LOCAL CLIMATE CHANGE IMPACT: SOCIETAL PERCEPTIONS OF RISK, VULNERABILITIES AND ADAPTATION

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University of Missouri-Kansas City, 2011

ABSTRACT

In terms of the Kansas City metropolitan area, there is a need to look at climate change and try to limit and modify various practices in order to further understand and mitigate climate change issues. To comprehend climate change issues, it is necessary to identify the overall problem. For the purpose of this research, focus groups were established in various sectors in the Kansas City metropolitan area. The sectors included: agriculture, transportation, health, water, energy, land use, and commerce. Local stakeholders were identified for each sector and invited to participate in panel discussions. It is our goal that the input from each focus group will provide an extensive background on how each stakeholder views climate change, along with perceptions of risk, vulnerabilities, and adaptation. This information should prove vital in comprehending the effects of climate change.

The debate on climate change has primarily relied upon global data and draws global climate change implications. Solutions to human caused acceleration of climate changes must be locally based – driven by local organizations and individuals. This study is based on local data of climate variability impacts with the intention to create tools and methods that provide solutions and recommendations for business planning and local public policy. This approach to regional climate science is based on a matrix of likely scenarios for the region's future; potential directions that our local economy, social structures and environment will take relative to climate change issues.

We use targeted focus groups and case studies to (1) gain a better understanding of the sensitivities of different goods, services, and practices within major social and economic sectors to current climate variability and hazards; (2) quantify the risk that the natural environment poses for citizen stakeholders, the business community and craft means to prepare for and adapt to the expected changes; (3) determine critical process/resource specific environmental thresholds or non-linearities that have particular economic implications by ranking vulnerabilities under different scenarios, and (4) provide feedback to the political sector on actions that public and private sector resource managers must take to prepare for the climatological scenarios.

APPROVAL PAGE

The faculty listed below, appointed by the Dean of the College of Arts and Sciences have examined a thesis titled "Local Climate Change Impact: Societal Perceptions of Risk, Vulnerabilities and Adaptation," presented by Morris Tyler Willoughby, candidate for the Master of Science degree, and certify that in their opinion it is worthy of acceptance.

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CHAPTER 1

INTRODUCTION

Climate change refers to seasonal changes over a long period of time, affecting more than just a change in the weather. These climate patterns are of utmost importance in shaping the human economies and cultures that depend on them. Food production, health risks, and the availability and use of water are examples of how climate change can affect where and how people live.

Weather is the state of the atmosphere at a given time and place, with respect to variables such as temperature, moisture, wind velocity, and barometric pressure. Weather patterns do indeed play a major role in overall climate change. For example, according to a written testimony by Dr. Jimmy Adegoke to the Select Committee on Energy Independence and Global Warming of the United States House of Representatives, "Regional data for North America confirms that warming has occurred throughout most of the United States. As surface temperatures rise, the evaporation of water vapor increases from oceans and other moist surfaces. Increased evaporation is leading to higher concentrations of water vapor in the atmosphere. Increased atmospheric water vapor tends to produce weather systems that lead to increased precipitation in some areas. At the same time, increased evaporation and evapotranspiration from warming can lead to increased land surface drying and, therefore, increased potential incidence and severity of droughts in other areas" (U.S. House 2008).

The Weather Channel's Position Statement on global warming suggests,

> The climate of the earth is indeed warming, with an increase of approximately 1 to 1.5 degrees Fahrenheit in the past century, more than half of that occurring in the past three decades. Impacts can already be seen, especially in the Arctic, with melting glaciers, thawing permafrost, and rapid retreat and thinning of sea ice, all of which are affecting human populations as well as animals and vegetation. In various parts of the world, it is now assumed that increased frequency and intensity of heat waves in the warm season and warm spells in the cold season are contributors to overall climate change. There is evidence in recent years of a direct linkage between the larger-scale warming and short-term weather events such as heat waves. In some regions there has been a tendency for an increase in precipitation extremes, both wet (including floods) and dry (droughts). These observations over the past several decades are consistent with what theory and global climate models would suggest. (Weather Channel 2007)

Human activities, such as the burning of fossil fuels, greatly influence overall climate change. These activities add additional carbon dioxide and other greenhouse gases into the atmosphere. Climate observation studies indicate a dramatic increase in both carbon dioxide and temperature. These observations, coupled with computer model simulations and historical climate reconstructions from ice cores, ocean sediments and tree rings all provide strong evidence that the majority of the warming over the past century is a result of human activities. It is projected by the year 2020; Kansas City could experience greenhouse gas emissions from residential, commercial and industrial activities to rise to as much as 6.8 million metric tons (Figure 1). According to the diagram, for the year 2000, greenhouse gas emissions from residential, commercial and industrial categories totaled approximately 6 million metric tons. In 2005, greenhouse gas emissions, for all three categories, totaled approximately 6.1 million metric tons. For the years indicated, the grand total is approximately 18.9 million metric tons. The effects of weather and climate can be associated with the replacement of vegetation by impervious surfaces which create an urban heat island

effect and causes temperatures to increase. Land use changes, such as urbanization, are a contributing factor.

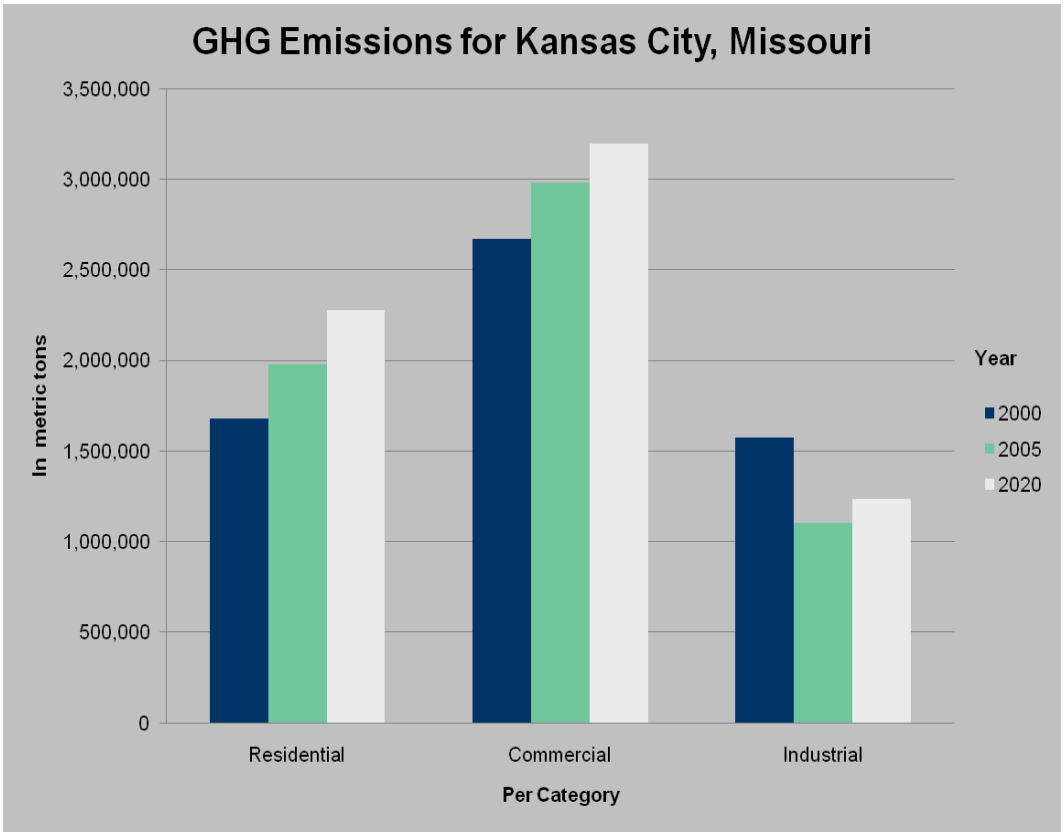

Figure 1. Projected greenhouse gas emissions for Kansas City, Missouri.

Source: Adegoke, Jimmy, and Chris Green. 2008. Towards a carbon-neutral future: Road map for scenario-based assessment of climate-induced risks to the regional economy in the Kansas City area. Presentation, Center for Applied Environmental Research, University of Missouri-Kansas City, Kansas City, Missouri.

While there has been a tremendous amount of climate change studies conducted on a global scale using a top-down approach, it is also important to note that climate change should be studied on a local scale utilizing a bottom-up approach. The need for climate

change to be studied from this type of approach can be seen as a method for researchers to look at a more precise picture of what are a specific region's climate patterns. For example, researchers can look at land use practices and realize there are variations in data depending on the specific region. In other words, land use practices throughout the world will have different impacts on different geographic regions. It is also important to note that global climate models cannot completely predict changes in a specific region. However, regional climate models are used to predict the future climate for a specific region of the world. In general, these models use the output of a global climate model to determine the overall global climate and energy budget and then apply dynamical principles to the new climate regime. These models simulate events on the local scale more accurately.

Agriculture has a significant impact on climate and the United States Midwest is one of the most agriculturally productive areas in the world and supports a wide range of agro-businesses and industrial-manufacturing complexes that are economically vital to the United States (U.S. House 2008). Climate change could affect agriculture in the Midwest in many ways. There could be a higher day-to-day and year-to-year variability in temperatures which can damage agricultural and fruit crops or delay spring planting and crop growth. Water logging of soils could result from more precipitation annually and during the growing season and increased precipitation would likely be accompanied by more cloudiness and hence less solar radiation, particularly in spring. This could slow early-season crop growth. There could be a reduction in wind speeds which can affect pollination and dispersion of pests and pathogens. A rise in temperatures could promote conditions that allow for the generation of

tropospheric ozone from automobile exhaust. Ozone near the ground can account for a small reduction in yield, but may rise to as much as 30% over the next century. Stronger storms could also result from climate change patterns.

By looking at a particular region, new region-specific ways can be created to mitigate climate change. In terms of the Kansas City metropolitan area, there is a need to look at climate change and try to limit and modify our agricultural, as well as other practices in order to further understand and mitigate climate change issues.

When thinking about climate change, there are four important ideas to take into consideration: perceptions of climate risk, climate vulnerability, mitigation efforts, and adaptation practices. These topics are of utmost importance when researching climate change and its impacts on our lives and well-being.

According to one intellectual,

> American public risk perceptions of climate change are critical for at least two reasons. First, the United States, with only 5% of the world's population, is currently the world's largest emitter of carbon dioxide, the primary heat-trapping gas, alone accounting for nearly 25% of global emissions. Per capita, Americans emit 5.40 metric tons of carbon each year. Second, successive U.S. presidents and congressional leaders have been at odds with much of the world community regarding the reality, seriousness, and need for vigorous action on climate change. For example, in 1997, just prior to the Kyoto climate change conference, the U.S. Senate passed a nonbinding resolution (95–0) co-sponsored by Robert Byrd (D) of West Virginia and Chuck Hagel (R) of Nebraska, which urged the Clinton administration to reject any agreement that did not include emission limits for developing as well as industrialized countries, arguing that to do so would put the United States at a competitive economic disadvantage. Furthermore, in 2001 President George W. Bush renounced a campaign pledge to regulate carbon dioxide as a pollutant, withdrew the United States from the Kyoto Protocol negotiations, and proposed national energy legislation to increase drilling for oil and natural gas, increase mining for coal, and build more than a thousand new fossil fuel-burning power plants. Clearly, the American public will play a critical role, both in terms of their direct consumption of fossil fuels, and resulting greenhouse gas emissions, and through their support for political leaders and government policies, in the effort to mitigate or

adapt to global climate change. (Leiserowitz 2005, 1434)

Virtually all polls taken since 1997 have found that a large majority of Americans believe global warming is real. According to Leiserowitz,

> Public opinion polls also demonstrate significant levels of public worry about global warming. In May 1989, a Gallup survey of American public asked: "How much do you personally worry about the greenhouse effect or global warming?" Gallup found that 35% worried "a great deal," 28% worried "a fair amount," 18% worried "only a little," and 12% worried "not at all." Thus, 63% of Americans were fairly to greatly worried about global warming in 1989. Gallup found that this level of worry oscillated over the subsequent 14 years, with a dip to 50% in 1997, an increase to 72% in 2000, and a decrease to 58% in 2002 (Leiserowitz 2005, 1435).

According to Eileen Claussen, President, Pew Center on Global Climate Change,

> In 2007, the science of climate change achieved an unfortunate milestone: the Intergovernmental Panel on Climate Change (IPCC) reached a consensus position that human-induced global warming is already causing physical and biological impacts worldwide. The most recent scientific work demonstrates that changes in the climate system are occurring in the patterns that scientists had predicted, but the observed changes are happening earlier and faster than expected—again, unfortunate. Although serious reductions in manmade greenhouse gas emissions must be undertaken to reduce the extent of future impacts, climate change is already here and some impacts are clearly unavoidable. It is imperative, therefore, that we take stock of current and projected impacts so that we may begin to prepare for a future unlike the past we have known (Ebi and Meehl 2007, i).

The International Council for Local Environmental Initiatives (ICLEI) is an international membership association of local governments dedicated to climate protection and sustainable development. ICLEI has developed a methodology consisting of five milestones for setting and meeting climate mitigation goals (ICLEI 2009):

1. **Conduct a baseline emissions inventory and forecast**
   The city first calculates greenhouse gas emissions for a base year (e.g., 2000) and for a forecast year (e.g., 2015). The calculations capture emissions levels from all municipal operations (e.g., city owned and/or operated buildings, streetlights, transit systems, wastewater treatment facilities) and from all community-related activities (e.g., residential and commercial buildings, motor vehicles, waste streams, industry). This inventory and forecast provide a benchmark for planning and monitoring progress.

