[25] By some estimates, a doubling of atmospheric carbon dioxide would change rainfall patterns in the Mississippi Valley, with the effect of increasing peak river discharge by as much as 20%.[26] This would increase flood risks, as well as exacerbating the hypoxic zone problem in the nearshore Gulf of Mexico.

- Recommendations for Louisiana

Over the past 10 years, Louisiana and its national partners have undertaken one of the largest ecosystem restoration projects in the world. A state coastal restoration program with a dedicated trust fund was established in 1989, and the federal Coastal Wetlands Planning, Protection, and Restoration Act (CWPPRA), establishing a restoration task force of five federal agencies and the state government, was enacted in 1990.[27]

These historic measures have provided a framework for coordinated action by multiple state and federal agencies, and have provided crucial learning experience. They have made a measurable impact, although this has not reached a scale sufficient to solve the problem. The combined effects of all projects currently being implemented under both the state and federal programs are estimated to slow the rate of land loss by only about 23%.[28]

Recognizing that an even broader approach will be necessary to achieve sustainability for the coast, the Coast 2050 initiative was begun in 1997 as an effort to integrate a number of existing restoration goals and to develop a broad consensus of support.[29] The Coast 2050 Plan, scheduled for adoption in 1999, will provide a larger unifying framework in which CWPPRA and other restoration measures can be carried out on a scale to match that of the problem. Opportunities for active coastal restoration will be further clarified by three major feasibility studies focusing on barrier islands, the lower Atchafalaya River, and the Mississippi River delta, all due to be completed in 1999.[30]

A key element in the Coast 2050 Plan will be integrated planning for coastal restoration and sustainability on the local and regional levels, including development of regulatory programs. Some preliminary work has been done towards planning for sea-level rise in Louisiana.[31] Projections of sea-level rise are acknowledged in Coast 2050, but the implications of this threat have not been formally recognized by the Coastal Zone Management program. Louisiana should include consideration of projections of land loss and sea-level rise in permit decisions on navigation channels, mineral extraction operations, and commercial and residential development in coastal areas.

There are precedents in Louisiana for coordinated planning to address complex problems like sea-level rise. A Comprehensive Conservation and Management Plan (CCMP) for the most rapidly eroding part of the coast was developed under the Barataria-Terrebonne National Estuary Program. The CCMP can provide a model for basin-wide planning and management for development, habitat protection, and water quality across the coast.[32]

The IPCC and other studies have tended to focus on defensive responses to sea-level rise.33 Because two thirds of its coast is a huge delta complex, Louisiana can also utilize offensive responses, such as major freshwater diversions and restoration of natural hydrology, to save its coast. Diversions from the Mississippi and Atchafalaya Rivers can "recharge" existing coastal wetlands, and the Atchafalaya is providing a case study in the growth of an active delta.[34]

"Pulsed" diversions have been proposed that would utilize periodic high volume river flows to recharge wetlands with freshwater and sediment.[35] These diversions would mimic the periodic "pulsing events" now thought to be a crucial part of deltaic land-building. Should higher river levels occur as a result of climate change, such diversions could also serve as a way to combine the necessities of flood control and coastal restoration.[36] Redirecting more of the river flow through coastal wetlands could, along with measures to reduce pollution and nutrient loading, help alleviate the problem of the Gulf hypoxic zone.

Coastal marshes are significant carbon sinks, and the Mississippi River and its delta play an important role in the global carbon budget.[37] Active rebuilding of coastal marshes can help sequester or trap carbon that would otherwise be released to the atmosphere.[38] A collateral benefit of restoration efforts would be significant carbon sequestration.

Clearly, the best response that Louisiana can make to current and future sea-level rise is to restore its coast to a sustainable condition. Along with measures to protect residents and infrastructure, a long-term strategy for restoring the health and functions of coastal ecosystems will be a necessity. The presence of two large river deltas gives Louisiana tools for protecting its coast that most other coastal states lack. It is abundantly clear that impacts from sea-level rise will be far greater for a coast that continues to fragment and disappear.

The best way to protect Louisiana's coast against present and future sea-level rise is to fund a full-scale coastal restoration program.

- **Addendum: Coastal Land Loss in Louisiana[39]**

Describing the potential effects of climate change on Louisiana's coast requires a brief history of the state's coastal system, why it is rapidly deteriorating, and why it is particularly vulnerable to additional stresses.

About 13,000 years ago, as the last ice age (the Pleistocene Epoch) drew to an end, global sea level was at least 300 feet lower than it is now and the northern Gulf shoreline was much further south, at what is now the edge of the Continental Shelf. At that time the lower Mississippi River occupied a deep canyon through what is now southern Louisiana. About 7000 years ago, the earth was well into the Holocene Epoch, and with a warming climate, sea level had risen to almost its present elevation. The Louisiana shoreline then followed the Pleistocene Terrace, at roughly the location of I-10 and I-12.

This is when the Mississippi River delta complex that forms the present day coastal ecosystem of Louisiana was born. For most of the seven millennia from then until now, net growth of the delta complex created virtually all of southern Louisiana's uplands and wetlands. As sea level rose during the first 4,000 years of the Holocene Epoch, the Mississippi River filled its canyon with sediment and then the Mississippi River delta complex commenced to grow seaward over the Continental Shelf, in shallow water adjacent to the coast.

When 17th century Europeans settled along the lower Mississippi River and founded New Orleans, they began building levees for protection against spring floods. Thus began a series of man-made changes to the "plumbing" throughout southern Louisiana that isolated the geologically young delta complex from the river system that had created and sustained it. At this point, the delta complex ceased to grow and began a slow but accelerating conversion of land to shallow open water that has become catastrophic with the past fifty years. Throughout their relatively short history, the older underlying delta sediments had been squeezed and compressed under the weight of new sediments deposited each year by the river, in a process known as subsidence. Subsidence over the delta complex ranges from about 1/3 inch (0.5 cm) to as much as 1 inch (2.54 cm) per year. It averages about 3/4 inch (1.2 cm) per year throughout the eastern two thirds of the Louisiana coast, or six times the current rate of sea-level rise along the northern Gulf of Mexico.

