THE LINK BETWEEN SMART GROWTH IN URBAN DEVELOPMENT AND CLIMATE CHANGE

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Submitted to the faculty of the University Graduate School
in partial fulfillment of the requirements
for the degree
Master of Arts
in the Department of Political Science,
Indiana University

August 2012

Accepted by the Faculty of Indiana University, in partial fulfillment of the requirements for the degree of Master of Arts.

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LIST OF ABBREVIATIONS and ACRONYMS

AAMP	Ambient Air Monitoring Program
CAA	Clean Air Act
CO_2	Carbon Dioxide
EPA	Environmental Protection Agency
FHA	Federal Highway Administration
GHG	Greenhouse Gases
NAAQS	National Ambient Air Quality Standards
NHTS	National Household Travel Survey
NOAA	National Oceanic and Atmospheric Administration
NRC	National Research Council
PRB	Population Reference Bureau
PFA	Priority Funding Areas
SGN	Smart Growth Network
TGM	Transportation and Growth Management
TRB	Transportation Research Board
UGBs	Urban Growth Boundaries
ULI	Urban Land Institute
UN	United Nations
US	United States
VMT	Vehicle Miles Traveled

CHAPTER I: INTRODUCTION

Sprawl over the course of several decades has spawned many negative characteristics in regions within and around urban areas. As homes move farther away from jobs, individual commute time increases, resulting in an overall rise in the vehicle miles traveled (VMT). In an effort to cope with such negative consequences of land development, legislative bodies are developing policy tools such as smart growth. This thesis seeks to answer the question: Is the smart growth model a viable policy tool for positively affecting climate change by reducing VMT? The way regional, state and local political governmental entities manage these policy tools to achieve positive environmental outcomes through urban land development and transportation is the primary focus of this study.

According to the US Census Bureau (2011), over the course of the next forty years, the US expects to see an increase in population to 392 million people, "more than a 50 percent increase from the 1990 population size." As the population surges in many urban areas, sprawl increases the strain on natural resources. As these urban communities struggle to provide housing for ever growing populations, mounting problems necessitate a transformation in the political arena of land development practices and applications. Wheeler (2004) notes that today's development practices "consume enormous amounts of land and natural resources, damage ecosystems, produce a wide variety of pollutants and toxic chemicals, create ever-growing inequities between groups of people, fuel global warming, and undermine local community, economies, and quality of life" (p.1). These practices can directly alter natural ecosystems and produce negative consequences, such as climate change.

A majority of scientists are convinced that in most places, average temperatures are increasing and the earth's climate is shifting. The Intergovernmental Panel on Climate Change (IPCC) (2007) establishes the fact that there is a connection between greenhouse gas (GHG) emissions and climate change. According to the US Environmental Protection Agency (EPA) (2009a), climate change refers to any significant variation in measures of climate lasting for an extended period. It reflects the alteration in temperature, rainfall, snow, or wind patterns over that time (p.2-3).

Smart growth aspires to combat the fragmented expansion that contributes to outcomes such as sprawl, traffic congestion, and housing inequality. The EPA (2001b) refers to smart growth as "development that serves the economy, the community, and the environment" (p.1). While some would argue that zoning regulations influence infrastructure, organic growth of urban areas does still occur. Lack of zoning regulations has led to the current built environment; however, an expansion of smart growth policy is slowly shifting the paradigm of urban design towards greater centrally regulated cities (LeGates et al., 2007, p.147).

Overview of Problem

Current planning methods fail to adequately address VMT reduction, which have a direct correlation with air pollution in the form of GHG emissions. The emission of GHG, from automobile use comes mainly in the form of carbon dioxide (CO_2). CO_2 is a primary contributing known element to climate change.

With population and employment continuing to decentralize within regions, and density levels continuing to decline in central urban areas, there is a growing concern of how to address the automobile dependent development patterns leading to sprawl (NRC, 2009, p.1). There is not a clear understanding of the relationship between compact urban development and transportation strategies that could reduce the GHG emissions contributing to climate change, therefore further research is needed to understand that role.

Purpose

The question of whether smart growth policies and legislation actually contribute to climate change is a relatively new field of study. Minimal data linking smart growth and climate change is readily available. However, the potential for a link between the two variables exists. The two variables share "similar concerns, draw on complementary modeling tools and are concerned with bridging the gap that may exist among science and engineering, stakeholders interests and policy implementation" states Ruth (2006, p.3). Despite similarities between the two variables, Salkin (2009) suggests "climate change can only be addressed comprehensively when decision makers take notice of, and incorporate, its land use implications" (p.357).

Methodology

This thesis will analyze CO_2 and VMT using transportation data in areas that have implemented a smart growth model compared to areas that have the potential for, but have not implemented a similar urban development tool. The independent variable is smart growth. The dependent variables are VMT and the air pollution emissions from transportation vehicles through the use of comparative analysis in a four-state case study.

The evaluation compares the air emissions of two states with smart growth programs (Maryland and Oregon) with two states without such programs trying to change their residential patterns (Colorado and Indiana). The state case studies and literature review suggests that areas embracing smart growth planning focused on transportation solutions have the potential to lower GHG emissions by reducing automobile dependency.

Inclusion-Exclusion Criteria

This thesis is not an evaluation of the effectiveness of smart growth policies and legislation as tools to combat climate change directly. But rather a demonstration that smart growth can influence the factors that contribute to climate change. Additionally, this thesis will not evaluate the economic or public health issues that are often raised when discussing compact development and air quality.

Literature Search

A review of smart growth literature indicates that, although it is possible to identify characteristics of development as smart growth, no single characteristic can accurately measure the effectiveness of smart growth policies. Likewise, no existing model can identify the specific patterns of climate change linked to those policies. However, analyzing available literature regarding transportation VMT; GHG air emissions; patterns of growth as they relate to population and housing development; and sustainable development concepts compared to policies and legislation related to smart growth, the connections begin to build a basic framework that may result in a deeper understanding of the relationship between smart growth and climate change. The goal of the literature research is to determine if policy tools, such as smart growth, can impact the total miles a vehicle travels in a region, which would correlate with a reduction in air pollution emitted for that specific region.

Preview of Findings

Through the exploration of urban growth boundaries (UGBs), transportation statistics, and air pollution regulations, this paper expected to witness emerging patterns of decreased VMT influenced by smart growth policies. The patterns that developed reflect the interconnectivity of smart growth policies and climate change. This thesis enhances the current knowledge base for urban planners and policymakers and enables them to draw direct correlations between the effects of smart growth policies on climate change outcomes.

The results of the analyses presented in the case studies in Chapter III, indicates that implementing concentrated smart growth development demonstrates promise for VMT and GHG emission reductions. Maryland and Oregon observed similar amounts of concentrated air pollution prior to enacting smart growth policies and legislation. However, after implementing smart growth, Oregon witnessed a decline in the total amount of air pollutants, demonstrating a relationship between smart growth policies and climate change. Although overall VMT increased over time, the increase was directly tied to the population increase. Oregon's implementations of smart growth that did focus on transportation solutions effectively reduced the pace of VMT increase.

A significant finding of the thesis indicates that while these states did observe a decline in air pollutants, the cities in Maryland that implemented smart growth measures still ranked among the worst in the nation for air quality. These findings indicate that Maryland's smart growth policies did not directly attempt to address transportation issues. As a result, the state was not able to reduce the overall VMT in those cities which contributed to its poor air quality status, despite observing an initial decline in air pollutants. However, Maryland's smart growth achievements in its first decade are demonstrated in cities and towns such as Cumberland. According to Martin (2010), Cumberland had "been abandoned by industry after industry. Today Cumberland's growing tourism economy capitalizes on its unique place in America's transportation history", due to state and local support to revitalize its downtown area (p.3).

The study also shows the potential implementation ability of smart growth initiatives in other areas. A main benefit of smart growth implementation according to the EPA (2010a) is that "Compact and transit-oriented development patterns, in conjunction with transit-focused transportation investment strategies, allow people to drive less if they choose, resulting in reduced vehicle fuel use" (p.4). For example, Colorado and Indiana are two states attempting to change residential patterns. Other states have a similar potential to begin to reduce GHG through the implementation of smart growth in their urban planning processes. States have an opportunity to address climate change by ensuring that political focus remains on VMT reduction through transportation solution design. Gentrified areas present an even more promising opportunity for smart growth implementation due to prevalent preexisting infrastructure that lends itself well to alternative transportation solutions.

This thesis establishes the connection by further developing four important findings:

- Lack of effective governmental policy tools, such as smart growth, in urban development contributes to fragmented land use expansion.
- Urban sprawl results in VMT increases due to longer commute times and less condensed commercial (retail) availability caused by this unplanned expansion.
- As VMT increase, there is an increase in air pollution, specifically from GHG (CO_2).
- Smart growth planning requires a specific focus on transportation solutions to reduce VMT, but is a more effective solution when implemented in already gentrified urban areas with state approval.

