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An analysis of fragmented land-use *policy and land-use change: The case study of metropolitan Pittsburgh

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An Analysis of Fragmented Land-use Policy and Land-use Change:

The Case Study of Metropolitan Pittsburgh

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Dissertation submitted to the College of Arts and Sciences at West Virginia University in
partial fulfillment of the requirements for the degree of

Doctor of Philosophy
in
Geography

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2005

**Keywords: Urban land-use, land-use planning policy, uneven development,
Pittsburgh**

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Abstract

An Analysis of Fragmented Land-use Policy and Land-use Change:

The Case Study of Metropolitan Pittsburgh

Richard J. Hoch

This research examines the relationship between remotely sensed land-use changes and particular land-use policies within metropolitan Pittsburgh, Pennsylvania from 1992 to 2002. During the 1990's the Pittsburgh region experienced a tremendous expansion of residential and urban land-use change while simultaneously experiencing a population decline. Within the metropolitan Pittsburgh area there are 525 local and independent municipal governments with the legislative right to enact or not to enact land-use planning policies enabled by the Pennsylvania Municipal Planning Code. This fragmentation creates uneven intra-urban development patterns at the urban scale. This research demonstrates that certain land-use changes that occurred during the study period share statistical relationships with certain land-use policies in the study area. The procedure to identify these relationships was twofold. First, a change detection analysis (CDA) of remotely sensed images of Pittsburgh acquired by Landsat satellites in October of 1992 and 2002 was conducted in order to determine the quantitative and spatial extent of land-use change within each municipality in the study area. The second step involved a logistic regression model used to determine the likelihood of the presence or absence of individual planning tools for each type of land-use change. The four planning tools examined in this research were, 1.) a comprehensive plan, 2.) zoning ordinance, 3.) subdivision regulation, and 4.) a planning commission. Results of this analysis are reported in terms of the global coefficients and the local characterization of some individual municipalities.

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Dedication

To my Mother:

Maria Carmella

To my Father:

Albert, Jr.

To my Brothers:

Albert, III
Virgil Wade
Keith Allen

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Acknowledgments

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CHAPTER 1 – Introduction

Pennsylvania's fragmented political structure composed of cities, towns, townships and boroughs creates an uneven planning-policy geography at the local level. This fragmentation has led to decades of unregulated development throughout the greater Pittsburgh area by private industrialists. For most of the twentieth century, struggles between public and private interests ensued as to which sector would direct the future of Pittsburgh's physical, political and economic growth.

Direct attempts by the public sector and many indirect attempts by the private sector all experienced moderate success in controlling the physical, political and economic transformations that Pittsburgh experienced during most of the 20th century. Later in the century, partnerships between the public and private sectors were formed to coordinate these processes. These public-private partnerships shared success partially due to the public sector's legislative authority in adopting policy, and partly due to the private sector's geographic freedom to elude regulation from the Commonwealth of Pennsylvania's fragmented political framework.

After decades of debate and struggle about how to manage the 'industrial district' known as Pittsburgh, the only authority yet to be established as a regional planning unit is a Metropolitan Planning Organization (MPO). MPO's are organizations mandated by the federal government to oversee and administer federal transportation funds. The pivotal policy action that led to metropolitan planning initiatives was the Highway Act of 1962. Prior to this, regional and metropolitan planning bodies existed, but had little or no authoritative role in the decision-making process. This Act made federal highway dollars contingent to those areas with populations over 50,000 by requiring such areas to

establish "a continuing and comprehensive transportation planning policy process carried out cooperatively by states and local communities" (Solof, 1996)[1]. This process become known as 'three – C's' planning and continues to be followed to this day. The establishment of MPO's as they currently exist took over two decades to fortify. Following the federal housing acts of the 1950's, the highway acts of the 1960's and the environmental acts of the 1970's, the need for a formal authoritative organization became evident, as compliance with social and environmental policies became increasingly comprehensive and bureaucratic.

The name of Pittsburgh's MPO is the Southwestern Pennsylvania Commission (SPC)[2]. Within the nine-county area planned by the SPC there are 525 local municipalities. The SPC's mission is 'the cooperative forum for regional collaboration, planning, and public decision-making' and it's main purpose is to help this region plan for the future by working to improve the transportation system, implementing economic development initiatives, and assisting local governments.

Local municipalities, however, are left with the actual task of community, conservation, and economic development planning. Local municipal governments are not, however, mandated by the state government to adopt land-use planning tools, but are empowered to do so by the Pennsylvania Municipal Planning Code (MPC). Therefore, guidelines are not set to dictate local planning policy, resulting in uneven intra-urban

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[1] For a chronology of the federal legislative acts that led to the establishment of MPO's, see Solof's, *History of MPO's, Parts I – IV*. Originally published in consecutive issues of NJTPA Quarterly starting in the July 1996 edition. Also available online at http://www.njtpa.org/public_affairs/mpo_history

[2] The Pittsburgh MPO previously operated under the name 'Southwestern Pennsylvania Regional Planning Commission (SPRPC).

development patterns. The nine-county area adopted by the SPC as its service region is

the study area for this research[3] (Figure 1).

Figure 1 – Study Area
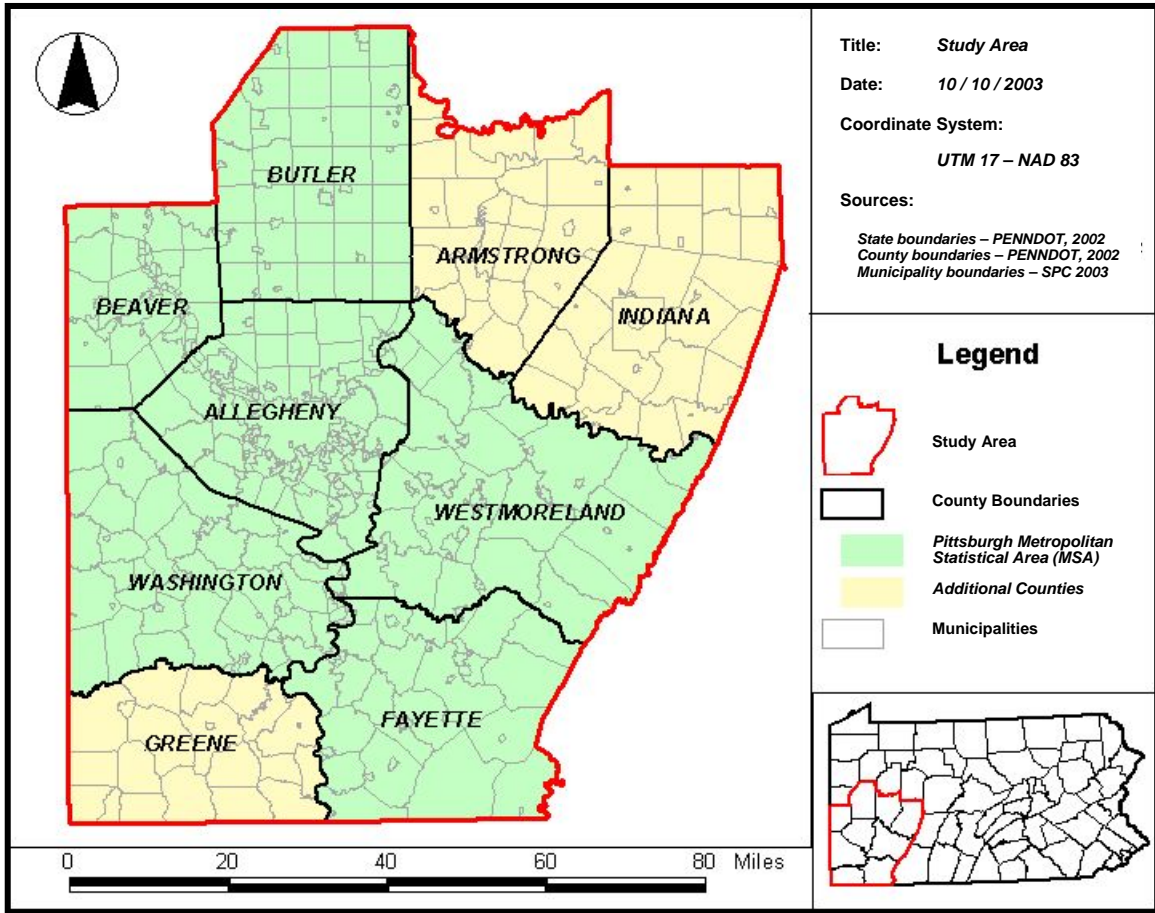
Despite the national mandate for metropolitan planning institutions, the practice

of comprehensive planning has faded as the predominant planning practice during the last