Within certain limits, healthy coastal wetland plants have the unique ability to maintain their elevation with respect to mean sea level, by producing organic matter even as the land they grow on subsides. Unfortunately, huge tracts of Louisiana's coastal marshes are being stressed from lack of nourishment. When stress from any source reduces plant production, the balance is tipped, causing the wetland system to fail to keep up with subsidence. As the surface sinks, the plants become more stressed from flooding, and the marsh is replaced with open water. As small interior ponds open up, wave energy increases, causing pond enlargement. Eventually many ponds coalesce and entire marsh systems become open water.

Acceleration of global sea level rise above the current rate could add stress to coastal marsh plants and further tip the balance against what was once a sustainable delta complex.

Notes

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Conclusion to Chapter II: The Case for Action

It is clear that Louisiana is at serious risk from the threat of climate change. A key question, then, is how to act in the near term to reduce or mitigate this risk. A report by the U.S. Environmental Protection Agency, The Probability of Sea-Level Rise (1995), estimated that if greenhouse gases could be stabilized by the year 2025, the projected rate of sea-level rise could be cut in half, while waiting until 2050 would reduce the rise by only 28%.[1] Even without relying on such precise estimates, it is clear that acting sooner allows for greater flexibility and time for adaptation.

The Precautionary Principle requires decision-makers to act in situations of risk, even with a degree of uncertainty, a challenge discussed by the IPCC:

Policymakers are faced with responding to the risks posed by emissions of greenhouse gases in the face of significant scientific uncertainties... Policymakers will have to decide to what degree they want to take precautionary measures by mitigating greenhouse gas emissions and enhancing the resilience of vulnerable systems by means of adaptation... Delaying such measures may leave a nation or the world poorly prepared to deal with adverse changes and may increase the possibility of irreversible or very costly consequences.[2]

Fortunately, many of the actions that can reduce greenhouse gas emissions, and the risk of climate change, offer substantial economic opportunities as well as environmental benefits.

Notes
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Chapter III: Opportunities in the Energy Sector

(This chapter reviewed by La. Department of Natural Resources)

Coal, gasoline, diesel fuel, and natural gas are the main fossil fuels that, when burned, emit carbon dioxide. Carbon dioxide constitutes the majority of the greenhouse gases that are emitted from human sources. In 1990, the world's communities, transportation systems, and economies emitted 22 billion metric tons of carbon dioxide into the earth's atmosphere.[1] Approximately 23% of the total -- ~5 billion metric tons -- came from the United States.[2] Louisiana emitted ~200 million metric tons of CO2 or slightly less than 1% of the global total.[3]

In 1990, industries accounted for 45% of all global C02 releases, the combined residential and commercial sectors accounted for 29%, and transportation 21%.[4] In the United States, carbon dioxide emissions in the industrial sector accounted for 34% of the U.S. total; the combined U.S. residential/commercial sectors 34%, and the transportation sector 32%.[5] In Louisiana, the break-down of carbon dioxide emissions is industrial - 61%, residential/commercial-13%, and transportation - 25%.[6]

IPCC Conclusions and Recommendations

The organizing principle of the IPCC around which reductions in greenhouse gas emissions should be made is found in Article 2 of the United Nations Framework Convention on Climate Change. It states that changes in the energy delivery system should ensure "...stabilization of greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system. Such a level should be achieved within a time frame sufficient to allow ecosystems to adapt naturally to climate change, to ensure that food production is not threatened, and to enable economic development to proceed in a sustainable manner."[7]

According to the IPCC, opportunities abound for reducing energy demand (and therefore carbon dioxide emissions) but these opportunities must be captured in a timely fashion. The IPCC states that "by the year 2100, the world's commercial energy system will be replaced at least twice".[8] This will occur through normal cycles of capital and equipment replacement in the industrial, commercial, residential and agricultural sectors. These cycles offer tremendous opportunities for improved efficiencies in energy systems without premature retirement of capital stock, and for use of new technologies.

This replacement of energy infrastructure should concentrate on technology that (1) reduces overall energy demand and (2) utilizes less-carbon-intensive or even carbon-free fuel sources. Numerous studies have indicated that 10-30% energy efficiency gains above present levels are feasible at little or no net cost in many parts of the world through technical conservation measures and improved management practices over the next 2 to 3 decades.

Using technologies that presently yield the highest output of energy services for a given input of energy, efficiency gains of 50-60% would be technically feasible in many countries over the same time period. Achieving these potentials will depend on future cost reductions, financing, and technology transfer, as well as measures to overcome a variety of non-technical barriers. The potential for greenhouse gas emission reductions exceeds the potential for energy use efficiency because of the possibility of switching fuels and energy sources.[9]

The last sentence illustrates how multiple strategies will outdistance any single strategy when estimating carbon reductions or energy efficiency improvements. For example, switching to less-carbon-intensive fuel and utilizing fuel in a more efficient power plant multiplies the savings of either fuel switching or efficiency investments alone. The following discussion is taken directly from the IPCC report and goes into more detail.

More efficient conversion of fossil fuels: New technology offers considerably increased conversion efficiencies. For example, the efficiency of power production can be increased from the present world average of about 30% to more than 60% in the long term. Also, the use of combined heat and power production replacing separate production of power and heat, whether for process heat or space heating, offers a significant rise in fuel conversion efficiency.

