PLANNING FOR MITIGATING CLIMATE CHANGE RISK TO METROPOLITAN AREAS (USA)

A Thesis

by

HIMANSHU GROVER

Submitted to the Office of Graduate Studies of
Texas A&M University
in partial fulfillment of the requirements for the degree of

MASTER OF SCIENCE

August 2006

Major Subject: Urban & Regional Planning

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Approved by:

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ABSTRACT

Planning for Mitigating Climate Change Risk

to Metropolitan Areas (USA).

(August 2006)

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In the last couple of decades, there has been increasing evidence of changes in global climate. With urban areas identified as the primary contributors to the climate change, there is an impetus for initiatives to persuade major contributors of greenhouse gases to undertake policy measures for climate change mitigation. The support for such initiatives at the international level has been mixed with many nations, including the United States, not accepting the Kyoto protocol. In view of the evident disagreement at the international level, initiatives promoting local communities to adopt self regulating policies for climate change mitigation have gained importance. One such initiative is the Cities for Climate Protection (CCP) supported by the International Council for Local Environmental Initiatives.

This research explores the differences in the socio-economic and civic characteristics of metropolitan areas in the contiguous United States that have committed to CCP (as a policy measure for climate change mitigation) to those that have not. The data in this study has been primarily collected from the census documents and government publications. The indicators are grouped into risk, stress and civic variables. The differences amongst the metropolitan areas with CCP committed jurisdictions and those with non-committed jurisdictions have been analyzed through statistical t-tests and use of geographical information system (GIS). The research reveals that metropolitan areas with a higher degree of risk are more likely to commit to climate change mitigation policies whereas those with higher stress index are less likely to commit. The metropolitan areas with higher civic index were also found more likely to commit to policy measures for climate change mitigation. The results of the study are significant as they reveal that communities that are at risk are not necessarily adding to the climate stress and those contributing the most to the climatic stress are not committed to climate change mitigation. The results of the study support the need to discontinue the closed box approach and instead adopt an approach with vertical integration. Cooperation and coordination amongst the hierarchical aggregate levels of communities, from a place to a region, are imperative for effective implementation of climate mitigation initiatives.

DEDICATION

To my parents

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CHAPTER I

INTRODUCTION

This chapter outlines the research context and identifies the purpose of this study. The need for the study and its significance have also been discussed in detail in this chapter.

1.1 Context of the study

The scientific community now concurs that the global climate is changing. The scientific data collected as part of the Intergovernmental Panel on Climate Change (IPCC) assessment and other various international initiatives reveals that the global mean surface air temperatures are rising, the arctic ice mass is reducing, and the global mean sea-level rise is estimated to be 1.0-2.0mm/year in the 20th century (Houghton et al. 2001). This change may be slow but is certain and affects every aspect of the life on earth. The change in the average global temperatures and marginal increase in the sea-level may not be that evident but certainly the general feeling of increased heat in summers and increasing dry spells in the year is now being felt (Andrews 1995). Recent research now firmly establishes that the present global climate is experiencing changes beyond the natural variability as a consequence of anthropogenic activities (Crowley 2000; Karl and Trenberth 2003).

This thesis follows the style of *American Political Science Review*.

Beyond this general agreement on the changes in the climate and role of anthropogenic activities in exacerbating this change, there is little consensus on the future predictions of climatic change. The magnitude and extent of climate change are debatable, with each side representing scientific merit. The anticipated future trajectory of the greenhouse gas emissions forms the underlying basis of the future climate change predictions. The most common way of predicting the future climate changes is based on the complex global circulation models (GCMs) that rely on mathematical relationships based on the general principles of physics amongst the underlying forcing scenarios. The number of variables involved, complexity of the data required and disagreement on the relationship effects has resulted in a number of such models with an equal number of possible predictions. These predictions necessarily do not agree with each other, consequently resulting in a wide range of future possibilities.

Within this high level of inherent uncertainty, the IPCC provides most realistic estimations (IPCC 2001a) based on the six scenarios capturing most of the emissions and driving forces are generally accepted as a benchmark. These estimations project carbon dioxide concentrations, the primary anthropogenic greenhouse gas, in the year 2100, to range from 540 to 970 ppm, compared to about 280 ppm in the pre-industrial era and about 368 ppm in the year 2000. The resulting globally averaged surface temperature is projected to increase by 1.4 to 5.8°C over the same period.

The global response to climate change thus far has predominantly been on developing a coordinated international response to control the discharge of greenhouse gases through international agreements (IPCC 2001a). The principal international agreement on reduction in global emissions of greenhouse gases is the Kyoto protocol that was adopted at the third session of the Conference of the Parties to the UNFCCC in Kyoto, Japan, on 11 December 1997; it was open for signature from 16 March 1998 to 15 March 1999 at United Nations Headquarters, New York. By that date the Protocol had received 84 signatures. It entered into force on February 16th, 2005, after at least 55 incorporating Annex I Parties which accounted in total for at least 55 % of the total carbon dioxide emissions for 1990 (within the group of Annex I parties), deposited their instruments of ratification, acceptance, approval or accession. As of 18 April 2006, 163 states and regional economic integration organizations had deposited instruments of ratifications, accessions, approvals or acceptances. Notably, Australia and United states, two primary producers and consumers of fossil fuels have not ratified the treaty. The international agreement itself has been widely criticised for being too weak to have much impact upon future climate change and for being too strong in its obligations upon industrialised countries. Thus, it has not been easy to achieve international consensus on an acceptable climate change mitigation strategy.

Climate change has up to this point been predominantly framed as a global issue. However, with the growing numbers of world's population moving to urban areas and most of the activities contributing to climate change being urban, it is obvious that without the active participation of the urban areas none of the countries can aim to achieve their international commitments (Betsill 2001; Kates and Torrie 1998). Local governments control the emissions within their jurisdiction through control of economic and land use development activities (Collier 1997). Additionally, the local authorities are direct agents in contact with the community and can therefore help realize the broad policy initiative into local level actions. Recently, there has been an increased interest in promoting local climate change mitigation initiatives (Blanco 2006).

Despite growing interest, there is a general lack of appreciation of the multi-scalar nature of the issues related to climate change mitigation in most initiatives. These local initiatives are being treated within ‘socio-spatial containers’(Marvin and Guy 1997) of the respective jurisdictions ignoring the inter-connectedness to the larger regional context. The failure of such an approach in achieving sustainable development has been documented in detail in the context of United Kingdom (Bulkeley and Betsill 2005). Another study on the effectiveness of cities in US to deal with the problem of climate change mitigation identifies the limitations of administrative capacity, budgets and the inability to exercise control outside their limited jurisdiction as the primary limiting factors (Betsill 2001). Similar research concludes that most US cities have limited control over utilities, especially energy generation and are thus unable to make any effective changes in one of the most important sectors of climate change mitigation (DeAngelo and Harvey 1998).

Wilbanks and Kates (1999) note that as a consequence of the realization of these limitations of the present approach there is an increasing interest in considering a bottom-up approach which seeks to investigate not only how local places contribute to climate change and what measures can they take to mitigate these changes, but also to identify what controls the local interests that guide these forces. There have been climate change policy studies in US at the local level of cities (see Betsill 2001) and at the county level (see Zahran et al. 2005a), but the most obvious level of economic and functional aggregation – the metropolitan statistical area has so far been overlooked.

This research seeks to fill in this gap by identifying characteristics at the metropolitan area level that influence the decisions of the constituent local jurisdictions to enact climate change mitigation initiatives. Using the Cities for Climate Protection (CCP) campaign as a measure of policy commitment to climate change, this study measures the level of interaction between the metropolitan level activities and the decision of a constituent jurisdiction (city or a county) to join this international climate change mitigation initiative.

The next chapter reviews the existing literature on various aspects of climate change including its causes and anticipated impact. Recent research on the role of local government in climate change mitigation is also briefly discussed. Thereafter the background on the CCP initiative is included in the same section.

Chapter three identifies the conceptual framework, discusses the hypothesis and details the variable measures included in this study. The study flow and the details of the nature of analysis are included in this section.

Chapter four presents the results and findings of the research. The following final chapter discusses the implications of the findings and research conclusions. The recommendations and possible avenues for future research are also outlined in the final chapter.

1.2 Research purpose and objectives

This research is thus based on the understanding that support for climate change mitigation policies at the local level cannot be evaluated independent of the local regional context. In fact, in most cases it is the regional realities that not only dictate the local jurisdictional response but also limit its ability to respond effectively. Using the CCP campaign, this research seeks to identify metropolitan area scale factors that affect local support for climate change mitigation initiatives.

Specifically this research will focus on the following four areas of inquiry. First, I will identify the developmental challenges imposed as a consequence of the threat of global climate change. There exists a variety of climate change impact models and scenario simulations. This scientific data would be simplified in terms of tangible challenges they pose to the development and growth of urban settlements. Based on these vulnerability indicators I will conduct a broad assessment of threat levels to metropolitan areas in North America (US) due to anticipated climate change.

Secondly, I will assess the levels of stress that the various metropolitan areas exert on the environment through a variety of stress indicators. Finally I will analyze the nature of relationship between the metropolitan level risk indicators, the stress variables and the policy support for climate change mitigation through commitment to CCP by the constituent local jurisdiction in the context of the community's civic attributes. A combination of statistical techniques and advanced GIS analysis will be undertaken in order to realize this research.

1.3 Significance of the research

The significance of this research lies in identifying the critical link between metropolitan level activities and the limitations imposed by them on the capacity of the constituent communities to adopt climate change mitigation measures. Presently the capacity and the efficiency of local governments to implement climate change mitigation initiatives is hampered by the regional activities over which they have little control. Identification of these meso-level factors would help the local communities realign and re-evaluate their policy and planning options in order achieve the desired goals of climate change mitigation.

In the context of the United States this research represents an important building block towards creating a planning model that enables the nation to realize the national mandate of “emissions reductions through voluntary action” (BBC 2005). Additionally it could set an example for settlements all over the world to follow and could result in overcoming the many hurdles that hinder the implementation of an effective climate mitigation strategy at the global level through local action.

This research could help redefine local planning strategies that: help implement the climate change mitigation policies effectively at the local level, contain the increasing exposure of human settlements to climate change impacts, and identify practical means for adapting existing settlements to the climate change impacts. It is expected that this research will play an important role in increasing the capacity of local governments to respond to and adopt climate change mitigation initiatives.

CHAPTER II

THEORETICAL CONCEPTS

This chapter outlines the underlying theoretical concepts and the literature relevant to this research. The scientific concepts have been discussed briefly with more emphasis on their planning implications and findings of earlier related research.

2.1 The earth's climate

A detailed scientific description of the earth's climatic system is beyond the scope of this research. However in order to effectively comprehend the anticipated impact and the nature of climate change predictions it is important to briefly discuss the underlying concepts and phenomena that drive climate change.

Generally the terms 'weather' and 'climate' are used interchangeably in the common parlance. However each conveys a different interpretation of the atmospheric system. 'Weather' may be defined as our experience of the atmosphere around us, characterized by typical elements like temperature, wind, precipitation and clouds, over a limited time (usually) a few hours over a particular area (1997). The weather is highly variable and is a consequence of rapidly developing atmospheric phenomenon. 'Climate' refers to the prevalent or characteristic meteorological conditions, and their extremes, of any place or region (Glickman 2000). Climate is usually a statistical average of the weather conditions over a long period of time in a larger region.

The climate system as defined by IPCC (2001a) is "an interactive system consisting of five major components: the atmosphere, the hydrosphere, the cryosphere, the land surface and the biosphere” forced or influenced by external forcing mechanisms including the sun and the human activities. Various kinds of physical, chemical and biological processes and interactions take place within each of the components of the climate system. These components itself are open systems linked with each other by fluxes of masses, heat and momentum (Baede et al. 2001). Climate variations are caused by changes that take place within the various components of the climatic systems. These changes could be natural or anthropogenic.

2.2 Human impact on the climate

2.2.1 Evidences of climate change beyond natural variations

The climate of earth is the product of a number of complex processes and interactions among the sun, oceans, atmosphere, land and the biotic environment. The natural variability in the climate has been long accepted by the scientific community. The climate has always been variable and undergone slow as well as abrupt climate changes resulting in consequential impact on the biotic environment (Crowley and North 1988). The climatic variations are an intrinsic component of the natural climatic systems and are a result of the natural forcing processes. These natural climatic variations include El Nino-Southern Oscillation (ENSO), global and hemispheric variability, regional patterns, and extreme events signified by drastic deviation in the normal weather conditions. The various natural forcing mechanisms that contribute to these climatic variations include; the global energy balance, radiative forcing and the natural greenhouse effect.

In the recent years, especially following the industrial revolution the human activities have had an appreciable impact on the climate. The human impact on the global climate is primarily a result of interference with the natural flows of energy through changes in atmospheric composition and not by the actual generation of heat in energy usage. The increased release of greenhouse gases into the atmosphere by human activities is resulting in global warming which is beyond the limits of natural variation (Karl and Trenberth 2003).

The recent scientific assessments by IPCC confirm evidence of an anthropogenic signal in the climate record of the last 35 to 50. Most of the studies undertaken in the last couple of decades find that the estimated rate and magnitude of warming observations over the last 140 years has been found in best agreement with model simulations including anthropogenic and natural forcing factors (IPCC 2001b).

The first calculations of the magnitude of global warming were attempted by Arrhenius (1896) who predicted an average global temperature increase of 5 deg. C, if the atmospheric concentrations of carbon dioxide were doubled. Recent more scientifically robust estimations predict that the most likely global average temperature rise for a doubling of the concentration of atmospheric carbon dioxide will be 3.5 °C, with a 90% probability of the warming being between 2.4 °C and 5.4 °C (HCCPR 2005). As per the assessment published by the Intergovernmental Panel on Climate Change (IPCC), the global mean surface air temperatures have already risen by 0.3 °C to 0.6 °C since the late 19th century and by 0.2 °C to 0.3 °C over the past 40 years (IPCC 2001b).

2.2.2 Enhanced greenhouse impact

The concept of green house effect was first proposed by the French mathematician Fourier in 1827 and followed up by the British scientist Tyndall in 1860, with the discovery that the effect was a result of the absorption of heat by the minority gases, predominantly water vapour, carbon dioxide and methane (King 2005). A part of the energy radiated back into the atmosphere by earth is trapped by the atmospheric greenhouse gases (water vapor, carbon dioxide, and other gases), retaining heat somewhat like the glass panels of a greenhouse. Without this natural "greenhouse effect," temperatures would be much lower than they are now, and life as known today would not be possible. As a result of this effect the earth's average temperature is a maintained at a comfortable 60°F.