2. **Adopt an emissions reduction target for the forecast year**
   The city passes a resolution establishing an emission reduction target for the city. The target is essential. It both fosters political will and creates a framework that guides the planning and implementation of measures.

3. **Develop a Local Climate Action Plan**
   The local government then develops a Local Climate Action Plan, ideally with robust public input from all stakeholders. The plan details the policies and measures that the local government will take to reduce greenhouse gas emissions and achieve its emissions reduction target. Most plans include a timeline, a description of financing mechanisms, and an assignment of responsibility to departments and staff. In addition to direct greenhouse gas reduction measures, most plans also incorporate public awareness and education efforts.

4. **Implement policies and measures**
   The city implements the policies and measures contained in their Local Climate Action Plan. Typical policies and measures include energy efficiency improvements to municipal buildings and water treatment facilities, streetlight retrofits, public transit improvements, installation of renewable power applications, and methane recovery from waste management.

5. **Monitor and verify results**
   Monitoring and verifying progress on the implementation of measures to reduce or avoid greenhouse gas emissions is an ongoing process. Monitoring begins once measures are implemented and continues for the life of the measures, providing important feedback that can be used to improve the measures over time.

Mitigation efforts are an important process for all levels of government. Through mitigation practices, everyone has a chance to get involved and participate to try and minimize the impacts climate change can have on a specific region.

Some degree of future climate change will occur regardless of future greenhouse gas emissions. Adapting to or coping with climate change will therefore become necessary in certain regions and for certain socioeconomic and environmental systems. The need for adaptation may be increased by growing populations in areas vulnerable to extreme events (EPA 2009a).

The IPCC defines adaptation as the "adjustment in natural or human systems in response to actual or expected climatic stimuli or their effects, which moderates harm or exploits beneficial opportunities" (Parry et al. 2007, 27). Climate change impacts upon different ecosystems, regions and sectors of the economy will depend not only on the sensitivity of those systems to climate change, but also on the systems' ability to adapt to climate change (EPA 2009a). Adaptation to climate change is crucial in order to reduce the impacts of climate change that are happening now and increase resistance to future impacts.

To comprehend climate change issues, it is necessary to identify the overall problem. On a local level, the Environmental Management Commission (EMC) of Kansas City, Missouri began a new, innovative study in 2007. The EMC, composed of experts commissioned by Kansas City's mayor to provide recommendations on local environmental problems, set the tone and direction for development of a Climate Protection Plan for the city. This plan includes recommended goals for community-wide greenhouse gas reductions:

- Adopt a goal of reducing community-wide greenhouse gas emissions in Kansas City, Missouri by 30% below year 2000 levels by year 2020;
- Adopt an aspirational goal of reducing community-wide greenhouse gas emissions by 80% below year 2000 levels by 2050 and focus on a long-term outlook on being a climate-neutral Kansas City;
- Adopt the greenhouse gas emission reduction measures in the Climate Protection Plan as a statement of intent and strategy, while providing the City administration with flexibility to implement them in a timely and workable manner;
- Support the continuation of the Climate Protection Steering Committee as an ongoing oversight entity for implementation of Kansas City's Climate Protection Plan.

The Climate Protection Plan establishes goals for the reduction of greenhouse gas emissions from Kansas City municipal operations and from the wider community. The community-

wide emission reduction goals include the entire public and private community as well as the subset of city government. The Kansas City Climate Protection Plan contains several major areas of emphasis that are critical to achieving its goals:

- We must dramatically reduce our vehicle emissions by a combination of increased use of convenient public transportation, ride sharing, telecommuting, living and working in closer proximity, choosing the fuels we use to power our vehicles, and reducing the miles we choose to drive.

- As individual residents, businesses, and a municipal government we must conserve the electrical energy we are consuming and seek new economically feasible renewable energy sources.

- We must better understand the impact of our buildings (including residential, commercial, institutional, industrial and governmental) on greenhouse gas emissions and create policies and action plans that comprehensively reduce the impact of our current and future building stock on greenhouse gas emissions.

The EMC believes, "while climate change is an enormous challenge and a defining issue for our time, it is also an opportunity for our community. We believe the ways we respond to the challenge of reducing greenhouse gas emissions that contribute to climate disruption will result in substantial benefits to Kansas City" (City of Kansas City, MO 2008, 1).

For the purpose of this research, a similar study was completed in the summer of 2010 and consisted of focus groups representing various sectors in the Kansas City metropolitan area. The sectors included: agriculture, transportation, health, water, energy, land use, and commerce. Each focus group consisted of 10-15 management-level staff members with operational responsibilities in a particular sector. It is our goal that the input from each focus group will provide an extensive background on how each stakeholder views climate change, along with perceptions of risk, vulnerabilities, and adaptation practices. This information should prove vital in comprehending the effects of climate change.

Research hypothesis is as follows – Climate change will present new opportunities and risks that will affect all sectors of the regional economy. Better knowledge will improve the resilience of Kansas City's economic health and continued competitive advantage.

CHAPTER 2

LITERATURE REVIEW

An international agreement called The Kyoto Protocol was created in hope to significantly reduce carbon emissions by 2012. It requires governments in developed countries to cut emissions by 30% below current levels. Governments are required to set goals and accomplish these goals in order to reduce emissions. Major sources of emissions include agriculture, commerce, transportation, and power generation. Through government intervention, reductions can occur throughout these sectors by forcing mandatory reductions and/or offering various incentives to encourage alternatives.

While this protocol is very important, there is another important point to make. It is the idea of individual action. Individuals are just as important as government agencies when viewing climate change and global warming. For example, they can decide how to manage energy consumption and choose to use more public transportation for starters. However, without adequate education on the topic and more public intervention, individual action will remain at a minimum.

Key vulnerabilities, perceptions of risk, mitigation efforts, and adaptation techniques are all factors to take into consideration when thinking about individual action and the bottom-up approach. Schneider notes,

> The elucidation and determination of dangerous anthropogenic interference is a complex socio-political process, involving normative judgments. While information on key vulnerabilities will inform and enrich this process, there may be useful insights from the social sciences that might support this process, such as better knowledge of institutional and organizational dynamics, and diverse stakeholder inputs. Also needed are assessments of vulnerability and adaptation that combine top-down climate models with bottom-up social vulnerability assessments. (Schneider et al. 2007, 804)

Schneider also states,

> Many social, biological and geophysical systems are at risk from climate change. Since the Third Assessment Report, policy-makers and the scientific community have increasingly turned their attention to climate change impacts, vulnerabilities and associated risks that may be considered 'key' because of their magnitude, persistence and other characteristics. An impact describes a specific change in a system caused by its exposure to climate change. Impacts may be judged to be either harmful or beneficial. Vulnerability to climate change is the degree to which these systems are susceptible to, and unable to cope with, the adverse impacts. The concept of risk, which combines the magnitude of the impact with the probability of its occurrence, captures uncertainty in the underlying processes of climate change, exposure, sensitivity and adaptation. (Schneider et al. 2007, 782)

Schneider concludes that,

> Key vulnerabilities are associated with many climate-sensitive systems, including, for example, food supply, infrastructure, health, water resources, coastal systems, ecosystems, global biogeochemical cycles, ice sheets, and modes of oceanic and atmospheric circulation. (Schneider et al. 2007, 781)

Determining which impacts of climate change are potentially 'key' and what is 'dangerous' is a dynamic process involving and combining scientific knowledge with factual and normative elements. Normative criteria are influenced by the perceptions of risk, which depends on the cultural and social context (Oppenheimer and Todorov 2006, 1-6).

Many of the societal impacts will be felt within regions. At a regional and sub-regional scale, vulnerabilities can vary. For example, while mid- and high-latitude areas

would have increased crop yields up to about 3°C of warming, low-latitude areas would face decreased yields and increased risks of malnutrition at lower levels of warming. Climate change is likely to increase the frequency and intensity of extreme heat events, as well as concentrations of air pollutants, such as ozone, which increase mortality and morbidity in urban areas (Parry et al. 2004; Schneider et al. 2007).

According to the U.S. Environmental Protection Agency (EPA),

> Throughout the world, the prevalence of some diseases and other threats to human health depend largely on local climate. Extreme temperatures can lead directly to loss of life, while climate-related disturbances in ecological systems, such as changes in the range of infective parasites, can indirectly impact the incidence of serious infectious diseases. In addition, warm temperatures can increase air and water pollution, which in turn harm human health.
>
> Human health is strongly affected by social, political, economic, environmental and technological factors, including urbanization, affluence, scientific developments, individual behavior and individual vulnerability (e.g., genetic makeup, nutritional status, emotional well-being, age, gender and economic status). The extent and nature of climate change impacts on human health vary by region, by relative vulnerability of population groups, by the extent and duration of exposure to climate change itself and by society's ability to adapt to or cope with the change. (EPA 2009c)

Human beings are exposed to climate change through changing weather patterns (for example, more intense and frequent extreme events) and indirectly through changes in water, air, food quality and quantity, ecosystems, agriculture, and economy. At this early stage the effects are small but are projected to progressively increase in all countries and regions.

Climate change may directly affect human health through increases in average temperature. Such increases may lead to more extreme heat waves during the summer while producing less extreme cold spells during the winter. Rising average temperatures are predicted to increase the incidence of heat waves and hot extremes. In the United States,

Chicago is projected to experience 25 percent more frequent heat waves and Los Angeles a four-to-eight-fold increase in heat wave days by the end of the century (Confalonieri et al. 2007, 396-401). Particular segments of the population such as those with heart problems, asthma, the elderly, the very young and the homeless can be especially vulnerable to extreme heat.

Extreme weather events can be destructive to human health and well-being. The extent to which climate change may affect the frequency and severity of these events, such as hurricanes and extreme heat and floods, is being investigated by the United States Global Change Research Program. An increase in the frequency of extreme events may result in more event-related deaths, injuries, infectious diseases, and stress-related disorders (United States Global Change Research Program 2000).

According to the EPA,

> Climate change may increase the risk of some infectious diseases, particularly those diseases that appear in warm areas and are spread by mosquitoes and other insects. These "vector-borne" diseases include malaria, dengue fever, yellow fever, and encephalitis. Also, algal blooms could occur more frequently as temperatures warm, particularly in areas with polluted waters, in which case diseases, such as cholera, that tend to accompany algal blooms could become more frequent.
>
> Higher temperatures, in combination with favorable rainfall patterns, could prolong disease transmission seasons in some locations where certain diseases already exist. In other locations, climate change will decrease transmission via reductions in rainfall or temperatures that are too high for transmission. For example, temperature and humidity levels must be sufficient for certain disease-carrying vectors, such as ticks that carry Lyme disease, to thrive. And climate change could push temperature and humidity levels either towards or away from optimum conditions for the survival rate of ticks. (EPA 2009c)

Tick-borne Lyme disease may also expand its range in Canada. However, socioeconomic factors such as public health measures will play a large role in determining

the existence or extent of such infections. Water-borne diseases may increase where warmer air and water temperatures combine with heavy runoff from agricultural and urban surfaces, but may be largely contained by standard water-treatment practices.

Climate change is expected to contribute to some air quality problems. Respiratory disorders may be exacerbated by warming-induced increases in the frequency of smog (ground-level ozone) events and particulate air pollution.

Ground-level ozone can damage lung tissue, and is especially harmful for those with asthma and other chronic lung diseases. Sunlight and high temperatures, combined with other pollutants such as nitrogen oxides and volatile organic compounds, can cause ground-level ozone to increase. Climate change may increase the concentration of ground-level ozone, but the magnitude of the effect is uncertain. For other pollutants, the effects of climate change and/or weather are less well studied and results vary by region (EPA 2009c).

Studies conducted in the Midwest, such as corn and soybean yields, focus on the relation between climate variation and crop production by synthesizing data on temperature, precipitation, solar radiation, and county corn and soybean yields throughout the United States for the period 1982-98. Two regions with distinct relations between crop yield and climate anomalies were observed: a large area centered in the Midwest where yields were favored by cooler, wetter years and a smaller region including the Northern Great Plains favored by hotter, drier years. The majority of counties experienced negative trends in growing season temperature over the study period. Using the observed relationship between temperature and yield trends, values were computed and resulted in 78% and 80%,

respectively, of the trends in total national production, indicating that yield gains due to non-climatic factors are roughly 20% lower than previously assumed. As the United States is the largest producer of both corn and soybean in the world, predicted future global production of these crops based on historical trends may be over-estimated (Figure 2).

Gradual temperature changes have had a measurable impact on crop yield trends. It is estimated that there has been approximately a 17% relative decrease in both corn and soybean yield for each degree increase in growing season temperature. Previous modeling studies predict changes of similar magnitude for a 3° temperature increase, suggesting that the observed sensitivity is higher than previously expected. On the basis of this investigation, there is a clear and present need to synthesize crop yield and climate data from different areas, perhaps with more detailed information on management, to provide critically needed observational constraints to projections of both climate change and management impacts on future food production (Lobell and Asner 2003, 1032).