This thesis will evaluate the link between smart growth and climate change by exploring the effects that urban land development policies have on VMT. Smart growth implementations should result in a reduction of VMT, if the planning includes a direct focus on reducing automobile dependency. Dense urban living centers, such as those areas that have undergone gentrification, provide ample opportunities for alternative transportation options. By reducing VMT, the communities implementing smart growth should expect to see a reduction in GHG emissions, thereby decreasing the impact that urban development has on climate change.

CHAPTER II: LITERATURE REVIEW

Key factors taken from the literature provide the theoretical framework to demonstrate a link between smart growth policies and climate change. An evaluation of key aspects in the literature review reveals that the implementation of policy tools, such as smart growth in gentrified areas targeting transportation, can mitigate the outcomes of climate change in urban areas. This thesis reviewed various papers and studies that analyzed the relationship between compact development patterns and VMT with the potential to reduce GHG emissions through politically influenced design strategies such as smart growth. The organization of the literature reviews operates on the premise that population increases leads to urban sprawl, which increases VMT, resulting in increased GHG emissions that impacts climate change.

How does the sustainability concept impact smart growth?

In 1983, the United Nations (UN) General Assembly fashioned the World Commission on Environment and Development to "provide a way for the world to address environmental degradation and poverty" and formed the objective to improve the human condition (as cited in Dernbach, 2009, p.7). This commission, better known as the Brundtland Commission (1987), determined that "sustainable development is development that meets the needs of the present without compromising the ability of future generations to meet their own needs" (as cited in UN, 1987, p.67).

Urban areas seek sustainable development models to reduce their dependence on automobiles, which according to Wheeler (1998) are a source of "non-renewable resource consumption, hazardous waste generation, and inequity" (p.503). Wheeler also believes that sustainable urban land development models reduce automobile dependence and produce the following outcomes:

- Compact and Efficient Land Use: balances between human responsibility and private property rights.
- Reduced Automobile Dependence: reduces the total amount people need to travel and increases access to common needs.
- Resource Efficiency: plans for intelligent utilization of resources during every stage of the process.
- Restoration of Natural Systems: reclaims original ecosystems to achieve a healthy community.
- Affordable Housing: provides access to shared facilities and other essentials that enhance the community's value.
- Social Health: minimizes social problems and promotes community empowerment.
- Economics: promotes economic democracies, local control, diversity of ownership and social responsibility.
- Community Involvement: creates a more functional local and regional democracy.
- Culture: protects local products and supports local preservation of development (p.504-7).

These expected sustainable development outcomes also mimic the desired results of smart growth initiatives. It is important to recognize that smart growth embodies the similar objectives of the sustainable development in combating environmental degradation, but each remains a distinct practice.

What has been published on the topic of smart growth policies?

According to Martin's (2010) study, smart growth is not a new tool or concept instead, it is a refined label for those policies referred to in previous decades as 'growth management' or 'sustainable development' (p.22). Smart growth's progression stems from the adoption of a stringent environmental management planning process at various levels of government (Ingram et al., 2009, p.6). Ruth (2006) indicates that much like urban planning, smart growth concentrates on the changes of transportation and land use as markers for measuring the quality of life in a social, economic and environmental context (p.3). Landers (1999), asserts that smart growth is a tool that attempts to identify the channels that can balance the economic and environmental necessities of a community.

Dreier et al. (2001) argues that government incentives can direct negative consequences such as poverty and sprawl in urban areas just as much as consumer preference (p.104). While individual choices dictate how people work, live, and commute, government policies can indirectly influence those choices through factors such as mortgage subsidy programs, tax incentives or abatements, and highway building programs (Wolch et al., 2004, p.2).

The increase in population and associated increased consumption of developed land necessitates the requirement for the introduction of policy tools to suppress the negative environmental outcomes. Effective management of urban development to preserve green space has become a high-profile political issue, resulting in elevated local, state and federal efforts (Tuthill, 2009).

As the desire to protect fiscal, cultural and natural resources evolves, it is becoming apparent that smart growth is the platform that can shape urban development to meet those needs. Dear (2004) recognizes that municipalities' nationwide "have begun to experiment with "smart growth" tools, new regionalist frameworks, and urban sustainability programs" in an effort to define how government manages growth and the implications of those changes (p.ix).

Numerous states have sought to execute comprehensive development programs intended to direct growth, which demonstrate a positive trend and response towards conservation (Theobald, 2001, p.560). DeGrove (1984) notes that Hawaii was the first to embark on state planning efforts in 1961, followed by Colorado and Vermont (1970), Florida (1972), and then Oregon (1973). Shortly thereafter, during the 1970s and 1980s, a number of other states enacted state planning and growth management legislation (p.43).

In the 1990s, as a response to growth, a renewed interest in supporting smart growth initiatives began to emerge in federal, state and local politics (Landers, 1999). More recently, in 2008, California was the first state to pass legislation (Senate Bill 375) "to include land use policies directed at curbing urban sprawl and reducing automobile travel as part of the state's ambitious strategy to reduce greenhouse gas (GHG) emissions" (NRC, 2009, p.ix).

The Ruth study (2006) indicates that smart growth design is creating multi-use neighborhoods that decrease the dependence on automobiles by incorporating offices, schools, shops, and other services in a location accessible to a citizen's home. It attempts to address the needs of increasing populations and to combat the adverse effects of rapid urbanization on limited natural and fiscal resources, while requiring local and regional planning commissions to focus on the evolution of growth management (p.3).

Effective smart growth incorporates ten design principles to achieve a more stringent level of urban planning. According to Ingram, et al. (2009), these principles specifically include the following goals:

- Develop in urban areas utilizing existing infrastructure and land.
- Provide a variety of housing choices by promoting mixed land use.
- Ensure an equitable and predictable process in land development decisions.
- Provide a mix of transportation modes.
- Conserve open space, farmland and sensitive land areas.
- Preserve local culture and natural environmental features in design.
- Promote stakeholder collaboration and community participation.
- Design staged growth with compact development patterns.
- Enhance access to public and private resources for all residents.
- Revitalize existing neighborhoods into safe and livable communities (p.2).

Because development decisions have lasting impacts on the communities they are altering and affect future generations, these smart growth principles help focus development decisions on both short- and long-term benefits. Therefore, smart growth is a creative strategy to develop communities without subjecting them further to urban sprawl and environmental degradation (EPA, 2009d). The ten smart growth design principles offer a community all the necessary amenities for living within relative proximity, reducing citizens' dependence on automobiles.

How does smart growth affect sprawl and land development?

Most urban planning experts in the US are concerned for the potential environmental impacts caused by the prevalence of sprawl. According to Schmidt (1998), "Many of the nation's cities are consuming land faster than their populations are growing, pushing the specter of urban and suburban pollution farther into rural corridors" (p.A274). Population growth creates a question of how local resources will be used to accommodate the residential and commercial needs of the new residents. Continuation of current land development practices that further exacerbates the strain on local environmental resources stems from population growth (Frumkin, Frank, and Jackson, 2004, p.107).

According to Gregory D. Squires (2002), "Sprawl can be defined as a pattern of urban and metropolitan growth that reflects low-density, automobile dependent, exclusionary new development on the fringe of settled areas often surrounding a deteriorating city" (p.2). Miller (2008a) states that urban sprawl in its simplest form is “the unplanned expansion of urban development into rural areas surrounding cities” (p.16). Although a uniform definition of urban sprawl does not exist, this study synthesizes the definitions of both Squires and Miller to acknowledge that urban sprawl reflects the automobile dependent nature of unplanned expansion of urban development into rural fringe areas surrounding cities.

Local governments recognized a need to coordinate planning strategies and policy implementation, as a mechanism to combat the emerging patterns of urban sprawl and its exploitation of land. In 1989, the National Growth Management Leadership Project identified some of those negative aspects caused by sprawl as outlined by Freilich (1999):

- Poverty becomes concentrated in existing built up areas.
- Society continues segregation along racial and economic lines.
- Investment in urban facilities and services becomes impossible.
- Increased automobile dependence undermines environmental, agricultural, and energy policies.
- Social anxiety increases due to financial instability, rising housing costs, and limited employment opportunities (p.21).