30 years. Postmodern influences have encouraged the concept of 'consensus through

collaboration' as the prevalent contemporary planning model. This postmodern shift has

further been supported as a result of the trend towards the privatization of land-use

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[3] The study area is the nine-county area consisting of Allegheny, Armstrong, Beaver, Butler, Fayette, Greene, Indiana, Washington and Westmoreland counties. At the time this research began, these 9 counties comprise the Pittsburgh MPO (the Southwestern Pennsylvania Commission) planning area. Recently, Lawrence County was added as a 10th county in the Pittsburgh metropolitan area.

planning. The trend of planning being a practice performed by for-profit planning firms

in lieu of government agencies – a practice that increasingly focuses on the most

advantageous scenario for the most local unit – compounds the race to-the-bottom traps

of uneven intra-urban development.

The population of Southwestern Pennsylvania has been declining since the 1960's

and the current population count is close to what it was in the 1940's. During the 1990's

nearly every US metropolitan region experienced tremendous economic growth.

Pittsburgh, however, did not. The one trend that Pittsburgh did follow during the 1990's

was the consumption of undeveloped land. According data produced by the US

Department of Agriculture, between the years 1982 and 1997 Pittsburgh developed

"nearly half (43 percent) as much land as had been previously developed… despite a

regional population decline of 8 percent" (from Sustainable Pittsburgh, 2002). This

contextual and historical chain of events has led Pittsburgh to the point where it is

possible that it ranks number one in sprawl during the 1990's when taking into account

the region's population decline.

> *"…Pittsburgh did not perform very well in the 1990's. Pittsburgh, in fact, could*
> *be considered one of the worst sprawling places in the country."*
> *Bruce Katz*
> *Senior Fellow, the Brookings Institute*[4]

In 2003, The Brookings Institution Center on Urban and Metropolitan Policy

released, 'Back to prosperity, a competitive agenda for renewing Pennsylvania' which

addressed Pennsylvania's current status in regards to population, taxes, jobs and land-use.

According to this report, "Among the nation's largest metropolitan regions no area can

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[4] Pittsburgh Post-Gazette, June 08, 2001 "Scholar says area sprawl worse than L.A.'s".

compete with Pittsburgh for profligate land consumption per household" (p.47). This

statement is supported by the facts that "Metropolitan Pittsburgh developed an

astonishing 202,000 acres of land – or 315 square miles of it – even though it lost

166,000 residents between 1982 and 1997 and gained just 24,000 households. This

means the region urbanized an astounding 8.5 acres for every new household it added

over the 15 years, compared to just 1.3 acres nationally". These statistics lead the

Brookings report to conclude, "This makes Pittsburgh by far the worst-sprawling large

metropolitan area in the country" (p. 49).

The overall goal of this research is to analyze the relationship between local

planning policy and land-use change in the Pittsburgh metropolitan region using remotely

sensed imagery and to analyze this information utilizing statistical methods. The specific

objectives of this research are:

- Identify changes in land-use within the municipalities of the Pittsburgh region by
  means of remote sensing change detection analysis, and

- Identify the relationship between local municipal planning policy tools with particular
  land-use changes throughout the Pittsburgh region by means of statistical analysis.

A post-classification comparison method of change detection analysis (CDA) was

performed using two Landsat TM data sets. The dates of these images are October 02,

1992 and October 06, 2002. The results of the CDA were then be distributed by

municipal unit. The amount and type of change in each municipality were then be tested

with four land-use planning policy variables for each of the 525 municipalities within the study area. The four land-use planning policy variables used in this research will be 1.) zoning ordinance, 2.) subdivision regulation, 3.) comprehensive plan, and 4.) planning commission. These four planning tools have been identified as the most basic and primary of the set of tools that local governments are empowered to use under the Pennsylvania Municipal Planning Code (Center for Rural Pennsylvania, 2001). Many local municipalities in the Pittsburgh region have not enacted all or even some of these foundational planning-tools, which they are entitled to do at their discretion.

The remainder of this research document is structured as follows: Chapter 2 provides background in the conceptual underpinnings of urbanization as an economic process and the endemic uneven development that occurs as a result of this process. Chapter 3 reviews contemporary issues pertaining to land-use planning and practice, including a discussion of the paradigm shift in contemporary planning theory and the privatization of land-use planning. Chapter 4 provides a brief overview of the documented historical processes that have manifested into Pittsburgh's land-use planning legacy. Chapter 5 will outline the research design where the data and software used will be reviewed, and the analysis methods will be discussed. Chapter 6 will explain the results of the case study with discussion and interpretation. Chapter 7 is the conclusion that discusses further research directions, some research limitations to the analysis, and final remarks.

CHAPTER 2 – The Urbanization Process

This chapter discusses the conceptual literature pertaining to urbanization, and more specifically, urbanization as a political and economic process. Modern and post-modern urbanization processes are the result of the advanced capitalist modes of production that are dominant in industrial and post-industrial nation-states. Various and numerous scales are produced as a result of production and these scales provide units for geographic inquiry. The most abstract scales for inquiry are the global, the nation-state, and the local – often referred to as the urban in this framework. This research uses this urban scale as its unit of inquiry. However, like other scales, the urban scale also produces a variety of other nested scales in which other processes take place.

The remainder of this chapter will discuss a rethinking of urbanization in the United States, and shows us that the urbanization process can now be conceptualized as a process of uneven economic development, where urban areas must compete with one another. A theory of scale follows with a discussion of the production and the politics of scale, particularly as they pertain to the urban scale. There is then a discussion of how the urban scale functions in the global economy, as urban governments are decreasingly functioning in a state hierarchy and increasingly forced to operate in a global economic network interacting with multiple scales, and increasingly relegated to deal with local economic crises independently. Last is a discussion of the tendency of urban regimes to rely less and less on urban government to facilitate reproduction, but rely more on urban governance as a mechanism to ensure continued accumulation.

Urbanization as an Uneven Process of (Economic) Development

Gordon (1977) identifies three historic forms of urbanization that took place in the US since it's colonial times. These forms correspond directly with the political economic view that capitalism has experienced three main stages of capital accumulation in the advanced capitalist nation states. These three forms and urban functions are: commercial accumulation/cities, industrial (or competitive) accumulation/cities, and corporate (or monopoly) accumulation/cities. Capitals' continuous 'creative destruction' of the urban landscape in order to continue to produce and control the production of capital accumulation and the reproduction of labor has been extensively examined (Harvey, 1978, 1987, 1989a; Brenner, 1997; Smith, 2000).