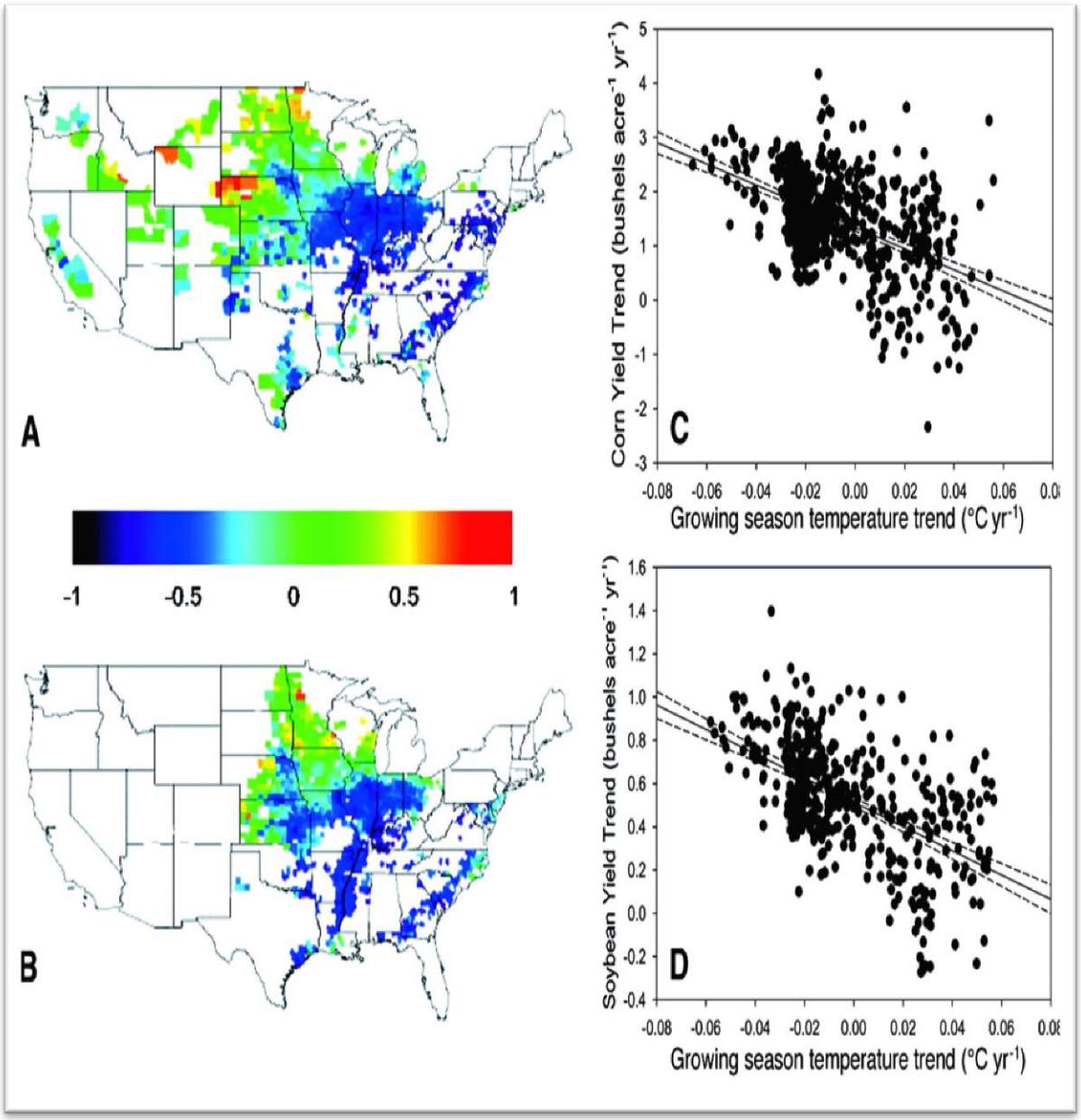

Figure 2. Correlation between June to August average temperature anomalies and (A) corn and (B) soybean yield anomalies for 1982-98. Areas with significantly negative correlations (in blue) were selected to investigate the relative importance of climate and other factors in yield trends. (C and D) Regression statistics for corn and temperature trends.

Source: Lobell, David B., and Gregory P. Asner. 2003. Climate and management contributions to recent trends in U.S. agricultural yields. *Science* 299, no. 5609 (February). http://www.sciencemag.org/content/299/5609/1032 (accessed June 5, 2009).

Recent extreme climate events have demonstrated that such events can cause significant loss of life and property damage. While individual events cannot be attributed solely to anthropogenic climate change, recent research indicates that human influence has already increased the risk of certain extreme events such as heat waves and intense tropical cyclones (Stott et al. 2004, 610-614). Schneider notes, "There is high confidence that a warming of up to 2°C above 1990-2000 levels would increase the risk of many extreme events, including floods, droughts, heat waves and fires" (Schneider et al. 2007, 796).

Sustainable development has environmental, economic and social dimensions:

> Properly designed climate change responses can be part of sustainable development. Mitigation, by limiting climate change, can conserve or enhance ecosystems and the environment as sources for economic activity. Mitigation can also prevent or avoid damage to human systems and contribute to the overall productivity of capital needed for socio-economic development, including mitigative and adaptive capacity. Sustainable development paths can reduce vulnerability to climate change and reduce greenhouse gas emissions. (Rogner et al. 2007, 100)

Making development more sustainable by changing development paths can make a major contribution to climate change mitigation. Irrespective of the scale of mitigation measures, adaptation measures are necessary. Climate change and other sustainable development policies are often but not always synergistic. There is growing evidence that decisions about macroeconomic policy, agricultural policy, multi-lateral development bank lending, insurance practices, electricity market reform, energy security and forest conservation, for example, which are often treated as being apart from climate policy, can significantly reduce emissions.

Climate change policies related to energy efficiency and renewable energy are often

economically beneficial, improve energy security and reduce local pollutant emissions. Other energy supply mitigation options can be designed to also achieve sustainable development benefits such as avoided displacement of local populations, job creation, and health benefits.

Reducing both loss of natural habitat and deforestation can have significant biodiversity, soil and water conservation benefits, and can be implemented in a socially and economically sustainable manner. Forestation and bioenergy plantations can lead to restoration of degraded land, manage water runoff, retain soil carbon and benefit rural economies, but could compete with land for food production and may be negative for biodiversity, if not properly designed. There are also good possibilities for reinforcing sustainable development through mitigation actions in the waste management, transportation and buildings sectors.

Making development more sustainable can enhance both mitigative and adaptive capacity, and reduce emissions and vulnerability to climate change. There are still relevant gaps in currently available knowledge regarding some aspects of mitigation of climate change. Additional research addressing those gaps would further reduce uncertainties and thus facilitate decision-making related to mitigation of climate change (Sathaye et al. 2007, 693-734).

According to the United States Global Change Research Program,

> Over the 20th century, the northern portion of the Midwest, including the upper Great Lakes, has warmed by almost 4°F (2°C), while the southern portion, along the Ohio River valley, has cooled by about 1°F (0.5°C). Annual precipitation has increased, with many of the changes quite substantial, including as much as 10 to 20% increases over the 20th century. Much of the precipitation has resulted from an increased rise in the number of days with heavy and very heavy precipitation events. There have been

moderate to very large increases in the number of days with excessive moisture in the eastern portion of the basin.

During the 21st century, models project that temperatures will increase throughout the Midwest, and at a greater rate than has been observed in the 20th century. Even over the northern portion of the region, where warming has been the largest, an accelerated warming trend is projected for the 21st century, with temperatures increasing by 5 to 10°F (3 to 6°C). The average minimum temperature is likely to increase as much as 1 to 2°F (0.5 to 1°C) more than the maximum temperature. Precipitation is likely to continue its upward trend, at a slightly accelerated rate; 10 to 30% increases are projected across much of the region. Despite the increases in precipitation, increases in temperature and other meteorological factors are likely to lead to a substantial increase in evaporation, causing a soil moisture deficit, reduction in lake and river levels, and more drought-like conditions in much of the region. In addition, increases in the proportion of precipitation coming from heavy and extreme precipitation are very likely.

A reduction in extremely low temperatures and an increase in extremely high temperatures are expected. Thus, a reduced risk of life-threatening cold and an increased risk of life-threatening heat are likely to accompany warming. Reduced expenditures on snow and ice removal and fewer snow and ice related accidents and delays are likely. During the summer, however, in cities, heat-related stresses are very likely to be exacerbated by the urban heat island effect, a phenomenon in which cities remain much warmer than surrounding rural areas. This elevates nighttime temperatures, and in combination with the greater expected rise of nighttime temperatures compared to those of daytime, there will be less relief at night during heat waves. Elevated nighttime temperatures were a notable characteristic of the 1995 heat wave that resulted in over 700 deaths in Chicago. In addition, during heat waves in the Midwest, air pollutants are trapped near the surface, as atmospheric ventilation is reduced. Without strict attention to regional emissions of air pollutants, the undesirable combination of extreme heat and unhealthy air quality is likely to result. There is also a possibility of an increased risk of water-borne diseases with increases in extreme precipitation events, and increased insect- or tick-borne diseases, such as St. Louis encephalitis. Recreational activities will very likely shift as cold-season recreation such as skiing, snowmobiling, ice skating, and ice-fishing, are reduced, and warm-season recreation such as swimming, hiking, and golf, are expanded, although during mid-summer, these activities are likely to be affected by excessive heat.

Active responses, such as those taken by Chicago during the 1999 heat wave, are likely to help reduce the death toll due to extreme heat. Separate storm water and sewer lines and other appropriate preventative measures can help mitigate the possible increased risk of water-borne diseases. (United States Global Change Research Program 2000)

Agriculture is of vital importance to this region, the nation, and the world. It has exhibited a capacity to adapt to moderate differences in growing season climate, and it is

likely that agriculture would be able to continue to adapt. With an increase in the length of the growing season, double cropping, the practice of planting a second crop after the first is harvested, is likely to become more prevalent. The carbon dioxide fertilization effect is likely to enhance plant growth and contribute to generally higher yields. The largest increases are projected to occur in the northern areas of the region, where crop yields are currently temperature limited. However, yields are not likely to increase in all parts of the region. For example, in the southern portions of Indiana and Illinois, corn yields are likely to decline, with 10-20% decreases projected in some locations. Consumers are likely to pay lower prices due to generally increased yields, while most producers are likely to suffer reduced profits due to declining prices. Increased use of pesticides and herbicides are very likely to be required and to present new challenges.

Plant breeding programs can use skilled climate predictions to aid in breeding new varieties for the new growing conditions. Farmers can then choose varieties that are better attuned to the expected climate. It is likely that plant breeders will need to use all the tools of plant breeding, including genetic engineering, in adapting to climate change. Changing planting and harvest dates and planting densities, and using integrated pest management, conservation tillage, and new farm technologies are additional options. There is also the potential for shifting or expanding the area where certain crops are grown if climate conditions become more favorable. Weather conditions during the growing season are the primary factor in year-to-year differences in corn and soybean yields. Droughts and floods result in large yield reductions; severe droughts, like the drought of 1988, cause yield

reductions of over 30%. Reliable seasonal forecasts are likely to help farmers adjust their practices from year to year to respond to such events.

Climate extremes in the Midwest can drastically impede the highly weather-sensitive transportation systems that serve not only the region, but the entire nation. According to an article published by the (Association of American Railroads 2004),

> Kansas City Southern is rated as one of the Class I railroads in the United States. Class I railroads are those with operating revenue of at least $272 million in 2002. Freight railroads are critical to the economic well-being and global competitiveness of the United States. They move 42 percent of our nation's freight (measured in ton-miles) and connect businesses with each other across the country and with markets overseas. Major commodities carried by rail include coal, chemicals, including massive amounts of industrial chemicals, plastic resins, and fertilizers; grain and other agricultural products; non- metallic minerals such as phosphate rock, sand, and crushed stone and gravel; food and food products; steel and other primary metal products; forest products, including lumber, paper, and pulp; motor vehicles and motor vehicle parts; and waste and scrap materials, including scrap iron and scrap paper. They also contribute billions of dollars each year to the economy through investments, wages, purchases, and taxes. (Figure 3)

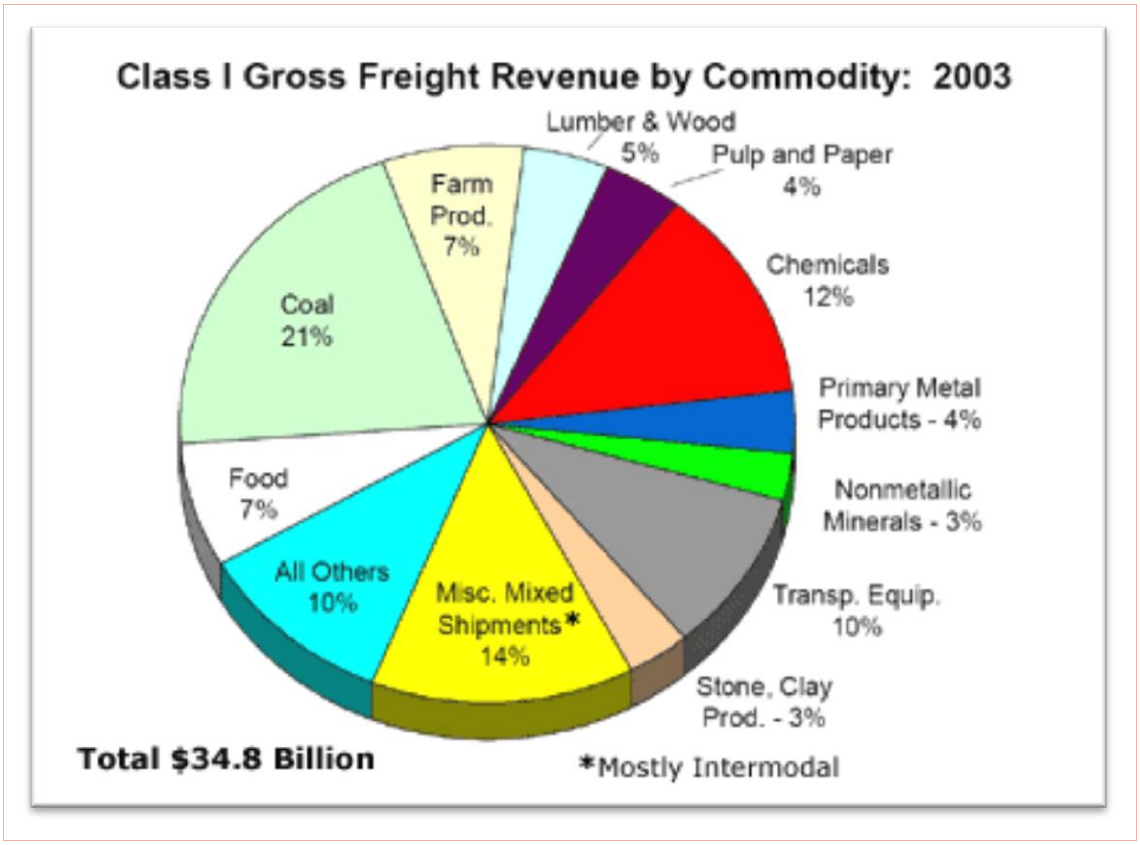

Figure 3. Class I Gross Freight Revenue by Commodity in 2003.