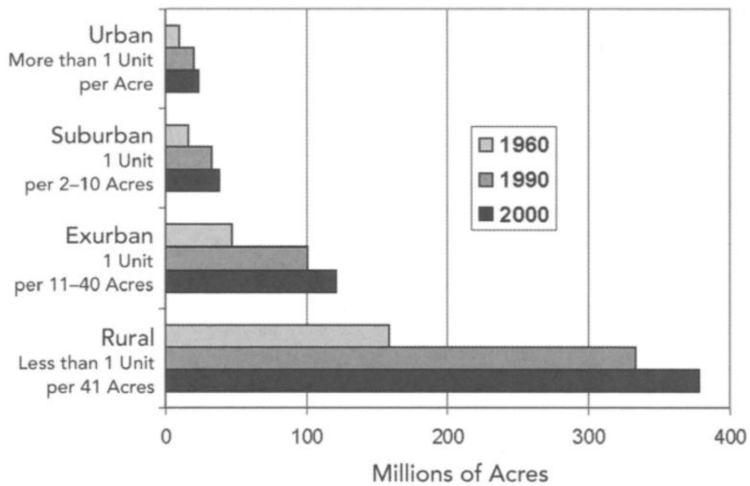
Wheeler (1998) argues, “Land is perhaps our most important limited resource, and current urban development patterns are clearly consuming the landscape in unsustainable ways” (p.504). The literature on land use indicates that development is the primary cause of natural resource degradation and biodiversity loss within the US.

Milder (2007) also suggests that a compact approach to urban development would decrease biodiversity losses (p.758).

Increased urban development continues to threaten biodiversity, notes Milder (2007); to reduce those threats, conservation development strives to protect natural resources (p.757). Salkin (2009) believes that "consistent integration of social, environmental, and economic considerations into decision making" are required "to produce results that promote a sound, coordinated, and harmonious built environment" (p.349). The 'built environment' Salkin (2009) describes, integrates compact development and smart growth to maintain "resource management and sustainable land use" (p.350).

Heimlich and Anderson (2001) suggest that recent trends toward development will continue due to the expected increase in land consumption per capita and growth in population. Figure 1 demonstrates the rates at which rural land is developed (Theobald, 2001, p.552). Additionally, EPA (2010c) researchers contend, "When land consumption rates exceed the rate of population growth, per capita air pollutant emissions from driving tend to be higher," implying lower urban densities.

FIGURE 1: Amount of Developed Land in the US (1960-2000)



Source: US Census Bureau 1993, 2001 (Borrowed from Theobald, 2001, p.556)

As a specific subset of land use development, residential development presents several challenges according to the literature, because development is often "inappropriately designed and located" and supplying decent affordable housing remains a challenge (Wheeler, 2004, p.2). The approach of constructing new structures rather than repurposing with existing materials or buildings can lead to further destruction of the environment (Landers, 1999, p.6).

While it is important to promote mixed-use land options that incorporate a variety of income levels for housing, it is just as important to understand how constructing homes in such a manner will affect the quality of life in terms of the environment. According to the Smart Growth Network (SGN) (2007), various adverse effects stem from sprawl that influence housing development and the environment (p.3). Housing development lends itself to additional environmental degradation in areas of air pollution, traffic congestion, and possible flooding (Copper, 2004, p.471-2).

Policy makers can exercise powerful authority to persuade the direction of growth in areas, which includes the development of housing through zoning laws and fees. Therefore, governments actually help to promote or deter sprawl. How political entities employ policy tools can play a vital role on the effectiveness of the tool. One school of thought is that the current trend of development patterns has little regard for the availability of affordable housing. Arigoni (2001), believes that implementation of policy tools on a regional approach, provide an opportunity to increase choices and improve “the quality, distribution, and supply of affordable housing” (p.1).

Lack of affordable housing due to gentrification drives out migration of lower classes simultaneously, larger houses and increased plot size drives out migration of middle and upper class, both resulting in sprawl. Intrinsic to an all-inclusive growth strategy, smart growth affords a valuable opportunity for communities to respond to affordable housing needs rather than with the traditional approaches to development (Arigoni, 2001, p.49). Consideration of sustainable practices during the development of housing correlates with the goals sought by smart growth policies. Areas that have seen out migration as a result of gentrification contain prime locations for smart growth applied re-development. The larger, gentrified housing units can be transformed into multi-family units or rezoned into multi-purpose construction.

As a component of smart growth, many planning experts identify urban growth boundaries (UGBs), as another policy instrument to combat sprawl. As Wheeler (1998) suggests, UGBs instituted as a regulatory device “can help lead to more sustainable land use” (p.504). UGBs have been around as a policy for land use since 1956 and became prominent in the 1970s (Kolakowski et al., 2000, p.5). UGBs could restrict certain types of development while encouraging others. Miller (2008a) indicates that these boundaries "are drawn around a city center in order to specify limits for additional urban growth. Areas within the boundary are available for higher density urban development, while land outside of the boundary is limited to lower density development" (p.23-4).

Similar to smart growth policies, the intentions of UGBs are to protect green spaces in and around cities and reduce urban sprawl (Kolakowski et al., 2000, p.5). The ability to safeguard natural areas and resources such as watersheds, farms, and parks that surround many cities is the fundamental objective of UGBs. UGBs, according to Cho, et al. (2006), represent a "growth management tool of choice by local communities because they offer potential solutions for urban sprawl and the preservation of farmland and open space with higher intensity of investment and development in restricted areas" (p.287).

Current practices, however, appeal to developers seeking to build new neighborhoods, because zoning laws or requirements encourage development versus reuse (Cooper, 2004, p.484). In contrast, Kolakowski et al. (2000) notes, UGBs are primarily the focus of growth management programs "to increase cooperation among municipalities" regardless of "whether implemented at the local level or mandated from the state" (p.7). Therefore, policy makers must consider the shortfalls of UGBs and the need for ongoing collaboration between connected communities when creating smart growth policies, because UGBs can have unintended consequences. For example, if an area implements a UGB to reduce land supply for housing and the surrounding area fails to implement similar measures, it is possible that the policy is counterproductive since the now limited housing supply can drive housing prices upwards (Staley, Jefferson, and Mildner, 1999, p.1).

How does land development influence transportation and VMT?

Automobiles are rising steadily as the preferred method of travel in the US and personal vehicles are no longer seen as a luxury item, but instead a common household staple. Schmidt (1998) identifies, "The keystone to the suburbs is the automobile, and with urban sprawl has come a dramatic rise in automobile use" (p.A275). Sprawl therefore necessitates automobile dependence to accommodate the increasing distance between work and home and thereby increases the amount of air pollution created.

The US Census Bureau (2000) reported that 91 percent of Americans drive to work rather than walking, biking, or taking public transportation (as cited in Reschovsky, 2004, p.3). While Lomax (2011) observes that Americans logged nearly 3 trillion vehicle miles traveled (VMT) in 2009, "of that amount, 717 billion VMT (24 percent) of those miles were traveled on interstates, and two-thirds of all VMT were on urban roads" (p .1). According to the Federal Highway Administration (FHWA), in 2009 alone there were over 246 million state motor vehicle registrations in the US. Furthermore, Ewing et al. (2008) contend, "many Americans now spend more time commuting than they do vacationing" highlighting that commute times are rising and believes that "since 1980, the number of miles Americans drive has grown three times faster than the U.S. population, and almost twice as fast as vehicle registrations" (p.2).

Cervero (2001) cites the issues associated with roadways such as traffic congestion, pollution, or sprawl stem from "the absence of thoughtful and integrated land use planning and growth management around new interchanges and along new corridors" (p.25). Wheeler (2004) is not surprised that poor land planning and development generate traffic congestion in both urban and suburban areas since, "populations that once walked most places are now are utterly dependent on the automobile" (p.1).

Areas with high-quality public transportation systems in place and strategies that seek to incorporate pedestrian and bicycle-friendly designs, restrict sprawl, and generate densely populated cities, can greatly reduce the overall emissions related to air pollution because of the overall reduction in VMT (Chatterjee, 2009, p.1660). Public transportation systems are not immune from contributing to air pollution; however, the concentrated smart growth efforts in transportation can limit the number of VMT by an individual. There is a growing need for public transportation options, as Wheeler (2004) notes, "vehicle miles traveled per capita in the United States is increasing at around 3.8 percent a year, meaning that the average person drives twice as much as he or she did 25 years ago" (p.7).

The burning of fossil fuels within the US accounts for one-fifth of the world's CO_2 emissions (Marland, et al., 1999). According to the EPA (2010b), transportation accounts for roughly 28 percent of total US GHG emissions since 1990 (p.14). These statistics indicate that transportation represents a sizeable contribution to the GHG that are released into the atmosphere. The current trends seen in Table 1, illustrate a steady increase in vehicle fuel consumption compared to the growth rate of population in the US.