Historical data reveals that before the Industrial Revolution, the amount of greenhouse gases in the atmosphere remained relatively constant. Since then, the concentration of various greenhouse gases has increased. The amount of carbon dioxide, for example, has increased by more than 30% since pre-industrial times and is still increasing at an unprecedented rate of on average 0.4% per year, mainly due to the combustion of fossil fuels and deforestation. The increased concentration of greenhouse gases in the atmosphere enhances the absorption and emission of infrared radiation (Karl and Trenberth 2003). This effect is called the enhanced greenhouse effect. If the amount of carbon dioxide were doubled instantaneously, a temperature increase of 1.5 to 4.5°C in the mean global temperature may be expected. To appreciate the magnitude of this temperature increase, it should be compared with the global mean temperature difference of perhaps 5 or 6°C from the middle of the last Ice Age to the present interglacial (IPCC 2001b). However it still represents a large range of uncertainty. This uncertainty arises from our limited knowledge of clouds and their interactions with radiation.

2.2.3 Urban development

The effect of urban development on the local regional climate has now been scientifically documented and confirmed. The physical elements of the city, its urban fabric, the surfaces and the resulting interaction result in modifying the local climate to a great extent (Landsberg 1981). Table 2.1 provides a general description of climatic alterations created by cities. It may be highlighted that the extent and actual magnitude is dependent on the size and function of the settlement.

Table 2.1: General alterations in climate created by cities (Landsberg 1981)

Climatic Element		Comparison with rural areas
Temperature	Annual mean	0.5-3.0°C higher
	Winter minimum	2.5-4.0°C higher
	Summer maximum	1.0-3.0°C higher
Relative humidity	Annual mean	6% lower
	Winter	2% lower
	Summer	8% lower
Cloudiness	Clouds	5-10% more
	Fog, winter	100% more
	Fog, summer	30% more
Solar radiation	Total, horizontal surface	0-12% less
	Ultraviolet, winter	30% less
	Ultraviolet, summer	5% less
	Sunshine duration	5-15% less
Wind speed	Mean	20-30% lower
	Extreme gusts	10-20% lower
	Calms	5-20% more
Precipitation	Amounts	5-10% more
	Days with <5 mm	10% more
	Thunderstorms	10-15% more
	Snowfall, inner city	5-10% less
	Snowfall, lee of city	10% more

This localized heating effect in the urban area is commonly known as the urban heat island effect. Within the urban area temperatures tend to decrease as the radial distance from the city centre increases, with the most marked effect during the night when rural areas cool more in relation to urban areas (Graves et al. 2001).The study identifies the primary cause of the heat island effect: a lower rate of radiant cooling during the night in urban areas which leads to an overall net radiation gain relative to a rural area; the storage of solar energy by building materials (especially those with a dark surface), which is then released at night; anthropogenic heat sources (e.g. transportation, heating, air conditioning, cooking and industrial processes); the decrease in evaporation from soil and vegetation; the decrease in convective heat loss from buildings to the air due to a decrease in wind speeds.

2.3 Predicting climate change impact

The behaviour of the climate system, its constituents and their interactions is simulated through climate models based on the basic laws of physics like conservation of mass, momentum and energy and on empirical relationships derived from observation. The most comprehensive and commonly models used for global climate change predictions are the General Circulation Models or GCMs (IPCC 2001b; Nihoul 1985). These models are constructed so as to represent key climatic processes with sufficient detail that large scale climate and its sensitivity to human activities can be calculated consistently (Gates 1999; Meehl et al. 2000a). Models of various components and processes of the climate system are coupled to produce increasingly complex models.

The efficiency and reliability of these models depends on the realistic representation of the interaction between various components of the climate. As the relationship between the various climatic functions is non-linear, these are solved numerically by means of well-established mathematical techniques (IPCC 2001a).

Though the models have become more reliable over time, they still do have limitations in terms of the spatial resolution, simulation errors, and parameterizations, resulting in varying degrees of confidence in the quantitative model simulations. Most of the recent models can not only simulate the mean variables but also the natural occurring variability in the climate (Tett, Johns, and Mitchell 1997). The coupled models have shown to have a higher degree of reliability in producing realistic simulations of the climate change that has already been observed in the 20th century (Tett et al. 1999). The past climate simulation with these models have also been increasingly successful (Hougton et al. 1996). Thus there is increasing confidence in the presently used climate models to provide projects of change that may be anticipated in the future climate (Meehl et al. 2000b).

2.4 Anticipated global impact

The following synthesis of the anticipated global climate change impact is primarily based on the recent IPCC assessments (IPCC 2001a). The future climate change is dependent on the existing and the future changes in the atmospheric compositions. Future emissions are determined by various driving forces such as the population, socio-economic development and technological change. Evidently most of these are highly uncertain and cannot be predicted. Therefore IPCC utilized the six scenarios detailed out in the Special Report on Emissions Scenarios for predicting the future climate change. These scenarios are based on the respective storylines and comprise a wide range of driving factors. No probabilities have been assigned to them as all scenarios are considered plausible and internally consistent.

The predictions in each of the SRES scenarios are different in magnitude but do provide a number of similar propositions. Carbon dioxide concentrations, globally averaged surface temperature, and sea levels are projected to increase in the 21st century under all IPCC emissions scenarios. The global average surface temperature is projected to increase by 1.4 to 5.8 deg C over the period 1990 to 2100. The global average annual precipitation is also expected to increase further during the 21st century. The global mean sea level rise is projected to rise by 0.09 to 0.88 m by the year 2100 (base year 1990).

Substantial regional differences are projected in climate and sea level, compared to the global mean in the various climate change scenarios. It is likely that all land areas, particularly those at northern high latitudes, will warm more rapidly that the global average. Most notable would be the warming in northern regions of North America, and northern and central Asia, which is expected to increase by almost 40% in all the modelling scenarios. The glacier and ice caps are expected to continue their retreat. The regional variations in the sea level rise are expected to be much more than the climate. This is because the level of sea level rise is dependent to a large extent on a variety of local physiological as well as climatic factors. However the models are consistent in the prediction that a greater average rise may be expected in the Arctic Ocean and a less than average in the Southern Oceans.

Projected climatic change will have beneficial and adverse environmental and socio-economic effects, but it is expected that the larger the changes and the rate of change in climate, the more the adverse effects would be.

2.5 Anticipated impact in US

Herein, I summarize the impacts as identified by the National Assessment Synthesis Team, US Global Change Research Programme (2000). These assessments were created by the team using a combination of models developed by the Hadley Center in the United Kingdom and the Canadian Center for Climate Modeling and Analysis (NAST 2001). The assessments are based on the mid-range emissions scenario for the future (IPCC emissions scenarios) and assume the following in the perspective year 2100 with no change in policies to limit greenhouse gas emissions:

i. world population will double to about 11 billion people;

ii. global economy will grow to more than 10 times its present size (year 2000), maintaining the present rate of growth;

iii. carbon dioxide emissions would reach 700 ppm with increased use of fossil fuel; and

iv. the share of non-fossil sources of energy would be more than 40% of the world's total energy.

The identified possible impact of global warming on US has been identified as:

1. Increased warming: Assuming continued growth in world greenhouse gas emissions, the primary climate models used in the assessment project that temperatures in the US will rise 5-9ºF (3-5ºC) on average in the next 100 years.
2. Increased damage in coastal and permafrost areas: Climate change and the resulting rise in sea level are likely to increase the threat to buildings, roads, power lines, and other infrastructure in climatically sensitive places.
3. Vulnerable ecosystems: The report suggests that a few vulnerable ecosystems, such as alpine meadows in the Rocky Mountains and some barrier islands, are likely to disappear entirely in some areas. Others, such as forests in the Southeast, are likely to experience major species shifts or break up into a mosaic of grasslands, woodlands, and forests. The loss of goods and services lost through the disappearance or fragmentation of these ecosystems are is expected to be costly or even impossible to replace.
4. Differing regional impacts: Climate change is expected to vary widely across the US. Temperature increases will vary somewhat from one region to the next. Though heavy and extreme precipitation events are likely to become more frequent, yet some regions of US are expected to get drier.

In addition to the above the report suggests that climate change will very likely magnify the cumulative impacts of other stresses, such as air and water pollution and habitat destruction due to human development patterns. For some systems, such as coral reefs, the combined effects of climate change and other stresses are very likely to exceed a critical threshold, bringing large, possibly irreversible impacts. The report also cautions of uncertainties and surprises. It is accepted that significant uncertainties remain in the science underlying regional climate changes and their impacts. Thus it is likely that some aspects and impacts of climate change will be totally unanticipated as complex systems respond to ongoing climate change in unforeseeable ways and recommends a cautious approach.

2.6 Cities for climate protection

In 1991, the ICLEI launched the Urban CO2 Reduction Project to counter the increasing carbon emissions from the growing urban areas in the world. The program coordinated the CO2 reduction efforts of 14 municipalities in Canada, the United States, and Europe. The program proved remarkably successful, with municipalities achieving both significant reductions in CO2 emissions and operating expenditures (Betsill 2000; Bulkeley and Betsill 2005). In 1993, the ICLEI officials converted the CO2 project into the more ambitious CCP campaign. The stated mission of the campaign is to enlist “cities to adopt policies and implement measures to achieve quantifiable reductions in local greenhouse gas emissions, improve local air quality, and enhance urban liveability and sustainability” (ICLEI 2005). The CO2 reduction target set for cities is a 20 percent reduction from 1990 levels (Betsill 2000; Collier and Lofstedt 1997). This ‘Toronto Target’ is significantly more stringent than the standards set by the Kyoto Protocol (VanKooten 2003). To join, a locality must pass a resolution or issue an executive decree that binds it to the CCP campaign’s master objective – reduction of GHG emissions. The CCP campaign uses a performance-based approach, structured on five milestones that localities commit to undertake (Strengers 2004). The milestones move localities from a baseline inventory of emissions, to the adoption of targets, to the elaboration and implementation action plans and standardized progress reports (ICLEI 2005). The administrative costs vary by the size and complexity of the local government, the nature and pace of plan enactment, and whether officials can galvanize community and private support for plan initiatives.

2.6.1 Participation in CCP

Because participation in the CCP campaign is voluntary, and the ICLEI has no coercive authority to reward or punish the behavior of participants and non-participants, coordinated action across localities to mitigate the risks of climate change can be considered a collective action dilemma (Zahran et al. 2005b). CCP campaign initiatives, like all collective policy actions on climate change, produce collective and selective costs and benefits that are market and/or non-market in nature (Griffin 2003). A collective benefit of participation in the CCP campaign is the reduction of aggregate GHG emissions – a major cause of climate variability in the last century (Oreskes 2004). With greater climate stability, the expected impacts of climate change on terrestrial and marine ecosystems, infrastructure, and patterns of mortality are reduced.

The problem with such collective benefits, as with all collective action dilemmas, is that they cannot be withheld from non-participants in the CCP (Lubell et al. 2006). The non-excludability of collective benefits significantly undermines incentives to participate, leading to suboptimal provision of policy goods (Olson 1965). Absent a coercive authority to monitor and sanction behavior, collective endeavours like the CCP campaign are more likely to succeed if localities accrue selective (excludable) benefits from participation.

The ICLEI offers excludable benefits to CCP participants like software and analytic services, access to case studies and fact sheets, and strategic plans to enable localities to inventory, track, and reduce GHG emissions (ICLEI, 2005). ICLEI officials claim that participation in the CCP campaign provides secondary benefits such as reduced utility and fuel costs, improved local air quality, and increased job growth in energy goods and services.

The results of recent studies indicate that specific geographic and socioeconomic characteristics motivate (and de-motivate) local jurisdictions to participate in the CCP campaign. These factors are also distributed across the various geographic scales within which the city is nested. At the local city level the global climate change mitigation is the way the problem is framed determines the level of participation in the program. The local officials succeed in garnering support for the initiative only if they are successful in 'localizing' the climate change problems by linking the mitigation policies with other issues already on the local agenda (Bulkeley 2000). Kates and Torrie (1998) identified that most of the CCP cities had prior interest in environmental issues. The only feasible way for such a global issue (climate change mitigation) to get on the local agenda has been through presenting the preferred policy option (emissions control) as solutions to the problems already being addressed at the local level (Kingdon 1995). This indirect strategy of localizing the climate mitigation policies is considered the only way to include emissions concerns within the broader range of local community concerns (Sarewithz and Peilke 2000).

However there are limitations to which the local cities in US can influence the overall climate change mitigation efforts and prevent the communities from taking effective policy action (Betsill 2001). There are practical difficulties wherein the mitigation agenda does not fit the existing priorities and the pattern of development; institutional barriers wherein the organization of the local government is not effective for mitigation initiatives; budgetary constraints; and more importantly lack of control over the regional economic and functional linkages. The research suggests that the regional context of the city with its regional functional linkages is an important factor in determining its ability and capacity to undertake sustainable development measure like climate change mitigation (Wilbanks and Kates 1999). A recent study by Zahran (2005a) indicates that the powerful triggers for CCP involvement at county level include: presence of a physical threat and geographic vulnerability associated with climate; the socioeconomic make-up of a local jurisdiction; and organized environmental activities. The study indicates that a combination of high geographic risk and socio-economic capacity associated with climate change are the most compelling attributes that prompt participation in the CCP campaign.

In the following chapter, I detail out the conceptual domain, the construction of the indicator variables and discuss the statistical analysis undertaken in this research.

CHAPTER III

RESEARCH DESIGN AND METHODS

This chapter outlines the research design and the methodology of analysis adopted in this study.

3.1 Conceptual framework

The uncertainty associated with climate change impact and lack of any tangible incentives make adoption of climate change mitigation policies at the local level represents a challenge. Lack of funds for enacting measures for effective emissions controls, and necessity for an integrated action at regional and global scales has resulted in limited policy commitment from the local government. Consequently the climate change mitigation policy decisions are a result of the internal assessment of local capacities in relation to climate change threats. The decision of the local governments to adopt climate change mitigation measures is thus likely to be dependent on their assessment of risk associated with climate change impacts, the appreciation of the contribution of the stress imposed by community on the climatic system, and finally the civil society attributes that promote environmental ethics.

The risks include levels of estimated physical exposure to the direct impact of climate change, such as sea level rise and indirect impacts such as increased losses due to higher frequency of the extreme weather events and loss of ecosystem functions. The perception and experience of risk has been found to promote risk management initiatives including resilience and mitigation activities by the concerned communities (Hood and Jones 1996; Moran and Colless 1995).