Switching to low-carbon fossil fuels and suppressing emissions: Switching from coal to oil or natural gas, and from oil to natural gas, can reduce emissions. Natural gas has the lowest CO2 emissions per unit of energy of all fossil fuels. The lower carbon-containing fuels can, in general, be converted with higher efficiency than coal. Large resources of natural gas exist in many areas. New, low capital cost, highly efficient, combined-cycle technology has reduced electricity costs considerably in many areas. Natural gas could potentially replace oil in the transportation sector. Approaches exist to reduce emissions of methane from natural gas pipelines and emissions of methane and/or CO2 from oil and gas wells and coal mines.

Decarbonization of flue gases and fuels and CO2 storage: The removal and storage of CO2 from fossil fuel power station stack gases is feasible, but reduces the conversion efficiency and significantly increases the production cost of electricity. Another approach to decarbonization uses fossil fuel feedstocks to make hydrogen-rich fuels. Both approaches generate a byproduct stream of CO2 that could be stored, for example, in depleted natural gas fields. The future availability of conversion technologies such as fuel cells that can efficiently use hydrogen would increase the relative attractiveness of the latter approach. For some longer-term CO2 storage options, the costs and environmental effects and their efficacy remain largely unknown.

Increasing the use of nuclear energy: Nuclear energy could replace baseload fossil fuel electricity generation in many parts of the world, if generally acceptable responses can be found to concerns such as reactor safety, radioactive waste transport and disposal, cost, and proliferation.

Increasing the use of renewable sources of energy: Solar, biomass, wind, hydro, and geothermal technologies already are widely used. In 1990, renewable sources of energy contributed about 20% of the world's primary energy consumption, most of it fuelwood and hydro power. Technological advances offer new opportunities and declining costs of energy from these sources. In the longer term, renewable sources of energy could meet a major part of the world's demand for energy. Power systems can easily accommodate limited fractions of intermittent generation, and with the addition of fast responding backup and storage units, also higher fractions. Where biomass is sustainably regrown and used to displace fossil fuels in energy production, net CO2 emissions are avoided, and the CO2 released in energy conversion is again fixed in biomass through photosynthesis. If the development of biomass energy can be carried out in ways that effectively address concerns about environmental issues and competition with other land uses, biomass could make major contributions in both electricity and fuels markets.[10]

Findings of several recent studies of the U.S. energy system are consistent with the IPCC. The Oak Ridge National Laboratory concluded that U.S. greenhouse gas emissions could be reduced by roughly 1/3 with energy savings equaling or exceeding the costs of conservation and efficiency investments.[11]

Other studies have found that: Replacing existing industrial process motors with advanced models would, in itself, reduce the country's electricity consumption by about 25%.[12]

Installing readily available energy-efficient lighting technologies could reduce electricity use by 50-70%, and earn average internal rates of return of 40%.[13]

By using energy efficient products and technology, U.S. businesses could reduce their annual $100 billion energy bill by 35% - saving $35 billion.[14]

Louisiana's Sources of Energy Use and Carbon Dioxide

Louisiana has historically been a major producer and user of energy, especially energy from fossil fuels. In 1997, Louisiana ranked second to Texas in total energy production (including outer continental shelf production) and in natural gas production, and third to Texas and Alaska in crude oil production. On a BTU-to-BTU basis, Louisiana produces nearly twice as much natural gas as crude oil and supplies approximately 25% of the nation's natural gas.[15]

Despite having a relatively small population (about 4.2 million), Louisiana has a very high level of energy use. On a per capita basis, Louisiana trails only Alaska in energy consumption, with a consumption rate over 2.5 times the national average.[16] High per capita energy usage is due to the concentration of major refining, chemical, and petrochemical industries in the state. In 1995, 66% of Louisiana's energy use was in the industrial sector, the highest percentage of any state. [17] Louisiana's total refining capacity and petrochemical production is second only to Texas, a state with a population exceeding 18 million people.

In terms of carbon intensity, i.e. the amount of carbon dioxide emitted per dollar of gross state product, Louisiana consistently ranks near the top. Overall, the state was ranked the 4th most carbon intensive state by the U.S. EPA using 1990 data.[18] However, Louisiana's industrial sector was ranked the most carbon intensive per dollar of gross state product. In fact, Louisiana's industrial sector was eighty-five percent more carbon-intensive than Alaska (the #2 state) and ten times more carbon intensive than the national industrial average.[19]

According to U.S. EPA data (1990), transportation is the second major source of greenhouse gases in Louisiana, accounting for 25% of all carbon dioxide emissions.[20] In a national ranking by EPA, Louisiana had the 3rd highest level of per capita CO2 emissions in the transportation sector, nearly twice as high as the national average.[21]

Opportunities for Louisiana

Opportunities for reducing greenhouse gas emissions in beneficial ways exist across all sectors in Louisiana. Four options offer a combination of economic and environmental benefits while significantly reducing greenhouse gas emissions: 1) increasing energy efficiency, 2) promoting the state's natural gas resources, 3) promoting renewable energy resources, and 4) improving the state's transportation systems.