TABLE 1: Recent Trends in Various U.S. Data *(Index 1990 = 100)*

Variable	1990	1995	2000	2005	2006	2007	Growth Rate [a]
GDP [b]	100	113	138	155	159	162	2.9%
Electricity Consumption [c]	100	112	127	134	135	137	1.9%
Fossil Fuel Consumption [c]	100	107	117	119	117	119	1.1%
Energy Consumption [c]	100	108	117	119	118	120	1.1%
Population [d]	100	107	113	118	119	120	1.1%
Greenhouse Gas Emissions [e]	100	106	115	117	115	117	0.9%

[a] Average annual growth rate
[b] Gross Domestic Product in chained 2000 dollars (BEA 2008)
[c] Energy content-weighted values (EIA 2008a)
[d] U.S. Census Bureau (2008)
[e] GWP-weighted values

Source: US EPA Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990 –2007 (April 15, 2009, ES-18)

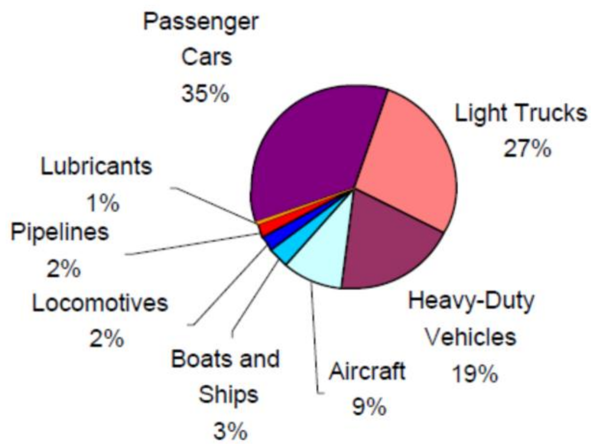
As a response to the growing concern about climate change, the Transportation Research Board (TRB) conducted a 2008 study focusing on the potential impacts of climate change on US transportation. The TRB reported that transportation infrastructure could be susceptible to flooding and the gradual sinking of land due to climate change. The report suggests climate change adaptation should be included in both land use planning and transportation (NRC, 2008, p.23). The TRB additionally examined the relationship between land development patterns and motor vehicle travel in the US to support an assessment of the energy conservation benefits of more compact development patterns (NRC, 2009, p.17). Key findings of the 2009 study support the following:

- Developing at higher residential and employment densities, is likely to reduce VMT.
- More compact development can produce reductions in energy consumption and CO_2 emissions both directly and indirectly (p.2-6).

Ewing et al. (2008) believes “It is hard to envision a ‘solution’ to the global warming crisis that does not involve slowing the growth of transportation CO_2 emissions in the United States” (p.2). The various costs related to environmental pollution stem from the increases in consumption of energy, rising energy costs, and the amount of time spent in the car for travel, as Freilich (1999) maintains “Car time is one negative employment quality-of-life factor that results as sprawl increases” (p.28).

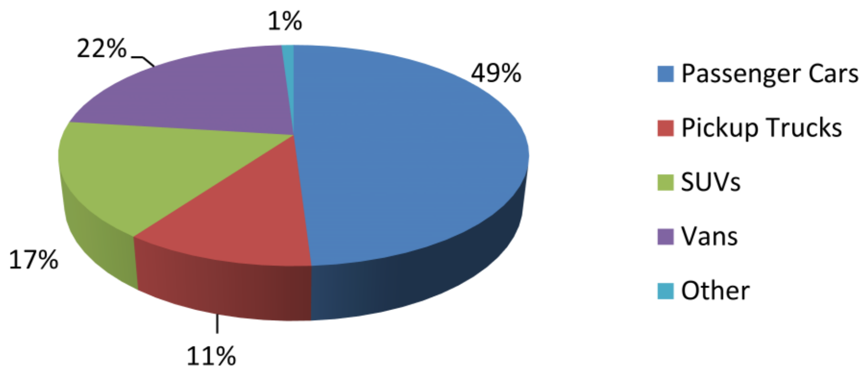
The overall research leads to the supposition that while GHG emissions from the transportation sector are not completely avoidable, they are manageable. Figure 2 provides a dissection of the transportation sector and the percentage of GHG released from each source, while Figure 3 classifies the consumption of vehicle fuel by each household in 2001. Both represent the overall potential impact that the transportation sector bears on climate change and suggest that personal transportation behaviors must change to have a positive impact on climate change. From the statistics indicated in Figures 2 and 3, which demonstrate the transportation sector as a whole, this paper expects to see similarities in the specific concentrated ambient air monitoring data around urban areas that contribute to GHG emissions.

FIGURE 2: Transportation Greenhouse Gas Emissions by Source (2003)



Source: US EPA (2006, p.7, Figure 2-2)

FIGURE 3: Household Vehicle Fuel Consumption by Mode (2001)



Source: Energy Information Administration, 2005. Household Vehicles Energy Use: Latest Data & Trends. Washington, DC. Table A1, p.54. US EPA (2006, p.11, Figure 3-2)

Urban planners use VMT as a measurement to establish the impact of land-use variations on the transportation system. Reducing the sum of VMT through mechanisms such as increased densities, mixed use development, limiting trips or providing transit can reduce the amount of GHG (Taylor and Winters, 2009, p.3). A 2008 study by the Urban Land Institute (ULI), examining research on VMT, CO_2 emissions and compact development, attempted to determine how efficient development patterns could help reduce our impact on the climate (p.3). One conclusion reached by the study according to the EPA (2009d) was that compact development could reduce VMT “by 20 to 40 percent compared to conventional development patterns”.

How is climate change affected by smart growth policies?

The impacts of urban development are not limited to land resources, but as Cieslewicz (2002) states, “land use is the key factor behind the remaining water and air quality issues we face” (p.23). The influences on transportation air quality are multifaceted and include the concentration and location of development, the quantity of expansion, mixed uses, and access to transportation choices (EPA, 2001a, p.18).

Federal regulations set forth by the EPA, such as the Clean Air Act (CAA) provide the principal framework for national, state, regional and local efforts to protect air quality in the US. The CAA establishes standards for pollutants considered harmful to people and the environment through the National Ambient Air Quality Standards (NAAQS). The NAAQS addresses six criteria pollutants that contribute to the chemical elements found in GHG (EPA, 2010b).

The EPA designates areas with higher levels of concentration of the criteria pollutants above the set standard by the NAAQS, as nonattainment areas and those areas that meet the levels for the criteria pollutants as attainment areas. The Ambient Air Monitoring Program (AAMP) scrutinizes air quality samples to determine how ambient air quality standards contribute to pollution trends. The objective is for states to acquire an attainment status by developing plans to achieve and maintain those levels with the cooperation of various levels of government. Despite the standards that are set forth, large amounts of air pollution continues to exist (2010a).

While most air pollution stems from the activity of burning fossil fuels, Driesen (2009) contends the continuation of this pattern occurs because alternatives do not incorporate sustainable living (p.240). The data and research from the EPA in Table 2 indicates the trend in concentrations of criteria pollutants have improved air quality since 1980, and are attributable to policy tools and regulations limiting air pollution (2009c). This reduction demonstrates that policy tools can influence the reduction of pollution in air quality; however, despite the improvements and progress, pollution levels in 2008 were above the NAAQS levels for over 126 million people nationwide, demonstrating the need for additional regulation tools. The ability of policy implementations to have measurable effects on air pollution, by effectively reducing criteria pollutants provides evidence that other policies have the potential to effectively reduce CO_2 emissions.

TABLE 2: Percent Change in Air Quality (1980 and 2008)

	1980 versus 2008	*1990 versus 2008*
Carbon Monoxide (CO)	-79	-68
Ozone (O_3) (8-hr)	-25	-14
Lead (Pb)	-92	-78
Nitrogen Dioxide (NO_2)	-46	-35
PM10 (24-hr)	---	-31
PM2.5 (annual)	---	-19
PM2.5 (24-hr)	---	-20
Sulfur Dioxide (SO2)	-71	-59

1. --- Trend data not available
2. PM2.5 air quality based on data since 2000
3. Negative numbers indicate improvements in air quality

Source: US EPA (2009c)

The release and removal of gases from the atmosphere continuously occur by natural processes. However, the average atmospheric concentrations are constantly changing due to the additional quantities produced by human activities. Therefore, human influence alters the organic equilibrium of plant and animal life cycles either indirectly or directly. This disruption of GHG absorbed by the atmosphere (Table 3) indicates that the gases are not readily broken down. Since GHG naturally regulate the earth's temperature, altering that balance naturally or through human activities, will inevitably fluctuate climate (EPA, 2009b, p.1-3).

Researchers estimate that the long-term patterns of energy consumption will be responses to the changes in energy efficiency and consumer behavior. The recent trends in US GHG emissions reveal that total emissions have risen 17 percent from 1990-2007. Additionally, the EPA (2009b) believes changes in land use and land management practices modify the "carbon fluxes between biomass, soils, and the atmosphere." The effects are not entirely negative; the practice of planting trees in urban landscapes can net a positive effect by sequestering carbon emissions (p.2-2 and p.2-15).