Source: Association of American Railroads. 2004. Overview of U.S. Freight Railroads. http://www.nationalatlas.gov/articles/transportation/a_freightrr.html

The United States Global Change Research Program documents,

Prolonged heavy rainfall in the spring and summer of 1993 produced extensive flooding across nine states in the upper Midwest. The flood waters poured over and through many levees and inundated numerous floodplains that many of the key rail lines cross. The flood waters became an absolute barrier to surface transportation in the region for more than six weeks. Train traffic had to be rerouted around the flood area, resulting in long delays and large costs to manufacturing. Barges operating on the Mississippi River system, that includes the Ohio, Illinois, and Missouri Rivers, handle a large fraction of the country's bulk commodities, such as grain and coal. River barge traffic suffered a similar fate with the additional costs to shipping and manufacturing approaching $2 billion.

This came on the heels of the 1988 drought that also had a major impact on barge shipping due to low river levels, illustrating the sensitivity of transportation systems to both wet and dry climate extremes. (United States Global Change Research Program 2000)

Adaptation to climate change takes place through adjustments to reduce vulnerability or enhance resilience in response to observed or expected changes in climate and associated extreme weather events. Adaptation occurs in physical, ecological and human systems. It involves changes in social and environmental processes, perceptions of climate risk, practices and functions to reduce potential damages or to realize new opportunities. Adaptations include anticipatory and reactive actions, private and public initiatives, and can relate to projected changes in temperature and current climate variations and extremes that may be altered with climate change. Adaptations tend to be on-going processes, reflecting many factors or stresses, rather than discrete measures to address climate change specifically (Adger et al. 2007, 717-743).

Adaptation to environmental change is not a new concept. According to the EPA, "Human societies have shown throughout history a strong capacity for adapting to different climates and environmental changes. For example, farmers, foresters, civil engineers, and their supporting institutions have been forced to adapt to numerous challenges to overcome hardship to sustained productivity" (EPA 2009b).

Nevertheless, human society and the natural environment are not entirely protected against, nor perfectly adapted to, current climate variability and extreme weather events. Current economic losses from climate variations and extremes can be substantial. These losses indicate that society is vulnerable and that adaptation has not been sufficient to offset damages associated with current variations in climatic conditions.

Human-induced climate change represents a new challenge, and may require

adaptation approaches to changes that are potentially larger and faster than past experiences with recorded natural climatic variability. Furthermore, the IPCC concluded that "adaptation will be necessary to address impacts resulting from the warming which is already unavoidable due to past emissions" (EPA 2009a; Parry et al. 2007).

In unmanaged natural systems, adaptation is not planned but occurs when forced to do so. For example, as the climate warms, tree and animal species may migrate northward to remain in suitable climatic conditions and habitat (to the extent that human barriers, such as roads and cities, allow such migration). In human society, much of adaptation may be planned and undertaken by private decision makers and by public agencies or governments. For humans, adaptation is a risk-management strategy that has costs and is not foolproof. The effectiveness of any specific adaptation requires consideration of the expected value of the avoided damages against the costs of implementing the adaptation strategy (Easterling, Hurd, and Smith 2004; EPA 2009a).

Furthermore, adaptive capacity is uneven across and within societies. According to the EPA, "There are individuals and groups within all societies that have insufficient capacity to adapt to climate change, and high adaptive capacity does not necessarily translate into actions that reduce vulnerability. For example, despite a high capacity to adapt to heat stress through relatively inexpensive adaptations, residents in urban areas in some parts of the world continue to experience high levels of mortality" (EPA 2009a).

It's important to understand human impacts on the environment – both what's done to accelerate and decelerate (or perhaps even reverse) the tendency toward climate change.

Alternative fuels, greenhouse gas emission controls, and conservation efforts are worthwhile endeavors. In addition, we should prepare for the inevitable effects of abrupt climate change which will likely come regardless of human activity. According to an article by (Schwartz and Randall 2003), some preliminary recommendations to prepare the United States for abrupt climate change are:

> **1) Improve predictive climate models.** Further research should be conducted so more confidence can be placed in predictions about climate change. There needs to be a deeper understanding of the relationship between ocean patterns and climate change. This research should focus on historical, current, and predictive forces, and aim to further our understanding of abrupt climate change, how it may happen, and how we'll know it's occurring.
>
> **2) Assemble comprehensive predictive models of climate change impacts.** Substantial research should be done on the potential ecological, economic, social, and political impact of abrupt climate change. Sophisticated models and scenarios should be developed to anticipate possible local conditions. A system should be created to identify how climate change may impact the global distribution of social, economic, and political power. These analyses can be used to mitigate potential sources of conflict before they happen.
>
> **3) Create vulnerability metrics.** Metrics should be created to understand a country's vulnerability to the impacts of climate change. Metrics may include climatic impact on existing agricultural, water, and mineral resources; technical capability; social cohesion and adaptability.
>
> **4) Identify no-regrets strategies**. No-regrets strategies should be identified and implemented to ensure reliable access to food supply and water, and to ensure national security.
>
> **5) Rehearse adaptive responses.** Adaptive response teams should be established to address and prepare for inevitable climate driven events such as massive migration, disease and epidemics, and food and water supply shortages.
>
> **6) Explore local implications.** The first-order effects of climate change are local. While we can anticipate changes in pest prevalence and severity and changes in agricultural productivity, one has to look at very specific locations and conditions to know which pests are of concern, which crops and regions are vulnerable, and how severe impacts will be. Such studies should be undertaken, particularly in strategically important food producing regions.

> **7) Explore geo-engineering options that control the climate**. Today, it is easier to warm than to cool the climate, so it might be possible to add various gases, such as hydrofluorocarbons, to the atmosphere to offset the affects of cooling. Such actions, of course, would be studied carefully, as they have the potential to exacerbate conflicts among nations. (Schwartz and Randall 2003, 21-22)

It is quite plausible that within a decade the evidence of an imminent abrupt climate shift may become clear and reliable. It is also possible that our models will better enable us to predict the consequences. In that event the United States will need to take urgent action to prevent and mitigate some of the most significant impacts. Diplomatic action will be needed to minimize the likelihood of conflict in the most impacted areas. However, large population movements in this scenario are inevitable. Learning how to manage those populations, border tensions that arise and the resulting refugees will be critical. New forms of security agreements dealing specifically with energy, food and water will also be needed. The United States itself will be relatively better off and with more adaptive capacity.

CHAPTER 3

METHODOLOGY

The research method used for this study is qualitative. Qualitative research is the examination, analysis and interpretation of observations for the purpose of discovering underlying meanings and patterns of relationships, including classifications of types of phenomena, in a manner that does not involve mathematical models. Qualitative researchers aim to gather an in-depth understanding of human behavior and the reasons that govern such behavior. Qualitative researchers may use different approaches in collecting data. Some methods are the use of focus groups and key informant interviews. The focus group technique involves a moderator facilitating a small group discussion between selected individuals on a particular topic. This research method differs from quantitative research. Quantitative research refers to the systematic empirical investigation of social phenomena via statistical, mathematical or computational techniques. The objective of quantitative research is to develop and employ mathematical models and theories pertaining to phenomena.

Prior to the commencement of this research, approval was granted by an Institutional Review Board (IRB) (Appendix A). An IRB is a committee mandated by the National Research Act, to be established within each university or other institution that conducts biomedical or behavioral research involving human participants and receives federal funding for research involving human participants. The purpose of the IRB is to review all proposals

for human research before the research is conducted to determine whether the research plan has adequately included the ethical dimensions of the project. Humans must not be participants in research projects unless they are fully informed of the proposed procedures and voluntarily consent to the procedures. The IRB reviews all protocols for research using human subjects, weighing the ethical issues raised, assessing potential benefits against risks, the importance of the knowledge that may be gained, and assuring that appropriate recruitment and consent procedures are used. Any institutions not in compliance with the law may lose federal funding.

In order to initiate this research, multiple processes were established and accomplished. A consultant was hired to assist in developing research goals relating to the interaction between climate change and societal perceptions of risk, vulnerabilities and adaptation strategies; and to refine our knowledge about risk and uncertainty so that decision makers would better understand the immediate and local consequences of climate variability, policy and operational adaptations. The consultant assisted in identifying various economic sectors within the Kansas City metropolitan area. The sectors were selected for their importance in the Kansas City region: all had significant corporate presence, all were highly impacted by climatological change or were subject to likely regulatory and policy change. Stakeholders were then identified and recruited for each sector. Each stakeholder was chosen based on their local involvement in a particular sector and how climate change affects their professional, as well as personal lives. A question survey was developed for the sectors, and the same questions were asked to each of the stakeholders (Appendix B). A matrix of likely scenarios was prepared for each focus group. These scenarios were based on the region's

future; potential directions that our local economy, social structures and environment will take relative to climate change issues. The risks and mitigation strategies inherent in each scenario was assessed across a range of sectors. Information received provided a narrative of citizen specific perceived risks, opportunities, cost of living implications, public policy implications shaped by environmental justice and climate impact mitigation strategies, as well as pertinent case studies with an outline of the analysis and a narrative illustrating the range of likely adaptations by individuals and organizations (Appendix C). A moderator was selected to facilitate each panel discussion and ensure all topics were addressed. The panel discussions were audio-taped to ensure all information was captured. Afterwards, all stakeholder responses were transcribed from the audio tapes and the transcriptions were analyzed. The responses that correlated most with our research goals have been recorded in the Results section of this paper. In order to maintain regulations with the Institutional Review Board, all stakeholders remained anonymous.

Climate model outputs were utilized for research and decision support. Information was used from an article entitled, *Guidelines for Constructing Climate Scenarios*. According to the author, "In order to conduct impact research or to support adaptation planning, there is a need to select, treat, and combine the vast amount of climate model output into useful climate scenarios. Two questions are often asked: (1) How best can scientists understand and characterize uncertainty? (2) What are some key considerations when selecting and combining climate model outputs to generate scenarios? To condense the large number of model simulations into a small group of scenarios, it is logical to focus on simulations that seem more credible."

Since modeling efforts can be challenging, there are guidelines to assist researchers who plan to use climate model scenarios:

- Understand to which aspects of climate your problem or decision is most sensitive (e.g., which climate variables, which statistical measures of these variables, and at what space and time scales).
- Determine which climate projection information is most appropriate for the problem or decision (e.g., variables, scales in space and time).
- Understand the limitations of the method you select.
- Obtain climate projections based on as many simulations, representing as many models and emissions scenarios, as possible.
- It may be worth the effort to evaluate the relevant variables against observations, just to be cognizant of model biases, but recognize that most studies have found little or no difference in culling or weighting model outputs.
- Understand that regional climate projection uncertainty stems from uncertainties about (1) the drivers of change (e.g., greenhouse gases, aerosols), (2) the response of the climate system to those drivers, and (3) the future trajectory of natural variability.
- Use an ensemble to characterize consensus not only about the projected mean but also about the range and other aspects of variability.

These guidelines may assist researchers in creating and using climate scenarios in their research endeavors (Mote 2011, 257-58). Scenarios in our research were suggested as likely potentials relative to regional weather variability, projection of societal reactions to climate related disruption and local momentum to address the issue.

Kansas City's Climate Protection Plan, developed by the Environmental Management Commission, brought forth a variety of benefits for the city. Cities that take action to reduce greenhouse gases are saving millions of taxpayer dollars while boosting real estate values, attracting new jobs and businesses and improving livability. Investments in mass transit,

commitments to clean energy sources, healthier air quality, and new partnerships with the private sector all result in greater economic prosperity for residents. They make a city a cleaner, safer and more desirable place to live.