Gordon (1977) offers a radical perspective of US urban development stating that decentralization and the population and economic shifts to the sunbelt cities was not simply 'progress' but was caused by capital's inability to control labor in the existing manufacturing centers during the post-industrial period. Gordon (1977) attempted to show that urban development in the US was a result of class struggles and how capital adapts to counter-maneuver such struggles. This argument is counter to the traditional historical explanation that cities change (decentralized or grew elsewhere) due to new investment in technology and primary circuit modes of production (plants and equipment). Gordon (1977) argues the opposite – that "an eruption of class struggle initially prompted the decentralization and, by implication, that the new plant and equipment developed as a result of the dispersal in order to permit corporations taking advantage of the new locational facts" (p. 78). Capitals' response to this class struggle during the 1970s and 1980s was simply to move to other cities that did not mature during

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the industrial period therefore providing capital with more leverage over labor in these new locales. The ability of capital to move from its industrial 'local dependence' during the corporate stage of capitalist accumulation has also been extensively explored (Cox, 1988, 1993; Swyngedouw, 1997; Brenner, 1998; Smith, 1998).

To Harvey (1985), urban development manifests as a consequence of industrial capitalism. Harvey contends that urban development is in itself urbanization and that it is important to understand that urbanization is a process; a process implemented purely for the accumulation of profit by capital. In Harvey's words, "a class of capitalists is in command of the work process and organizes that process for the purpose of producing profit" (p. 101).

There is also a second theme that is crucial to the urbanization process; the conflict between the capitalist class and the working class, also known as the class struggle between capital and labor. The work process is the transformation of resources into products with added value. This transformation occurs by the work of human labor and the added value is derived from the difference between the wage earned by labor and the added value of that transformation. This surplus value is profit and the accumulation of profit is the goal of capitalism - therefore, in order to maximize accumulation, capital organizes this process, in its own interests. This organizing spatially manifests itself and leads to the creation of the built-environment, or more eloquently stated, "Capital represents itself in the form of a physical landscape created in its own image, created as use values to enhance the progressive accumulation of capital" (Harvey, 1985, p. 124).

A Theory of Scale

Smith (1997) has urged that a contemporary theory of the production and the politics of scale be developed within geography. Smith begins the discussion of such a theory starting with Giddens (1984) work where he views space as a mosaic, perhaps more like a jigsaw puzzle that is constructed laterally. Smith contends that space is hierarchical rather than a mosaic and these spaces are essentially socially constructed scales. Smith contends that an essential question is '(if) social life operates in and constructs some sort of nested hierarchical space rather than a mosaic. How do we critically conceive of these various nested scales…?" (Smith, 1997, p. 72).

This questioning has led Smith to attempt the construction of a geographic theory of the politics of scale. In this attempt, Smith revisits the work of Henri Lefebvre (1991). Lefebvre actually conceptualizes two types of space – social space and state space. According to Brenner (1997), Lefebvre describes social space as "an ensemble of social relationships, not an object, a void, a container" (p. 104). State space consists of three things; territory, administrative and organizational hierarchies to configure interaction, and the construction of a mental state space that is manifest from everyday social consciousness. These distinctions are important to clarify when discussing scale, the state, space and the politics of scale. At times what has been discussed as scale in the literature sometimes mixes these two concepts of space simply as 'scale'. But Lefebvre makes the distinction that social space is not the container of social interaction, but the result of it, and that if any container of social interaction exists, then it is that of state space.

Smith (1997) blurs the differences between Lefebvre's two concepts of space. Smith contends that while the two different types of space may exist, that essentially they are both scales of economic-social construction and, therefore, exist simultaneously in a nested hierarchy. In reference to the urban politics of this hierarchy, Smith writes,

> *"the same capitalists that cooperate through the local state, chambers of commerce and local growth coalition, in establishing local conditions for the reproduction of labor bower, also compete for wage labor and for local markets. The production of scale is a central means by which capital is both contained and freed, provided with a territory and at the same time a global base" (p.72).*

Smith (2002) later writes,

> *"the specific logics of capital accumulation embody equally specific geographies of economic expansion and that the unevenness of geographical development – between developed and underdeveloped areas on different spatial scales – owes not to geography in the old sense (differences in geographical endowment) but to the inherent logic of economic expansion per se" (prologue, p. xxi).*

This theory of uneven development provides an analytical framework for the study of the geography of capitalism; understanding that scales are produced and dynamically related.

The Production of (Urban) Scale

It is the urbanization process that creates urban space therefore producing the urban scale – a scale that is constructed due to the relations of capital and labor. Scale is inherently relative and if discussed independently of other scales, is therefore irrelevant (Jessup, in Brenner, 1997). Howitt (1998) defines the theory of scale as a concept of *relations*. This concept of scale is not a <u>size</u> or a <u>level</u> as has been argued and traditionally taken for granted, but this concept of scale is the extent of the interaction or relations between parties. Howitt (1998) distinguishes this concept from traditional definitions and "seek(s) to assert the importance of scale in a web of relationships between dialectically intertwined foundational concepts of co-equal importance" (p. 51).

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Smith (2002) builds on this concept of scale and offers his distinction of different kinds of scale and offers the explanation that scale is "not only material scale worded and reworded as landscape but it is also the scale of resolution or abstraction which we employ for understanding social relationships" (p. 75).

To preserve and continue accumulation, capital must adapt to the class struggle that occurs due to the exploitive nature of the work process. This struggle produces the urban scale *of relation* that is identified by the spatial extent of the dependence between local capital and labor. Further, the urbanization process creates urban scales partially by maximizing the extent of the labor market so as to input excess labor into the work process in order to keep wages low thus in effort to maximize profit. Thus, the urban footprint is the physical manifestation of capital's dominance of a labor-shed.

This scale/relation/struggle, is a dynamic one and each of the players involved (capital, labor, and the state) find ways to regulate the struggle in an attempt for control of power. One way that capital does this is to direct investment from the primary circuit to the secondary circuit of capital during periods of over accumulation crisis. This type or redirection of investment serves to alleviate over accumulation crisis while also, (1) facilitating the reproduction of labor, and (2) to establish a 'structural coherence' (Harvey, 1982). This structural coherence is a production of space; space with investment 'spatially fixed' for the purpose of continued accumulation.

The tactic of spatially embedding capital to facilitate accumulation does not necessarily mean that the class struggle is also 'spatially fixed'. Nor does it mean that the work process is temporally fixed. As Harvey (1982) states,

'Under capitalism there is, then, a perpetual struggle in which capital builds a physical landscape appropriate to its own condition at a particular moment in time, only to have to destroy it, usually in the course of a crisis, at a subsequent point in time" (p. 124).

The Politics of (Urban) Scale

Capitalism's contradictory nature of seeking out infinite resources in a world of finite supply results in the constant production and reproduction of spaces for both production and consumption (Harvey, 1989b). Historically, this production inspired exploration and the settling of North America's western frontier. Recently, this contradiction presents itself as urban renewal, urban restructuring, and local economic (re)development.

The global economic transformation has delegated much of the nation-states former responsibilities to the urban scales. Such re-scaling is also a mechanism developed to counter the contradictions of capitalism and to offset oncoming economic crises. As Brenner (1997) states,

> *"Once capital circulation has been extensively globalized, there is no longer any single scale on which stabilized long-run accumulation can occur. The frontiers for crisis-displacement are thereby exhausted, leading capital to revalorize and recolonize the spaces it has already conquered in its restless search for new sources of surplus value"(p. 154).*

The re-colonization of already conquered space is the 'new frontier' for capital, which, according to Smith (2000) is popularly defined as urban re-development. These new frontiers are the urban scales of social relation; cities now transform and re-develop for capitalisms re-expansion. Prior to the global expansion of capital, economic expansion could mirror capitals absolute geographic expansion. As a result of the globalization of capital, economic expansion takes place not through absolute geographic expansion but thorough the 'internal differention' of geographical space (Smith, 1990;

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2000). Smith (2000) argues that this internal differention materializes in urban renewal

programs and redevelopment authorities, which are both precursors and responses to

uneven development. Capital's need to structure and restructure urban space in order to

continue accumulation is not new and in fact it is endemic in the urbanization process

(Harvey, 1982; Brenner, 1997). "What is new" Smith (2000) adds, "is the degree to

which this restructuring of space is an immediate and systematic component of a larger

economic and social restructuring of advanced capitalist economies" (p. 344).