Kushner (2009) claims, "Carbon is of primary concern because while other greenhouse gases are often destroyed by chemical reaction in the atmosphere, carbon dioxide is not" (p.9). Table 3 illustrates the lifespan of gases and their strengths in the atmosphere, in addition to their "own unique ability to absorb energy and contribute to climate forcing", which is another term scientists use to describe climate change, states the EPA (2010c, p.18). These factors allow scientists the ability to predict the gases' potential global warming impact. The EPA also believes that "By considering both the lifetime of the gas and its ability to absorb energy, scientists have come up with an overall global warming potential for each gas, which is expressed relative to the global warming potential of carbon dioxide" (p.18).

TABLE 3: Atmospheric Lifetime and "Global Warming Potential" of Greenhouse Gases		
Greenhouse gas	*Average lifetime in the atmosphere*	*Global warming potential of one molecule of the gas over 100 years (relative to* CO_2 *= 1)*
Carbon Dioxide (CO_2)	50-200 years*	1
Methane (C_4H_4)	12 years	21
Nitrous Oxide (NO_2)	120 years	310
CFC-12	100 years	10,600
CFC-11	45 years	4,600
HFC-134a	14.6 years	1,300
Sulfur hexafluoride	3,200 years	23,900

** CO_2 gas is not destroyed over time, but instead moves between different parts of the ocean, atmosphere, and land system. Some of the excess carbon dioxide will be absorbed quickly (for example, by the ocean surface), but some will remain in the atmosphere for thousands of years. Source: US EPA (2010c, p.18)*

Sachs (2008) deduces that the goal of carbon management is to "avoid dangerous thresholds that could have devastating effects on human societies and ecosystems" (p.96). Since CO_2 does not break down over time and it can either remain in the atmosphere or travel between land and water masses, the buildup of CO_2 can result in shifting the balance of energy released or absorbed by the earth. The entrapment of gases can lead to the forced changes in the climate (EPA, 2010c, p.18).

How is smart growth a viable solution to address climate change?

It is evident that active planning is required to reduce the levels of GHG emissions in and around urban areas. There are a wide variety of solutions that communities can use to work towards this goal.

> Achieving reductions in the levels of greenhouse gases requires addressing a number of issues that are intertwined with land use, including transportation planning; combating sprawl through revitalization and infill of cities and towns; continued implementation of smart growth principles that include promoting mixed use and walkable communities, and reducing dependency on the automobile; proactively inviting and planning for the siting of alternative energy uses such as wind farms; and promoting other energy-efficient green development construction and renovation projects (Salkin, 2009, p.357).

The benefits of implementing smart growth in gentrified areas can be a viable political policy tool to address concerns of climate change in urban development. Florida (2005a) notes, gentrified areas provide the framework for smart growth implementation as “forward-looking regions” that “see the environment as a source of economic competitiveness” (p.58). As a result, these creative class communities undertake “efforts to reduce sprawl and move to smart growth, promote environmental sustainability, clean up and reuse older industrial sites” (Florida, 2005a, p.58).

There is also a new school of thought when speaking in terms of gentrification. Lees, Slater, and Wyly (2005), “analyze the relationship between new-build developments and earlier definitions of gentrification,” to determine if new development on reclaimed industrial land constitutes as gentrification, since there is minimal if any displacement of residents and no refurbishing of existing structures are taking place (p.138). Davidson and Lees (2005) evaluate the cases for and against new-build gentrification and note that displacement does indeed occur, but development in already highly dense communities work well for implementing partial smart growth.

CHAPTER III: STATE CASE STUDIES

This chapter will review the four-state case studies and compare how each state's urban development policies and legislation influences transportation and air quality. The comparative analysis reviews the implementation of smart growth policies and the transportation related CO_2 emissions found in each respective state.

Maryland Overview

Maryland's landscape consists of estuaries and wetlands with the Chesapeake Bay as one of its most notable assets in terms of environmental prosperity (Ingram et al., 2009, p.167). The state's central location and proximity to Washington DC provides ease of access to interstates and businesses that helps drive population growth. The Maryland Department of Planning (2010) projects a 29 percent increase in population from 2000 to 2040. It is the nation's fifth most densely populated state and continues to expand in terms of growth.

Maryland Policy and Legislation

Many policy analysts consider Maryland to be a pioneer in the field of smart growth policy initiatives. In 1997, the state gained national recognition almost instantly and earned several awards for its innovative methods at promoting smart growth without obtrusive land control policies. The legislation consisted of several programs seeking to curb the growth of sprawl in rural areas while revitalizing existing developed areas.

In 1998, an executive order established the Smart Growth and Neighborhood Conservation Policy, which implemented the 1997 Smart Growth Areas Act. This act designated priority funding areas (PFAs) that permitted state and local governments to determine where future growth and development should occur, which included issues related to infrastructure, economic development, and housing. It excluded state agencies from providing support or funding outside of the designated PFAs (EPA, 2001a, p.36).

The design of PFAs compliments other Maryland policies and programs such as the *Voluntary Clean Up and Brownfield's, Live Near Your Work, Job Creation Tax Credits, and Rural Legacy Areas* programs. It also promotes three main initiatives:

- Provide preference to central business districts, downtown cores, and empowerment zones when funding infrastructure projects or locating new facilities;
- Locate workshops, conferences and other meetings in the designated zones;
- Work with rural local governments to retain the rural character of their communities (EPA, 2001a, p.36).

The objective of these programs is to balance the regulatory PFA policy by supporting developers, employers, and homebuyers to locate within the PFAs. Since the inception of these smart growth actions, Maryland's policies and programs have served as a template for other states while encouraging the development of additional rules and regulations regarding smart growth development.

The 2006 session of the Maryland General Assembly passed legislation (House Bill (HB) 1141 and HB 2) directly affecting comprehensive plans, annexations and land preservation programs. The law specifically made changes to basic land use planning and zoning requirements and annexation procedures, agricultural land preservation, and to the smart growth programs (Maryland Department of Planning (MDEP), n.d.).

In 2009, Maryland's governmental bodies continued to address the mounting concern related to development and expansion in its state. The *Smart and Sustainable Growth Act of 2009* (Senate Bill (SB) 280 and HB 297) objective helped to clarify the link between local comprehensive plans and local land use ordinances. Then in 2010, the Maryland legislature again attempted to strengthen its regulations with the enactment of three bills (HB 474, 475 and SB 278) for the future of growth, development and sustainability in Maryland. According to MDEP, HB 475 favors transit-oriented development, which affords Maryland citizens "more transportation choices, which will decrease household transportation costs, reduce our nation's dependence on foreign oil, improve air quality, reduce greenhouse gas emissions, and promote public health" (n.d.). A continued effort by political entities, such as the state government general assembly, allows Maryland to address and refine smart growth policies to address the changing environment.

Maryland Transportation and Air Quality

According to Moore (2009), total VMT growth over the next 10 years should increase by 22 percent and the "rates of VMT growth are predicted to exceed the rate of population growth, which means that VMT per capita would be increasing" for

Maryland (p.16). Its population growth around high-density areas rose because efforts to address transportation problems only fell within the PFAs and improved only those infrastructures (Ingram et al., 2009, p.172). However, Maryland's failure to address transportation solutions at a broader level resulted in lackluster improvements in air quality outside of the PFAs, which caused Maryland as a whole to unsuccessfully "meet federal health standards for ground-level ozone or smog" notes Ingram et al. (2009), and receives the designation of severe nonattainment while "the Baltimore area has the fifth worst air quality in the nation for ozone" (p.168). According to the Maryland Department of Transportation (MDOT) (2011), in 2006 the total amount of VMT was 56,618 million and the total GHG emissions were 32.7 million metric tons (mmt), demonstrating a shift in air quality as represented in Table 4 of this chapter (p.2-4).

Maryland Outlook

Maryland's attempt at shifting the balance of land use control from local level to state level has been rife with challenges. While Maryland led the way for other states to embark upon implementing smart growth concepts as a method for controlling growth, it is apparent that the use of PFAs has their limitations. Lewis, Knaap and Sohn, (2009) assert "It is difficult to ascertain what would have happened had the Maryland smart growth policies not been adopted. That said, it is clear that PFAs have not produced the intended effects over the last 10 years" (p.473). Because there is an apparent lack of enforcement related to the state requirements for funding an area, it is difficult to regulate the amount of congestion regardless of the funds allocated towards transit projects (Ingram et al., 2009, p.174). While governments cannot regulate congestion, transportation solutions which can address congestion can be influenced by political entities.

However, PFAs are still a valuable demonstration of patterns growth in and around particular areas. The growth patterns from the PFAs exhibit the impact that newer transportation solutions have on VMT in these condensed areas (DeCorla-Souza, 1992, p.74). The state is now focusing its efforts in addressing the issues of air quality and transportation, which the original strategies of smart growth failed to acknowledge as evidenced by new legislation in recently passed HB 475.