The stress functions refer to activities that contribute to carbon emissions, such as increased vehicular trips and carbon-intensive industrial activities. Controlling the emissions from traditionally high emitting regions is considered critical for ensuring effective climate change mitigation. The Kyoto protocol also seeks to promote emissions control in industrialized countries that constitute a large proportion of the carbon emitters. This approach is based on the proposition that countries should not to be harmed by others' actions without suitable compensation (Rayner et al., 1999). The approach places the responsibility of remediation on the communities that have caused the damage by overuse of the common pool resources. The CCP program itself aims to enlist the higher polluting cities to commit to emissions reductions within sustainable limits.

The third dimension influencing the decision of communities to adopt climate change policies is local civic and environmental participation. Levels of engagement are defined by both a community's ethical environmental responsibility and its economic capacity. Ethical responsibilities are based on accepting the "responsibility for nature" (John Passmore 1974) and relates to the modern concept of environmental ethics. It implies reflective, normative rules of action and forbearance toward entities and regions which exist and persist "on their own," independent of human "management," and instead are maintained in balance by natural processes. Associated with the concept is the economic ability of the community to adopt such environmental ethics as they are usually associated with higher personal costs.

The combination of these three local dimensions of risk, stress, and civic attributes are expected to be important factors that influence local governments to adopt climate change mitigation policies.

3.2 Research questions

This research specifically explores 3 principal research questions:

R1: What is the level of threat to metropolitan areas due to the anticipated impacts of climate change in the USA?

The extent of geographical impact of the anticipated changes in the climate is yet to be accurately identified. The problem is further compounded by the fact that the nature of the impacts is variable and may not be negative for all the affected regions. For example, positive gains are expected in the northern colder regions of the nation with the increasing average temperatures. However, over the longer term the net impacts are expected to be detrimental to the continued growth and development of the human activities. Existing research on use of scientific findings in environmental policy making suggests that the 'assessment' of risk is an important link between the science and policy realms (Alcamo, Kreileman, and Leemans 1996; Jager 1998). To a large extent, the knowledge and reliability of environmental risk determines of the nature of local policy response.

Therefore it is important to map the geographical spread of the vulnerable regions. Identifying the most likely vulnerable areas to climate change is the first step leading to further analysis of the need for adaptation and mitigation measures. As climate mitigation and adaptation are expected to involve considerable investment of resources, this geographical analysis would help prepare an appropriate tool for identifying geographic priority areas.

R2: What is the relationship between metropolitan areas expected to be at risk due to climate change and those that exert high levels of stress on the natural climatic system?

One of the major issues in the climate change debate is sharing mitigation and adaptation costs. The equity and justice considerations at the international level in identifying the criteria for fixing the responsibility and proportional cost sharing among industrialized and the developing countries are a major impediment in achieving consensus on global mitigation initiatives (Bastianoni, Polselli, and Tiezzi 2004). The Kyoto protocol emphasizes the duty of the developed nations in cutting down their emission and assisting the developing countries by the sharing the costs of mitigation (Paavola and Adger 2006). In US, with the uneven distribution of resources and income across the states and the cities, there possibly exist similar levels of equity and environmental justice issues.

An empirical analysis of the nature of this relationship, identifying the stressors and at risk metropolitan areas can be instrumental in developing regional agreements for distributing costs of climate change mitigation and adaptation within the country. Ideally, following the internationally accepted principles of equity, the stressor metropolitan areas need to undertake proportional investments in climate change mitigation efforts and compensate the metropolitan areas at risk for adaptation measures necessary to ensure their continued vitality.

R3: What is the relationship between estimated level of climate change risk, level of stress imposed, and the metropolitan areas' policy commitment to climate change mitigation?

Protection against climate change impact can be achieved through a combination of mitigation and adaptation efforts. Mitigating climate change risk involves controlling greenhouse gas emissions to avoid adverse climatic change; and adaptation entails changes in production and consumptions to reduce the impact when the climate change does occur (Kane and Shogren 2000). The international focus has been on mitigation through policy measures whereas adaptation in response to anthropogenic climate change seeks to maintain viability by maximising benefits that can be accrued as a result of changing climate and minimize the expected losses (Pittock and Jones 2000). A combination of mitigation and adaptation techniques has been proposed as the best way to achieve optimal utilization of resources in response to the changing climate (Ausubel 1993; IPCC 2001a; Kane and Shogren 2000). Existence of a supportive mitigation policy helps increase the efficiency of the adaptation measures. Exploring the drivers of policy commitment to adopt climate change mitigation policies in context of the estimated levels of risk and the stress contribution would help understand the expected response of metropolitan areas in the face of climate change threat. The analysis would also help identify the existing levels of equity in terms of sharing responsibility for mitigating climate change impacts.

3.3 Predicted outcomes

Within the framework of the research questions outlined above, this study specifically seeks to scientifically test the following hypothesis:

H1: Climatic stressor metropolitan areas are not proportionally at risk.

It is expected that the level of stress that the metropolitan area exerts on the local environment is a function of the socio-economic activities, whereas the level of risk from climate change impact is a function of its physical location. Therefore, the risk levels associated with a metropolitan area are not expected to proportionally correspond to its contribution to climatic stress. The metropolitan areas exerting high levels of stress may not necessarily have high level of risk too.

H2: MSAs with higher climatic risk are more likely to commit to climate change mitigation policies.

Location in a high risk zone is more likely to result in a metropolitan area adopting climate change mitigation policies. The metropolitan areas in risk zones such as low lying coastal watersheds that are prone to frequent flooding are expected to be involved actively in climate change mitigation that can ensure some level of risk reduction.

H3: MSA exerting higher climatic stress are less likely to adopt climate change mitigation policies.

A reduction in carbon emissions by adopting climate change mitigation policies is expected to have negative economic impact on industrial production and related activities. Local economic dependent on carbon intensive sectors thus stand to suffer economic losses due to any mitigation initiatives. Therefore, it is expected that the settlements exerting higher levels of climatic stress would be less likely to support climate change mitigation efforts due to the local economic concerns.

H4: Metropolitan areas with higher levels of civic engagement are more likely to adopt policies to mitigate the adverse effects of climate change.

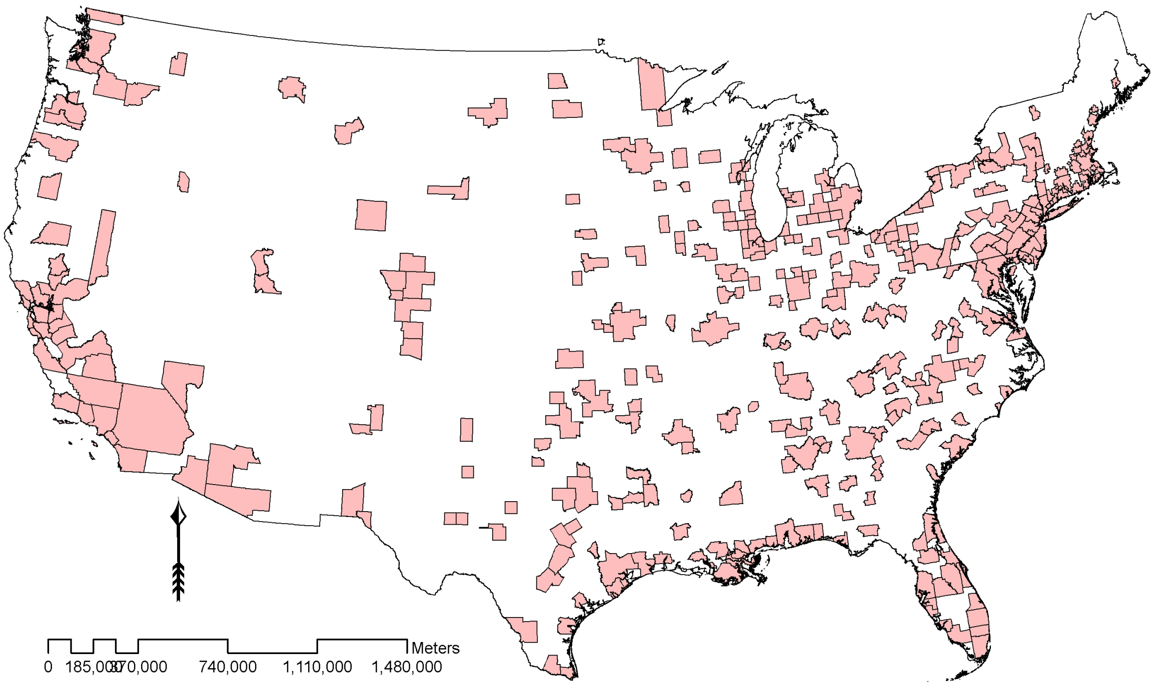
The policies associated with climate change mitigation are expected to result in changes in lifestyle and at times increased personal costs to the local communities. In this context, it is expected that the metropolitan areas with higher level of civic capacities including sensitivity to ecological concerns and availability of resources for bearing the mitigation costs are more likely to adopt climate change mitigation policies.

3.4 Unit of analysis and sample selection

Anthropogenic causes of climate change are usually associated with urban uses. The distribution of workers in a community among various economic sector, the mode of travel to work, travel time to work, and similar functions that are concentrated within large urban agglomerations exert a high degree of carbon stress on the natural environment. In United States such urban agglomerations with high degree of economic interconnectivity have been identified by Office of Management and Budget (OMB) as the statistical metropolitan areas. This unit of aggregation has been adopted as the unit of analysis on this study. The use of metropolitan areas as the primary unit of analysis is supported by its high degree of urbanization and the inherent characteristic of internal socio-economic integration. As a result of this integration, the policies and regulations adopted or implemented by any unit of local government within the metropolitan area are expected to have ramifications through out the metropolitan area. Similarly, more importantly, the risk, stress and civic characteristics of the metropolitan areas are expected to influence the constituent communities decision to adopt policy measure for climate change mitigation.

This study specifically focuses on the Metropolitan Statistical Areas (MSAs) as defined in federal register (OMB 2001) Vol. 65, No. 249, Wednesday, December 27, 2000. The general concept of a metropolitan statistical area as outlined in the census definition, is that of a core area containing a substantial population nucleus, together with adjacent communities having a high degree of economic and social integration with that core. Each metropolitan statistical area must have at least one urbanized area of 50,000 or more inhabitants. Counties or equivalent entities form the geographic "building blocks" for metropolitan statistical areas. As of June 6, 2000, there are 362 metropolitan statistical areas in the United States. The geographic spread of these areas corresponding to 2000 census data was downloaded from US census cartographic download database (http://www.census.gov/geo/www/cob/bdy_files.html) and is presented in figure 3.1.

Figure 3.1: The metropolitan areas in U.S (Census 2000)



The population of these regions[1] constituted 98% of the urban population of the nation in 1991 (US Census 1990) and 98.2% of the urban population in 2000 (US 2000). The combined population of these settlements has increased by 19% in the decade 1990-2000 whereas the total population of the nation grew at a rate of 13% during the same duration (based on data from US Census 1990 and 2000).

3.5 Concept measurement

This section details the measurement of variables used to test the hypothesis outlined in the preceding section.

[1] *Hereon referred to as 'metropolitan areas'*

3.5.1 Dependent variable

3.5.1.1 Policy commitment to climate change mitigation

Participation in the Cities for Climate Protection (CCP) campaign initiated by International Council for Local Environmental Initiatives' (ICLEI) has been adopted as the measure of policy commitment to climate change. As a member of the campaign, each city must pass a resolution indicating its intent to reduce GHG emissions and agree to follow the CCP 5-milestone framework, which consists of calculating a base-year emissions analysis, forecasting emissions growth, adopting an emissions target, completing an action plan of how to reach that target and then implementing the plan (http://www.iclei.org). Research conducted by Kousky and Schneider (2003) suggests that the local governments (in the US) that are actively implementing any climate change mitigation measures are all part of the CCP network. As of 2003, there were 152 US members in the CCP campaign. In this research, the participation of any jurisdiction (county or any urban center) in the metropolitan area has been accepted as an indicator of the policy commitment to climate change mitigation at the respective metropolitan level.

3.5.2 Independent variables

The independent variables that were constructed for testing the proposed hypotheses include the following measures at the metropolitan scale:

1. Risk due to anticipated climate change impacts
2. Stress imposed on the climatic system
3. Civic capacity

3.5.2.1 Risk due to anticipated climate change impacts

The purpose of this measure to create a relative risk scale on the basis of the estimated level of exposure to anticipated impacts of climate change. The selection of the specific measurement variables is based on the commonly cited impacts in the US National Assessment (NAST 2000). All the climate change models considered in the national assessment agree that the climate is going to get warmer; the heat index is going to rise; and precipitation is likely to come in heavy and extreme events. The national assessment report concludes that the anticipated changes in climate would result in a rise in sea level, changes towards extremes in the temperature and precipitation and increased negative impacts of urbanization. In this context the following indicator variables have been used in this research to measure the levels of risk to metropolitan areas.

3.5.2.1.1 Precipitation above normal levels (1990-2000)

The total precipitation in excess of the normal levels in the metropolitan area during the decade 1991-2000 has been adopted as a measure of risk. The annual precipitation data (1980-2000) for the contiguous USA has been downloaded from Spatial Climate Analysis Service, Oregon (http://www.ocs.orst.edu/prism/). This dataset was created at the center through interpolation of the station data using PRISM (Parameter-elevation Regressions on Independent Slopes Model). PRISM is an analytical model that uses point data and a digital elevation model (DEM) to generate grid estimates of monthly and annual precipitation (as well as other climatic parameters). PRISM is well suited to all regions because it incorporates a conceptual framework that addresses the spatial scale and pattern of orthographic precipitation. It has been found suitable for localized analysis at the level of 2 km grids. The total excessive precipitation was calculated for each grid cell form the yearly average data. The grids lying with a metropolitan jurisdiction were then averaged out using GIS tools.

A higher cumulative precipitation in the decade 1991-2000 is expected to result in increased perception of risk and consequently have a positive impact on adoption of climate change mitigation policies.

3.5.2.1.2 Number of days above 85th percentile normal daily average apparent temperature

This variable is a measure of the temperature extremes being experienced by the local community. The apparent temperature is a measure of the combined effects of temperature and humidity. Ignoring wind effects, apparent temperature can be estimated as A (deg. C) = -1.3 + 0.92T + 2.2e, where T is ambient air temperature (deg. C) and e is water vapor pressure (kPa) (Steadman 1984). These 85th percentile values have been shown to be closely correlated with weather related mortality statistics (Kalkstein and Davis 1989). The data set was downloaded from the National Climatic Data Center (NCDC) web based data sharing interface (ftp://ftp.ncdc.noaa.gov/pub/data/heatstress /stationdata/). The data is available for 183 climatic stations. 162 out of these stations were found to lie with the jurisdiction of at least 1 metropolitan area. For the rest of the metropolitan areas the records of the nearest station were utilized for the purpose of the construction of this variable. The average distance between the metropolitan area and the nearest weather station was 91 miles with the maximum being 186 miles. The numbers of days exceeding the yearly 85th percentile normal average apparent temperature were summed up for the decade 1991-2000 for each of the metropolitan areas.