Energy Efficiency

After having lagged behind for years, Louisiana has begun to take important steps towards improving its energy efficiency. In 1997, the La. DNR Energy Section established a Commercial Building Energy Conservation Code. The Code was enacted by the Louisiana Legislature after being developed by a panel of experts, government officials, and other private sector stakeholders. It recognizes that Louisiana, a major producer and consumer of energy, has an important role to play in reaching the efficiency and conservation goals set by the federal Energy Policy Act of 1992.[22]

According to the Louisiana Department of Natural Resources, within ten years, the Code is estimated to achieve the following annual energy savings:

- Save Louisiana building owners over $4 million in energy costs.
- Save 323 billion BTU's of energy (equivalent to 2.5 million gallons of gasoline).
- Reduce CO2 emissions by 113 million pounds (equivalent to emissions from 54,249 cars).[23] As a collateral benefit, the statewide building energy code may help Louisiana avoid higher building insurance premiums when the Insurance Services Organization Building Code Effectiveness Grading Scale is applied in the state.[24]

Following the enactment of the Commercial Building Energy Code, the Louisiana Department of Natural Resources (DNR) received competitive grants from the U.S. Department of Energy (DOE) to develop a Model Energy Code for efficiency standards in residential buildings.[25] Two earlier DNR programs, the Home Energy Loan and Energy Rated Homes of Louisiana, have also promoted efficiency gains in the residential sector.[26]

Another competitive grant awarded from DOE will fund the Rebuild Louisiana program, which will incorporate energy efficient technologies into redevelopment and revitalization efforts for economically depressed areas.[27] The City of New Orleans has joined the federal Rebuild America Program, which promotes energy efficient systems and designs for new and existing buildings, as well as reductions in municipal electric bills.[28] An efficiency program begun by the New Orleans Utilities Department in January 1998 has saved the city $1 million by September 1998.[29]

A key area of energy savings and strong collateral benefits comes from efficiency measures for educational institutions at the state and local levels. Some of the federal oil overcharge settlement funds that supported the state's Home Energy Loan Program in 1997 also went to public and private colleges for energy conservation and management efforts.[30] Rebuild Louisiana will coordinate several universities to participate in a statewide energy audit program.[31] These audits will be available free of charge to building owners, schools, government buildings, etc. in the surrounding areas of the university. The DNR plans to provide financial information for retrofits to be made.

At the local level, an energy management program adopted by the public schools in East Baton Rouge Parish led to power bill reductions of over $1 million in its first two years.[32] A substantial portion of the schools' savings came from avoided costs, extra money that would have been spent without the conservation program. Money saved from energy bills can then be applied to education.

In addition, a number of projects are underway in the industrial sector. A project at Louisiana State University will facilitate adoption of "pinch" and on-line optimization technologies in small to medium size chemical plants, where studies indicate energy savings in the range of 30 to 60% can be achieved.[33] On a broader scale, another DOE grant will fund Industries for the Future, an ambitious program to unite industry, government, economic development groups, and environmental organizations to help Louisiana's businesses and industries reduce emissions of greenhouse gases and toxic pollution while increasing their competitiveness.[34]

Another important collateral benefit of energy conservation and efficiency is the resulting increase in the reserve capacity for utilities. Louisiana's utilities experienced high peak load demand during recent summer heat waves.[35] Lowering energy usage, especially during the time of peak demand, through energy efficiency is far cheaper than building new power plants.[36]

Because Louisiana has lagged behind other states in its investments in energy efficiency, such investments can be undertaken more cheaply and to greater effect here, with important benefits for economic development. An empirical study of the 50 states found that a higher level of energy efficiency tends to correlate with higher incomes, less poverty and unemployment, and less income disparity, as well as lower pollution levels.[37] This correlation suggests that increasing energy efficiency is good economic strategy - a conclusion the state recognized when it implemented the commercial building energy code: "[Energy efficiency measures] enhance the economic viability of the commercial community and increase the buying power of citizens. Dollars not spent on energy are spent on other goods and services in the local economy, whereas unnecessary expenditures on energy largely flow out of the local economy." [38]

Louisiana has made a good start in developing energy efficiency programs. However, these programs should be expanded to increase participation and effectiveness.

Promoting Natural Gas

Natural Gas is the cleanest burning fossil fuel. It has the lowest CO_2 emissions per unit of energy of all fossil fuels, approximately 45% less carbon-intensive than coal and 25% less carbon intensive than oil.[39] Moreover, natural gas lends itself easily to use in more efficient high technology such as combined cycle combustion turbines which have significant efficiencies over present power plants.[40]

Policies that promote low-carbon fuels offer significant economic oppor-tunities to Louisiana, which currently supplies approximately 25% of the domestic natural gas market and holds 19% of domestic U.S. reserves of natural gas.[41] In addition, Louisiana possesses extensive infrastructure for processing and distribution of natural gas.

Virtually all economic and environmental indicators are trending toward more natural gas usage and away from coal, the most carbon-intensive fossil fuel. Besides the threat of climate change, accelerated implement-ation of the Clean Air Act to alleviate air pollution can also be a significant driver of this shift, especially in the Northeastern states polluted by ground level ozone, a major lung and throat irritant, caused by nitrous oxide emissions from Midwestern coal plants.[42] Increasing competition in the electricity generating business could also provide further impetus for expanded use of natural gas, as utilities compete to produce energy more cheaply. This trend -- called "deregulation" or "restructuring" -- has already prompted the building of new natural gas-fired combined cycle combustion turbines throughout the U.S.

The natural gas advantage is already being recognized among Louisiana's leading economists. In a recent speech in New Orleans, Dr. Tim Ryan at the University of New Orleans College of Business stated (as reported by the Times Picayune) that "energy will continue to be the region's most significant sector. The region has several factors working in its favor when it comes to the energy sector, including a healthy stash of environmentally friendly natural gas, which will grow as an energy source in the 21st century." [43]

Although natural gas production and exploration has fallen off somewhat in the Gulf of Mexico, it has fared very well during the decline in oil prices. A Times Picayune article headlined "Gas steady as crude falters," (February 9, 1999), points out that "...natural gas --though hardly insulated from the current downturn -- emerges as the far sturdier commodity when compared with the Gulf of Mexico's other prime resource, crude oil... Since last year, the number of rigs involved in exploring and producing natural gas has sunk to 433 from 584, a 26% drop, according to Baker Hughes' rig count, a key industry benchmark. But over the same period, the rig count for oil-related work has plummeted 67% to 125 from 376."[44]

This means that, although the absolute number of oil & gas rigs has fallen, the overall percentage of natural gas drilling rigs has risen from 61% of the total to 78%, another indication of the increasing importance of natural gas production.