Studies from the 1990s suggested that a centralized development pattern would generate less VMT in the highly congested areas of Baltimore and conversely, a decentralized development pattern expected to see an increase in VMT (DeCorla-Souza, 1992, p.74). While an improvement in Maryland's air quality did take place, over time the state did not experience a significant reduction in pollutants because the original focus of these PFA initiatives was not on transportation alternatives. Therefore, as governments and policy makers recognize the impact GHG emissions can have on air quality, they will be forced to make a larger investment in transportation alternatives and transit oriented development in order to achieve a long term reduction in GHG emissions (Martin, 2007, p.6).

Oregon Overview

Oregon's diverse landscape includes the coastline of the Pacific Northwest and mountainous Cascades. Many of Oregon's inhabitants reside in the Willamette Valley, which ranges from Eugene to metropolitan Portland. The US Census Bureau (2010) estimates that the population is roughly 3.8 million people, while in 1995 the US Census Bureau indicates a population of 3.1 million people, indicating a steady growth over the years.

Oregon Policy and Legislation

Similar to Maryland, the state of Oregon was a pioneer in planning policy programs related to smart growth and is not without its own challenges. Oregon incorporated nineteen smart growth goals that regulated development on a local level to improve compact urban development and has recently begun to make similar adjustments to their policy planning system based on the present concerns for climate change (Ingram et al., 2009, p.189).

In 1973, Oregon enacted its most recognized growth management law, the Land Conservation Act (LCA), as response to the increased suburban growth in the Willamette Valley. Because of this legislation, the UGB compels all incorporated cities to adopt boundaries to distinguish rural and urban land. The UGB framework connects actions and decisions related to land use and development. These efforts aim to limit the standard residential and commercial development that many other cities face. (Ingram et al., 2009, p.191).

Statewide and local planning efforts in Oregon have been in place for over three decades. Oregon includes all stakeholder's input during the planning process. For example, in the city of Eugene, policy planners "engaged faculty and students from the nearby University of Oregon planning department to help them carryout their widely successful 'Eugene Decisions' process" (SGN, 2002, p.79). The Oregon Department of

Transportation and Land Conservation and Development work jointly to "offer a way to make many small, low-cost improvements that, taken together, yield big results for the system as a whole" (2009, p.2). For example, inexpensive improvements to community design, such as the addition of bicycle racks and lanes, can provide additional incentives for non-automobile transportation options.

Oregon Transportation and Air Quality

Oregon's Transportation and Growth Management (TGM) (2010) program supports community efforts to expand transportation choices for people. The aim is to link land use and transportation planning, and work in partnership with "local governments to create vibrant, livable places in which people can walk, bike, take transit or drive where they want to go". Although data from the Federal Highway Administration (FHA) indicates that increases in per capita VMT are occurring, these increases have been less than other cities due to available transportation options (as cited in Moore, 2001, p.19). The TGM aids in the improvement of transportation options and reduces the overall need to drive (2010).

An estimated 23 percent of all downtown Portland workers commute by transit, increasing to more than 40 percent during peak commute periods, each workday. As demonstrated by the data in Table 4, VMT for Oregon as a whole did increase due to the natural progression of population growth over time. However, the percentage increase of CO_2 emissions over the same period of time is relatively miniscule. This minimal increase in state emissions can be attributed to the introduction of more condensed neighborhoods through compact development. Due in part to the TGM program, Portland has experienced no federal ozone standards since 1988. Prior to 1988, studies note that the city recorded one day out of every three to five days as a violation of federal ozone standards (Moore, 2001, p.18).

According to TriMet (n.d.), which provides bus, light rail and commuter rail service in the Portland metro area, "for more than a decade, ridership has been increasing faster than other indicators of regional growth, including population and automobile vehicle miles traveled. Weekly ridership on buses, MAX and WES has increased for all but one year since 1988". Based on available data, originating ridership for the total system in fiscal year (FY) 1999 was 60,327,574 compared to FY 2011 at 79,350,322. Therefore, over the course of twelve years, originating ridership has increased by 19,022,748 or 32 percent.

Oregon Outlook

Oregon's agenda concentrates on preservation of land and the development of compact urban areas. These strategies regulate expansion by requiring UGBs around every city to encourage higher density within those boundaries and to safeguard natural land from low-density development. Oregon has been successful at beginning to address the goals emphasized by its UGB policies. One key success is shifting commuters out of automobiles by increasing the amount of pedestrian friendly communities and various transportation options such as the streetcars, which has slowed the rate at which VMT and GHG emissions contribute to Oregon's environment (Ingram et al., 2009, p.196).

Colorado Overview

Colorado's landscape includes natural grasslands and mountains, along with its many national parks, monuments, national forests and state parks. Colorado is the country's eighth largest state in land area mass, with the federal government owning more than a third of the land (Ingram et al., 2009, p.201). Although Colorado consists of wide-open spaces, more than 80 percent of residents live along the Front Range that follows the eastern edge of the Rockies. The Denver-Boulder metropolitan area is home to about two-thirds of the Front Range population. According to the US Census Bureau (2009), approximately 5 million people reside within Colorado, the state observed a 17 percent increase in population growth since the 2000 census. Colorado's population growth rate has ranked third in the nation in comparison to other migration states, which also tend to have high levels of population due to the influx of residents from other states (Ingram et al., 2009, p.201). This rapid growth in population places a demand on Colorado's natural resources.

Colorado Policy and Legislation

Colorado lacks formal legislative policies to manage growth and development. Because Colorado does not have established regulation standards to manage growth, there is mounting concern that growth will continue to outpace resources. The state approved plans to construct alternate methods of transportation that will alleviate the increased congestion in metropolitan areas due to population. The plan includes light and commuter rail lines in the urban infrastructure (Ingram et al., 2009, p.201).

There have been numerous attempts and efforts to institute a statewide growth management plan but the efforts have fallen short of success. Since the early 1990s, the state attempted to achieve a middle ground with smart growth objectives through voluntary regional participation. Without specific land use legislation and policies to enforce, the state and regional level regulatory agencies have not had a great impact on these voluntary programs. Several attempts at the local level have also had limited success due to the rapid amount of growth (Ingram et al., 2009, p.201). The inability for the state to enforce growth management with policy tools leads to the continuation of sprawl.

Colorado Transportation and Air Quality

The state conducts transportation planning activities to ensure that transportation projects such as road and highway construction or mass transportation projects incorporate air quality protection features as they are required to do by federal regulation. However, according to the Colorado Division of Transportation (2011), the VMT have increased by 65 percent from 1990 to 2009, and congested roadway miles are projected to triple by 2035 (p.29). The state tries to meet its transportation objectives as defined by federal air quality standards (APPP, 2010). Strait et al. (2007) states that Colorado's gross GHG emissions have increased by 35 percent between 1990 and 2005 (p.v). This continued increase demonstrates the limitations faced by legislative bodies' reliance on voluntary self-regulation. As shown in the Appendix, Colorado falls almost exactly in the middle of the states ranked for GHG emissions. Colorado's attempts to address air quality, without enforceable governmental policy and legislation, have fallen short. Although they have managed to increase bus and rail ridership in high-density areas, Colorado has not yet been able to implement a sound policy to combat the increased VMT demonstrated in Table 4 (Ingram et al., 2009, p.207).

Colorado's Outlook

Colorado has been able to implement growth management though without a comprehensive state-level growth management program and demonstrate the effectiveness of bottom-up self-regulation through efforts by the Denver Region Council of Governments (DRCOG) and the state Land Use Commission. For example, DRCOG established a voluntary growth boundary in a six-county area that contains more than 60 percent of the state's population. (Ingram et al., 2009, p.204). Colorado has a physical landscape that could support a concentrated focus on dense community building. The significant distances between large cities in Colorado make the potential for reducing interstate and large highway VMT less likely. However, if the lawmakers are able to include regulations that support smart growth concepts, with a focus on transportation options, the state should see an overall reduction in local and regional VMT.

Indiana Overview

Considered the 'Crossroads of America', Indiana connects the urban and rural landscape because of its centrally located highways and railways that unite various socio-economic endeavors that help shape its development (Ingram et al., 2009, p.211). Indiana provides a diverse set of ecosystems from the sandy dunes of northern Indiana to the marshy wetlands and rolling hills of scenic Brown County. Indiana's rich agriculture background includes high numbers of corn, soybean, and dairy farms throughout the state. Although Indiana still has a vibrant steel and aluminum mill industry, the state has now turned its attention to utilizing the land for harvesting biodiesel fuels such as ethanol and installing wind farms for alternative energy uses.

Although Indianapolis, the state's capital, has grown and expanded over the last several decades, many residents sought to move away from the urban center to surrounding outlying areas and counties. Areas like Hamilton County have grown very quickly as they attempt to keep development in pace with increasing population demands. This type of speculative development leaves very little consideration for smart growth management.