More number of days with extreme temperatures (high) in the decade 1991-2000 are expected to result in increased perception of risk by the local community and consequently have a positive impact on adoption of climate change mitigation policies.

3.5.2.1.3 Casualities due to weather related disasters

One of the most debated impacts of climate change is its effect on the weather related hazards. Even though there is lack of scientific consensus on the same a measure of this probable impact has been included in this analysis. The rationale underlying this selection is that communities tend to view their future level of risks in the perspective of the past impact of extreme events. The variable utilized in the study is the sum of all the deaths and injuries in the weather related extreme events from 1991 to 2000. This data was downloaded from the Sheldus v.4.1 (www.sheldus.org) database maintained by Hazards Research Lab, University of South Carolina. The data is available at the county scale. It was spatially aggregated for each of the metropolitan areas using GIS tools.

Higher casualities in last decade due to the extreme weather events is expected to result in increased perception of risk and consequently have a positive impact on adoption of climate change mitigation policies by the local communities.

3.5.2.1.4 Percentage of low lying coastal areas within the metropolitan area

Coastal areas below 3.5 mts above msl (mean sea level) have been identified as most vulnerable to the estimated sea level rise expected by the middle of the 21st century (Nicholls and Tolls 2006). Environment Protection Agency (EPA) has prepared a detailed high scale map of the US coastline identifying regions ranging from 1 m to 4m above mean sea level (Titus and Narayanan 1995). This digital data was procured from the EPA and used to identify regions less 3.5 m above mean sea level (msl). The area occupied by the low lying coastal lands has been calculated as percentage of the total metropolitan area it was situated within using GIS tools.

Presence of a high percentage of such coastal low lying areas within the metropolitan areas is expected to add to the perception of risk associated with sea level rise and consequently have a positive impact on adoption of climate change mitigation policies by the local communities.

3.5.2.1.5 Percentage of area occupied by sensitive land uses

The forests and wetlands have been identified as sensitive ecosystems that may be impacted by the change in the climatic system. The shifts in the regional climate pattern would lead to changes in the species composition, succession of natural ecosystems and even loss of wetlands (NAST 2000). Thus areas with relatively larger percentage of such sensitive land uses stand the risk of loss of ecological functions that would impact all other developmental activity in the region. This measure was crated using the medium resolution vector land use data available from NOAA (CA&DS 1999). The most recent updating of this data set was carried out in early 1990s. The vector data was intersected with the metropolitan area boundaries and the combined percentage of the forests and wetlands was calculated for each of the metropolitan areas.

Presence of a high percentage of these sensitive ecosystems within the metropolitan areas is expected to add to the perception of risk associated with climate change and consequently have a positive impact on adoption of climate change mitigation policies by the local communities.

The following table details out the expected impact of each of the above discussed indicators on the cumulative perception of risk amongst the local communities.

Table 3.1 List of risk variables

Risk Indicator	Source of Primary data	Expected impact on perception of Risk
Precipitation (1991-2000, mm>normal)	National Climatic Data Center (NCDC)	+
Temperature (1991-2000, days > 85th percentile apparent temp.)	PRISM data set, Spatial Climate Analysis Service, Oregon.	+
Natural Hazards Casualties (1991-2000)	Sheldus v.4.1, university of South Carolina	+
Percent Coastal low lying area	EPA	+
Percent Eco-Sensitive Area	NOAA	+

3.5.2.2 Climatic 'Stress'

The research literature on climate change identifies growth of urban population, carbon intensive industries, use of fossil fuels in energy generation and unsustainable traveling pattern as important causes of environmental stress that contributes to climate change. In order to asses the level of climate change stress imposed by a metropolitan area the following variables have been constructed so as to best capture these dimensions of stress with the limitations of data availability.

3.5.2.2.1 Population density (persons per sq km)

The gross density of the metropolitan area based on the US census 2000 data was calculated to create this measure. Urban density is a relative measure of efficiency. In general, and other things being equal, higher density land use is less energy and resource consuming and thus is more efficient from an ecosystem perspective and consequently effective in limiting the urban impact on regional climate (Bulkeley and Betsill 2003). For example, transportation in higher density areas is less resource demanding since distances are shorter and public transportation is often more available and inexpensive. As a result, air pollution will be lower in more densely populated areas. A low density growth would thus result in higher stress on the climatic system than a denser pattern of development.

Thus a higher density in the metropolitan area is expected to have a negative impact on the overall stress imposed and consequently positively impact the commitment of the local community to adopt climate change mitigation policy.

3.5.2.2.2 Percentage of workers employed in carbon related sectors

The percentage of workers employed in the carbon related sectors was calculated using the US census 2000 data. The industry sectors included in the carbon intensive sectors are NAICS category of Agriculture, forestry, fishing, and hunting, and mining; Manufacturing and Transportation and Warehousing, and Utilities. A higher percentage of employment indicates the dominance of this sector in the respective jurisdiction. It is an obstacle in promoting policy measure for climate change mitigation due to the local economic considerations (Saporito 1992).

Thus more employment in the carbon intensive sectors is expected to add on to the climatic stress and consequently have a negative impact on the local community's decision to adopt climate change mitigation policies.

3.5.2.2.3 Per capita carbon emissions (1990)

The year 1990 has been identified as the baseline year for promoting the climate mitigation initiatives to achieve emissions below this level. It is employed as the base measure for measurement of unsustainable levels of emission. The data for carbon emissions for all the states of U.S.A was obtained from Blasing, Bronaik, and Marland (2004). The authors used the data for consumption data for coal, petroleum, and natural gas for calculating the carbon emission obtained directly from the Department of Environment for calculating the overall carbon emissions. The state level data was used to calculate the total emission in each constituent county on basis of the census 2000 population. The county level data was then aggregated into the respective metropolitan area and then converted to a per capita figure. Even though the climate change mitigation programs target high emission areas for controlling emissions, the intrinsic linkages with the local economy make it difficult for these communities to adopt climate change mitigation policies. The local carbon based economic sectors are expected to be financially strong and influential to prevent such measures by the local government.

Thus higher emissions indicating larger number of carbon intensive industries is expected to add on to the climatic stress and represent strong local economic concerns that are expected to have a negative impact on the local community’s decision to adopt climate change mitigation policies.

3.5.2.2.4 Percentage of workers travelling alone in private vehicles to work

The data was collected at the metropolitan level from US census 2000 data. This provides a measure of the general extent of the use of private vehicles. Car pooling and use of public transportation help curb vehicular pollution whereas individual drive to work adds to environment stress. This is a better measure than simple vehicular ownership as it signifies the actual usage of the vehicle on a regular basis.

A higher percentage of workers using private vehicles for travelling contribute to the stress imposed by the metropolitan area. As climate change mitigation measures are expected to discourage this travel behavior, this indicator is expected to have a negative impact on the community’s decision to adopt climate change mitigation policies.

3.5.2.2.5 Percentage of households using solar energy as heating fuel

The use of solar energy as heating fuels is obviously more ecologically sustainable than any other form of energy. The percentage of households using solar energy for heating purposes was calculated from data available in the 2000 US census. A higher proportion of households using solar energy for heating results in reduced demand on energy generate from other sources that are more detrimental to the environment and would result in higher carbon emissions.

Thus more use of solar energy by the households will result in reducing the overall stress imposed on the environment and also have a positive impact on adopting climate change mitigation policies.

The following table 3.2 details out the estimated impact of the various stress variables on the cumulative climatic stress imposed by the metropolitan area.

Table 3.2 List of stress variables

Indicator Variable	Source of Primary data	Impact on Cumulative Stress
Population Density	US Census 2000	-
Percent Carbon Employment	US Census 2000	+
Carbon Emissions per Capita (1990)	Carbon Dioxide Information Analysis Center (CDIAC)	+
Percent Travel Alone	US Census 2000	+
Percent Households Solar Energy Use	US Census 2000	-

3.5.2.3 Civic capacity

Since the climate change adaptations are associated with higher level of personal costs it is perceived that the economic capacities, education and general environmental behaviour of the people will be an important determinant of the dependent variables.

Environmental behaviour is defined as significant actions that directly or indirectly cause positive environmental change (Stern 2000). The measures of civic capacity sue indicators of environmental behaviour as well as socio-economic capacity that is expected to support such behaviour. This study utilizes the following variable as measures of civic capacity:

3.5.2.3.1 Proportion of population participating in environmental causes and proportion of population recycling products

These measures were derived from MRI consumer behaviour survey conducted by Mediamark Inc. in 2003. Researchers at Applied Geographic Solutions Inc have configured MRI household records to various levels of political, administrative and statistical scale using a mosaic coding technology based on cluster algorithm. The dataset on the metropolitan areas was collected for inclusion in this study. The data is based on the self reporting by the respondents if they did recycle or participated in environmental causes in the year prior to the survey.

3.5.2.3.2 Percent of population above the national 80th percentile income

This data was derived at the metropolitan scale from the 1000 US census. It provides a relative measure of economic capacity of the local population to absorb financial implications that come with climate change mitigation policies.

3.5.2.3.3 Percent of population graduating from high school

This variable created from the US census 2000 data set signifies the level of literacy in the metropolitan area. Higher levels of literacy are confirmed to promote environmental behaviour through better understanding of the ecological process and human's relationship with nature. Higher education levels are expected to promote climate change mitigation efforts in the metropolitan areas.

3.5.2.3.4 Number of environmental NGOs

The number of registered environmental NGOs in at the county level (for the year 2000) was derived from the National Center for Charitable Statistics. The county level data was subsequently aggregated into the metropolitan level. A higher number of environmental NGOs signifies higher environmental activism in the metropolitan area and is more likely to translate into policy measures for climate change mitigation.

All the civic variables are expected to have a positive impact on the local community's decision to adopt climate change mitigation policies. Table 3.3 highlights the expected impact of each of the variables and the cumulative impact of the respective group variables on the local community's policy commitment to climate change mitigation.

Table 3.3 List of variables used in the study

	Source of Primary data	Expected impact on policy commitment to climate change mitigation
RISK		**+**
Precipitation (1991-2000, mm>normal)	National Climatic Data Center (NCDC)	+
Temperature (1991-2000, days > 85th percentile apparent temp.)	PRISM data set, Spatial Climate Analysis Service, Oregon.	+
Natural Hazards Casualties (1991-2000)	Sheldus v.4.1, university of South Carolina	+

Table 3.3: Continued

	Source of Primary data	Expected impact on policy commitment to climate change mitigation
Percent Coastal low lying area	EPA	+
Percent Eco-Sensitive Area	NOAA	+
STRESS		**-**
Population Density	US Census 2000	+
Percent Carbon Employment	US Census 2000	-
Carbon Emissions per Capita (1990)	Carbon Dioxide Information Analysis Center (CDIAC)	-
Percent Travel Alone	US Census 2000	-
Percent Households Solar Energy Use	US Census 2000	+
CIVIC		+
Proportion participated in Environmental Causes	MRI Consumer Behavior Survey, Mediamark Inc.	+
Proportion Recycled Products	MRI Consumer Behavior Survey, Mediamark Inc.	+
Percent 80th Percentile Income	US Census 2000	+
Percent College Educated	US Census 2000	+
Number of Environmental Organizations	National Center for Charitable Statistics	+

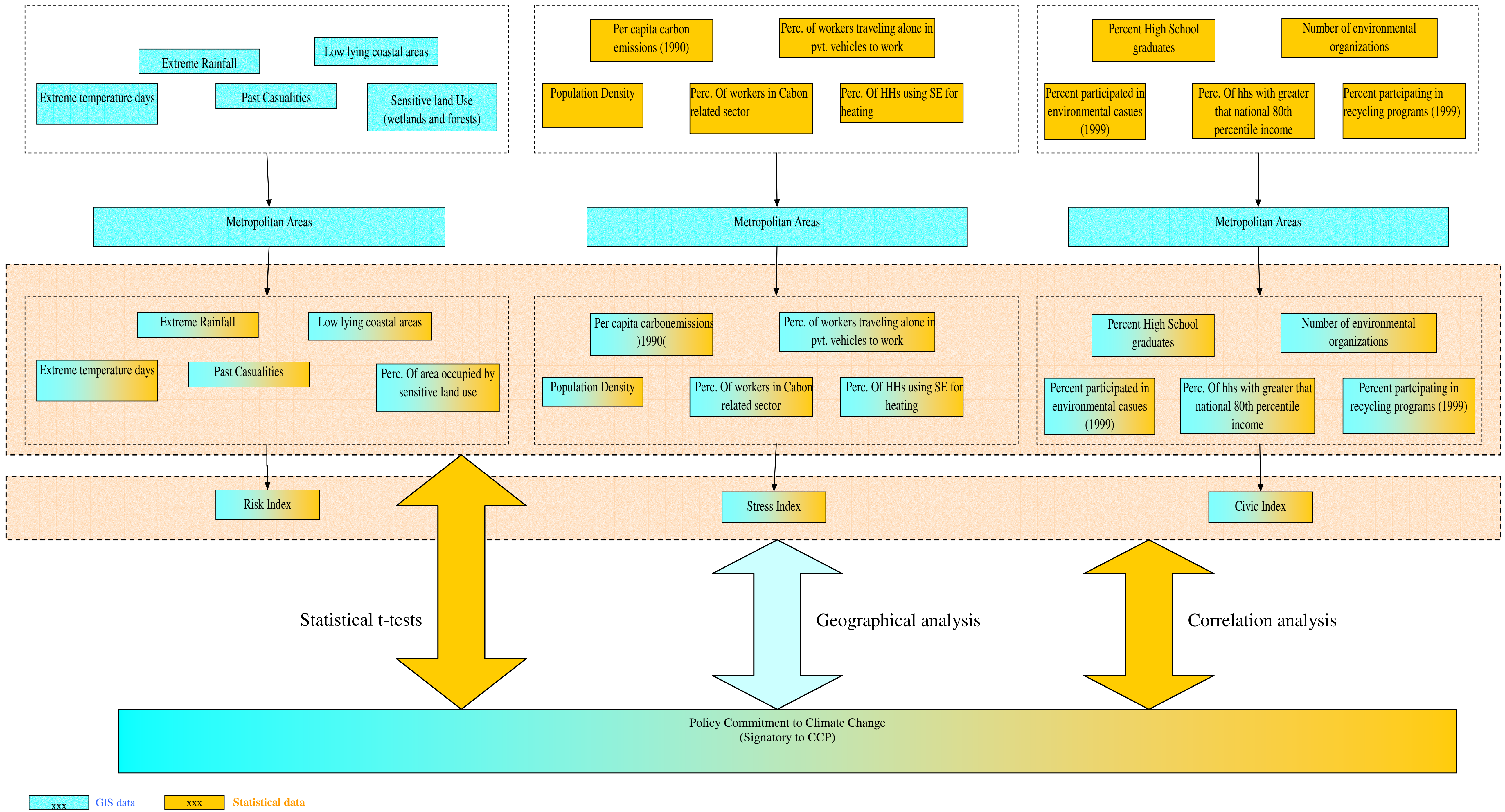
3.6 Study flow and research techniques

This research employs a combination of GIS and statistical analysis in order to achieve the research results and empirically test the hypothesis discussed earlier.