The natural gas advantage has been recognized for at least a decade in Louisiana. In a 1988 paper prepared for a legislative committee studying energy policy, Robert Bauman, Executive Director of the Center for Energy Studies at LSU writes in an analysis entitled "A Louisiana Energy Overview" that "Louisiana's future as a producer lies in natural gas over oil" and "[n]atural gas is currently abundant; its source is secure within U.S. borders; it is environmentally superior to most other sources of energy; it is very competitively priced for its energy value; and it is relatively underutilized on a national basis."[45]

In his summary statement, Bauman concludes: "Natural gas...might benefit from a campaign promoting natural gas over other primary fuels, leading to higher but competitive gas prices, and helping Louisiana producers. Note, however, that coal interests have historically been successful in defeating natural gas promotion policies in Washington."[46]

Currently, approximately 20% of the nation's energy needs -- ~20 trillion cubic feet (TCF) -- is supplied by natural gas, virtually all of it domestically produced. Louisiana produces twenty five percent of that total, approximately 5 tcf, from state lands and Louisiana's outer continental shelf. An increase in the use of natural gas from 20% of the nation's energy needs to 30% (a reasonable amount in an increasingly environmentally sensitive world) could dramatically increase employment and economic activity in Louisiana both in direct and indirect jobs.

Research is also underway on potential opportunities to "sequester" or store carbon dioxide out of the atmosphere in natural underground containers such as abandoned oil & gas wells. Dr. Robert Socolow, director of Princeton University's Center for Energy and Environmental Studies, has taken the lead in this research. Among other things, this research is also studying ways to turn natural gas into hydrogen, which can then be used as a clean burning fuel in fuel cells and other technologies, with the carbon dioxide by-product stored underground.

"In its simplest form, this involves steam-treating natural gas or coal to transform its carbon content into carbon dioxide, leaving pure hydrogen behind. This hydrogen can then be used in hydrogen fuel cells to provide electric power and transportation (the cells are already being tested in prototype cars and buses). The unwanted carbon dioxide would be pumped into aquifers, deep coal seams, or the deep ocean, where it would remain indefinitely." [47]

The IPCC also noted this research, which is in an early stage.[48] This research could be applicable and, perhaps quite profitable, in Louisiana, where we have abundant natural gas, a pipeline infrastructure and thousands of abandoned oil and gas wells.

Renewable Energy Development

The U.S. is the biggest center of solar power manufacturing, and American companies that make solar equipment have a thriving export business, with sales reaching $300 million in 1996, or 30% of the world market.[49] Renewable energy - solar-electric (photovoltaic), passive solar for heating homes or water, wind or hydroelectric - can provide energy services cleanly, and as prices for these technologies drop, affordably. Prices of renewable energy sources such as wind and solar have been dropping steadily.[50]

Louisiana has tapped into its renewable energy potential only in a very limited way. In contrast, Florida and Texas, direct energy industry competitors to Louisiana, have thriving solar energy business groups which are actively researching, developing, and implementing renewable energy technologies.[51]

Although some see natural gas development and renewable energy development as competitive and mutually exclusive, others see cooperative linkages between the two technologies over the next decades.

Today, inexpensive natural gas limits the market for renewable energy. Yet, substantial opportunities for renewables remain; the availability of gas is uneven across the world and accelerating climate change will require a conversion to carbon-free energy sources. Happily, competition between the two resources does not preclude cooperation since both technologies will benefit from similar polices and market structures. In the long term, natural gas can serve as a bridge to a renewable energy future if each community, acting in its own interest, supports the development of the other.[52]

Looking farther into the future, renewable energy and natural gas also are linked through their role in preparing for a renewable hydrogen economy. As a fuel, hydrogen produces virtually no pollution; its principal combustion by-product is water.

Natural gas is linked to this potential hydrogen future in three ways. First, it now serves as a feedstock for most of the hydrogen produced, and hydrogen derived from gas likely will provide the initial basis for any large-scale penetration of hydrogen into the energy market. Second, fuel cells that run on natural gas also can use hydrogen, and may do so in the future. Third and more speculatively, hydrogen might someday flow through the pipeline system that has been constructed for natural gas.[53]

One Louisiana elected official has already taken a special interest in renewable energy. On a recent trip to Israel, U.S. Senator Mary Landrieu had the opportunity to inspect the technically sophisticated renewable energy industry that has flourished there for many years.[54]

Improving Transportation

According to U.S. EPA data (1990), transportation is the second major source of greenhouse gases in Louisiana, accounting for 25% of emissions.[55] In a national ranking by EPA, Louisiana had the 3rd highest level of per capita CO2 emissions in the transportation sector, nearly twice as high as the national average.[56] This may be due in part to the relative age of the state's vehicle fleet, which itself may reflect low per capita income levels, as well as a lack of widely available mass transit options.

Most of Louisiana's metropolitan areas have lagged behind in investing in mass transit, even as they have developed serious problems with traffic congestion. These problems indicate a need for more public transportation, as well as a greater degree of regional and metropolitan transportation planning.

The federal Intermodal Surface Transportation Efficiency Act (ISTEA) of 1991 identified some basic goals that regional and metropolitan transportation planning must address:

- Mobility and access for people and goods, with access to jobs and shopping;
- Maintenance of existing transportation networks, with relief and prevention of congestion;
- Environmental and quality of life concerns, such as conserving energy, minimizing air pollution, implementing land use planning, and fostering economic development.