There are potential benefits associated with Kansas City's Climate Protection Plan including economic, air quality, forestry, and agricultural benefits. Economic benefits include a reduction in energy costs to households. Since this reduction is recognized by a certified rating system, it increases property values. Reduced energy costs also strengthen a lower cost of living. Reduced energy cost to businesses would have a similar effect and increase efforts to bring new business to Kansas City. Air quality benefits for the city include a reduction in emissions of air pollutants and decreased instances of respiratory diseases. There would also be a reduction in environmental costs associated with air pollution. Forestry benefits include a reduction in summer cooling costs through strategic tree planting and city wide reduction of the "urban heat island effect" reducing the cost of living for all Kansas Citians. This would lead to aesthetic benefits of tree planting programs in urban and suburban locations. Initiatives for biomass energy or carbon sequestration would lead to the promotion of sustainable forestry. And, there could be a reduction of urban runoff resulting in lower property damage, loss of life, and reduced pressure on stormwater systems. Agricultural benefits include a new potential source of income for farmers from the use of agricultural crops for biofuels such as methanol or biodiesel and bio-energy generating systems with rapidly renewable crops such as switch grass. Also, there would be a reduction in energy costs for farms through processing of livestock waste to produce power in

bioenergy generating systems (Kansas City Environmental Management Commission 2006, 17-18).

According to the City Manager and Chief Environmental Officer of Kansas City, Missouri, "Our view of sustainability incorporates green programs into a broader triple bottom line approach that simultaneously promotes social equity, economic vitality and environmental quality. It is a foundation that the Mayor, City Council and City management have identified as a top long-term priority in making Kansas City a national leader among local government efforts." City staff is responding to new initiatives to reduce greenhouse gas emissions, a long-term control plan for reducing sewer overflows with extensive green infrastructure, and a new development code to promote green solutions in land use and development. These new approaches will better serve the community and enhance the quality of life for residents. The City is prepared to be a municipal leader in sustainability and work with public and private sector stakeholders throughout the community to make Kansas City "America's Green Region" (City of Kansas City, Missouri 2006, 6).

The research conducted in our study was based on a resource-specific and placed-based vulnerability framework. The targeted focus groups and case studies were utilized to (1) gain a better understanding of the sensitivities of different goods, services, and practices within major social and economic sectors to current climate variability and hazards; (2) quantify the risk that the natural environment poses for citizen stakeholders, the business community and craft means to prepare for and adapt to the expected changes; (3) determine critical process/resource specific environmental thresholds or non-linearities that have particular economic implications by ranking vulnerabilities under different scenarios, and (4)

provide feedback to the political sector on actions that public and private sector resource managers must take to prepare for the climatological scenarios. The research accomplished the following:

- Refined methodologies for collection and analysis of local climate-related data, sector-based surveys, focus groups and facilitated community workshops.

- Concluding findings were envisioned on three dimensions:

    1. Direct socio-economic impacts resulting as a consequence of climate variability.
    2. Compelling, vivid, credible and divergent scenarios of near-term Kansas City futures. These were cross-correlated with select socio-economic population sectors.
    3. Sector-based categorization of socio-economic groups, each with prioritized concerns and points of opportunity relative to climate change.

- To the greatest extent possible, the research concluded with tools that were particularly applicable and tailored for each of the sectors.

- Organized a variety of public presentations of findings and tools for professional organizations, governments and civic groups.

- Publication of methodologies and tools to inform of similar efforts in other metropolitan areas and further the science of regional climatology.

This research provided Kansas City area officials, business leaders and interested citizens a powerful decision making tool and methodologies – shaped by local data and public engagement processes – to inform their planning, assess the risks that climate change poses to their organizations, prioritize effective risk management approaches for their sectors and suggest carbon footprint reduction strategies tailored as much as possible to their individual needs and concerns.

CHAPTER 4

STAKEHOLDER RESULTS

Agriculture

Many stakeholders in the agricultural sector are still seeking the resolution of scientific issues concerning the magnitude of climate change and its impact on their businesses and well-being. Farmers are uncertain whether to begin implementing adaptation practices in response to the uncertain climatic future, which can incur high costs, or to choose to continue their 'business-as-usual' principle and run the risk of leaving future generations unprepared when the changes materialize. A clear-cut answer may not be readily available to farmers, at least for the next decade, but improving our scientific knowledge on the agronomic and ecological effects of climate change, and on the ability of humans and ecosystems to adapt, might reduce the uncertainty and help formulate better policy.

A general consensus among agricultural stakeholders interviewed all agree that agriculture is totally dependent on climate and those variations in annual climate, whether anthropogenic in nature or not, do have direct and large impacts on the agricultural sector and have potential to impact global, as well as regional economies. Part of the stakeholders' uncertainty about the causes and significance of climate change may stem from limited knowledge of climate-related research. Several stakeholders indicated that they were

dissatisfied with climate change information provided by main-stream media sources like newspapers, websites, and radio and television broadcasts. These were identified as some of the stakeholders' main sources of climate information, and some felt that the information these sources provide is not based on sound scientific research, but instead is biased by certain economic and political agendas. The stakeholders also identified their personal networks of other farmers and agricultural workers as a source of information on climate variability.

Stakeholders described their knowledge of and experiences with climate variability and extreme weather events in the past. One stakeholder mentioned the Dust Bowl of the 1930s as the quintessential example of an extreme climate event and its devastating impact on agricultural production. Stakeholders also discussed the flood of 1993 and its effect on the local agricultural sector. The adaptations that were implemented to cope with the effects of the '93 flood were described as temporary; members of the agricultural sector had to change many of their practices in that year to keep their operations running, but as floodwaters receded they returned to their previous methods of operation. No lasting long-term adaptations to flooding events were mentioned by any of the stakeholders. The general consensus here is that farmers or agricultural stakeholders in the area believe climate variability rather than climate change to be more important in planning their farm activities.

Several of the stakeholders reported that they have seen an increase in climate variability and in the number and intensity of extreme weather events (such as severe thunderstorms and flooding) over the past few years. They also noted that over the past few

years the spring season has been cooler than normal. Other potential impacts of cooler and wetter conditions include the appearance of different types of insect and weed pests, root rot, and fungus. These factors can reduce crop yields and also increase operating costs on farms as farmers may need to apply more herbicides and insecticides to prevent further crop losses. Increases in severe rainfall events may also lead to increased soil erosion due to runoff which can affect soil fertility.

Stakeholders acknowledged that agricultural operations are a significant contributor to greenhouse gas emissions. Methane and carbon emissions come from cattle operations, land cover changes, fossil fuel burning in farm equipment, and the processing and distribution of agricultural outputs. Some of the stakeholders indicated that they had already been taking steps to reduce emissions from their farms, and that they were committed to more sustainable and carbon-neutral farming practices. There are a wide variety of strategies that can be implemented to reduce agricultural emissions, and unlike climate adaptation strategies, many of these can be practiced on small or large-scale farms alike. No-till farming may be practiced on small and large farms for a wide range of crops.

None of the stakeholders seemed to have any definite plans for the future regarding the possible effects of climate change on their operations. They reiterated the fact that farmers are used to dealing with variability in climate conditions across seasons and years. It would likely take many consecutive years of the same extreme climate conditions before farmers started to worry about the future of their farms. Climate variability they have observed thus far does not seem to indicate to them a directional shift in climate conditions

that would warrant significant changes in the way they do business. Furthermore, a lack of specific knowledge as to how and to what extent climate change will impact their business makes planning for the future more difficult.

The overall outcome of this research provides us with valuable insight into perceptions of climate change in the agricultural sector and vulnerabilities to climate effects. There is a need for more locally oriented climate research to explore likely future climate scenarios and to assess the particular vulnerabilities of the agricultural sector in the Kansas City area. Such research could provide ideas to local farmers on how to adapt to climate variability. The results reiterate the need for more work to be done in disseminating and interpreting climate information to users. Surprisingly, even as the IPCC and some other notable climate scientists widely declared that climate change is now unequivocal, most of the stakeholders are still skeptical. Farmers and other stakeholders are expected to continue to explore ways to effectively adapt and cope with the attributes of the changing climate rather than continue to question its reality.

Transportation

Transportation sources in the U.S. account for nearly a third of our nation's greenhouse gas (GHG) emissions, and are rising faster than in any other sector. It is critical that an effective climate change policy for the U.S. address these emissions. The U.S. is the owner of the world's largest transportation system, and reducing emissions from this system is critical to an effective GHG reduction strategy.

Climate change will affect transportation primarily through increases in several types of weather and climate extremes. Climate warming over the next 50 to 100 years will be

manifested by rising sea levels coupled with storm surges and land subsidence, increases in very hot days and heat waves, increases in Arctic temperatures, more frequent intense precipitation events, and increases in the intensity of strong hurricanes. The impacts will vary by mode of transportation and region of the country, but they will be widespread and costly in both human and economic terms and will require significant changes in the planning, design, construction, operation, and maintenance of transportation systems.

The past several decades of historical regional climate patterns commonly used by transportation planners to guide their operations and investments may no longer be a reliable guide for future plans. In particular, future climate will include new classes (in terms of magnitude and frequency) of weather and climate extremes, such as record rainfall and record heat waves, not experienced in modern times as human-induced changes are superimposed on the natural variability of the climate.

Stakeholders for the transportation sector are all aware of climate change. Although the media believes that transportation plays a big role in the contribution of carbon dioxide, all of the stakeholders interviewed say they are doing their best to reduce their carbon footprint. Their definition of climate change tends to be an idea of warming or cooling of the weather. They rely on media to get any information regarding climate or global warming. The stakeholders feel they are vulnerable to future climate change because this can and does indirectly affect their transportation businesses. All of the stakeholders agree that governmental agencies should react to climate change issues. Energy reform and a need for more environmentally-friendly vehicles could be a start. They all mentioned that it is not

only the transportation industries that should do something, but also everyone should play a role in reducing their carbon footprint. Most stakeholders said in order to tackle the problem of climate change in Kansas City, there has to be a need to curb uncontrolled growth in every sector, to increase energy efficiency, to find a source of alternative fuel, and to create an overall awareness among everyone regarding climate change. State, region, and local areas should act as 'laboratories' to allow for social learning across geography and time. Plans should include specific goals for emissions reductions from all sectors. Actions should describe politically acceptable and technologically feasible programs and policies, while specific enough to estimate emissions reductions.

Transportation sector emissions are relatively difficult to reduce and also difficult to forecast. Vehicle technology improvements and emissions standards are most promising, while fuel conversion to low-carbon intensity bio-fuels (i.e. bio-diesel and ethanol) may be relatively promising. Freight, aviation, shipping and high speed rail also deserve further analysis. The stakeholders agree that state governments are taking the lead; however, they think local governments have limited authority.

Health

Climate change can have devastating effects on regional and local scale populations around the world. With the concern that many people may be impacted by the events, it is imperative for individuals within a multitude of sectors be aware of the changes that the climate could have on the quality of life for their community. Disease, asthma and allergies, and consumption of food and water are some of the areas of study that are increasingly threatening our health due to climate change.

Stakeholders within the health sector are important for both obtaining information on what has or will be considered regarding the impacts of population health in Kansas City. They have the ability to provide remediation efforts necessary to combat likely impacts. Given how large the metropolitan area is, it is important that stakeholders from several different counties are considered when determining what must be done to aid the mitigation effort in the case of extreme and prolonged climatic variation.

Based on stakeholders' responses, it appears clear that they are all aware of the importance of climate-related health risks and the need to mitigate this issue. It is clear through previous research that efforts must be made to further reduce carbon dioxide emissions in order to preserve natural environments and to ensure a brighter future. Government policies should consider mandating fewer emissions from industrial plants. Furthermore, education of climate change and its impacts should be readily given to the public on a regular basis. The biggest problem is that many people within a city may be aware of some dangers associated with climate change, but do not see the full picture. Many people may not even know of councils or committees within their own community specially formatted to discuss this topic. Publicly advertising these meetings and announcing that they are open to the public may peak more interest in the mitigation effort. Health professionals should be notified of such meetings and the government should contribute by readily providing incentives to those willing to make a change in their lifestyles. For example, the recent tax credits supplied to those purchasing hybrid cars is merely a stepping stone for further accommodations necessary to make the public more interested and involved. By

expanding such practices, people and stakeholders alike will be able to take action and produce a healthier tomorrow.

Water

Water is essential to all life forms. Water is a key component of the earth's climate and could be highly affected by many possible changes associated with climate change. Due to the high importance of water there are controls on water at the federal, state, local, and private organization levels. While these organizations control the water sector every individual has a stake in it. Water is used for drinking water, recreation, in many product production processes, and many other areas that affect us daily. In the Kansas City metropolitan area there are many different organizations that represent the water sector, from large businesses and government agencies to the individual residential water user.

An understanding of the Kansas City metropolitan area is important in recognizing the possible outcomes of climate change. Kansas City has a particular dependence on river systems just like many other major cities. The Kansas City area is the meeting point of two major rivers, the Kansas and Missouri Rivers. Much of the city's water supply, as well as other important aspects, depend on the river systems in Kansas City. Agriculture is also of particular interest. There are large agricultural areas surrounding the Kansas City metropolitan area, which consists of a large population core spread throughout a fifteen-county area. The area contains many different water supply districts from large cities to small rural communities that use groundwater wells to supply the local populations' water needs.

Since water is essential to all life forms, the water sector has many different levels of stakeholders including drinking water, wastewater, and storm water management. These stakeholders will feel the direct impact of climate events in many ways and plays a key role in the water sector.