First, I used two sample independent t-tests to ascertain the differences between the characteristics of metropolitan areas that have within them jurisdictions signatory to the CCP campaign and those that do not. The t-test is commonly used to determine if two groups of data have statistically different means (Tabachnick and Fidell 2001). Second, I created a scale for each of the conceptual variable groupings of risk, stress and civic attributes. In the creation of the scale a few variables were dropped in order to maintain a high degree of reliability. The combination of variables with the highest value of Cronbach's alpha was used in creation of the respective scales. The variables were normalized (z-scored) and adjusted for consistency in direction with respect to the grouping concept before incorporation into the scaled measure.

Third, I mapped and geographically evaluated the risk, stress and civic scales. The scales were divided into 5 standard deviation intervals namely very low, low, normal (average), high and very high. The normal or the average category include the scores nearest to the mean and is indicative of the general trend on the respective scale. The scales are relative and may necessarily not imply the associated degree of importance (like high or very high). However, they are still useful in comparing the set of metropolitan areas included in the study. In order to compare within the metropolitan areas t-test analysis was undertaken. Finally correlation analysis is undertaken to compare the relationship between the various indices in the metropolitan areas. Procedures adopted for analyzing the data are represented in Figure 3.2.

Figure 3.2: Study flow



3.7 Validity threats

3.7.1 Geography of the study area

The GIS files for the study area consisting of statistical metropolitan areas as available from US census bureau and are designed for small scale, thematic mapping applications at a target scale range of 1:500,000 to 1:5,000,000. Thus these are suitable for the purpose of this research. The data downloaded from the census website however did have multiple polygons for a number of metropolitan areas. These were aggregated and merged. The final base data layer was created using GIS to signify a unique set of polygons for each of the metropolitan areas and sustain the accuracy of the source data.

3.7.2 Independent variables

The raw data on the dependent variable is dichotomous based on the list of CCP signatory members available for ICELI as of March 2003. Most of the signatories to the agreement are cities, municipalities or counties and not the metropolitan statistical areas. Thus the larger scale of analysis at the metropolitan area level is acceptable on the basis of conceptual validation of the research issue and the underlying definition of metropolitan areas as integrated economic and social entities which implies a high probability of impact by policy changes in any of the constituent jurisdictions. However with the number of jurisdictions uneven in each of the metropolitan areas and relative variation in the level of intra-regional linkages, the use of a non-political unit may represent a possible limitation of this study.

3.7.2.1 Independent geographic variables

The independent geographic variables (mapped areas) utilized in this study are; low lying coastal areas, cumulative measure of excessive precipitation, number of days of extremes in temperature, and percentage of sensitive land use areas.

The coastal elevation data was collected in the vector form EPA and is suitable for site level analysis. The extreme temperature event data is available as number of days yearly exceeding 85th percentile average annual apparent temperature associated with the respective climatic divisions (183) across USA from National Climatic Data Center (NCDC), US Department of Commerce. The data set was joined to the respective climatic divisions in GIS and then aggregated across the metropolitan using the minimum distance to station measure. This aggregation assumes similar climatic situation in the metropolitan area and ignores any local climatic variations. At the metropolitan scale this level of data precision is appropriate. Ratio of urban area to the sensitive ecological land uses was created using the Land Use/Land Cover digital data available from NOAA. The data was progressively updated up to early 90’s and is classified into 30 land use classes. It possibly represents land use character only up till mid-1990s. Thereafter there may have been changes in the land use that are not captured by the data set. The use of GIS procedures to merge and then compare the required land uses has resulted in maintaining the accuracy and reliability of the original dataset.

3.7.2.2 Independent non-geographic data

Statistical data has been collected from the various sources primarily at the metropolitan level. In case where only the county level data was available, for example the casualities data, the same was aggregated into the appropriate metropolitan area. Civic engagement data are derived from the MRI Consumer Behavior survey. Civic engagement and psychographic data on US adults are collected bi-annually by Mediamark Inc. Adults are selected randomly from a population list of 90+ million households. Each wave consists of 12,000+ face-to-face interviews, totalling 25,000 per year since 1979 (about 550,000 in all). However as the data is based on self –reporting behaviour it may be prone to error due responder bias. The number of environmental NGOs present in the metropolitan statistical area is derived from the record of registered NGOs with National Center for Charitable Statistics and is subject to the definitions adopted by the organization.

In addition to the above discussion, it is important to mention the possible threat of external validity. Specific to this study is the issue of temporal validity wherein there may be a possibility that the action undertaken earlier (CCP acceptance before 2000) is being compared with the independent data for the year 2000. Since this study uses a cross-sectional research design, the results and findings are subject to limited interpretation and cannot be generalized beyond MSAs.

CHAPTER IV

RESULTS

This chapter presents the results of the analysis carried out as part of this research. The first section details out the statistical analysis and the subsequent section presents the geographic analysis. Finally the combined results of the overall geo-statistical analysis are discussed.

4.1 Statistical analysis

Descriptive statistics and results from t-tests of all the variables used to identify the difference in characteristics of metropolitan areas with policy commitment to climate change mitigation and those without it, in term of climate change risk, stress, and civic capacity are presented in table 4.1 and table 4.2.

The results of the t-test indicate that there are significant differences between metropolitan areas that have adopted CCP and those that have not. Starting with the risk variables, the difference between the mean precipitation levels among the two sets of municipalities is found to be insignificant but difference between the mean numbers of days exceeding the 85th percentile average apparent temperatures (1991-2000) is found to be significant. The metropolitan areas that have accepted the CCP have significantly lower number of days exceeding the apparent temperature than those that have not accepted it. This is possibly because the metropolitan areas that have a higher number of days with temperature exceeding normal heat conditions do not consider the anticipated marginal increase in these excessive heat days as risk.

Table 4.1: Descriptive statistics comparing CCP committed and non-committed metropolitan areas on risk, stress, and civic variables

	CCP Signatory	N	Mean	Std. Deviation	Std. Error Mean
RISK VARIABLES					
Precipitation (1991-2000, cm > yearly normal)	1	122	1036.21	376.88	34.12
	0	185	1042.51	328.68	24.16
Temperature (1991-2000, days > 85th percentile yearly apparent temp)	1	122	4.66	7.59	0.69
	0	185	5.94	6.70	0.49
Weather Related Natural Hazards Casualties (1991-2000)	1	122	151.62	478.22	43.30
	0	185	110.68	184.11	13.54
Percent of Eco-Sensitive Area	1	122	39.20	24.89	2.25
	0	185	33.44	27.16	2.00
Percent of Low Lying Coastal Area	1	122	19.01	32.08	2.90
	0	185	10.48	25.87	1.90
STRESS VARIABLES					
Density of Population (persons/sqkm)	1	122	260.88	465.12	42.11
	0	185	91.04	61.18	4.50
Percent Carbon Employment (2000)	1	122	26.19	5.23	0.47
	0	185	28.51	7.17	0.53
CO2 Emissions per Capita (1990)	1	122	5.75	5.46	0.49
	0	185	7.82	5.87	0.43
Percent Workers Traveling Alone to work in Pvt. Vehicles (2000)	1	122	76.66	6.91	0.63
	0	185	80.47	3.75	0.28
Percent Households using Solar Energy for Heating (2000)	1	122	0.05	0.13	0.01
	0	185	0.02	0.03	0.00
CIVIC VARIABLES					
Proportion participated in Env. Causes	1	101	0.03	0.00	0.00
	0	182	0.03	0.00	0.00
Proportion Recycled Products	1	101	0.39	0.03	0.00
	0	182	0.37	0.03	0.00
Percent High School Educated	1	122	53.70	5.31	0.48
	0	185	51.45	5.26	0.39
Percent Households with income > 80th Percentile National household Income	1	122	22.02	8.82	0.80
	0	185	15.33	4.30	0.32
Number of Environmental Organizations	1	122	896.68	560.07	50.71
	0	185	598.41	413.66	30.41

Table 4.2: Independent samples t-test comparing CCP committed versus non-committed metropolitan areas on risk, stress, and civic variables

	t ^	df	Sig. (1-tailed)	Mean Difference	Std. Error Difference
RISK VARIABLES					
Precipitation (1991-2000, cm > yearly normal)*	-0.15	305.00	0.44	-6.30	40.66
Temperature (1991-2000, days > 85th percentile yearly apparent temp)*	-1.55	305.00	0.06	-1.28	0.82
Weather Related Natural Hazards Casualties (1991-2000)	0.90	144.90	0.19	40.94	45.36
Percent of Eco-Sensitive Area	1.91	274.40	0.03	5.76	3.01
Percent of Low Lying Coastal Area	2.46	220.35	0.00	8.53	3.47
STRESS VARIABLES					
Density of Population (persons/sqkm)	4.01	123.77	0.00	169.84	42.35
Percent Carbon Employment (2000)	-3.274	301.837	0.00	-2.32098	.70902
CO_2 Emissions per Capita (1990)*	-3.116	305	0.00	-2.07455	.66577
Percent Workers Traveling Alone to work in Pvt. Vehicles (2000)	-5.56	168.50	0.00	-3.80	0.68
Percent Households using Solar Energy for Heating (2000)	2.36	128.02	0.01	0.03	0.01
CIVIC VARIABLES					
Proportion Participated in Environmental Causes	5.31	178.78	0.00	0.00	0.00
Proportion Recycled Products*	4.79	281.00	0.00	0.02	0.00
Percent High School Educated*	3.65	305.00	0.00	2.25	0.62
Percent Households with income > 80^{th} Percentile Avg. National household Income	7.79	159.35	0.00	6.69	0.86
Number of Environmental Organizations	5.04	206.17	0.00	298.27	59.13

Note: * Equal variances assumed

^ Appropriate statistical technique employed in selection of the t value

The prior history of experiencing extreme heat conditions may have resulted in lowering the perception of risk associated with increasing number of extreme heat days. Instances of similar behavior by communities in regards to other natural disasters like earthquakes and hurricanes have been cited frequently in social science research (Dynes 1970; Quarantelli 1978). On the other hand the metropolitan areas with less number of days exceeding normal heat stress conditions may be more sensitive to the risk of expected increase in the number of extreme heat days. This variation in interpretation of the risk on the basis of past experiences may be responsible for the observed negative direction of this risk variable as against the expected positive direction.

The results also reveal that there are no statistically significant differences between the numbers of casualities due to the past weather related natural disasters in the CCP signatory metropolitan area and the non-signatory metropolitan areas. There however are significant difference between the mean percentage of area occupied by the eco-sensitive land uses of forests and wetlands within the metropolitan jurisdiction. The CCP signatory metropolitan areas have significantly higher area of these areas in comparison to the non-signatory metropolitan areas. This is in line with the expected results as a larger sensitive ecosystem in a metropolitan area indicates a high probability of local community's acceptance of the need to protect such critical ecosystems. The conservation attitude of the local government towards its fragile bio-diversity is probably the motivator for such metropolitan areas to join the CCP campaign.

The percentage of low lying coastal areas is also found to be significantly higher in the metropolitan areas that have joined CCP. The sea level rise is probably one of the most publicly accepted anticipated impacts of climate change. Thus it seems to have the expected positive effect on making the metropolitan area take an initiative in mitigating climate change. The metropolitan areas not within the low lying coastal zones are certainly more protected from sea level rise and therefore are possibly not inclined towards adopting mitigation programs.

In regards the stress variables all the indicators have statistically significant mean differences between the metropolitan areas signatory to CCP and those that are not. The metropolitan areas signatories to CCP have a higher density of population. A higher density of population signifies a higher degree of urban efficiency and is indicative of the local government taking measures to ensure lower stress on the local environment. Such metropolitan areas that have higher densities and a sustainable growth pattern (in terms of urban coverage) are expected to have a higher degree of sensitivity to climate change issues. Thus as expected the results indicate that the metropolitan areas signatory to CCP are denser and compact in comparison to the other metropolitan areas.

The percentage of workers in the carbon sector is found to be significantly lower in metropolitan areas that have joined the CCP campaign. Probably because the costs associated with limiting the carbon emissions under the CCP program are expected to be high especially for the carbon intensive sectors. These costs include cost of technology change and process innovation. With the local economic base comprising of a carbon intensive activities the local governments are seen to be less inclined to adapt climate change mitigation measures that will adversely impact the local economy. It may be argued that probably the long term gains outweigh the short term losses to these industries. However in the context of a political decision to join with CCP the context of 'long term' as associated with the pay back period of required innovations is certainly too long. The results thus indicate that as expected the metropolitan areas that have not joined the CCP have a large percentage of the work force employed in the carbon sector.

In terms of the per capita emission (1990) the results indicate that the metropolitan areas that joined the CCP had comparatively lower per capita emissions to start with. The metropolitan areas with high per capita emissions are probably the areas with high percentage of carbon intensive industries, longer per capita travel miles and higher energy use. The level of emissions is thus directly related to the nature of the local economic activities and the development pattern in the metropolitan area. Therefore as expected municipalities that are not a part of CCP have higher per capita carbon emissions as they are probably reluctant to undertake climate change mitigation measures that would adversely impact the existing economic base and the development pattern.

In the metropolitan areas that have signed the CCP, the percentage of workers traveling alone to work in private vehicles is found to be significantly lower. The use of single occupancy private vehicles to work indicates lack of public transportation facilities, higher consumption of energy and probably a more spread out pattern of development. Imposition of climate mitigation measure in such areas is expected to involve large capital costs to modify the present level of development and change the traditional habits of the community. As expected the results indicate that the metropolitan areas that have jurisdictions with CCP have a lower percentage of population driving private vehicles (with single occupancy) to work.