Urban Regimes as Economic Crisis Managers; or the New Urban Politics

Kevin Cox has contributed greatly to our understanding of the urban scale as a

result of the politics of scale Smith argues above. The global politics of scale has

transformed the function of the urban and urban politics. Cox's major conceptual

contributions to this understanding are, 1) local dependence (with Mair, 1988), 2) the

New Urban Politics (NUP) (1993), and 3) spaces of dependence and spaces of

engagement (1998). What follows is a discussion of each of these concepts.

Developed from locality studies, Cox and Mair (1988) devised the concept of

'local dependence'. Local dependence is defined as the dependence of various actors

(capitalist firms, the local state, local labor markets) on the reproduction of certain social

relations within a particular territory. This dependence leads to local growth coalitions

between public and private interests with the goal of stimulating local economic

development. The local state, local labor unions and certain local industries are heavily

invested in particular localities, which necessitate this new type of boosterism.

Potential conflicts arise from this kind of (loosely defined) solidarity of the

various actors. While a sense of community is constructed by these coalitions through

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the actions of local economic development offices, local dependency leads to the inevitable conflict between other, competing localities that share a similar situation. Firms try to escape local dependence by developing strategies that free their capital from local dependence. One way firms do this is by geographically diversifying into multiple locations (what Cox is calling multilocationality) by spreading the risk of local economic fluctuations over space. Simply state another way, the more spatially widespread a firms investments, the less likelihood of total loss. Another way is to avoid the immobility of the built-environment all together by renting the local means of production rather than investing in their fixity. Certain types of industries are more adapt at the latter strategy than others. Utility companies, for example, are not able to rent their needed local means of production, as they are the provider of a form of capital's spatial fix to those firms that are capable. This spatial diversification strategy at avoiding local dependence is a model that can be employed by the emerging industries of service-based economic activities.

However, Cox and Mair (1988) view these attempts at avoiding local dependence as a temporary and scale-specific remedy (a time/space fix), which works at the metropolitan local-scale. According to Cox and Mair (1988) "Multilocationality is merely a temporary and scale-specific remedy" because "it only reconstitutes local dependence at some broader geographic scale (p. 309). Therefore, local dependence 'jumps scales' as capital continues to globalize meaning that local dependence is not place specific but scale specific.

Capital's re-scaling of the state to defer crisis has resulted in the urban scale as the new crisis manager. Whereas global capital once relied on the underdeveloped world to shift crises where nation-states were subjected to a race to the bottom,, the rescaling of

the state now enables this shift to occur at the urban scale. Mobile capital benefits from the local dependence of urban state structures, other firms still fixed by capital investment in particular localities, and local labor markets that are 'traditionally' locally dependent for their continued social reproduction (i.e., family, churches, and other local social support structures). The mobilization of capital resulting from the increasingly globalized system relegates the responsibility of social reproduction and economic development to the urban scale, thus pitting urban centers against each other in an inter-scale competition for resources.

This new competition between urban scales is what Cox (1993, 1995) refers to as the New Urban Politics (NUP). Cox criticizes the emerging literature on urban politics as being too focused on attracting local economic investment. The NUP is simply the new priority local urban politics place on local economic development. The scale of the NUP is now different ["Urban politics has become globalized…" (1995, p. 213)] and as a result of the globalization of capital "cities (now) compete with one another for investment" (p. 214). The NUP argument is based on the assumption that there is a power struggle between capital and local communities. The NUP, then, is driven by the competition that capitalism forwards to invent new competitive edges but in the long run net rates of return, to what Cox (1995) refers to as, "above merely the normal" and he admits that, "there is some truth to the NUP, but it is a very qualified one and risks being overextended" (p. 220). Cox criticizes the NUP by arguing that ultimately, "localities are essential non-substitutable resources in the appropriation of super-profits" (p. 219). Cox (1993) warns that, "the NUP is a body of ideas that is ideological in form and which may therefore mislead as to the essential character of US urban politics" (p. 447).

Cox's conceptualization is criticized by MacLeod and Goodwin (1990) for not acknowledging the "discourses, hegemonic ideologies and regulatory practices in and through which the scalar materialization of the state is constructed and how this, in turn, impacts back upon these relative dependencies" (p. 510) and by Jones and Judd (Cox, 1998) who claim that Cox fails to see the role that scale plays in capital accumulation.[5]

Cox (1998) responds to these criticisms and further contributes to the understanding of the politics of urban scale by asserting that "The question of scale is crucial to political geography. We do nothing without making some reference to it" (p. 21). He then questions if such politics of scale can be spatially characterized, both in content and form, in areal terms. His distinctions of the two are what he calls 'spaces of dependence' and 'spaces of engagement'. Spaces of dependence are defined "by those more-or-less localized social relations upon which we depend for the realization of essential interests and for which there are not substitutes elsewhere; they define place-specific conditions for our material well being and our sense of significance" (p. 2). Cox (1998) goes on to explain that these social relations construct a different form of space which he calls spaces of engagement. Spaces of engagement are defined as "the space in which the politics of securing a space of dependence unfolds" (p.2). Cox explains that the spatial aspects of the politics of space may be better conceptually understood as a network of association and that these networks "signify unevenness in the penetration of areal forms" (p.2). Therefore, a space of engagement is actually a political network that operates within the socially produced spaces of dependence.

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[5] In Cox (1996), he provokes the question, "Scale seems to make a difference; but does it really?" (p. 669).

From Urban Governments to Urban Governance

Jessup (Brenner, 1998) has argued that state space at the national level has delegated much of its prior responsibilities as a facilitator of the economy to the urban scale state. This denationalization of the state, as postulated by MacLeod and Goodwin (1999) means, "regional and local states are seen to have 'gained' an enhanced role in such governance (from the nation state), and have also begun to promote territorial and functional transnational linkages with other cities and regions, thus helping to by pass the nation state (p. 505). Therefore, an increased amount of the burden of employment and economic development has shifted from nation-state institutions to urban governments.

Harvey (2001) details another important clarifying distinction between urban 'governance' and urban 'government'. 'Government' is defined as the established bureaucracy of the state at any and all scales that emerged as a necessity of the urbanization process. 'Governance' is a combination of the state and capital's interests as a strategy which formulates the reproduction of urban space as a suitable and desirable place for capital's accumulation.

Harvey (2001) observes that the reorientation of urban governance has been symptomatic of the post-modern shift from a 'managerial' approach typical of the 1960's in which cities operated as a unit guided by the logic of rationality, to the 'entrepreneurial' forms of action that have supplanted rationality beginning in the 1970's. This entrepreneurial approach to urban government activity shifts focus to stirring economic development and has, according to Harvey, emerged as the predominant and excepted strategy across national boundaries and even across political parties and ideologies.

The distinction between process and object is obvious and pertinent to Harvey (2001) who suggests that urbanization is the "spatially grounded set of social processes… that produce innumerable artifacts: a built form, produced spaces and resource systems of particular qualities organized into a distinctive spatial configuration" (p. 350). The process also creates institutional and legal forms, political and administrative systems, as well as hierarchies of power. All of these relational constructs that result from the process create a livable object known as a city in which particular cultures arise, predominantly (and historically) due to the struggle between local capital and labor. Historically because the advanced rate of globalization has made it increasingly easier for capital to transform from local dependency, relying on resources and skilled labor within a particular place, into a streaming flow of capital free to exploit labor and resources where markets demand the least amount of return. It is this macroeconomic shift that has forced the hand of local urban regimes to become less managerial and more entrepreneurial.

Urban governance has emerged as urban entrepreneurialism, of which Harvey (2001) has argued, exist four alternative strategies. These strategies identify the practices employed by many contemporary urban regimes' usage of urban planning as a tool in the production and politics of urban scales. What follows is a brief description of the four strategies.