A number of studies have shown that these goals can be achieved through greater investments in public transportation, with a resulting increase in economic productivity.[57] Transportation planning plays a key role in the "smart growth" policies being adopted by a growing number of communities and states such as Maryland and New Jersey.[58]

Municipalities in Louisiana, like those elsewhere, need to choose a combination of transportation options that best suit their particular needs. An increasing number of cities across the U.S. are choosing a mix of transportation alternatives, such as bus, light rail, and park and ride, along with road improvements, as part of a "strategic portfolio" of options.[59] An important collateral benefit of many of these transportation options is a reduction in air pollution, including greenhouse gas emissions, through a reduction in driving time.

.Reliance on traditional road construction projects to the exclusion of other options can result in more, not less congestion, by furthering the problem of "induced traffic."[60] Cost is a key consideration in transportation policy and planning, and a "mixed approach" is often a more cost-effective way to address local traffic problems than merely building more roads. A recent demonstration of this fact in Louisiana can be seen in an interstate bypass proposed for Baton Rouge in 1998. Cost estimates for the proposed bypass totaled around $1 billion, yet best estimates showed it would only reduce interstate congestion in the city by 6 to 12%[61].

An independent cost comparison by the Alliance for Responsible Transportation found that for the same amount of money, the city-parish could carry out the following projects:

- Complete 93% of the currently unfunded parish road improvements for the next ten years;
- Fund a complete bicycle and pedestrian plan for the city-parish;
- Widen Interstate 10 from the Mississippi River Bridge to the I-10/I-12 split;
- Fund an expansion of city bus service for the next five years;
- Construct a light rail line from mid-city to downtown via Louisiana State University.[62]

In this case, the mix of transportation options (or a partial combination of them) would have far greater benefits for traffic, and provide a greater return on the expenditure of taxpayer dollars, than merely diverting a small portion of traffic. It would also lead to a substantial reduction of carbon emissions, whereas the proposed bypass would have increased them through the induced traffic effect.[63]

Investing in public transportation can be a significant business oppor-tunity. A recent study on the potential for intercity rail service in Louisiana recommended a passenger rail line between Baton Rouge and New Orleans.[64] With traffic increasing on Interstate 10, the study estimated that 1 million or more rail riders would travel between those cities annually. Tourism would benefit in both cities, and commuters and travelers would have another transportation option. The study also found that the costs of adding more highway lanes to the interstate to accommodate more cars would run about $6.5 million per mile, whereas upgrading existing rail lines for passenger trains would cost about $1.5 million per mile.

The federal government has designated the route from Houston to the Mississippi Gulf Coast as one of five potential high-speed rail corridors in the country.[65] This represents another important economic opportunity for Louisiana, with the reduction of carbon emissions from the reduction in interstate traffic again a collateral benefit.

A number of federal programs exist to help cities and communities plan their transportation systems. The U.S. EPA Transportation Partners Program offers information, technical assistance, and financial advice on how to reduce congestion while at the same time enhancing commuter mobility, economic growth, and preservation of natural areas. The EPA Transportation Action Network provides an on-line reference service with a library of technical information and case studies.[66]

The Department of Natural Resources is encouraging cooperative participation by state and local governments, private sector fleet operators, fuel suppliers, and interest groups to help the Baton Rouge metropolitan area meet the criteria for the U.S. Department of Energy's Clean Cities Program. These criteria involve targets for motor vehicle fleets in fuel conservation and use of alternative motor fuels, both measures which reduce emissions and air pollution. A Clean City designation would also open up DOE funding for public and private sector projects to continue progress on using alternative fuels and reducing emissions.[67]

Although the Clean Cities Plan is fuel neutral, a national increase in natural gas-based transportation would result in a net increase in Louisiana production, with positive employment impacts.

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Addendum: Business and Federal Government Initiatives in Response to Climate Change

A growing number of businesses, corporations, and utilities have undertaken voluntary initiatives to reduce emissions of greenhouse gases.

British Petroleum has pledged to reduce its greenhouse gas emissions by 10% below 1990 levels, a level of reductions exceeding that agreed by the US and other industrial countries at the Kyoto Conference.[1] The company will set targets for each refinery and factory to use less energy, with fixed reduction targets, and will call on its 90 business units worldwide to participate by improving energy efficiency, using new technologies, and trading emissions. The CEO of British Petroleum believes that these goals can be met without compromising growth or profits. BP has also invested $160 million in solar power.[2]

Mobil Oil has voluntarily initiated measures to reduce their emissions, such as installing energy-saving technology at refineries, undertaking energy management audits, reducing gas flaring at offshore facilities, and working to eliminate methane leaks.[3] Mobil, which has participated in government-sponsored programs to promote energy savings by upgrading lighting and maximizing energy efficiency in their buildings, as well as supporting reforestation projects, plans to accelerate the pace of their emission reductions.

Managers of major commercial structures such as the Empire State Building, the Sears Tower, and the World Trade Center have signed on to the federal Energy Star Buildings Label Program and pledged to reduce the amount of energy their buildings consume.[4] The Empire State Building has replaced all of its windows with more efficient panes and glazing. The Sears Tower spent almost $1 million on efficiency upgrades, and expects to recoup the cost in four years or less through lower utility bills. The World Trade Center upgraded 23,000 light fixtures with energy-saving bulbs.

The Utility Photovoltaic Group, a non-profit association of over 80 electric utilities and energy service companies, is promoting solar business ventures through its Team-Up program, one of the first major projects supporting President Clinton's Million Solar Roofs Initiative.[5]

The Business Council for Sustainable Energy, whose members include several utilities as well as producers of solar and wind power and natural gas, is promoting energy efficiency and alternative power sources.[6]

A Municipal Energy Program run by the Climate Institute is working with 10 cities across the U.S. to increase energy efficiency, primarily through DOE's Rebuild America and EPA's Energy Star programs.[7] Their program showed Atlanta how energy use in municipal facilities could be reduced by at least 30%, using building upgrades that pay for themselves.