In terms of the use of solar energy, the metropolitan areas with the CCP campaign have a significantly higher percentage of households using it as means of energy for heating their homes. This is an indicator of the local government's ability to provide a more ecological friendly means of energy to the community. On the other hand the metropolitan areas with households using other means of energy for heating may be expected to make large capital investments in infrastructure if they were to adopt a cleaner energy source. This might be an effective economic deterrent in adopting the CCP. Thus as indicated by the results the variable behaves as expected, with the metropolitan areas not joining the CCP having lower percentage of households using solar energy as a heating fuel for their homes.

In regards the civic variables, the mean proportion of population participating in environmental causes and proportion of population recycling is significantly higher in metropolitan areas that are signatory to the CCP program. This is indicative of the general environmental behavior of the society which provides the local political administration the support to adapt more environmental friendly measures. The communities with a higher level of environmental participation may be expected to accept marginal increase in financial burden for conservation of the natural environment. As expected the metropolitan areas that have not joined the CCP campaign have a comparatively lower percentage of population engaged in environmental activities and recycling programs.

The percentage of high school graduates in the population of the metropolitan areas that have adopted the CCP program is found to be significantly higher. Better education levels have multifold societal impact including higher income levels, more environmental sensitivity and better understanding of common resource issues. Consequently these civic attributes are expected to promote environmental friendly measure include climate change mitigation. Thus as expected metropolitan areas that have not joined the CCP have lower percentage of high school graduates.

The percentage of population earning more than the 80^{th} percentile of the national household income is also found to be significantly higher in the metropolitan areas committed to CCP. A higher percentage of the population in the highest income domain signifies a higher capacity of the community to adopt measures involving increased outlay of resources. These communities have the capacity to absorb the enhanced costs of mitigation policies that may be required for effective control of emissions. Comparatively, lower economic capacity to meet the estimated costs of mitigation measures will prove to be a deterrent to participation in CCP. Therefore as expected the metropolitan areas that have a lower percentage of population earning higher incomes have not committed to the CCP.

The number of environmental organization was also found to be significantly higher in the metropolitan areas that have joined the CCP campaign. The role of environmental NGOs as active catalyst for facilitating consensus on broader issues of ecological importance was expected to be a factor in promoting policy measure for mitigating climate change. The results reveal that as expected metropolitan areas that have not joined the CCP have comparatively lower number of such environmental NGOs.

4.1.1 Index construction

The risk, stress and civic variables were combined together within the respective conceptual domains to create risk, stress and civic indices. Initially all the variable in each domain were included in the index and evaluated for statistical reliability of the scale. The table 4.3 presents the results of the analysis.

Table 4.3: Preliminary reliability analysis of indices

Index Items	Item Total Correlation	Alpha	Variance	SD
Climate Change Risk Index		**.426**	**7.589**	**2.7548**
Precipitation	.372			
Temperature	.107			
Natural Hazards Casualties	.070			
Percent Eco-Sensitive Area	.351			
Percent Coastal Area	.229			
Climate Change Stress Index		**.537**	**8.766**	**2.9607**
Population Density (per meter)	.322			
Percent Carbon Employment	.342			
CO_2 Emissions per Capita	.191			
Percent Travel Alone	.582			
Percent Household Solar Energy Use	.116			
Civic Index		**.762**	**-.1175**	**3.5368**
Percent Participated in Environmental Causes	.737			
Percent Recycled Products	.797			
Percent 80^{th} Percentile Income	.681			
Percent College Educated	.510			
Number of Environmental Organizations	.059			

The civic variables are found to statistically hang together really well with an alpha coefficient of 0.762. However the variable- number of environmental organizations is evidently the least correlated with the other variables included in the civic index. The climate change risk variables also seem to statistically hang together with an alpha coefficient of 0.537. However this represents only a low to moderate level of reliability for creating a common scale of stress. Amongst the variables included, per capita CO2 emissions and percentage of households using solar energy are found to be the least correlated with the other variables included in this scale. The climate change risk variables seem to have the minimum level of reliability for developing a common scale with a low alpha coefficient of 0.426. The temperature variable and the natural hazard causality variable are found to have minimum correlation with the other variables in the scale. Thus statistically the risk and the stress indices created above cannot be considered reliable.

Therefore the scales were revised to drop the least correlated variables in each of the groups. The reliability analysis was carried out for this shortened list of variables within each group. The results are presented in the table 4.4.

Table 4.4: Final reliability analysis of indices

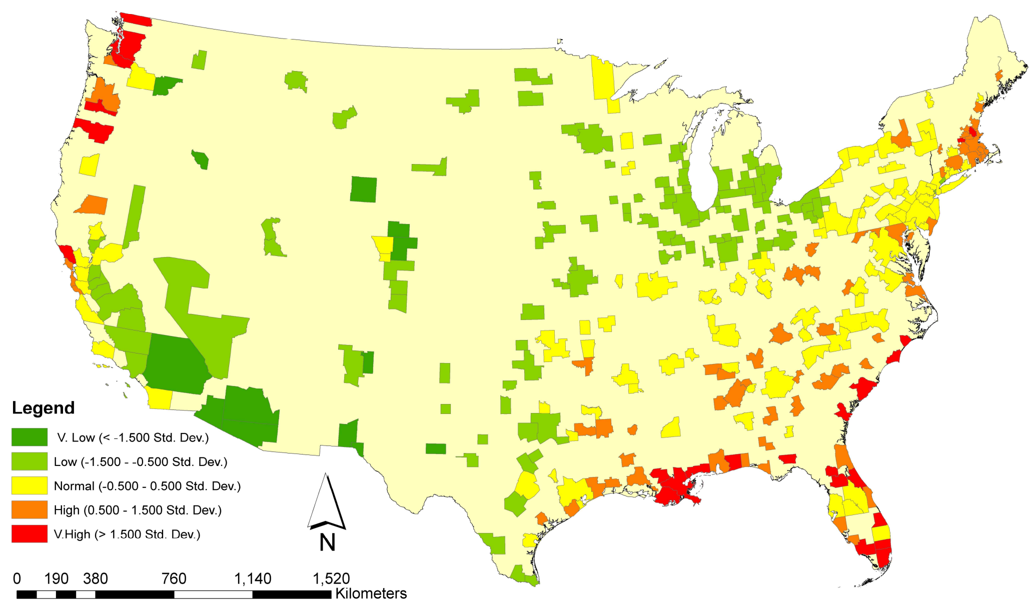
Index Items	Item Total Correlation	Alpha	Variance	SD
Climate Change Risk Index		**.632**	**5.183**	**2.2767**
Precipitation	.563			
Percent Eco-Sensitive Area	.485			
Percent Coastal Area	.295			
Climate Change Stress Index		**.637**	**5.212**	**2.2830**
Population Density (per meter)	.425			
Percent Carbon Employment	.267			
Percent Travel Alone	.692			
Civic Index		**.870**	**11.064**	**3.3262**
Percent Participated in Environmental Causes	.810			
Percent Recycled Products	.852			
Percent 80^{th} Percentile Income	.649			
Percent College Educated	.598			

These indices created with the shortened list of variable are found to be statistically more reliable. Each of the indices has the alpha coefficient of more than 0.6 that is generally considered a measure of sufficient reliability for creation of a scale.

4.2 Geographical analysis

The metropolitan areas were subsequently mapped out along with the indices created through statistical analysis earlier. In order to provide a relative measure of degree (high or low) amongst the metropolitan areas the indices were segregated into 5 standard deviation intervals. The figure 4.1 highlights the distribution of risk amongst the metropolitan areas.

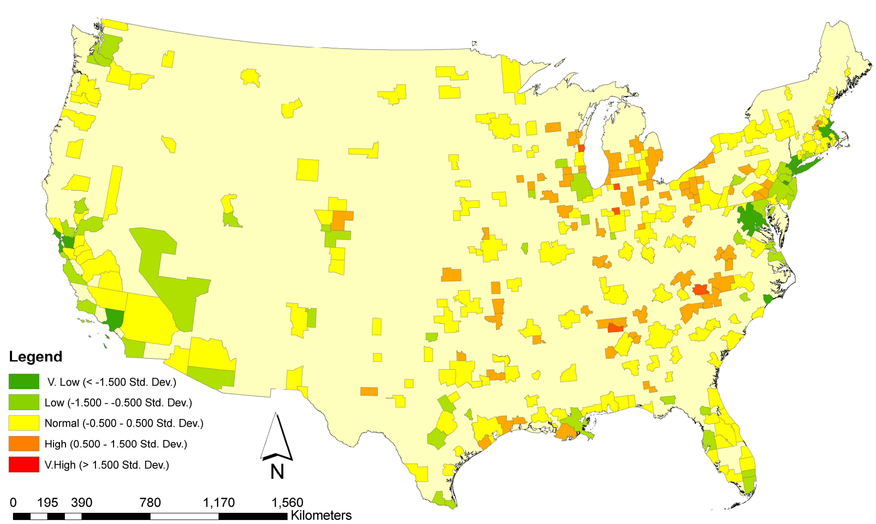
Figure 4.1: Distribution of risk due to climate change impact



Almost 30% (87 nos.) of the metropolitan areas fall within the high to very high risk category. List of these metropolitan areas is provided in the appendix. The map reveals that the risk due to climate change is concentrated around the gulf coast and the eastern coast. The high risk areas as identified in this study seem to include the coastal regions that have historically been under threat of hurricanes and other severe weather conditions. Existence of large number of wetlands and low lying coastal areas, along with higher than normal precipitation in the last decade is the cause for this high level of risk in parts of Louisiana, Mississippi and Florida. High percentage of low lying areas adds to the vulnerability along the northern half of the east coast. Along the west the pockets of high vulnerability are seen in regions with concentration of wetlands in the low lying coastal areas.

The figure 4.2 shows the distribution of the metropolitan areas in the context of the levels of stress they impose on the natural climatic systems.

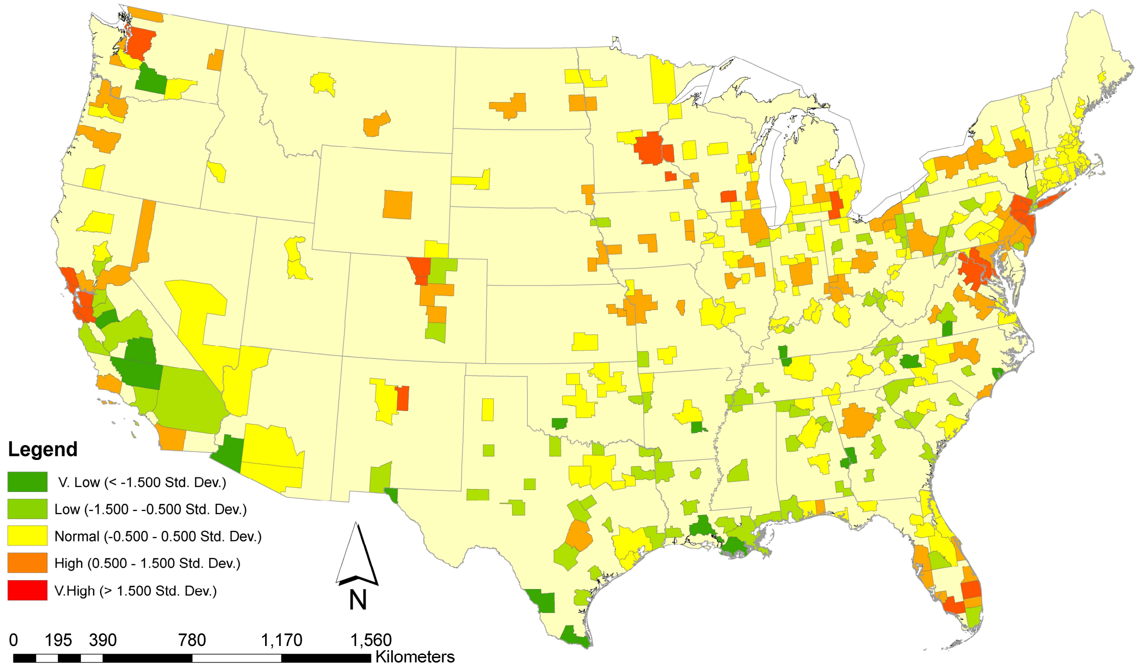
Figure 4.2: Level of stress imposed by the metropolitan areas on climatic systems



The above geographic analysis reveals that only 5 of the metropolitan areas exert very high stress on the climatic system. These are; Elkhart--Goshen, IN; Kokomo, IN; Hickory--Morganton--Lenoir, NC; Sheboygan, WI; and Decatur, AL. All these settlements have a high percentage of workers employed in carbon intensive industries, high per capita emissions and extremely low densities. 71 metropolitan areas are identified as high stressors. The map reveals high concentration of these metropolitan areas in states that have a high share of manufacturing employment (refer annexure for 2004 state rankings for manufacturing employment). The western states with less of the manufacturing sector and higher tertiary sector economic base seem to be contributing only average or below average stress levels. However this analysis needs to be interpreted with caution as the normal (average) of the stress as identified in this analysis is only a relative measure and not absolute. In all probability due to the overall higher levels of per capita energy consumption and waste generation in US even the average stress may qualify as high stress in an absolute analysis. For instance, the per capita CO_2 emissions in US due to consumption of fossil fuels were 5 times than the world average per capita in the year 2003 (http://www.eia.doe.gov/environment.html) and almost 20 times that of India. This represents the magnitude of difference between the developed and developing nations in terms of emission contributions. The relative scale of analysis will thus have to be adjusted in the international context if the results are to be compared with other countries. The analysis of the stress index reveals that more than 80% (248 nos.) of the metropolitan areas exert average to and above average stress on the climate.

The figure 4.3 shows the distribution of the civic index across the metropolitan areas of US.