The first of four alternative strategies for urban governance dictaits that since urban governments compete within the international division of labor, exploitation of particular local advantages for the production of goods and services must occur. Some advantages can arise from indigenous natural resources or location relative to markets.

Others are created from public and private investment in physical and social

infrastructure, which strengthen the metropolitan economic base for the exporting of

goods and services. The reduction of local development costs through subsidization and

of labor costs through the replacement of local collective bargaining in lieu of national

collective bargaining can be powerful magnets for new economic investment.

The second alternative strategy focuses not on competitive production, but on the

competitive position of spatial consumption. Tourism, retirement attractions, natural and

cultural amenities, consumer attractions and the like together define a 'quality of life'

attraction. The city must be attractive to new types of businesses and workers for those

businesses. A city must develop as a place that is innovative, creative, and safe to live

and recreate in. Thirdly, a large emphasis on the establishment and control of structural

functions, such as; information, finance, decision-making, communication and

transportation must be managed at the metropolitan governance level. The fourth

strategy for urban governance involves the re-distribution of wealth from state or national

government expenditures that serve to create a primary core investment, which then

creates secondary spin-off industrial development.

Conclusion

The body of literature presented in this section provides a conceptual

underpinning that is underlying throughout this research, which is that a metropolitan

area, no matter how politically fragmented, is an economic whole. And as the mode of

production, or economic engine, changes within this whole – other social, political and

physical changes in scale occur along with the economic change. As a consequence,

these changes reconstruct the spatial relationships of each of these scales, and in an

expanding global economy it becomes increasingly difficult to distinguish one scale from

another, as more and more social constructions become part of the global mode of

production.

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CHAPTER 3 – Planning Paradigms in Theory and Practice

This chapter will review the debate of the paradigm shift that is present in contemporary planning theory and planning practice; a debate that is represented by the modern method of comprehensive planning represented as the rational planning model (RPM) and the postmodern critique of this model. Next will be a discussion on the privatization of planning; as planning activities increasingly shift from the responsibility of the state to for-profit professional planning firms. Following will be a discussion of the combined effects that the postmodern critique's approaches have had with this privatization, as the profession contradicts itself - and in fact creates more dysfunction - by emphasizing the sustainability of the individual local unit rather than the sum of units that creates the metropolitan region – often ignoring the production and politics of scale that is endemic in economic development.

Planning Theory Paradigms

During the last 30 years, two movements have radically changed the theory and practice of land-use planning in the United States. The first movement has resulted in a debate that questions whether 'planning' has experienced a paradigm shift; is in the process of a paradigm shift; or if planning needs to move toward a paradigm shift. This debate juxtaposes two seemingly conflicting approaches to planning, each comprised with opposing epistemologies, outcomes, and purposes. This is a debate between 'expert' (or top-down) vs. 'consensus' (or bottom-up) planning approaches. This debate is conceptually framed as a paradigm shift from a modern to a postmodern epistemology and is theoretically contested as questioning the fundamental role of planning as

'planning for' or 'planning with' communities (Klosterman, 1999, Hoch, 1994; Gondim, 1988; Moore, 1978).

The second movement is the privatization of land-use planning and the effects that market forces have had in producing planning geographies in the US (McCaan, 2000). Combined, these two concepts have created a complex structure that dictates where, who, why and how much land-use planning occurs. In Metropolitan Pittsburgh, this complex structure is compounded due to the vast political fragmentation that exists.

Modernity (Rationality)

'Expert' models place the planner in a role of technocrat, employing methods that are perceived as top-down and data driven. This is known as the traditional role that planners play – producing documents that are comprehensive in scope, guided by local public and private elites, and enforcing 'rational' decision making. This process is defined as the rational planning model (RPM) and originates in the scientific viewpoint that modernity popularized (Allmedinger, 2002).

In 1984, Ernest Alexander asked the poignant question, "After rationality, what?" This question asks if the traditional and comprehensive RPM is inadequate for contemporary planning practice. The RPM has been considered the dominant paradigm in US planning theory and method since it's adoption after World War II. Rationality stands for scientific decision-making built on a foundation of truth derived from data, statistics and neo-classical economic theory. The origins of the RPM grew with the 'quantitative revolution' that had influenced the physical and social sciences, and planning seemed to teeter between both. Before the general acceptance of the RPM, planning in the US originated from the Reformist movement "at the turn of the century in

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response to the widespread dissatisfaction with the results of existing market and political processes reflected in the physical squalor and political corruption of the emerging industrial city" (Klosterman, 1985). Rationality emerged as the 'best management practice' to address these urban ills and the focus of this rational planning, at that time, related to land-use in the city (Levy, 1990).

Planning soon became a growing enterprise. No longer was 'Planning' recruiting planners from engineering, architecture, and the like – planning had now established itself as a legitimate discipline and was now producing professional planners. Planning was no longer an activity taken up by various city departments; it had become a city department unto itself, establishing itself as a legitimate and authoritative activity. Planning had also become an academic discipline worthy of its own discourse, theory and canon of literature to be drawn upon – all legitimizing its existence and supporting its future reproduction (Howe, 1992).

What resulted has been both beneficial and destructive to planning. Rationality and its positivistic methods were adopted by practitioners, taught by educators, debated by theorists and ultimately challenged by all. The RPM offered a curtain of liability and an aura of expertise to the practitioner, a set of methods and theories to the educator and intellectual rhetoric to be supported or negated by theorists (Howe, 1992).

This institutionalization of planning and the dominant paradigm of rationality invited attack from those inside and outside of the discipline. Methods of planning practice have been criticized as unrealistic, authoritarian, paternalistic or serving capital (Wildavsky, 1973; Harvey, 1998). The legitimate existence of the planning discipline

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has been questioned and analyzed (Brooks, 1988; Hoch, 1994) and theoretically, planning has been criticized for its epistemological underpinnings (Escobar, 1992).

Planning has brought much of this criticism on itself. It has tried to do too much too fast. Progressive practitioners soon left physical land-use planning to the traditionalists and moved into social planning, where advocacy for the low-end of the public interest spectrum took precedence (Krumholz, 1982). Planning's reactive policies oriented toward the spatiality of the physical environment became less important to proactive policies of the cultural environment where 'justice' now served as planning's predominant role. Planning schools de-emphasized design and new faculty entered from the social sciences while the founding faculty of the design school exited (Levy, 1992).

Proponents of the RPM have argued that the technical aspect of plans and the planning process "is but one factor in a network of relationships which are essentially political but not, therefore, irrational" (Alexander, 1984, p. 140). In the years since the Second World War, the role of planning has expanded beyond that of reform. Levy (1992, p. 81) alludes to the planner as "part of the administrative apparatus of land development and a facilitator of community economic development"

Critics of this modern process advocate for a more bottom-up and collaborative method that incorporates the many voices of the many publics of a place's citizenry that focuses on short range goals intended to better the quality of life for communities affected by micro, meso and macro economic processes (Dalton, 1986; Dear, 1986). Klosterman (1978) reminds us of planning's reformist origins in contradiction to the rationalist tradition that formed in the 1950's, arguing that planners can combine their dual commitments of reform and science as long as they understand the balance of

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planning for the means as well as the ends. However, this post-modern turn in planning theory has proved difficult to implement in practice. It is impossible to fully address the input of a diverse local public. Therefore, a planner must advocate for the causes and goals that she or he feels best represents the 'public interest' (Klosterman, 1999).

(Post) Modernity

The postmodern paradigm is in actuality an epistemological turn from the rational paradigm. The praxis of postmodernism's skepticism and rationality's empiricism is difficult to pin-point. Postmodernism challenges rational science's 'way of knowing' which reflects largely of the greater divide between Asian ('eastern') and European ('western') thought. "Postmodernism argues for a more de-centered view that we can never represent reality and instead must accept a never-ending chain of signifiers" (Allmendinger, 2002, p20), yet the western world since modernity has "been reduced to one form of reasoning that excludes all others.