All stakeholders agree that extreme climate events in the past put stress on the available water supply, especially in times of drought. They also agree that past flooding events had damaged property managed by the stakeholders which jeopardized the drinking water supply for many people. During the flood of 1993, when the levies on the river failed, some wells were flooded and damaged. Water distribution lines and sewer collection lines as well as water treatment facilities that were near the river were also damaged.

In response to increased water demand caused by drought or heat waves, water consumption has been restricted in the past. This decreased the daily demand of drinking water allowing the water systems to produce enough water to meet their customers' demand. They also interconnected with other systems that have a surplus water supply to help meet their supply needs. During past extreme climate events a combination of the two solutions has been applied in many circumstances.

The stakeholder responses give insight into how the water sector plans and reacts to climate events. The stakeholders said that the extreme weather events, such as droughts and floods along with population growth, are main factors to take into consideration in terms of planning. While drought and flood events are important, population growth estimates have a bigger role. The water sector is continually renovating its infrastructure to keep up with

increased demand due to population growth. The sector will forecast water use, wastewater generation, and storm water runoff potentials under possible population growth to properly plan for it.

The stakeholders do believe that climate change is occurring and that the earth is warming due to human actions. However, they believe the water sector will not feel any direct impacts from climate change. One of the participants even said, "The water isn't going away." They felt that population changes and land use changes would have a much greater impact on the water sector than climate change would.

This is an example of society's vulnerability toward climate change. Climate change does affect our water resources. Freshwater resources are highly sensitive to variations in weather and climate. The changes in global climate that are occurring as a result of the accumulation of greenhouse gases in the atmosphere will affect patterns of freshwater availability and will alter the frequencies of floods and droughts. Climate model simulations and other analyses suggest that total flows, probabilities of extreme high or low flow conditions, seasonal runoff regimes, groundwater-surface water interactions and water quality characteristics could all be significantly affected by climate change over the course of the coming decades. According to the Climate Institute, "Water scarcity is expected to become an ever-increasing problem in the future, for various reasons. First, the distribution of precipitation in space and time is very uneven, leading to tremendous temporal variability in water resources worldwide. Second, the rate of evaporation varies a great deal, depending on temperature and relative humidity, which impacts the amount of water available to

replenish groundwater supplies. The combination of shorter duration but more intense rainfall (meaning more runoff and less infiltration) combined with increased evapo-transpiration and increased irrigation is expected to lead to groundwater depletion" (Climate Institute 2007). Therefore, it is wise to begin planning for changes that can be foreseen and to build resilience to deal effectively with the increased uncertainty arising from the potential impacts of climate change.

Energy

Energy is a necessity in the American lifestyle and encompasses all the conveniences people have come to enjoy and use at home, at work, and in recreational activities. With such a broad definition and heavy dependency, any potential changes affecting this sector are extremely important to understand. Electricity, natural gas, propane, nuclear, and renewable resources are all used in the Midwest. These energy generators have potential risks and opportunities from climate change. For example, if the average temperature were to rise we could expect an increased demand for electricity and a decrease in the use of natural gas.

Kansas City, Missouri, is home to nearly 500,000 people. The larger fifteen-county metropolitan area is comprised of over 120 cities and more than two million people (Figure 4). Kansas City, Missouri is a regional transportation and financial hub. Within the metro-politan area in nearby Kansas, Overland Park, Kansas City-Kansas, and Olathe are the second, third, and fifth most populous cities in Kansas, while in Missouri, Kansas City-Missouri, Independence, and Lee's Summit are the second, fourth, and sixth most populous cities in the state.

Figure 4. Map of the Greater Kansas City Metropolitan Area.

Source: Ingram's Online. 2006-2007. http://www.ingramsonline.com/dkc2/images/kcmap.gif (accessed September 26, 2011).

Over the next twenty years, the metropolitan population is projected to expand by 32% above year 2000 levels, according to the Mid-America Regional Council (MARC 2011). This population growth coincides with projected increases in extreme weather, which also raises the risk of property damage and weather-related deaths.

Electricity is the main energy source used in the Midwest, and the Midwest has the

lowest average electricity cost in the country. Coal-fired power plants, renewable wind resources, nuclear, and even oil all contribute to the large consumer demand for electricity. Coal is the cheapest fuel to mine and transport to power plants. The emissions from coal-fired power plants have far-reaching impacts on down-wind environments and health. Unfortunately, the majority of power production in Missouri and Kansas are coal-fired power plants. Other than the electricity generated from burning coal, other types of energy providers all could expect expansion with new renewable energy initiatives in the Obama administration.

Stakeholders such as Missouri Gas Energy and Kansas City Power and Light offered their assistance and opinions on climate change and where it could potentially cause problems or benefits down the road.

Kansas City Power and Light (KCP&L) services some 800,000 customers in over 18,000 square miles with about 25,000 miles of distribution lines and 3,300 miles of transmission lines. They have 26 generating units and 10 peaking power plants to keep up with operations and the need for power in the regional Kansas City area. Last year, they reported earnings of $2.67 billion dollars, making them the largest economic stakeholder in this study. KCP&L is working to reduce emissions over the long-term while keeping energy prices low for consumers. It will take time to move from old technologies to new, more efficient technologies. We need to move away from fossil fuels over the long term. Coal will not cease to be a vital resource any time soon; it's also an abundant natural resource. We can take all of the pollutants out of generation (referring to electricity generation from

coal). Ultimately, using coal becomes a carbon issue. The Midwest has some of the cheapest electricity in the United States, but that could change. The Midwest has affordable electricity because the assets have been paid off by local consumers. Coal-fired power plants have life spans of 30-40 years, and are built with the assumption that they'll be paid off by the 25th year. Most of the power plants in the Midwest are over 30 years, so they're paid off and consumers have to pay only for the plant's operational costs and fuel, not their construction costs. KCP&L does yearly planning for extreme weather using historical weather data from the past several decades. Extreme weather does and will affect the company's operations, but contingency plans are in place to handle those events.

Heat waves affect demand and stress the system. When the region experiences five to eight days over 105 °F, heat stress builds up. Basically, there is only a limited amount of redundancy or excess capacity in the system. That excess capacity is in place in case one of the several power plants have to close due to maintenance or an accident. During heat waves, all of the excess capacity is used to keep up with demand, so if a power plant does have to go off line temporarily, there may be power shortages. KCP&L does plan for these events though, and historical temperature data are analyzed along with generation capacity to make sure that there is enough electricity even in a worst-case scenario. Droughts have never affected operations, but KCP&L always keeps an eye on the level of the Missouri River. Water is used to cool the power plants. The only plant that could be affected by a drought would be the plant on the Missouri, but there are plans in place in case the river does drop below the intake pipes. Fortunately, snowfall has been good for the last 6-7 years on the

upper Missouri River basin. Ice storms do affect electricity distribution, and that is an issue each year. In 1993, the Iatan plant was shut down for a short time due to flooding. The redundancy in the system picked up the slack. KCP&L forecasts the peak demand using empirical data and projections. They also have implemented demand reduction policies to reduce demand on peak use days, and are also interested in increasing energy efficiency in Kansas City and will continue to link up with other weatherization programs.

Missouri Gas Energy (MGE) is a natural gas company located in Kansas City with other facilities in the surrounding counties serving over 500,000 customers. It is a division of Southern Union Company which is the provider involved in transportation, gathering, storage, and processing the gas. According to its website, natural gas used for heating can help reduce greenhouse gas emissions, acid rain, smog, and water pollution versus electricity produced from coal, due to it being the cleanest burning fossil fuel. MGE considers climate change to be irrefutable. Customers need to be efficient; MGE is becoming more efficient.

Natural gas is one of the cleanest fossil fuels. The federal government could let companies drill for natural gas in coastal regions that are currently off limits. Currently, drilling for oil is allowed only off the coast of Louisiana and Texas. There are undoubtedly areas within the U.S. that could be drilled for oil or natural gas but those areas are probably minimally productive or are cost-prohibitive. If all the resources in the Gulf were tapped, there would be more natural gas, which would make it more affordable for customers as well as limit the use of dirtier fossil fuels such as coal. Missouri gets 85% of its electricity from coal, making it the 5th largest polluting state in the union. To become more efficient, MGE

has encouraged recycling at all of its facilities. They are building a new service center that will be LEED certified. They also have installed GPS devices in their vehicles to increase fuel efficiency.

Land Use

On a local scale, leapfrog development is a problem in the land use sector. Kansas City has allowed "big box" retail to proliferate and expand so that the city has sprawled out further and further away from its center. This sprawl also forces some existing farmers to convert their land to commercial or residential use, which leads to a decrease in local food supplies.

The flooding of Brush Creek was a repetitive event that all the stakeholders discussed. They listed the floods from 1951, 1977, and 1998 as all being major incidents. Such floods will get only worse in time. Though there were improvements made to the Brush Creek waterway after the flood of 1998, like the rebuilding of the Prospect Bridge and the removal of another bridge, it will still flood periodically. The flood of 1951 was a significant weather event because it closed the meat packing and stock yard businesses permanently. This event dramatically impacted the land use and economy of Kansas City. The implementation of reservoirs and dykes on the Missouri River resulted in the elimination of large barge traffic across the entire river system. The transportation of fiber, fuel, and food then had to depend on trains and trucks.

Along with freezes and urban flooding in Kansas City, another weather occurrence observed is less snow pack in western Kansas. There is less precipitation than in previous

years and the snow is falling later in the year and melting earlier. This results in less surface water and the inability of groundwater aquifers to recharge. These effects could cause the type of land use there to change from irrigated agriculture to dry farming or wind farms, and these climate changes may lead to droughts. As the climate continues to change in this region, land use planning will also evolve. Land use planning has adapted to known events and tries to anticipate the more intense weather that could be associated with climate change.

Mitigation practices in any city or community are vital to the well-being of its citizens and overall viability of its economic survival. Each of the stakeholders brought to the table information that should be implemented or is currently under discussion in Kansas City. Since the stakeholders were from different surrounding counties, they looked at mitigation from their counties first and then were able to show the linkage to other areas of the Kansas City area.

One point that was clear from all stakeholders is that the development in floodplains has to be stopped permanently. The main reason for building on floodplain lands is because they are generally level and next to a water source. For developers, this is prime land for building, but we need to heed the reason it has been designated as a floodplain. Kansas City has already passed ordinances to no longer build on floodplains, but many counties still build in these areas, which lead to flooding and devastation of whole towns and communities. One example of this was the 1993 Midwest Floods that occurred due to high levels of precipitation over many consecutive days. Some cities had mitigation plans in place for floods, but because these plans are an inconsistent practice across the state, there were areas

that did no mitigation planning. These areas flooded, causing more water to move through the waterways, putting additional pressure on levees, which eventually gave way. Mitigation practices should be a necessity throughout all communities and not just a selected group of cities.

We have to evaluate how our land is being used currently and then move to smarter and more sustainable decisions. Currently, our park lands are at risk and agricultural land is being consumed by suburban sprawl. The urbanization of prime agricultural land was viewed as rational, creative, safe, and affordable for fast-track development. Rational and creative reuse of land that has existing infrastructure can assist in the support of development that does not consume agricultural land and can make the energy grid more efficient. The more spread out the grid is, the more energy is lost. We need to find a way to change how we view energy and the environment. Possibilities for these changes would be to implement changes in our tax system that would include carbon taxes, increased water taxes for high use, property tax based on the square footage of a house, and vehicle registration fees based on mileage driven and gas efficiency.

Commerce

The effects of climate change on commerce are another important topic. Here in the Midwest, business enterprises are the backbone of the economy and often times represent American ingenuity. The void of empirical research that exists presents a unique opportunity for researchers to engage in and consider the effects of climate change on small businesses in particular. It is vital to gain some understanding on the effects of climate change on small businesses, particularly in the Kansas City metropolitan area.

Small and medium size businesses are the main drivers of innovation, diversity and job creation, and they are the most vulnerable to the impacts of climate change. Even without climate change, it is difficult for small businesses to survive. Many small businesses have yet to take the threat posed by climate change seriously. There is little support from governmental institutions for small enterprises that are the centers of social cohesion. Certain risks such as floods, rising temperature, and rising costs associated with climate dependent variables make small and medium sized enterprises more vulnerable. With respect to floods, small businesses are often underinsured and are thus ill prepared to deal with the possibility of increased floods that are bound to occur with climate change. Rising temperatures require that more green buildings are constructed and this is also a challenge for small businesses given the initial costs that come along with green building.

Perhaps the easiest and most effective place to start in regards to energy projects is on the local/regional level. It is crucial to focus on the local programs and policies. Regional governments should still be involved, and should act as a mediator, but local governments should be the leaders of such efforts. Local climate policy is generally easier to sell because citizens can begin to see the effects quicker and start to benefit from the results on a more individual basis. It is also easier to make it a joint endeavor that encompasses corporations as well as small and medium businesses throughout a community. It is important to continue to educate and help businesses integrate the concept of sustainable energy. Local government involvement is necessary because it has policy instruments as well as the means to implement them. It also has intimate insights and connections with local citizens and businesses.

Local small business owners often think, sometimes deeply, about the climate and its effects on their enterprises. They also acknowledge the importance of further education on the issue. Focus group analysis revealed a more positive attitude towards green initiatives. Focus group participants were more conscious of climate change and easily made connections between this phenomena and their business. They suggested that the small business community is beginning to realize, not only the benefits, but also to observe opportunities that are available for small business owners who choose to be good stewards. In one participant's words, "people want to be associated with green companies. It can be a great marketing tool."