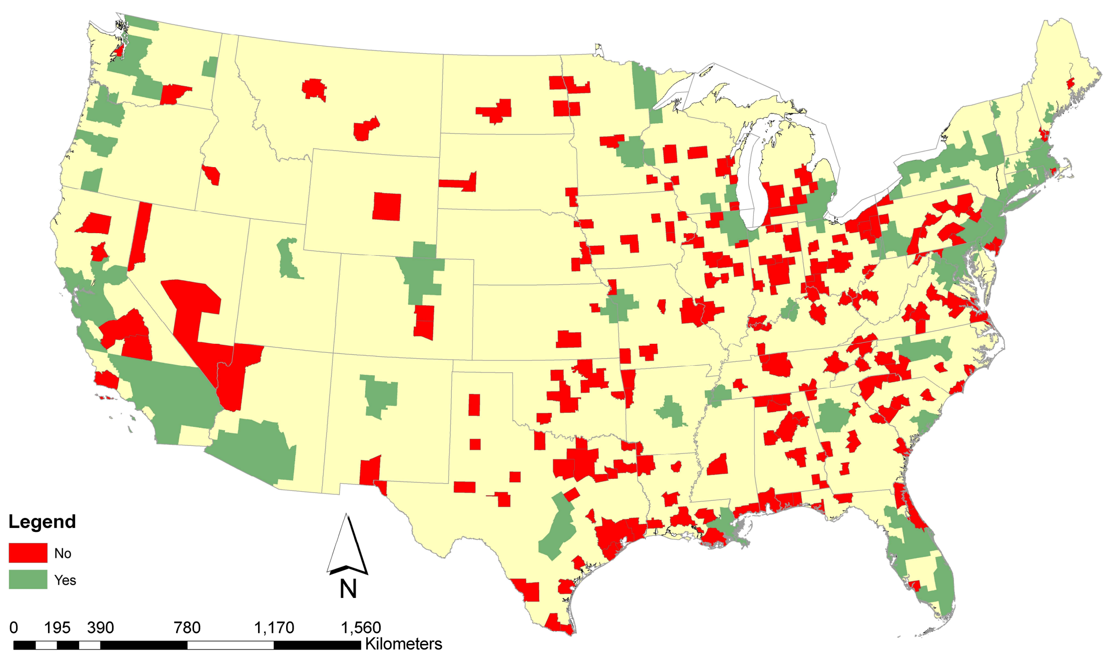
Figure 4.3: Civic indices for the US metropolitan areas



The civic index reveals that a high percentage of the metropolitan areas (70%) have an average or better than average civic index as calculated in this study. The distribution of the civic index across the country seems to correspond with the per capita earnings and the educations levels of the respective states (refer annexure for per capita state rankings). In comparison with the metropolitan areas that have adopted CCP (refer Figure 4.5), almost 80%, have average or above average civic index as calculate din this study.

The figure 4.4 reveals that the metropolitan areas that have accepted the CCP are clustered along the east and the west coasts. This distribution seems to correspond to the distribution of above normal risk metropolitan areas (figure 4.2). This validates the results of the t-tests wherein a difference in the means of the risk variables was observed between the two sets of metropolitan areas. The data reveals that almost 30% of the settlement with associated climatic change risk above normal are signatory to the CCP.

Figure 4.4: Status of CCP in the US metropolitan areas



The comparison of the CCP metropolitan areas with the stressor areas as identified by this study (refer Figure 4.3) reveals that the location of these areas generally corresponds with the normal and below normal stressor metropolitan areas.

The analysis of the data reveals that only 13 of the high stressor metropolitan areas are part of the CCP campaign. None of jurisdictions in the top 5 stressor (very high category) metropolitan areas have signed onto the CCP campaign.

The t-test was conducted to explore the differences between the CCP committed and non-Committed metropolitan areas in terms of the risk stress and civic indices. The results are presented in table 4.5.

Table 4.5: Independent samples t-test comparing CCP committed versus non-committed metropolitan areas on risk, stress, and civic indices

	t^	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference
Risk	1.88*	305.00	0.06	0.50	0.26
Stress	-5.65	305.00	0.00	-1.59	0.25
Civic	5.66	281.00	0.00	2.35	0.39

Note: * Equal variances assumed
^ Appropriate statistical technique employed in selection of the t value

The above results reveal that the metropolitan areas with CCP committed jurisdictions have significantly higher levels of risk and civic indices. This indicates a higher probability of adoption of CCP in metropolitan areas with higher risk levels. Similarly metropolitan areas with a high civic index may be expected to adopt policy measures for climate change mitigation (as defined by acceptance of CCP). In contrast the stress index is found to be significantly lower in CCP committed metropolitan areas implying that high stressor metropolitan areas not likely to join the CCP campaign.

In order to analyze the relationship amongst the three indices of risk, stress and civic attributes correlation analysis was undertaken. The results are presented in the following table 4.6.

Figure 4.6: Correlation between risk, stress, civic indices and CCP status

		RISK Index	CIVIC Index	STRESS Index
CCP Status	Pearson Correlation	0.11	0.34	-0.34
	Sig. (2-tailed)	*0.06***	*0.00**	*0.00**
RISK Index	Pearson Correlation	1.00	0.00	-0.08
	Sig. (2-tailed)		*0.95*	*0.19*
CIVIC Index	Pearson Correlation	0.00	1.00	-0.21
	Sig. (2-tailed)	*0.95*		*0.00**
STRESS Index	Pearson Correlation	-0.08	-0.21	1.00
	Sig. (2-tailed)	*0.19*	*0.00**	

*significant at .05
**significant at .1

The above results do not reflect any statistically significant relationship between risk and civic indices. Similarly no statistically significant relationship is revealed between the risk and stress indices. However statistically significant negative relationship is revealed between the stress index and the civic index ($r=-0.21$, $p<.05$). Thus suggests that civic attributes as defined in this study are lower in high stressor metropolitan areas.

4.3 Summary of results

The summary of the results of the geo-statistical analysis as discussed in the preceding section are summarized below:

H1: Climatic stressor metropolitan areas are not proportionally at risk.

The research results support the above hypothesis as no significant relationship is observed between the level of stress exerted by the metropolitan area and its associated level of risk due to climate change.

H2: MSAs with higher climatic risk are more likely to commit to climate change mitigation policies.

In general the research results suggest validation of hypothesis as jurisdictions within high risk metropolitan areas were found to favour CCP acceptance.

H3: MSA exerting higher climatic stress are less likely to adopt climate change mitigation policies.

The research results also provide support for this hypothesis as the metropolitan areas show a significant negative relationship between their level of stress and those with jurisdictions signing on to the CCP. The higher the stress the lower is the chances of the jurisdictions within the metropolitan area becoming part of the CCP.

H4: Metropolitan areas with higher levels of civic engagement are more likely to adopt policies to mitigate the adverse effects of climate change.

The research results support this hypothesis as the data analysis reveals that there exists a significant positive relationship between the civic attributes of the metropolitan area and the CCP acceptance.

4.4 Discussion of results

The results of the study confirm the influence of metropolitan areas on the constituting jurisdiction in regards adopting climate change mitigation policies by joining CCP. There is an evident lack of relationship between stress and risk variables at the metropolitan level. This represents dilemma of equity and justice similar to that as being encounters at the international level. Anthropogenic cause of climate changes is attributed to greenhouse gases emitted by developed countries but the impact are expected to disproportionately burden the developing countries making the sharing of costs difficult (Neumayer 2000). A similar situation seems to be emerging within the metropolitan areas of US.

The continued reluctance of the higher carbon emitting regions to adopt climate change mitigation measures is identified through the correlation analysis. The metropolitan areas with higher stress index were found to be less likely to have constituent jurisdictions commit to support climate change mitigation policies by joining the CCP. With the CCP campaign focusing enlisting an appreciable percentage of the greenhouse gas emitting urban areas, this remains a cause of concern. Enlisting cities and counties in metropolitan areas with comparatively lower carbon emissions in the mitigation program would not help much in the long run if the metropolitan areas with higher emission continue to increase their emissions. This challenge for the CCP has also been identified in recent county level study of factors affecting participation of localities in policy commitment to climate change (Zahran et al. 2005b).

This is of serious concern because if the metropolitan areas emitting higher carbon are unable to control their emissions, all mitigation efforts would prove ineffective. In such a scenario the overall reduction in emission statistics of the nation is only a statistical average of these high emission areas along with reducing low emission regions. Consequently the perceived success in the mitigation efforts would be short lived as further reduction of emission in already low emission areas may become too small in comparison to the increasing emissions by the high stressor metropolitan areas.

The positive impact of the risk index on the status of CCP supports the findings of the earlier literature that the perception of risk is a powerful trigger for adopting climate change mitigation measures. The level of risk due to the anticipated impact of climate change to the metropolitan area is seen to translate into local policy initiatives for climate change mitigation. The relationship between the community's civic index and policy commitment to climate change mitigation highlights the role of environmental activism and inherent adaptive capacities. Higher level of civic attributes as described in this study are a positive factor that promote eco-consciousness translating into effective participation in climate change mitigation initiatives like the CCP.

Overall the results o the study indicate that the metropolitan area level attributes of risk, stress and civic capacities have an important role to play in the decision of the local governments participating in the climate change mitigation initiatives. The regional economic concerns and the developing pattern dependent on high carbon emissions prevent such positive local initiatives. However perception of higher risk does influence enhanced commitment to mitigation efforts. Similarly the regional adaptive capacities are also found to support local mitigation initiatives.

4.5 Limitations

This study stops short of measuring the level of impact of the metropolitan area level variables on the local government's decision to join CCP. Thus the interpretation of the analysis in terms of the relative level of influence of the metropolitan level variables with reference to the national level or county/local level variables cannot be undertaken.

The lack of temporal qualification of the data on the acceptance of CCP limits the extension of these results. The list of CCP signatory jurisdictions utilized in this study includes even those that may have joined before the date of metropolitan data acquisition.

The use of metropolitan area level variables as influencing factors in the local government's decision to adopt climate change mitigation policies may have limited political relevance as these areas are not formal politico-administrative jurisdictions.

Further the use of CCP itself as a climate change mitigation measure is limited. Even though ICLEI claims significant progress in emissions control by participation of in CCP there is no way to empirically confirm the same. Due to the lack of sufficient time lag following the policy adoption empirical measurements of the emissions are difficult. Thus there may be a possibility that some metropolitan areas may be adopting measures other than CCP enrollment for climate change mitigation.

CHAPTER V

CONCLUSIONS AND RECOMMENDATIONS

This section discusses the conclusions draw from the discussion of the results of the research and proposed some recommendations of the local governments in order to ensure effective climate change mitigation. The final sub section identifies future areas of research that arise out of this study

5.1 Conclusions

This study highlights the influence of metropolitan level characteristic in influencing the local initiatives for climate change mitigation. The climate mitigation programs at the local level like the CCP cannot achieve the desired objectives by adopting a closed box approach. The regional socio-economic linkages are pertinent to the process of decision making at the local level especially for issue like climate change mitigation that have ramifications beyond the local jurisdiction. For instance if a local government within a predominantly industrial metropolitan area decides to apply stricter emission norms it is effectively going result in negatively effect its competitiveness in the regional market for attracting more industrial use. The other service industries and even residential developments would then follow the way the primary economic activities go. Thus the local governments are severely constrained in terms of what they can achieve as regards climate change mitigation.

The research reveals that a higher level of stress exerted by the metropolitan function has a negative impact of the local government's policies towards climate change mitigation. This highlights the possibility of failure of most of the national and international climate mitigation efforts in creating a culture of responsibility amongst the worst carbon emitters. The results of this research echo findings similar to those in disaster research in terms of the broader economic interests taking precedence in decision related to adoption of mitigation policies. It represents a case for extending the research on “socio-political ecology” of hazards perspective (Peacock, Morrow, and Gladwin 2000).

5.2 Recommendations

In the context of the relationships identified in the statistical analysis undertaken the following is a brief list of planning recommendations that can play a decisive role in achieving the goals of the broader mitigation efforts:

1. Effective regional level climate change mitigation initiatives: There are number of national level and local level programs for promoting climate change mitigation. However as this research reveals that the success of such programs is qualified by the regional socio-economic realities. Thus logically the climate change mitigation programs need to evolve into an integrated network across the various spatial scales of linkages and take into account the regional socio-economic consideration. Planning at the level of economically aggregated units like the metropolitan areas for climate change mitigation will prove to be more effective aht the piecemeal local efforts.
2. Assessing long term risks and mitigation capacities in the regional context: With the results of this study validating the fact that climate change is slow but certain

process and mitigating its impact would also take time it is necessary to plan mitigation and adaptation strategies for a longer perspective duration extending even up to a couple of decades into the future. A temporary present day assessment of risks with limited boundaries of the local jurisdiction is not enough. The impact of present day stress contributions may be expected to bring about changes after a few decades. In such a scenario perspective regional planning would help identify possible future vulnerabilities and adopt a more resilient growth pattern.

3. Controlling growth in coastal areas: Directing growth away from the areas more vulnerable to the anticipated impact of climate change is necessary in view of the possibility that the present mitigation efforts would not result in any tangible gains for quite some time. Reducing densities in the low lying coastal zones has to be done in order to ensure limited exposure to the possible sea level rise.

4. Reducing the footprint of the settlement: Higher densities prove to help reduce the carbon emissions in the metropolitan area. The reasons for the same could be multi-fold. The reduction in overall vehicle trips, less use of construction materials that may result in urban heat island effect and of course possibility of higher public activism due to higher concentration of people. Additionally higher densities have also been found be more sustainable and social desirable by the new urbanism and smart growth researchers. Local planning policies can utilize principles like mixed use and street-scapes from these urban sustainability disciplines as common means of mitigating climate change and sustainability.

5. Controlling suburbanization: The analysis of the data used in this study indicates that there is a tendency of suburban households to increase in regions with higher percentage of land under sensitive land uses like wetlands and forests. Possibly this is because of the intrinsic value of these ecological resources that offer a pleasing setting for living. However the destruction of this resource is also linked to increasing stress on the climate and subsequent negative impact on controlling the growing emissions it is imperative that local planning guideline identify ways and means to control this phenomena. Use of planning tools such as growth boundaries, restricted use zones and transfer of development rights can be utilized by the local bodies to prevent urban sprawl into these regions.

6. Diversification of economic base: This study also revealed that higher proportion of the workforce employment in carbon intensive sector limits the benefits of mitigation policies. This is possibly because of the economic power exerted by these industries in the respective jurisdiction. In this respect it may be worthwhile to plan towards diversification of economic base and maybe re-evaluate the economic principles of concentration advantage with respect to the long term environmental costs. If cities can achieve a right balance of the economic base the continued vitality of the city can be maintained without increasing the stress on the environment.

7. Energy efficient buildings: the consumption of energy in the buildings has been identified as a prominent cause of environmental stress. By utilizing energy efficient techniques the urban impact on the climate change can be reduced.

Limiting the use of light during off-wok hours, longer lasting fixtures, and use of effective building materials for insulation can help reduce the energy costs of the buildings.

8. Environmental activism: This represents an important aspect in enabling successful adoption of climate change mitigation and adaptation measures. As such measures have associated costs that will have to be borne by individuals; their perception of the problem becomes an important determinant of success. There exists a great amount of research of risk perception and its direct relationship to the willingness to bear the costs to offset the same. In case of climate change it represents a more arduous task as it is difficult to personalize the risks associated with climate change. However it is imperative that the community realizes its level of risk along with the appreciation of stress it exerts on the environment. This would enable the local government to receive support of appropriate mitigation and adaptation measure.