The postmodern paradigm critiques the modern paradigm for its reliance on 'rationality' as the primary and central decision making logic. This logic manifested itself as the 'rational planning model' (RPM) – a model that has shaped the planning profession and land-use patterns of the US for the greater part of the 20th century. While not offering an alternative to rationality and the rational planning model itself, postmodernism has, by establishing a critical discourse, attempted to curtail the positivistic nature of rationality. Postmodern planning urges the decentralization of the decision making process utilizing communication, collaboration, and by measuring success with much more narrowly focused, incremental goals as opposed to the technocratic, paternalistic long-range and comprehensiveness associated with the RPM.

Wildavsky (1973) recognized the turmoil planning was headed into early on when he stated, "If planning is everything, maybe it's nothing" (p. 127). He criticized the idea of national planning on the grounds that efforts to that point have never achieved the successes that planning had prescribed. The criticism attacked conventional Planning from multiple angles, suggesting that planners had either become to political – or not political enough, and that Planning should concentrate on the particular economic relationships at hand while ignoring the macro-economy as a whole. To Wildavsky, planning is an act of 'secular faith' and concluded that planning is fooling itself if it thinks it can create the future from empirically interpreting the past. If planning were truly rational, Wildavsky suggests, then plans would never fail because, "It cannot be rational to fail" (p. 153).

Klosterman (1978) revisits the reformist foundation that US planning was built upon at the turn of the 20th century as opposed to the rationalist tradition that took hold as the dominant paradigm by 1950. Klosterman attempts to synthesize Planning's commitment to change, and it's claim to science by discussing the philosophical conceptions of these foundations in order to arrive at common ground. Klosterman documents the epistemological train between the logical-positivist conception of ethics and the means-end conception of rationality. Klosterman ends optimistically, arguing that planners can combine their dual commitments to reform and science as long as they understated the balance of planning for the means (rationality) as well as the ends (reform).

Robert Beauregard (1991) takes planning's dilemma and makes links with critical social theory by asserting that "Planning is currently suspended between a modernist

sensibility whose validity is problematic and a postmodern reality posing serious challenge to planning's underlying assumptions" (p. 189), and argues that "resolving this ambivalence is essential to making planning effective" (p. 192) Beauregard concludes that if planning is to forge the 'postmodern abyss', then it must share postmodernism's assertion that an increased reliance on scientific knowledge does not set direction, but only reveals difference. What is important to the postmodernist, therefore, "is not causality… but meaning" (p. 193).

Beauragard (1989) suggests that planning as a modern project is inextricably linked to the rise of capitalism, the middle class, scientific legitimization, spatially efficient cities and an interventionist state. This foundation of a totalizing vision, however, has been 'undermined' as Planning began to be less about reform as it "sacrifices regulation and the welfare state to the lure of new investment and jobs" (p. 387). This departure is the suspension of Planning between modernity and postmodernity and Beauregard offers three paths of action for planners to resolve this divide. They are for Planning to revisit and refocus its work on the process inherent to the built-environment, to establish itself as a mediator between capital, labor and the state, and to advocate the meaning and consequences of urban development for all.

Michael Dear (1986) contributes to the critique first by attempting to define the indefinable meaning of postmodernism as it applies to planning with three notions of postmodernism: as style, as method and as epoch. The second contribution is that Dear applies postmodern rhetoric by deconstructing planning history in the post WW II US, which reveals the 'pastiche', or borrowed patchwork, of postmodern planning. Dear's

reconstruction provides a discourse, which suggests three dimensions for planning to be conscious of:

- Function- context: to be aware of what planning does (function) in light of its socially constructed setting (context).
- Commodification- noncommodification: to understand the implication of planning as a product for capitalist manipulation.
- Penetration- participation: to weigh the political power infused in planning and not to let state penetration forgo public participation.

Responding to the postmodern critique, Harper and Stein (1995) claim that most of the challenges of postmodernism are valid, particularly the critique of modernism's narrow understanding of knowledge. Harper and Stein counter many of the critique's rejections as potentially dangerous to its intent and that any attempt at a complete postmodern 'way of knowing' is impossible because it retains many of the dualisms it supposedly rejects. Harper and Stein conclude that both modernism and postmodernism are insightful and valid although "they will not always agree with them" (p. 242). The complete consensus and representation of voices is as problematic and dangerous as rational representations of science. Planning, therefore, must meet somewhere between these two and that the best way to forge 'the abyss' is with open dialogue, communication and critique of each in an open and understanding forum.

Innes and Booher (1999a; 1999b) further document the differences in the paradigms by identifying the paradoxes that arise when attempting to identify success between the RPM and the Collaborative methods. Innes and Booher claim that decisive action, achievement of goals, and implementation – all components of the RPM – are not only impossible to measure when applying the Collaborative method, but that these

components are irrelevant because process and outcomes cannot be separated and are therefore blurred, making a never-ending dynamic in which ultimately everything is considered yet nothing is achieved.

Planning Practice Paradigms

Throughout the 1990's, collaborative (or communicative) planning has become a hegemonic concept in planning theory and practice (Tewder-Jones and Allmindinger, 1998). This focus has reoriented the planning debate on language, modes of communication, and power. These issues have been philosophically forged by Jürgen Habermas's call for a discoursive ethic and Michel Foucault's thesis of the omnipresence of discoursive power (Pløger, 2001). While the planning profession has embraced the Habermas collaborative model as inclusionary and consensus-based (Innes, 1999a, 1999b), a critical backlash has emerged following Foucault. The critique has condemned public participation as 'an art of governance' (Pløger, 2001) and practiced collaborative techniques, such as 'visioning', as power-grabs by local elites in effort to dictate the planning process (McCann, 2001).

The Dilemma of Sustainable Development

The prevailing practice that has resulted from the post-modern paradigm is collaborative planning (a notion that involves inclusiveness and consensus). The prevailing goal of this paradigm – both in practice and in theory – has emerged as the maxim of 'sustainability' and 'sustainable development'. Sustainable development has been broadly defined as, "…development that meets the needs of the present without compromising the ability of future generations to meet their own needs" (World Commission on Economic Development, 1987, as noted in Alshuwaikhat and Nkwenti

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(2002), and more precisely defined as, "…a dynamic process in which communities anticipate and accommodate the needs of current and future generations in ways that reproduce and balance local social, economic, and ecological systems, and link local actions to global concerns" (Berke and Manta, 1999, as noted in Alshuwaikhat and Nkwenti (2002). A globalization perspective may view these definitions as advocating for 'planning for the global market place'. Sustainable development differs from sustainability, in which human impacts on resources and the environment are constrained to protect life-support systems (Bowers, 1997 in Grainger, 1999) but without directly balancing them against the benefits of development" (Grainger, 1999, p. 252).

The notion that all places can experience simultaneous sustainable development is not possible; as the theories of urbanization and uneven development have showed us. As Grainger points out, "Because of uneven development the same degree of sustainability should not be expected at the same time for all spatial units and the same spatial level" (p. 251) (also see chapter two). This is a problem for both collaborative planning theory and the incremental planning practice. This is because the post-modern paradigm has evolved to be increasingly place-independent, meaning that space has been replaced by theoretical process and scale has been ignored in practice. Note that the broad definition of sustainable development above refers only to temporal scales (the present and the future), and that the precise definition identifies only independent local and global scales with disregard for relational local scale. Scale is inherently relative and if discussed independently of other scales, is therefore irrelevant (Jessup, in Brenner, 1997). Scale, as relation or extent, should be at the forefront of any progressive planning activity that is truly interested in achieving (near) sustainable development. The lack of

concern of scale (as relation) is prevalent throughout much of the canons of land-use planning literature. Planning is unique among professions, as it does not require those who practice planning to share a common educational background, therefore many planners bring their own conceptual and methodological dogma from their respected disciplines; thus creating the potential for contradiction in both theory and practice.