Indiana Policy and Legislation

In a stark contrast to Maryland, Indiana has maintained a historically traditional approach to policies and procedures regarding growth, in that it has made very little movement or progress to initiate a program to address growth management. Indiana lacks a statewide smart growth program, but in 1981, the state did pass progressive land use legislation to provide municipal and county governments the tools to address growth-related issues. However, local governments have failed to institute and execute any type of growth management ideologies since that time. Indiana still has no state level planning body, and no state agency that reviews local plans and implementation efforts (Ingram et al., 2009, p.211).

Indiana Transportation and Air Quality

Indiana residents are forced to choose from the very limited options available in terms of transport. Although some of the larger cities have local public bus systems, Indiana lacks a central transportation system, such as extended bus service that reaches suburban areas, or large scale rail systems that many other states and cities provide. The state continues to experience sprawling development moving away from urban city centers. Additionally, there are no incentives to move to high-density locations due to the lack of services and amenities available. Indiana residents accept the increased driving time as part of their daily routines. The patterns of sporadic growth in urban areas offset any type of conservation made in the rural settings. Table 4 demonstrates an increase in VMT over the 1990-2005 time period. Additionally, during the same period, CO_2 emissions also increased.

According to the Indiana Department of Environmental Management (2011), air quality in Indiana has several counties with the 'non-attainment' designation by the US EPA. The highest concentrations of non-attainment center around the largest cities in Indiana. These larger communities such as Lake, Marion and Hamilton Counties have an opportunity to reduce air pollution by focusing new planning and development around pedestrian friendly environments.

Indiana Outlook

It is apparent from the lack of policy initiatives that Indiana does not place a high priority on the environmental impact of land use development and planning. The state does not have a comprehensive plan that supports the ideas of smart growth policies. It is possible for Indiana to establish a framework that consists of a cohesive planning system. Indiana has not seen political support for smart growth initiatives from either the industrial or legislative communities. As demonstrated in Appendix A, Indiana ranks seventh out of all the states on overall GHG emissions. These high pollutant numbers are unlikely to decrease unless Indiana takes steps to enforce behaviors that will reduce VMT. Indiana's overall population is smaller than other states that rank high on the list of GHG emissions. If the state's population continues to grow at a low rate, it may be easier to create dense communities in already gentrified neighborhoods. As developers make use of existing urban infrastructure to provide incentives for downtown living, the availability and usefulness of dense communities may not be eclipsed by the ongoing increase in population. This could produce a viable opportunity to explore smart growth initiatives and focus on increased transportation options to reduce overall VMT.

Table 4: State GHG, VMT, and Population Comparison (1990 and 2005)

	Population (1990)	**Population (2005)**	**Total VMT (1990)**	**Total VMT (2005)**	**CO_2 Emissions from Fossil Fuel Combustion - Million Metric Tons (MMT)(1990)**	**CO_2 Emissions from Fossil Fuel Combustion - Million Metric Tons (MMT)(2005)**	**Ration of CO_2 Emissions/ Total VMT (2005)**
Maryland	4,781,468	5,600,388	40,536,000	56,319,000	23.63	32.09	0.00000057
Oregon	2,842,321	3,641,056	26,738,000	35,282,000	20.01	23.38	0.00000066
Colorado	3,294,394	4,665,177	27,178,000	47,962,000	19.15	29.9	0.00000062
Indiana	5,544,159	6,271,973	53,697,000	71,799,000	40.87	45.42	0.00000063
Source	US Census Bureau http://www.census.gov/		Federal Highway Administration http://www.fhwa.dot.gov/policyinformation/statistics/vm02.cfm		US Environmental Protection Agency http://www.epa.gov/statelocalclimate/documents/pdf/CO2FFC_2009.pdf		

CHAPTER IV: DISCUSSION

Current land development practices and policies often lead to fragmented community patterns. The compelling forces behind the patterns and rate of urban development observed today are a combination of community interests, economic conditions, environmental issues, and local fiscal goals. Balancing these forces requires a tool like smart growth, argues Landers (1999), "to provide the right type of development at the right place and time, while protecting our natural and socio-economic resources".

The research in this paper contends that the formation of comprehensible definitions, guidelines, and standards could help regulators and environmentalists engage in projects that incorporate land use planning with regulatory programs for smart growth development practices. A proactive approach to land use and development Milder (2007) notes, "can significantly reduce the negative impacts of for-profit land development in suburban, exurban, and rural areas, creating a landscape mosaic that is more hospitable and permeable to natives species, and more capable of providing ecosystem services" (p.765).

The process about how best to manage systems concerning growth and climate change should begin with decisions made at federal, regional, state and local levels. Many state entities have begun to take action regarding smart growth planning, but it remains within its infancy. As evidenced by the research and the current policies or legislation enacted, the myriad of challenges facing urban planners include economic growth, revitalization, preservation and protection of natural resources and spaces, transportation and infrastructure improvements, and community development (Arigoni, 2001, p.49). Policymakers have an obligation to not only to address the health concerns of its constituents, but also to address sustainable development practices for future generations.

Based on the research presented, the following prescriptive policy considerations are necessary for regulators to establish a framework that incorporates smart growth policy tools to help balance the initiatives of growth with preserving environmental prosperity and pursue additional research in the field.

Stakeholder Planning Coordination

After reviewing the policies and legislation in the case studies, it became apparent that states do not have a concerted effort towards urban planning. Coordination of potential stakeholders to create a cohesive approach in determining techniques to reduce automobile dependence in urban areas should be the first step. The Pew Center (2009) believes “Every level of government, as well as resource managers, industry, and community leaders, has a role to play in assessing the climate vulnerability of both natural and man-made systems” (p.4). An increased level of awareness and synchronized efforts for development programs will aid governments in establishing goals, since no systematic structure currently exists. Briechle (1999) believes governments can facilitate public development through a vision by educating citizens and building support and commitment for that vision, similar to the approach Maryland took to implement PFAs (p.5). Creating policies and plans on a federal, regional, state and local level is important in creating a cohesive vision and engaging all stakeholders to participate in implementing policies.

Sustainable Development Promotion

Governments should promote sustainable development by implementing policies that encourage compact development and provide financial incentives similar to Maryland's programs. Encouraging sustainable development through incentive programs such as Cap and Trade will not only address the climate change issues, but can also provide funding sources for implementing policy tools such as smart growth (NMI, 2008, p.5). The provision of tax credits for compact development in areas can shift the paradigm away from resource depletion and move towards conservation. Legislative implementation that considers smart growth objectives also help to establish a regulatory framework that concurrently limits climate change.

Information Accessibility

Similar to stakeholder coordination, there is no cohesive standard model that integrates data collected related to smart growth urban development and climate change. In order to gauge the progression of policy implementation tools with the development and improvement of future models for balancing sustainability, it is fundamental to institute a platform that allows the collection of data from smart growth and climate change. Regional, state and local governmental entities should collaborate to establishing a recordkeeping requirement that would allow access to information that is not presently available.

Streamline Policies

Many of the policy tools presented in this research related to smart growth carry similar if not identical objectives to combating climate change. Streamlining objectives from policies that attempt to manage areas such as sustainable development, compact urban development and transportation into a comprehensive program that regions and states can implement could begin to address the issues related to climate change sooner and commence the process of thinking in terms of smart growth as a more viable option. While policy frameworks already exist to address climate change, smart growth options could yield reductions in GHG emissions from transportation in urban areas.

Compact Development and Conservation

Concentrating efforts to construct amenities within a determined area allows for conservation of energy and protection of the environment (Greenberg et al., 2001, p.132). Unifying development to incorporate activities such as walking or using public transportation encourages high-density areas to promote and support activities that reproduce sustainability. Reuse of existing infrastructure can reduce the amount of additional air pollution often found in new construction developments. The 2008 ULI study shows that high-density development that uses compact development strategies can offset adverse impacts of climate change (p.99).

Transit

Current state legislation across the US does not address the projected increases in sprawling development patterns and population growth, which is likely to result in increased VMT. According to Moore (2009), "The more travel increases and is concentrated geographically, the more congestion: thus, one would expect increases in congestion to be accompanied by increases in VMT" (p.15). Therefore, a policy that can provide options for transportation, which minimizes automobile dependency, is an important step in combating the increased air pollution that can pose harm to human health and the environment.

CHAPTER V: CONCLUSION

Until recently, governments and policy makers have not focused their regulations and legislation on the relationships that exist between smart growth and climate change. Elinor Ostrom (2012) stated, “When it comes to tackling climate change, the United States has produced no federal mandate explicitly requiring or even promoting emissions-reductions targets”. However she did indicate, “some 30 US states had developed their own climate action plans, and more than 900 US cities have signed up to the US climate-protection agreement”, drawing attention to a growing unaddressed concern related to GHG emissions.