5.3 Future research

A comparative evaluation of the impact of national, metropolitan and county level socio-economic considerations on climate change mitigation would be a logical extension of this research. A detailed empirical analysis would help identify the comparative level of influence the various spatial scales exert and thus identify the optimal scale for policy interventions.

The research also suggests the need to develop integrated models of measuring climate change mitigation initiatives. The future research should look into using more risk perception variables in climate change mitigation research. The relationship between existing literature on environmental risk perception and the risk perception to the threats of climatic change need further study.

Some of the other research areas that this study identifies for future research include; assessment of level of understanding among the local officials and planners regarding the ‘risk’ and the ‘stress’ variables; use of economic development variable as independent variables to model the climatic risk perception and mitigation initiatives; and finally developing measures for urban planning tools that can be used as independent variable to model effective climatic mitigation.

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APPENDIX A

METROPOLITAN STATISTICAL AREAS WITH CCP CITIES/COUNTIES

1. Kansas City, MO--KS
2. Melbourne--Titusville--Palm Bay,
3. Ocala, FL
4. Orlando, FL
5. Fort Lauderdale, FL
6. Fort Pierce--Port St. Lucie, FL
7. Miami, FL
8. Naples, FL
9. West Palm Beach--Boca Raton, FL
10. Lakeland--Winter Haven, FL
11. Sarasota--Bradenton, FL
12. Tampa--St. Petersburg--Clearwate
13. New Orleans, LA
14. San Antonio, TX
15. Raleigh--Durham--Chapel Hill, NC
16. Greensboro--Winston-Salem--High
17. Philadelphia, PA--NJ
18. Lancaster, PA
19. Wilmington--Newark, DE--MD
20. Atlanta, GA
21. Charleston--North Charleston, SC
22. Gainesville, FL
23. Memphis, TN--AR--MS
24. Austin--San Marcos, TX
25. Killeen--Temple, TX
26. Little Rock--North Little Rock,
27. Pine Bluff, AR
28. Lawrence, KS
29. Buffalo--Niagara Falls, NY
30. Albany--Schenectady--Troy, NY
31. Glens Falls, NY
32. Pittsfield, MA
33. Middlesex--Somerset--Hunterdon,
34. Reading, PA
35. Trenton, NJ
36. Boston, MA--NH
37. Brockton, MA
38. Fitchburg--Leominster, MA
39. Lowell, MA--NH
40. Bridgeport, CT
41. Danbury, CT
42. Hartford, CT
43. New Haven--Meriden, CT
44. Springfield, MA
45. Waterbury, CT
46. Burlington, VT
47. Lawrence, MA--NH
48. Manchester, NH
49. Nashua, NH
50. Lewiston--Auburn, ME
51. Portland, ME
52. New London--Norwich, CT--RI
53. Providence--Fall River--Warwick,
54. Worcester, MA--CT
55. Rochester, NY
56. Syracuse, NY
57. Utica--Rome, NY
58. Binghamton, NY
59. Elmira, NY
60. Jackson, MI
61. Janesville--Beloit, WI
62. Madison, WI
63. Milwaukee--Waukesha, WI
64. Jamestown, NY
65. Duluth--Superior, MN--WI
66. Minneapolis--St. Paul, MN--WI
67. Albuquerque, NM

68. Santa Fe, NM
69. Tucson, AZ
70. Riverside--San Bernardino, CA
71. Bakersfield, CA
72. Los Angeles--Long Beach, CA
73. Phoenix--Mesa, AZ
74. Yuma, AZ
75. San Diego, CA
76. Modesto, CA
77. Sacramento, CA
78. Stockton--Lodi, CA
79. Vallejo--Fairfield--Napa, CA
80. Yuba City, CA
81. Oakland, CA
82. Salinas, CA
83. San Francisco, CA
84. San Jose, CA
85. Santa Cruz--Watsonville, CA
86. Santa Rosa, CA
87. Boulder--Longmont, CO
88. Cheyenne, WY
89. Fort Collins--Loveland, CO
90. Greeley, CO
91. Provo--Orem, UT
92. Salt Lake City--Ogden, UT
93. Spokane, WA
94. Medford--Ashland, OR
95. Olympia, WA
96. Portland--Vancouver, OR--WA
97. Salem, OR
98. Bellingham, WA
99. Seattle--Bellevue--Everett, WA
100. Tacoma, WA
101. Yakima, WA
102. Eugene--Springfield, OR
103. Denver, CO
104. Merced, CA
105. Baltimore, MD
106. Monmouth--Ocean, NJ
107. Washington, DC--MD--VA--WV
108. Louisville, KY--IN
109. Bergen--Passaic, NJ
110. Jersey City, NJ
111. Nassau--Suffolk, NY
112. New York, NY
113. Newark, NJ
114. Stamford--Norwalk, CT
115. Pittsburgh, PA
116. Steubenville--Weirton, OH--WV
117. Wheeling, WV--OH
118. Ann Arbor, MI
119. Toledo, OH
120. Chicago, IL
121. Gary, IN
122. Detroit, MI

APPENDIX B

METROPOLITAN STATISTICAL AREAS WITHOUT CCP CITIES/COUNTIES

1. Asheville, NC
2. Albany, GA
3. Macon, GA
4. Savannah, GA
5. Decatur, AL
6. Florence, AL
7. Huntsville, AL
8. Greenville--Spartanburg--Anderso
9. Dallas, TX
10. Fort Worth--Arlington, TX
11. Sherman--Denison, TX
12. Wichita, KS
13. Alexandria, LA
14. Lake Charles, LA
15. Jackson, MS
16. Columbia, MO
17. St. Joseph, MO
18. Daytona Beach, FL
19. Fort Myers--Cape Coral, FL
20. Houma, LA
21. Beaumont--Port Arthur, TX
22. Brownsville--Harlingen--San Beni
23. McAllen--Edinburg--Mission, TX
24. Corpus Christi, TX
25. Laredo, TX
26. Victoria, TX
27. Brazoria, TX
28. Bryan--College Station, TX
29. Galveston--Texas City, TX
30. Houston, TX
31. Fayetteville, NC
32. Norfolk--Virginia Beach--Newport
33. Charlottesville, VA
34. Richmond--Petersburg, VA
35. Danville, VA
36. Lynchburg, VA
37. Roanoke, VA
38. Jacksonville, NC
39. Wilmington, NC
40. York, PA
41. Charleston, WV
42. Huntington--Ashland, WV--KY--OH
43. Parkersburg--Marietta, WV--OH
44. Athens, GA
45. Anniston, AL
46. Birmingham, AL
47. Gadsden, AL
48. Tuscaloosa, AL
49. Johnson City--Kingsport--Bristol
50. Charlotte--Gastonia--Rock Hill,
51. Hickory--Morganton--Lenoir, NC
52. Chattanooga, TN--GA
53. Augusta--Aiken, GA--SC
54. Columbia, SC
55. Florence, SC
56. Jacksonville, FL
57. Knoxville, TN
58. Jackson, TN
59. Biloxi--Gulfport--Pascagoula, MS
60. Fort Walton Beach, FL
61. Mobile, AL
62. Pensacola, FL
63. Columbus, GA--AL
64. Montgomery, AL
65. Clarksville--Hopkinsville, TN--K
66. Nashville, TN
67. Longview--Marshall, TX
68. Monroe, LA
69. Shreveport--Bossier City, LA
70. Texarkana, TX--Texarkana, AR
71. Tyler, TX
72. Waco, TX
73. Abilene, TX
74. Fayetteville--Springdale--Rogers
75. Fort Smith, AR--OK

76. Lawton, OK
77. Wichita Falls, TX
78. Enid, OK
79. Oklahoma City, OK
80. Tulsa, OK
81. Baton Rouge, LA
82. Lafayette, LA
83. St. Louis, MO--IL
84. Joplin, MO
85. Springfield, MO
86. Topeka, KS
87. Allentown--Bethlehem--Easton, PA
88. Harrisburg--Lebanon--Carlisle, P
89. Portsmouth--Rochester, NH--ME
90. Bangor, ME
91. New Bedford, MA
92. Scranton--Wilkes-Barre--Hazleton
93. Altoona, PA
94. State College, PA
95. Williamsport, PA
96. Cleveland--Lorain--Elyria, OH
97. Columbus, OH
98. Mansfield, OH
99. Flint, MI
100. Saginaw--Bay City--Midland, MI
101. Elkhart--Goshen, IN
102. Fort Wayne, IN
103. Muncie, IN
104. South Bend, IN
105. Kalamazoo--Battle Creek, MI
106. Lansing--East Lansing, MI
107. Kenosha, WI
108. Racine, WI
109. Grand Rapids--Muskegon--Holland,
110. Bloomington--Normal, IL
111. Peoria--Pekin, IL
112. Sharon, PA
113. Youngstown--Warren, OH
114. Erie, PA
115. Akron, OH
116. Canton--Massillon, OH
117. Appleton--Oshkosh--Neenah, WI
118. Green Bay, WI
119. Sheboygan, WI
120. Wausau, WI
121. Fargo--Moorhead, ND--MN
122. Grand Forks, ND--MN
123. La Crosse, WI--MN
124. St. Cloud, MN
125. Davenport--Moline--Rock Island,
126. Dubuque, IA
127. Iowa City, IA
128. Rochester, MN
129. Des Moines, IA
130. Sioux City, IA--NE
131. Sioux Falls, SD
132. Eau Claire, WI
133. Odessa--Midland, TX
134. San Angelo, TX
135. Lubbock, TX
136. El Paso, TX
137. Las Cruces, NM
138. Amarillo, TX
139. Las Vegas, NV--AZ
140. Santa Barbara--Santa Maria--Lomp
141. Reno, NV
142. Chico--Paradise, CA
143. Bismarck, ND
144. Billings, MT
145. Casper, WY
146. Rapid City, SD
147. Boise City, ID
148. Great Falls, MT
149. Bremerton, WA
150. Richland--Kennewick--Pasco, WA
151. Redding, CA
152. Colorado Springs, CO
153. Pueblo, CO
154. Fresno, CA
155. Visalia--Tulare--Porterville, CA
156. Atlantic--Cape May, NJ
157. Vineland--Millville--Bridgeton,
158. Cumberland, MD--WV
159. Hagerstown, MD
160. Dothan, AL

161. Panama City, FL
162. Tallahassee, FL
163. Cincinnati, OH--KY--IN
164. Hamilton--Middletown, OH
165. Dayton--Springfield, OH
166. Lima, OH
167. Evansville--Henderson, IN--KY
168. Owensboro, KY
169. Bloomington, IN
170. Indianapolis, IN
171. Kokomo, IN
172. Lafayette, IN
173. Terre Haute, IN
174. Lexington, KY
175. Champaign--Urbana, IL
176. Decatur, IL
177. Springfield, IL
178. Rockford, IL
179. Johnstown, PA
180. Benton Harbor, MI
181. Kankakee, IL
182. Cedar Rapids, IA
183. Waterloo--Cedar Falls, IA
184. Lincoln, NE
185. Omaha, NE--IA

APPENDIX C

STATE RANKINGS – NON-FARM EMPLOYMENT -- PERCENT IN MANUFACTURING, 2004

State	Percent	Rank
Indiana	19.5	1
Wisconsin	17.9	2
Arkansas	17.6	3
Mississippi	15.9	4
Michigan	15.8	5
Alabama	15.3	6
Iowa	15.3	6
Ohio	15.2	8
Tennessee	15.2	8
North Carolina	15.1	10
Kentucky	14.7	11
South Carolina	14.7	11
Kansas	13.3	13
Minnesota	12.8	14
New Hampshire	12.8	14
Oregon	12.5	16
Pennsylvania	12.3	17
Vermont	12.2	18
Connecticut	12.0	19
Illinois	12.0	19
Rhode Island	11.7	21
Missouri	11.6	22
Georgia	11.4	23
Nebraska	10.9	24
California	10.5	25
Idaho	10.5	25
Utah	10.4	27
Maine	10.3	28
South Dakota	10.2	29
Massachusetts	9.9	30
Washington	9.8	31
Oklahoma	9.6	32
Texas	9.4	33
West Virginia	8.6	34
New Jersey	8.5	35

State	Percent	Rank
Virginia	8.3	36
Delaware	8.2	37
Louisiana	7.9	38
Arizona	7.4	39
North Dakota	7.3	40
Colorado	7.1	41
New York	7.1	41
Maryland	5.7	43
Florida	5.2	44
Montana	4.6	45
New Mexico	4.5	46
Alaska	4.0	47
Nevada	4.0	47
Wyoming	3.7	49
Hawaii	2.6	50
United States	**10.9**	**(X)**

SYMBOL X Not applicable.
Source: U.S. Bureau of Labor Statistics.

APPENDIX D

STATE RANKINGS - PERSONAL INCOME PER CAPITA IN CONSTANT (2000) DOLLARS 2004

State	Dollars	Rank
United States	**30,547**	**(X)**
District of Columbia	48,044	(X)
Mississippi	22,861	50
Arkansas	23,858	49
West Virginia	23,995	48
New Mexico	24,291	47
Utah	24,675	46
Montana	24,908	45
Idaho	25,132	44
South Carolina	25,200	43
Louisiana	25,580	42
Kentucky	25,698	41
Alabama	25,778	40
Oklahoma	26,051	39
Arizona	26,378	38
North Carolina	27,124	37
Oregon	27,796	36
Tennessee	27,828	35
Georgia	27,870	34
Indiana	27,910	33
Texas	28,029	32
Iowa	28,342	31
Maine	28,348	30
Missouri	28,387	29
Kansas	28,575	28
South Dakota	28,617	27
Ohio	29,049	26
Nebraska	29,065	25
North Dakota	29,120	24
Florida	29,173	23
Michigan	29,635	22
Wisconsin	29,824	21
Hawaii	29,826	20
Vermont	30,392	19
Pennsylvania	30,928	18

State	Dollars	Rank
Nevada	30,981	17
Rhode Island	31,285	16
Wyoming	31,817	15
Illinois	31,858	14
Alaska	31,954	13
California	32,478	12
Washington	32,738	11
Virginia	32,903	10
Delaware	33,259	8
Minnesota	33,259	8
Colorado	33,446	7
New Hampshire	34,352	6
New York	35,454	5
Maryland	36,399	4
New Jersey	38,333	3
Massachusetts	38,768	2
Connecticut	42,104	1

SYMBOL - X Not applicable

Note: Constant dollar estimates are computed by the U.S. Census Bureau using the national implicit price deflator for personal consumption expenditures from the Bureau of Economic Analysis. Any regional differences in the rate of inflation are not reflected in these constant dollar estimates.

Source: U.S. Bureau of Economic Analysis

INTERNET LINK
http://www.bea.doc.gov/bea/regional/data.htm

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