As populations become increasingly urban, those populations are then also increasingly dependent on the labor of others within the city they dwell in. To plan locally for global markets may benefit those communities that have found a successful niche to do so, however at the same time it can be irresponsible for those successful communities not to adhere to a larger, regional and comprehensive effort aimed at the economic success and longevity of the larger urban system in which they are inevitably a part of.

Sustainable development is not an attainable goal for all places independently, as uneven development theory informs us, however it should still be a goal that is set and strived for regionally. To facilitate actions toward that goal, places in metropolitan areas are to be intentionally under-developed. Again, Grainger (1999) points out, "Capital conversion processes influencing the sustainability of development of spatial units are constrained by processes at different levels, e.g. those imposing environmental conditions on development or affecting availability of investment capital" (p. 251). While natural and political variations in places have great influence over the economic health of localities, policy is a leveraging tool to be used by local states in the struggle with private capital. Land-use policies adopted by local states can either counter or embrace market

forces and these "(m)echanisms exist to compensate for the unevenness in development between spatial units" (Grainger, p 255).

This under-development is not only necessary, but when planned for in a regional effort, can serve to be places of both production and consumption; providing urban landscapes that are not produced uniformly but elicit varying forms necessary for continued reproduction. Such places can be desired destinations for a city's current residents while being advantageous for retaining existing and attracting outside investment. The key to this successful uneven development is to manage it at the local (metropolitan) level and not to be subject to the whims of global markets. Essentially it means dropping out of 'the race to the bottom' and challenging a city's leadership to 'aspire to the top' in order to attract the educated and professional labor pool that the global market will seek out.

Planning for Profit: The Privatization of Planning

The privatization of goods and services in urban environments is a growing trend in both developed and developing countries as the world-space economy increases in magnitude yet decreases in local control and decision-making. Planning is no exception, as for-profit planning and architecture firms now undertake an increasing amount of planning activities. In other words, the collaborative and incremental paradigm shift has benefited 'Planning' as an industry, but at what societal cost?

Throughout the 1990's, the primary concern of urban policy for most western cities was urban regeneration (Harvey, 1998). The changing societal structure from industrialization, deindustrialization, and into what is anticipated to be a service economy, also brought a shift in urban policy from what was managing city growth more

towards dealing with the consequences of economic restructuring. This entrepreneurial role of urban regimes has been identified as the New Urban Politics (NUP) by Cox (1993). Cox defines the NUP as a process which subordinates urban regime functions to the imperatives of globalized capital accumulation. This process requires urban governments to increase the urban system's competitive advantage by restructuring the built-environment more for the needs of capital and less for the needs of the citizenry (Rodriguez, 2001).

Furthermore, urban regimes now find themselves in new roles (especially those regimes that govern post-industrial cities) that require formulating strategic imperatives that promote their city as a better business climate then a neighboring city. This type of urban and civic boosterism is reminiscent of the 18th century's urban boosterism during the industrialization of American cities. And like the 18th century, the political might of private capital has forced the hand of urban governments to rely on the private sector for many of the functions that urban governments can either not afford or do not have the authority to conduct. Therefore, a critical component of the NUP has been a shift from urban government to governance (Rodriguez, 2001).

Governance, in this instance, is defined not as the act of governing or being governed, but has a much deeper meaning that reflects the privatization of governing. This definition of governance is applicable at all scales and, in the case of Pittsburgh, is contradictory to the municipal fragmentation that exists which confronts directly with those localities that are trying to attain 'sustainable development'. In fact, changes in the urban economy do not take place homogeneously inside the metropolitan area. According to Rodriguez, "On the contrary, processes of socio-economic restructuring

occur along the lines of existing social and functional divisions of space" (Rodriguez et al, p. 163).

Planning as a Product

Dear (1986) contends that the current (post-modern) planning practice has been stratified into two distinct practices that are synonymous in name only and not in their respective goals. Governments at all scales have increasingly relegated increased proportions of their planning efforts (whether willingly or due to fiscal constraints) to the private sector. Many elements of planning continue to be conducted as a function of the state. However, the degree unto which planning practice continues as a function of government is spatially uneven both among and within cities. As planning as a government action declines unevenly, planning practice as a product of private capital is inversely increasing unevenly.

Dear (1986) explains this privatization as a result of two things, what he describes as within the state's planning apparatus and through the creation of a private planning apparatus. The decline of planning as a state function is attributed to the restructuring of urbanization at the advent of the post-modern period[6]. This restructuring diminished the authority of public planning by way of cutting the funds available to state planning agencies to the point where many such entities ceased to exist.

Despite these cuts, the need for 'planning' increased as governments required municipal structures to undertake planning efforts in order to receive any of the already reduced federal funds available to them. It was this re-orientation of 'planning practice' that marked a fundamental shift from planning as a dynamic and continuing process into

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[6] Harvey has marked this starting point as 1972 when President Richard Nixon declared the urban crisis to be over and cut federal funds for urban programs (2001, p.347).

a practice that involved projects, tasks, endpoints and outcomes. Dear (1986) calls this shift 'commodification' (p. 126). Commodification of planning refers to the transformation of routine government functions into packageable units that can then be marketed and sold as a private product. The privatization approach to supplying goods and services is not novel to planning – as many urban necessities such as transportation to trash collection have faced the same transformation – however, the planning of the built-environment is not something that is easily commodified and such a transformation hands-off the future of a city from the local government to the market whims of corporate governance.

The ideology of planning can be explained through a number of discourses. Continuing with Dear's (1986) deconstruction, he identifies three distinct discourses that have emerged in planning as the planning practice continues to struggle with its identity in an advanced capitalist society. The first discursive rhetoric is a rhetoric of instrumentalism in which the planning discipline is seeking to reassert its authority and need in what Dear calls 'an obsolete professionalism'. This discourse contends that planning is a profession in which experts should lead the process as an agent of 'the public interest' and that comprehensiveness is a critical approach. The second discourse is a rhetoric of rhetorics that focuses on persuasion strategies, such as 'collaboration' and 'consensus' approaches, which have gained popularity among the private planning apparatus due exactly to the rhetorical promise of inclusiveness. And a third discourse of a rhetoric of performance that is also popular among the private planning apparatus, as it seeks to legitimize and judge planning primarily as a function of a small duration or to what extent it promotes a clients interests.

These discourses are somewhat chronologic in current practice, although the degree to which rhetoric is adopted and promoted is inherently linked to the spatially uneven shift from government to governance that occurs within a particular urban center.

The increasing privatization and commodification of planning, what Dear calls a 'mutant form of practice' is now the process that shapes the form and function of our current built environment. The implications of this mutation can be debated. This paper argues that the privatization of planning has resulted in the loss of planning's reformist origins and that privatization has resulted in Capital's cooption of the planning process in order to facilitate continued accumulation. This reorientation assimilates Planning into the circuit of production and consumption as part of Capital's organization process.

Contemporary Trends

The contemporary Pittsburgh case study has a private conglomerate of influential organizations that are steering the metropolitan region. The Allegheny Conference on Community Development (ACCD) has a long history of shaping the Pittsburgh region (see Chapter 4). The ACCD and its affiliates; the Pittsburgh Regional Alliance, the Greater Pittsburgh Chamber of Commerce, and the Pennsylvania Economy League-Western Division, all promote "working in collaboration to stimulate growth in southwestern Pennsylvania's economy and improve its quality of life" (Allegheny Conference on Community Development, 2005). The Pennsylvania Economy League (PEL) promotes the 'region' concept in slogan of sorts (Figure 2, below) with the saying "The Region Is a Product", displaying the 10-county metropolitan area in the cover of what looks to be a box similar to a software package. Despite the implication of this campaign, it is a powerful reminder that the private sector, unrestricted by local politics

and empowered by the market economy, is more powerful and successful at planning

Pittsburgh's future than any of the over 500 metropolitan, county, or local municipal

governments can achieve through Pennsylvania's fragmented government composition.