Future research must look at specific businesses to tease out how they perceive climate change and their vulnerabilities as well as coping mechanisms. Research should also inquire as to the role the government can play to encourage and stimulate local small businesses to adopt green initiatives across the country, starting at the local level.

CHAPTER 5

DISCUSSION

Many stakeholders in the agricultural sector were still seeking the resolution of scientific issues concerning the magnitude of climate change and its impact on their businesses and well-being. As one farmer said, "We are an adaptable bunch." Economic impacts from climate change are much slower in developing than business ability to adapt profitably to those changes. Even migration of affluent populations to more hospitable cities is more rapid than climate change. Innovation in a changing world and competitive advantage develop quickly. Effective and profitable adaptation to change is the art of running a financially sustainable business. Adaptation is always personal and tied to a unique set of factors. Adaptation is tactical – not strategic in a way that impacts the system – and on a widespread basis aggregated adaptations may increase human-caused climate change impacts if they are not sufficiently balanced by humankind's natural empathy and inclination to "do the right thing." A clear-cut answer may not be readily available to farmers, at least for the next decade, but improving our scientific knowledge on the agronomic and ecological effects of climate change, and on the ability of humans and ecosystems to adapt, might reduce the uncertainty and help formulate better policy.

Stakeholders for the transportation sector were all aware of climate change. Although the media suggests that transportation plays a big role in the contribution of carbon dioxide; all of the stakeholders interviewed said they are doing their best to reduce their carbon footprint. Their definition of climate change tended to be an idea of warming or cooling of the weather. They relied on media to get any information regarding climate or global warming. The stakeholders thought that they are vulnerable to future climate change because this can and does indirectly affect their transportation businesses. Many believed it is their social responsibility to do the right thing and one participant considered climate change to be one of the greatest challenges to human existence by stating, "The problem is so huge and the degree of adaptation that society and our economy need to implement at all levels is so great, we definitely need to take the small steps towards the big steps when looking at climate change." All of the stakeholders agreed that governmental agencies should address climate change issues. They all mentioned that it is not only the transportation industries that should do something, but everyone should play a role in reducing their carbon footprint. Most stakeholders said in order to tackle the problem of climate change in Kansas City, there has to be a need to curb uncontrolled growth in every sector; increase energy efficiency; find a source of alternative fuel; and create an overall awareness among everyone regarding climate change. State, region, and local areas should act as 'laboratories' to allow for social learning across geography and time. Plans should include specific goals for emissions reductions from all sectors. The stakeholders agreed that state governments are taking the lead; however, they believed that local governments, although active, have limited authority.

The stakeholders with the healthcare sector were all aware of the importance of climate-related health risks and the need to mitigate this issue. They all shared a concern for public health, especially the health and well-being of children. Many stakeholders viewed climate change as a 'business case' for reducing the public health burden on the economy. They agreed that many in our society will insulate their family behind air conditioners, medical treatment, and preferential suburban planning. Unfortunately, this leaves the most vulnerable in society to suffer the bulk of climate change impacts. The stakeholders agree it is clear, through previous research, that efforts must be made to further reduce carbon dioxide emissions in order to preserve natural environments and to lead to a brighter future. Government policies should consider mandating fewer emissions from industrial plants. Climate change can have devastating effects on regional and local scale populations around the world. With the concern that many people may be impacted by the events, it is imperative for individuals in a multitude of sectors be aware of the changes that the climate could have on the quality of life for their community. Disease, asthma and allergies, and consumption of food and water are some of the areas of study that are increasingly threatening our health due to climate change. Furthermore, education on climate change and its impacts should be provided to the public on a regular basis. The stakeholders agreed, by expanding such practices, our society will be able to take action and produce a healthier future.

All stakeholders from the water sector concurred that extreme climate events in the past put stress on the available water supply, especially in times of drought. They also

agreed that past flooding events had damaged property managed by the stakeholders, which jeopardized the drinking water supply for many people. The stakeholder responses give insight into how the water sector plans and reacts to climate events. The stakeholders said that the extreme weather events, such as droughts and floods along with population growth, are the main factors to take into consideration in terms of planning. One participant thought that energy is a direct connection to climate change issues, "We're a huge user of energy to do what we do by pumping and treating water, sending it out, bringing it back and treating it. So by using water, energy is a direct connection to climate change issues. So everyone everywhere needs to try and find ways to reduce the amount of water consumed, and be efficient about what they are using." Other stakeholders agreed with this statement and included there is a lack of conservation knowledge.

The stakeholders for the energy sector all agreed that climate change issues are economically driven. Examples used ranged from should we buy dirty coal power or clean renewable energy, and it's all about whether or not climate change legislation will happen or not. One stakeholder believed that ultimately climate change decisions are going to be made for economic reasons. Even the major global decisions are made based on economic reasons. However, there is a societal increase in the sensitivity and awareness of global climate change impacts and that probably is an indication that climate change is more understood. One stakeholder revealed that although climate change may not be understood by many, the rising cost of fossil fuels is felt:

> I think there is public detachment out there. The public feels it's something out there that they read about in the newspapers and a lot of times it is difficult to understand. They feel detached from the issue. However, if you talk about energy crisis, they are not detached about that, they understand that. They understand when they go to the

> gas pump and pay $3.50 a gallon, or they get their energy bill and it says you received a rate increase this month.

Stakeholders believed energy customers need to be more efficient, and that energy companies are becoming more efficient. To become more efficient, energy companies have encouraged recycling at all of their facilities. They also have installed GPS devices in their vehicles to increase efficiency.

All land use stakeholders agree that climate change is occurring, and it is evident that climate change issues have existed for over a decade:

> Changes occurring in our oceans are a good example. These changes were slow to evolve because of their vast sizes. Due to the slow reaction of the oceans, it makes it even more of a dramatic change. Other changes taking place in the oceans, such as temperature change is also climate related. The body of evidence supports a recent, unprecedented rise in carbon dioxide levels and average global temperature.

On a local scale, leapfrog development is another problem in the land use sector. Kansas City has allowed "big box" retail to proliferate and expand so that the city has sprawled outward further and further. This expansion also forces some existing farms to convert their land to commercial or residential use, which decreases the local food supply. Along with freezes and urban flooding in Kansas City, less snow pack in western Kansas was also mentioned:

> There is less precipitation than in previous years and the snow is falling later in the year and melting earlier. This results in less surface water and the inability of groundwater aquifers to recharge. These effects could cause the type of land use there to change from agriculture to wind farms, and these climate changes may lead to droughts.

As the climate continues to change in this region, land use planning will also evolve. Land use planning has adapted to known events and tries to anticipate the more intense weather that could be associated with climate change. Many stakeholders agree,

> We have to evaluate how our land is being used currently and then move to smarter and more sustainable decisions. Rational and creative reuse of land that has existing infrastructure can assist in the support of development that does not consume agricultural land and can make the energy grid more efficient. The more spread out the grid is, the more energy is lost. We need to find a way to change how we view energy and the environment. Possibilities for these changes would be to implement changes in our tax system that would include carbon taxes, increased water taxes for high use, property tax based on the square footage of a house, and vehicle registration fees based on mileage driven and gas efficiency.

Stakeholders agree we are all starting to make the connection between a healthy environment and healthy people. "We are starting to value the environment differently. Water is really coming on strong and people are beginning to understand that we have to change the way we treat our water systems. There is a growing knowledge that there is a direct relationship between our health and how we treat the environment."

Many stakeholders from the commerce sector feel small businesses have yet to take the threat posed by climate change seriously. There is little support from governmental institutions for small enterprises that are the centers of social cohesion. Certain risks such as floods, rising temperature, and rising costs associated with climate dependent variables make small and medium-sized enterprises more vulnerable. It is crucial to focus on the local programs and policies. Regional governments should still be involved, and should act as a mediator, but local governments should be the leaders of such efforts. Local climate policy is generally easier to sell because citizens can begin to see the effects quicker and start to benefit from the results on a more individual basis. It is also easier to make it a joint endeavor that encompasses corporations as well as small and medium businesses throughout a community. It is important to continue to educate and help businesses integrate the concept

of sustainable energy. Involvement of local government is necessary because they have policy instruments as well as the means to implement them. They also have intimate insights and connections with local citizens and businesses. Many stakeholders also thought climate change is economically driven. In their organizations, no one is really talking about climate change impacts. It is more of a pragmatic approach. They recognize resources are scarce and they are going to get even scarcer. They are concentrated on using resources more effectively and efficiently, while focusing on cost effectiveness. Stakeholders considered diversity of opinion and a wide political spectrum to be a good thing. They will help one develop a pragmatic approach and the basic motivations in a sense. Organizations are going green, not necessarily that they framed it as combating climate change, but that employee loyalty is higher, retention is higher, and employees are more satisfied in the workplace. They see positive, direct impacts to the business from that effort, regardless of where people are on the ideological spectrum.

The input from each focus group provided an extensive background on how each stakeholder views climate change, along with perceptions of risk, vulnerabilities, and adaptation practices. This information proved vital in comprehending the effects of climate change for each stakeholder. The use of sector-based survey questions and a matrix of likely scenarios brought forth compelling results as a consequence of climate variability. These results allowed the researchers and stakeholders to view climate change on a local level and its association with the regional economy. This also led to sector-based categorization of socio-economic groups, each with prioritized concerns and points of opportunity relative to

climate change. The targeted focus groups and case studies created a better understanding of the sensitivities of different goods, services, and practices within major social and economic sectors to current climate variability and hazards. The studies quantified the risk that the natural environment poses for citizen stakeholders, the business community and crafted means to prepare for and adapt to the expected changes, as well as provided feedback to public and private sector resource managers on actions they must take to prepare for the climatological scenarios.

Regarding the research hypothesis, climate change does present new opportunities and risks that will affect all sectors of the regional economy. The overall study presented new challenges and opportunities to stakeholders and provided better knowledge on climate change and its effects. All positive actions that local stakeholders will take, relating to their perceptions of risk, vulnerabilities, and adaptation practices toward climate change and its effects, will improve the resilience of Kansas City's economic health and continued competitive advantage. Based on the results of the study, the stated hypothesis has been proved.

CHAPTER 6

CONCLUSION

Information available today on climate change is confusing. What useful information do area business leaders and policy makers have regarding climate change impacts in the Kansas City region? What is the truth behind opposing sides in the debate over climate change legislation? Is sea level rise or polar ice melt a problem for Kansas City? Precisely how is the climate expected to change in the Midwest? What will it mean in our lives? These are just some of the many questions people think about regarding climate change issues. News media of all stripes have picked up the story. There are innumerable sources of information available to us. Most appear to be stirring the same stew of assertions based on global climate data. It is very difficult to know how to focus on primary authoritative information sources. We are information rich and knowledge poor regarding climate change here, close to home. All climate science today is derived from global data. Wide variations of climate change impacts are known to exist, but scientifically supported expectations of those regional variations are largely unknown.

Climate change can have devastating effects on regional and local scale populations around the world. With the concern that many people may be impacted by the events, it is

imperative for individuals in a multitude of sectors be aware of the changes that the climate could have on the quality of life for their community. Increasingly there is a demand to convene negotiating groups to reach consensus on solutions to community problems. These groups are made up of stakeholders – those segments of the community that are affected by or have a stake in the decision. Involvement in the community problem-solving processes is important for several reasons. It can assure that the decision addresses as many different stakeholder interests as possible. Involvement can increase the probability of a creative outcome, build broad-based support for the decision made by the negotiating group, and facilitate implementation of the decision. Meetings can be held by organizations, such as neighborhood association groups, churches, and non-profit centers. These meetings can educate community members on climate change and its effects, and provide information on environmental awareness. For example, community-based activities can be performed, such as tree planting events, additional recycling efforts, and carbon dioxide emission reduction strategies. Neighborhood association groups are interested in these topics and activities because it promotes better living conditions within its sector. Education of climate change and its impacts should be readily given to the public on a regular basis. Many people may not even know of councils or committees within their own community specially formatted to discuss this topic. Publicly advertising these meetings and announcing that they are open to the public may peak more interest in the mitigation effort. Without adequate education on the topic and more public intervention, individual action will remain at a minimum. Also, improving our scientific knowledge on the effects of climate change, and on the ability of

humans and ecosystems to adapt, might reduce the uncertainty and help formulate better policy.

As mentioned earlier, a matrix of likely scenarios was used in this study to gain insight on how each stakeholder viewed climate change on a regional scale. The stakeholders provided a narrative of scenario-specific perceived risks, vulnerabilities, and adaptation implications. Each scenario suggested likely potentials relative to regional weather variability, projection of societal reactions to climate related disruption and local momentum to address the issue. A cardinal objective of this initiative is to refine our knowledge about risk and uncertainty so that decision makers will better understand the immediate and local consequences of climate variability and policy/operational adaptations.

This research should provide Kansas City area officials, business leaders and interested citizens a powerful decision making tool, shaped by local data and a public engagement process, to inform their planning, assess the risks that climate change poses to their organizations, prioritize effective risk management approaches for their sectors, and suggest carbon footprint reduction strategies tailored as much as possible to their individual needs and concerns. This study is a first step in clarification of local climate change issues. Stakeholders' input will give researchers and participants a greater understanding of climate change perceptions of opportunities, risks, and adaptation strategies across seven primary economic sectors in response to changing climates in the Kansas City region. The discussions will also preliminarily identify priority actionable issues for Kansas City area policy making in government, business and civil society, while providing a foundation for

subsequent investigation of the interface between regional climate science and the social forces that drive change and improve Kansas City's environmental and economic resilience in an uncertain future.