Texas Utilities (TU) Electric worked with the administration and the Department of Energy to formulate a Climate Challenge program in 1995.[8] Over 600 participating utilities have pledged to reduce, avoid, or sequester more than 161 million tons of carbon dioxide by the year 2000. The Climate Challenge program involves tree planting projects, increasing energy efficiency at power generating plants, energy conservation and efficiency programs, renewable energy development, and natural gas production. TU's conservation and efficiency strategies have allowed the company to delay adding several large generating units.

The Edison Electric Institute, representing a number of utilities across the country, is working with the Clinton administration to promote voluntary energy efficiency efforts, and is undertaking cooperative efforts to reduce emissions in developing countries.[9]

Cooperative efforts by the private and public sectors are a central part of the Clinton administration's Climate Change Action Plan, which includes 50 voluntary initiatives addressing all major greenhouse gases and sectors of the U.S. economy.[10] Under the plan, credits for quick reduction of emission, as well as tax incentives and subsidies for low-carbon energy use, are being pursued.

The federal "Energy Star" program, run through DOE and EPA, focuses on increasing energy efficiency of appliances such as refrigerators, water heaters, air conditioners, etc., which are estimated to account for 1/3 of the nation's energy consumption and 2/3 of its electricity use.[11] The program generated over $300 million in energy savings in 1996.[12]

Since the EPA began its "Green Lights" program in 1991, more than 2600 partners have upgraded the lighting in over 3 billion square feet of building space, saved more than $1.2 billion on their energy bills, and eliminated 26 billion pounds of CO_2 emissions.[13] EPA estimates that if "Green Lights" were used in all facility space in the U.S., it would save over 150 billion kilowatt hours of electricity annually, and reduce the national electric bill by $12 billion per year.[14] These savings could then be invested in new jobs and enhanced productivity.

In 1997, President Clinton announced the Million Solar Roofs initiative, which aims to install one million solar energy systems on U.S. buildings by the year 2010, using existing federal grants and procurement programs, and working with local communities and governments, businesses, and utilities.[15] This initiative could produce electrical generating capacity equal to several coal-fired plants.

Notes

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Conclusions

Chapter IV: Conclusions and Recommendations

The IPCC Report and subsequent studies provide compelling evidence that the global climate is warming, and that the warming trend is due in part to the increase in concentrations of greenhouse gases from human activities.

It is clear that Louisiana has major vulnerabilities to climate change. Agriculture is the sector of the state's economy most immediately at risk. Serious vulnerabilities also exist for public health, forestry, and the state's deteriorating coast.

Louisiana should reduce its greenhouse gas emissions and protect its resources from the impacts of climate change. These efforts can be governed by a "No regrets" policy, i.e. actions which can be undertaken for reasons unrelated to climate change, but which can also play an important role in mitigating and responding to climate change.

For example, increasing energy efficiency will benefit consumers, promoting natural gas can improve our economy, and implementing an ambitious coastal restoration program, such as the Coast 2050 plan, will enable the state to better respond to sea level rise. In addition, ample evidence exists which demonstrates that greenhouse gas emissions can be reduced in ways that enhance economic growth and improve quality of life. The approach described by the IPCC, which utilizes normal cycles of capital and equipment replacement, offers an opportunity for changing energy systems and expanding new technologies without imposing undue burdens on the private sector.

As a state with both major vulnerabilities and unique mitigation opportunities, and as a significant source of greenhouse gas emissions in the U.S., Louisiana will have to actively participate in national and international efforts to address the problem of climate change.

Recommendations

1. Develop a state action plan. A state action plan should be developed to address the areas of risk and to pursue the opportunities identified in this report. The actions and options described here can form the basis for a state plan. Many of the actions are already underway to some extent, and others can be implemented quickly. Expanding actions already underway and coordinating them with steps still to be taken will multiply their benefits.

The state plan should include the following actions: Coordinate policies for key areas of risk: extreme weather, public health, agriculture, forestry and coastal impacts.

Pursue reductions of greenhouse gas emissions across all sectors of the economy. Louisiana has significant opportunities to reap economic benefits from cost-effective efficiency gains in the industrial, commercial, residential, utility, and transportation sectors.

Address metropolitan traffic problems by expanding public transportation systems.

Promote carbon sequestration opportunities in agriculture, forestry, and coastal restoration.

Promote the state's natural gas resource much more aggressively.

A crucial aspect of any state plan will be the ability to quantify greenhouse gas emission reductions and carbon sequestration efforts. Standards and methodology for quantifying the benefits of these activities can be developed with federal agencies and state universities. An inventory of sources and sinks for greenhouse gases is an important step in the development of a state action plan. The U.S. EPA is working with over thirty states, including Louisiana, to carry out inventories of their greenhouse gas emissions.

2. Involve all stakeholders
Louisiana should bring together a wide range of stakeholders to help develop policies on climate change. Government and the private sector will need to work cooperatively to achieve reductions of greenhouse gas emissions in economically beneficial ways. Industries for the Future, a new state program funded by a U.S. Department of Energy grant to the Department of Natural Resources, could provide a framework for cooperative action with the industrial sector. One precedent for this kind of broad-based, concerted action in Louisiana is the Barataria-Terrebonne National Estuary Program's Comprehensive Conservation and Management Plan, which was developed with extensive public involvement and support.

3. Learn from other states and from private sector initiatives. A number of other states, such as Texas, are much farther along in developing policies on climate change. A growing number of private sector initiatives are also underway that involve pro-active, economically beneficial actions to reduce greenhouse gas emissions. Louisiana should learn from these efforts and replicate the successes of other states and the private sector.