Requirements at the federal level are starting to direct state and local entities to consider the impacts that development and transportation planning can have on climate change. The federal statutes and regulations already governing the transportation planning process require additional action from state, regional and local governments to assist in the process. According to the 2008 ICF International studies, “The text of these documents provides some opportunities to link climate change considerations with the planning process” (p.6).

By using the concepts of smart growth and specifically focusing on pedestrian friendly and other alternative transportation friendly development, those entities involved in policymaking decisions have the ability to manage the challenges facing urban areas. Reducing the impact of anthropogenic activities needs to make its way on to the environmental sustainability agenda (Sachs, 2008, p.148).

Lack of Smart Growth Legislation Contributes to an Increase in VMT

Several studies indicate a strong correlation between the densities of an area in relation to the energy consumed by automobile use in that same location. The research reveals that cities that contain low-density development tend to have driving related energy consumption rates that are nearly triple than those cities that are densely developed (Newman and Kenworthy, 1999, p.100). Therefore, the relationship between development densities and consumption of energy for driving has an inverse association. Holtzclaw (2000) observes that “Residential density is the most effective urban variable in predicting auto ownership and driving” (p.1). By providing access to shopping and transportation to work, these high-density areas reduce the need for automobile use.

Automobile dependence prevents the redesign of cities and the development of new and existing communities around smart growth and public transportation initiatives (Kushner, 2009, p.174). The case studies in this paper demonstrate the successes that communities in Oregon have had with increased availability in public transit and the development of pedestrian friendly areas. By continuing to provide citizens a variety of alternatives to single passenger driving, other communities across the country will be able to significantly reduce VMT.

To prevent expensive reactive measures to minimize the impacts of climate change, stakeholders must recognize the risks and take a proactive approach. The first step begins with addressing development patterns at the local, state and regional levels. Focusing on coordinated compact development, with a specific emphasis on reducing

VMT, these governmental groups will be able to produce measureable results. Traditionally, it has proven problematic to encourage people to drive less, because the way most Americans live, they have made it a necessity for their daily routine (Pew Center, 2009, p.5). By starting with design and development, cities will be able to produce transportation options that support convenient continuation of the tasks that citizens currently accomplish by driving.

VMT Contribute to Increased GHG

Air quality is measured at the federal, state, regional, and local levels. According to the EPA (2009b), US GHG emission has risen 17 percent between 1990 and 2007. GHG emissions have increased in every major city in the US during this time period, and the major urban areas have outpaced their rural neighbors. It is no accident that this emission pattern coincides with larger urban areas. With the exception of a small number of pure electric cars, almost all transportation options currently available in the US are powered by fossil fuel combustion. Transportation is the second largest source of GHG emissions in the US, accounting for 28 percent of emissions since 1990 (EPA, 2010b, p.14).

The EPA estimated that passenger vehicles in the US emitted roughly 35 percent of CO_2 production in 2003. The EPA (2009d) recognizes “Lower-carbon fuels and higher gas mileage standards can reduce the CO_2 emissions from passenger vehicles, but the growth in population and in vehicle miles traveled would eventually outpace these reductions”. Simply making individual transportation more fuel efficient is not a comprehensive approach to reducing and limiting GHG emissions. It is evident that a significant and lasting reduction in VMT is only attainable by including efficiency programs with overall urban planning techniques.

GHG Have a Demonstrable Effect on Climate Change

In a 2008 report published by the National Oceanic and Atmospheric Administration (NOAA), scientists propose that additional change to the climate is unavoidable and that the effects are evident; the report further explaining that various regions throughout the US could witness these changes in terms of drought, intensified storms, increased floods, extreme heat or other shifts in weather patterns (as cited in Karl et al., 2008, p.16). It will not be possible to completely prevent climate change. However, it will be possible to mitigate the negative effects of climate change.

Climate change happens, and would happen even without any assistance from human interaction. The scientific evidence presented in the research for this thesis supports the claim that GHG directly impact climate change. CO_2 is perhaps the most disturbing GHG as it relates to climate change. Each automobile on the road produces more CO_2 than any other pollutant. As US EPA (2010b) points out, CO_2 is not destroyed or broken down over time, but ”instead moves between different parts of the ocean, atmosphere, and land system” (p.18).

Making the Connection

The thesis research helped to enhance the understanding of the link between smart growth and climate change within urban development planning and transportation research. Several studies document transportation as the major force behind increased GHG emissions as it relates to climate change (Heart, 2000, p.1). Since it is clear that GHG have a direct impact on climate change, and VMT have a direct impact on GHG emissions, it is also clear that smart growth initiatives that result in reduced VMT have a direct impact on climate change. The most plausible method for introducing smart growth policy tools is to do so in gentrified urban areas. Due to the already condensed neighborhoods, gentrification provides a gateway for smart growth to become a feasible method of reducing automobile dependency. By continuing to focus urban planning on smart growth concepts with a particular concern for transportation infrastructure, communities can have a positive impact on climate change.

APPENDIX

GHG Emissions and GHG Emission Drivers for All 50 States, Ranked by GHG Emissions (2003 Data) (as cited in Ramseur, 2007, p.CRS -23, 24: Table A2).

State	Rank	GHG Emissions		Population		Per capita Income		GHG Intensity
		$MMTCO_2E$		in 1,000s		GSP/person		TCO_2E / $million of GSP
Texas	1	782	-	22,134	X	34,837	X	1,015
California	2	453	-	35,466	X	37,787	X	338
Pennsylvania	3	301	-	12,351	X	33,224	X	734
Ohio	4	299	-	11,438	X	33,174	X	788
Florida	5	271	-	16,982	X	30,548	X	523
Illinois	6	269	-	12,650	X	37,818	X	561
Indiana	7	269	-	6,192	X	33,082	X	1,315
New York	8	244	-	19,238	X	41,731	X	304
Michigan	9	212	-	10,068	X	34,260	X	614
Louisiana	10	210	-	4,481	X	29,375	X	1,591
Georgia	11	186	-	8,750	X	34,228	X	621
North Carolina	12	168	-	8,416	X	34,288	X	581
Alabama	13	164	-	4,495	X	27,140	X	1,343
Kentucky	14	164	-	4,114	X	28,739	X	1,385
Missouri	15	163	-	5,712	X	32,123	X	886
Virginia	16	143	-	7,376	X	38,108	X	507
Tennessee	17	141	-	5,834	X	32,523	X	745
New Jersey	18	137	-	8,633	X	42,435	X	373
West Virginia	19	133	-	1,809	X	23,708	X	3,097
Oklahoma	20	124	-	3,504	X	27,047	X	1,308
Wisconsin	21	123	-	5,467	X	33,799	X	666
Minnesota	22	120	-	5,059	X	39,146	X	606
Iowa	23	108	-	2,942	X	32,481	X	1,133
Colorado	24	107	-	4,546	X	39,144	X	600
Kansas	25	101	-	2,727	X	31,668	X	1,166
Arizona	26	96	-	5,582	X	31,294	X	551
Washington	27	95	-	6,130	X	36,612	X	421
South Carolina	28	92	-	4,142	X	28,809	X	771
Massachusetts	29	92	-	6,440	X	43,850	X	327
Maryland	30	90	-	5,507	X	36,164	X	450
Arkansas	31	81	-	2,724	X	25,971	X	1,138
Mississippi	32	76	-	2,874	X	23,281	X	1,131

State	Rank	GHG Emissions		Population		Per capita Income		GHG Intensity
		$MMTCO_2E$		in 1,000s		GSP/person		TCO_2E / $million of GSP
Wyoming	33	72	-	501	X	37,857	X	3,799
Utah	34	69	-	2,356	X	30,115	X	977
New Mexico	35	66	-	1,878	X	28,590	X	1,236
Nebraska	36	65	-	1,737	X	34,593	X	1,088
North Dakota	37	57	-	633	X	31,464	X	2,885
Oregon	38	51	-	3,561	X	32,825	X	435
Nevada	39	48	-	2,241	X	36,933	X	574
Alaska	40	46	-	648	X	42,784	X	1,662
Connecticut	41	46	-	3,482	X	45,875	X	286
Montana	42	41	-	917	X	25,389	X	1,755
South Dakota	43	27	-	764	X	33,671	X	1,060
Maine	44	26	-	1,307	X	28,632	X	693
Idaho	45	24	-	1,367	X	26,906	X	651
Hawaii	46	23	-	1,246	X	34,180	X	550
New Hampshire	47	22	-	1,286	X	35,821	X	469
Delaware	48	19	-	817	X	54,667	X	426
Rhode Island	49	13	-	1,075	X	33,904	X	349
Vermont	50	8	-	619	X	31,693	X	399

Source: Prepared by CRS with data from the WRI, Climate Analysis Indicators Tool.

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R482-06 Sources & Control of Volatile Organic Air Pollutants EPA & Air Pollution Training Institute	Indianapolis, IN December 15, 2006
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