APPENDIX A

IRB APPROVAL LETTER

April 22, 2010

MORRIS TYLER WILLOUGHBY
UNIVERSITY OF MISSOURI-KANSAS CITY
5110 ROCKHILL ROAD
420 FLARSHEIM HALL
KANSAS CITY, MISSOURI 64110

SSIRB #: 100210: Local Climate Change Impact: Societal Perceptions of Risk, Vulnerabilities & Adaptation

Approval Date: March 28, 2010

Dear Mr. Willoughby:

Your study noted above was reviewed and approved with restrictions on March 28, 2010 through the Social Sciences Institutional Review Board's expedited review process. You have met the requirements of the restrictions.

Your study has received approval under Category 7 of the categories of research that may receive expedited review. You may therefore proceed with your study.

You have full approval of the consent form SSIRB date stamped 4/22/2010 thru 3/27/11 (which will follow in a separate email).

Notwithstanding the SSIRB's approval to conduct the study, in the following situations you must provide timely additional information in order to maintain the SSIRB's approval.

1. The SSIRB cannot approve studies for more than one year. Unless the SSIRB renews its approval, your authority to conduct this study will expire on 3/27/2011. To request a continuation of your authority to conduct the study you will need to submit a completed Research Progress Report to the SSIRB office. Your authority to conduct the study cannot be continued until your completed Research Progress Report has received the necessary SSIRB review and approval. Therefore, you need to submit the completed Research Progress Report at least one month prior to the anniversary date of your project's approval/reapproval. The date of this letter is the approval date for your study. However, if your study requires more than one extension, the applicable anniversary date may change from year-to-year. Consult your most recent approval/reapproval letter for the applicable anniversary date. Call the

SSIRB office if you have questions about this.

2. If you want to make a change to the study, you must obtain the SSIRB's prior approval of the change.

3. If you want to add or delete investigators from the study, you must obtain the SSIRB's prior approval of the addition or deletion.

4. If a participant in your study is injured in connection with their participation, you must inform the SSIRB regarding this adverse event in a timely way.

Please inform the SSIRB when you complete the study.

If we can be of further assistance, please don't hesitate to call the SSIRB office at 816-235-1764. Best wishes for a successful study.

PLEASE NOTE:
If you are using a signed consent form a stamped and approved by the SSIRB version will follow via a separate email. You must receive the stamped version before you begin consenting subjects. All subjects must be consented on a copy of the approved consent form with the SSIRB Stamp. If requested, a hard copy of the stamped consent can be mailed to you.

Thanks,

Ms. Germaine Hughes
Administrator
Social Sciences Institutional Review Board
University of Missouri - Kansas City
5319 Rockhill Road
Kansas City, MO 64110-2499
Office: 816-235-1764
Fax: 816-235-5602
hughesge@umkc.edu

Consent for Participation in a Research Study

"Local Climate Change Impact: Societal Perceptions of Risk, Vulnerabilities & Adaptation"

Principal Investigator: M. Tyler Willoughby
Faculty Supervisor: Jimmy O. Adegoke, Ph.D.

Invitation to Participate

You are invited to participate in a research study.

Who will Participate

A list of potential participants will be compiled by contacting the following organizations: Kansas City, Missouri Chamber of Commerce and Environmental Excellence Business Network – Kansas City Chapter.

Purpose

This research is a study of local climate impacts in the Kansas City metropolitan area. It is designed to develop tools that will provide solutions and recommendations for facilities, business planners and local public policy makers.

The research will accomplish the following:

- Refine methodologies for collection and analysis of local climate-related data, sector-based surveys, focus groups and facilitated community workshops.
- Concluding findings is centralized on three discussions.
    1. Direct socio-economic impacts resulting as a consequence of climate variability.
    2. Compelling, vivid, credible and divergent scenarios of near-term Kansas City futures. These will be cross-correlated with select socio-economic population sectors.
    3. Sector-based categorization of socio-economic groups, each with prioritized concerns and points of opportunity relative to climate change.
- To the greatest extent possible, the research will conclude with tools that are particularly applicable and tailored for each of the sectors.
- Organize a variety of public presentations of findings and tools for professional organizations, governments and civic groups.
- Publication of methodologies and tools to inform of similar efforts in other metropolitan areas and further the science of regional climatology.

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INSTITUTIONAL REVIEW BOARD
APPROVED from [illegible] to [illegible]

Description of Procedures

- Focus groups will be created and participants for the focus groups will consist of 10-15 management staff with operational responsibilities in a particular sector.

- Each focus group panel session will last approximately 1-2 hours per week and will be hosted in a conference room in the Center for Applied Environmental Research office located on the University of Missouri – Kansas City campus

- The research will begin in April, 2010 and end in August, 2010.

Voluntary Participation

Participation in this study is voluntary at all times. You may choose to not participate or to withdraw your participation at any time. Deciding not to participate or choosing to leave the study will not result in any penalty or loss of benefits to which you are entitled. If you decide to leave the study the information you have already provided will be discarded, unless you give us your permission to retain and use any such information.

Fees and Expenses

There will be no fees or expenses applied to the participants.

Compensation

No compensation is offered.

Risks and Inconveniences

There are no known risks or inconveniences.

Benefits

The project will directly benefit two primary ongoing initiatives in Kansas City. First, the Climate Protection Partnership of the Greater Kansas City Chamber of Commerce is a 180 corporate member agreement to inventory and reduce GHG emissions. Second, the Climate Protective Plan of Kansas City, Missouri is a 2-phase, 50 strategy plan to reduce Kansas City GHG emissions 30% by 2020 and 80% by 2050.

When complete, Kansas City area officials, business leaders and interested citizens will have a novel decision making tool and methodologies - shaped by local data and a public engagement processes - to inform their planning, assess the risks that climate change poses to their organizations, prioritize effective risk management approaches for their assessment suggest carbon footprint reduction strategies tailored as much as possible to their individual needs and concerns.

Alternatives to Study Participation

The alternative is not to participate.

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INITIAL APPROVED FOR: 2/24/2010 - 2/24/2011

Confidentiality

Individual identifying information will not be collected as part of this study. All results from the study will be identifiable by sector only and no individual participants. While every effort will be made to keep confidential all of the information you complete and share, it cannot be absolutely guaranteed. Individuals from the University of Missouri-Kansas City Institutional Review Board (a committee that reviews and approves research studies), Research Protections Program, and Federal regulatory agencies may look at records related to this study for quality improvement and regulatory functions. Only project staff will have access to the data/information provided by participants.

In Case of Injury

The University of Missouri-Kansas City appreciates the participation of people who help it carry out its function of developing knowledge through research. If you have any questions about the study that you are participating in you are encouraged to call Dr. Jimmy Adegoke, faculty project supervisor/advisor, at 816 235-2978.

Although it is not the University's policy to compensate or provide medical treatment for persons who participate in studies, if you think you have been injured as a result of participating in this study, please call the IRB Administrator of UMKC's Social Sciences Institutional Review Board at 816 235-1764.

Questions

If participants have further questions about this study or their rights, or if they wish to lodge a complaint or concern, they may contact the Chair of the UMKC Geosciences Department, Dr. Jimmy Adegoke, at (816) 235-2978; Dr. Syed Hasan, at (816) 235-2970; or the UMKC Institutional Review Board at (816) 235-1764.

Authorization

_____ _____
Participant's printed name, signature and date

_____ _____
Principal Investigator's printed name, signature and date

_____ _____
Faculty Project Supervisor/Advisor printed name, signature and date

UMKC SOCIAL SCIENCES
INSTITUTIONAL REVIEW BOARD
INITIAL APPROVAL FROM [illegible] 2011

APPENDIX B

SAMPLE QUESTIONNAIRE

1. Zip code location of your organization?
2. What is the size of your organization in terms of number of employees?
3. What is the extent of your organization's market reach?
    a. Local/Regional
    b. National
    c. International/Global
4. In which part(s) of the sector do you participate? (industry and market segment)

Agriculture	Transport	Healthcare	Water	Energy	Land Use	Commerce
Public Agency Research Institution Academia Commodities Association Aquaculture Processor Retail Farmer Rancher Dairy Farmer Winery Lumber Urban Ag Local Food Other	Planning Transit Trucking Heavy Rail Light Rail Airport Air Carrier Aviation Design Car Mfr. AFV Mfr. Civic Utility Road Design Other	Public Agency Hospital Clinic Insurance Pharma Consulting IT Systems Pulmonary Facilities Other	Water Services Public Agency Civic Utility Industrial User Infrastructure Hydrology Wastewater Consulting Other	Planning Bio-Energy Transport Fuel Biofuels Utility Consulting Civic Manufacturing Renewables Facilities Other	Public Policy Economic Dev. Consulting Developer Builder Real Estate Property Mgmt. Landlord Landscape Other	Chamber Manufacturing Distribution Retail Wholesale Finance Marketing International Services Mining Waste/Recycling Warehousing Information Mgmt. Venture Capital Greentech Consulting Other

5. How many years has your organization been in this market(s)?
6. How would you characterize your career level and your level of expertise in the field?
    a. Middle Management
    b. Upper Management
    c. Executive
    d. Other _____

7. Has your organization taken a position on climate change? Yes or No (please circle)
8. Has your organization assessed its environmental impacts? Yes or No (please circle)
    a. If so, have any of the following been documented?
        i. Greenhouse gas emissions
        ii. Supply chain environmental analysis
        iii. Sustainability Plan (not published)
        iv. Sustainability Report or Corporate Social Responsibly Report (published)
9. Has your organization modified operations or physical plant in any of the following ways? (if necessary, amplify your answer for each)
    a. Reduced fossil fuel use in the creation, packaging or distribution of your product or service Yes or No
    b. Improved building energy efficiency and/or water efficiency Yes or No
    c. Reduced, reusable or recycled content packaging Yes or No
    d. Vehicle fleet efficiency Yes or No
    e. Reduced air travel or employee commuting Yes or No
    f. Reduced cultivation or no-till farming practices Yes or No
    g. Use of low-emission alternative constituents in your product mix? Yes or No
    h. Reduced use of fossil based chemicals in your product mix? Yes or No
    i. Other practices that would reduce GHG emissions or increase sequestration Yes or No

APPENDIX C

MATRIX OF LIKELY SCENARIOS

Climate Related Scenario	Do you see evidence of any of these? Any Adaptation Strategies Taken or Considered?
Severe Spring Weather: Increasingly frequent severe spring storms and flooding	
Summer Heat Waves: Increasingly severe summer heat waves	
Warmer Summer Nights: Progressively warmer summer nighttime temperatures	
Warmer Winters: Progressively warmer winters with fewer hard freeze days	
Less Water and Moisture: Less year-round humidity and less surface water	
Infestation and Invasive Species: Migration of insect and plant species	
Weather Variability: Unpredictable year to year weather patterns	
Air Pollution: Increased atmospheric particulates, lead and/or mercury	

Disease States: Are states evolving? Who are they effecting?	
Other: Other scenarios related to weather or bio-systems	

Market Reactions	Do you see evidence of any of these? Any Adaptation Strategies Taken or Considered?
Building Efficiency: Low-carbon and low-water use in buildings such as high-performance envelopes, solar orientation, efficient systems and fixtures	
Multi-Modal Transportation: Increased demand for walkable development with nearby jobs, transit and community services	
Alternative Fuel Vehicles: Increased demand for alternative fuel vehicles such as electric and CNG cars and trucks	
Improved Vehicle Efficiency: Demand for improved vehicle efficiency, reduced vehicle size and reduced miles traveled per capita	
Process Energy: Improved efficiency of process energy used in manufacturing or distribution infrastructure	

Reduced Waste: Improved resource productivity such as waste elimination, recycling, byproduct synergy	
Other: Other scenarios related to reduced fossil fuel use or improved resource productivity	

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VITA

Morris Tyler Willoughby was born on January 17, 1962, in Memphis, Tennessee. He was educated in local schools and graduated from Oakhaven Baptist Academy in 1980. After graduation, he attended the University of Memphis and worked professionally in the banking industry.

He re-located to Kansas City, Missouri in 1994 and was employed at Sprint Corporation for five years. After his employment with Sprint terminated due to a company restructure, he went back to school. He first attended Kansas City Kansas Community College in Kansas City, Kansas and earned an Associate of Arts degree. Afterwards, he attended University of Missouri-Kansas City in Kansas City, Missouri. He was awarded a Bachelor of Arts degree in Environmental Studies in May, 2006. During his enrollment, Mr. Willoughby participated in a ground-level ozone project in Kansas City and co-authored a research publication entitled "The Kansas City, Missouri, Ground-Level Ozone (GLO) Project: A Community-Based Air Pollution Field Experiment."

Mr. Willoughby enrolled in August, 2006 at University of Missouri-Kansas City seeking a Master of Science degree in Environmental and Urban Geosciences. In August, 2009, he assumed a position as a Graduate Teaching Assistant in the Geosciences department. In August, 2010, while also teaching, he assumed a position as an Undergraduate Advising Assistant, also within the Geosciences department. Upon completion of his degree requirements, Mr. Willoughby plans to obtain employment with an environmental firm, or a governmental agency in the Kansas City area.