4. Coordinate and expand on-going research. The state's ability to achieve emission reductions, and its adaptive capacity for climate change, will both benefit from increasing our knowledge base. An inventory of greenhouse gas sources and carbon sinks in Louisiana, currently being carried out by Louisiana State University, will be a crucial tool in this process.

Research about different aspects of climate change and its effects on Louisiana is also being carried out at a number of universities in the state. The results of this on-going research should be compiled into a source readily available to state agencies, policy makers, the general public, and the private sector, and incorporated into state policies.

5. Become an active participant in national and international efforts to address the threat of climate change. Climate change will occur globally, but its effects will be felt locally. Louisiana has more at stake than most states in the outcome because of the range of risks that it faces. As Louisiana works to make restoration of its endangered coast a national priority, the state will have to demonstrate that it takes the threat of climate change seriously. By adopting and implementing a state plan on climate change, Louisiana will be able to point to a record of self-protection and early action to protect irreplaceable resources such as agriculture, our coast, and our way of life.

Addendum: What Some Other States Are Doing

Colorado: The Colorado Department of Public Health and Environment is implementing a state Climate Change Program. The program has two phases - Phase One involved the development of an inventory of key greenhouse gas emission sources and sinks in Colorado and of a set of environmental indicators to assess progress towards meeting reduction goals. Phase Two will assess the potential economic, environmental, and social impacts of global climate change on Colorado, utilizing statewide public forums and retreats for stakeholders. The Climate Change Program will work with the Colorado Sustainability Project, a coalition working to develop a sustainable Colorado by the year 2050.

Hawaii: Hawaii published a state Greenhouse Gas Inventory in 1997, detailing emissions from overall energy use, from stationary and mobile fossil fuel uses, from non-energy sources, from municipal waste management, and agriculture. The Inventory also outlined potential effects on Hawaii from climate change.

Illinois: Illinois launched a Global Climate Change Project with six components - a state task force on climate change, a Greenhouse Gases Inventory and Mitigation Options Project, a Joint Implementation Pilot Project, a Landfill Methane Outreach Program, a pilot education project, a Mitigation and Biennial Emissions Inventory Database. The state task force issued a Climate Change Action Plan for Illinois in 1994, and is working to implement the state plan.

Missouri: The state Department of Natural Resources' Division of Energy is coordinating an interagency cooperative project to identify and evaluate state policy and actions for reducing greenhouse gas emissions. In 1996, the Division of Energy completed a technical report on the state's greenhouse gas emissions. The Missouri Commission on Global Climate Change, established by the General Assembly in 1989, issued a report in 1991 on greenhouse gas emissions in the state, possible consequences of climate change, and recommended actions. The state is developing emission reduction strategies.

New Jersey: The New Jersey Department of Environmental Protection signed a letter of intent with the Ministry of Housing, Spatial Planning and Environment of the Netherlands in 1998, pledging to work jointly to develop initiatives for reducing greenhouse gas emissions. The initiatives will be in line with the Kyoto Protocol and will include identifying trading mechanisms, developing voluntary agreements with industry, and designing and implementing an emissions banking system.

Ohio: The Public Utilities Commission of Ohio (PUCO) became active in climate change issues in 1994, and attended the U.N. Intergovernmental Negotiating Committee for a Framework Convention on Climate Change. PUCO hosted a Forum on Global Climate Change attended by leading scientists and policymakers, and developed a Global Climate Change Web Site describing state policies on climate change.

Oregon: State law requires the Oregon Department of Energy to issue biennial energy plans for developing maximum use of cost-effective conservation and renewable resources. In 1989, the legislature committed the state to reducing greenhouse gas emissions by at least 20% below 1988 levels by 2005 by utilizing conservation, renewable resources, and alternative fuels.

Texas: Texas, the state with the largest greenhouse gas emissions, issued The Impacts of Global Warming on Texas in 1994, one of the most comprehensive state-based studies to date. In addition to examining vulnerabilities of Texas, and possible economic effects of reducing emissions, the report identified a range of energy-saving measures at the state level that are cost-effective on the basis on avoided production and transportation costs. Along with pursuing energy efficiency gains, the state launched a Texas Natural Gas Initiative. To prepare for the disruption of ecosystems due to climate change, the report recommends creating park areas with representative habitat types.

Utah: The Utah Departments of Environmental Quality and Natural Resources are working with EPA to develop a state action plan for reduction of greenhouse gas emissions. The report, based on a "no regrets" approach of collateral benefits, will focus on mitigation strategies that promote voluntary or cooperative solutions and performance-based strategies not currently found in regulation of other air pollution.

Vermont: In 1991, Vermont adopted a comprehensive state plan for reducing greenhouse gas emissions by at least 15%, and reducing per capita energy consumption to at least 20% below 1989 levels by the year 2000. State government agencies are directed to consider life-cycle cost, as opposed to immediate purchase cost, of energy-consuming items used for state business, such as appliances, computers, lighting and heating controls, and air conditioning.

Notes

1. Unless otherwise noted, information on states comes from the Public Utilities Commission of Ohio Global Climate Change Website http://www.puc.state.oh.us/ consumer/gcc/states2.html
2. "The Illinois Response to Climate Change: Report of the Task Force on Global Climate Change", Illinois Department of Natural Resources, January 1996. http://dnr.state.il.us/ftp/pub/climate.pdf
3. "NJ First to Pursue Int'l Partnership to Address Global Warming", State Environmental Monitor, 7/6/98.
4. North, G.R., Schmandt, J., Clarkson, J., The Impact of Global Warming on Texas: A Report of the Task Force on Climate Change in Texas, 1995, University of Texas Press, Austin.