Figure 2 – "The Region Is a Product"

Source: http://www.pelwest.org/

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CHAPTER 4 – Historical Background

Paul Kellogg's (1909) attempt to describe Pittsburgh and its area of influence surrounding the industrial heart of the city truly defines the spirited nature and result of the passing of the mercantile epoch and the maturing of industrial capitalism in the 20th century for a loosely defined Pittsburgh region.

> *"Pipe lines that carry oil and gas, waterways that float an acreage of coal barges, four track rails worn bright with weighty ore cars, wires surcharged with a ruthless voltage or delicately sensitive speech and codes, bind here a district of vast natural resources into one organic whole"*[7]

Pittsburgh's industrial complex explored and consumed the resources it needed to facilitate its capital accumulation early in its entering of the second industrial revolution. While this economic engine grew into the 20th century, Pittsburgh's struggle for some type of metropolitan control - be it civic government or private governance – grew too. The struggle has been complicated by many factors, most notably the political fragmentation of 'Penn's Woods', the region's narrow economic base, and the influence of industrial magnates. For urban centers to be successful in the globalized economy of the 21st century, however, 'permanent centers of decision and action' must be established (Lefebvre, 1991).

The history of this struggle to establish 'permanent centers of decision and action' is reviewed in this chapter. The following historical narrative utilizes the conceptual underpinning discussed in Chapters 2 and 3 as it documents the actions of Pittsburgh's public and private elite's in establishing control of what we now know as the Pittsburgh Metropolitan Region.

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[7] Quoted from Muller, 1996, p. 72, in *The Pittsburgh Survey.*

Planning History of Pittsburgh

Historically, the planning legacy in Pennsylvania has always been a fragmented one. William Penn founded Philadelphia (and 'Penn's Woods') during the mercantile era, premised on de-centralized, local governments forged together to create a common-wealth. In July, 1681, William Penn published his colonization plan for Pennsylvania, which started with Philadelphia. Penn's plan was a structured landscape organized to foster Quaker values but also to accommodate economic exchange (Fries, 1977). The grid pattern that Penn devised for private parcels of land in Philadelphia (Figure 3) stated that the streets had to be uniform to the river, with houses built upon a line. This was in contradiction to the metes and bounds method of municipal property land division that was dominant throughout Pennsylvania. Metes and bounds deeds often referred to landscape features such as trees and rock outcrops, relative property ownership, and non-standard measuring units. This contradiction spread throughout the Commonwealth, creating a mixture of state and private space being marked in both absolute and relative terms.

Penn's physical design of Philadelphia was somewhat revolutionary at the time, but the civic planning of urban environments and the city planning movement in the US truly began at the end of the 19th century, inspired by the Chicago World's Fair Columbian Exposition of 1892/3 (Cullingworth, 1997). As the reform movement emerged, industrial cities of the early 20th centuries engaged in efforts to centralize decision-making (Hays, 1989, 2000). Pittsburgh's first successful centralization campaign was directed at controlling the floodwaters of the Allegheny and Monongahela rivers. Starting in 1908, this movement involved public and private agents at local, state

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and national scales, eventually resulting in the construction of 16 regional dams and 42

additional local flood control projects, affecting millions of acres of land in four states

within the rivers' drainage basin (Smith, 1975, 1977). This transformation of the

physical landscape protected the central business district, allowing for the continued

growth and expansion of industry along the banks of the Allegheny, Monongahela and

Ohio Rivers (Muller, 2001).

Figure 3– William Penn's Philadelphia Plan

Source: http://www.brynmawr.edu/Acads/Cities/imgb/imgb3/018a.jpg
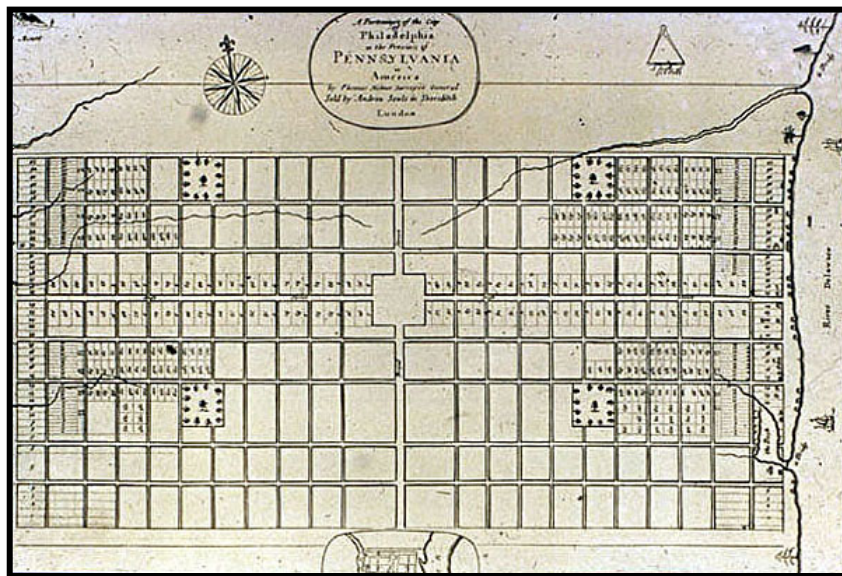
Zoning ordinances emerged in Pittsburgh in 1923 as a way to regulate how real

estate would be used and who would use it (Daly, 1988). In contrast to the flood control

campaign, which essentially implemented regulation on one large land mass (the

headwaters of the Ohio River), zoning legislation allowed local governments to regulate

land-use on the small parcels of private property owners.

Between 1908 and 1923, a number of additional policies aimed at political

centralization were adopted such as building and tax codes, municipal bureaucracies, city

charter revisions and annexation (Daly, 1988). Industry and government leaders

competed for control of the 'Pittsburgh industrial district' starting in the late 1800's and

there was competition amongst public efforts[8] and private efforts for control[9]. This

public and private competition has lead to the public-private partnerships that continue to

shape Pittsburgh's economic landscape (Lubove, 1995, 1996; Stewman and Tarr, 1982).

Prominent urban architects and politicians of the early 20th century agreed that a single

apparatus should govern the Pittsburgh industrial 'district'[10]. This local-regional struggle

is a process that is still prominent today.

Community and municipal land-use planning policies stem from the federal

Housing Act of 1954, specifically Section 701, which created a grant program for

communities to pay for comprehensive plans and land-use regulations. Most local

municipal planning in Pennsylvania is due to this program. As federal funding of local

planning ended, Pennsylvania created its own State Planning Assistance Grant Program.

Due to these programs, nearly two-thirds of Pennsylvania's municipalities and counties

engage in land-use planning to some degree (Center for Rural Pennsylvania, 2002).

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[8] Olmsted, F. L., 1911, *Pittsburgh Main Thoroughfares and the Down Town District, improvements necessary to meet the citys present and future needs, a report.* Pittsburgh: Pittsburgh Civic Commission.

[9] Citizens Committee on City Plan, 1923. The Pittsburgh Plan.

[10] Olmsted wrote in '*Thoroughfares...*' that *"The simplest and most logical procedure, if the boundaries of the city and of the boroughs are to remain substantially unchanged, would be to establish a common agency for dealing with the general problems of city planning for all of the municipalities and the related parts of the country outside of them...".*   In 1911, Mayor William F. Magee proposed a consolidation bill that would have annexed and additional 24 square miles and 227,000 people to the City of Pittsburgh, calling this area the "real Pittsburgh" (Daly, p. 109).

Urban Decentralization

There is a large literature about the suburbanization of North American cities in both urban history and urban geography that has focused on the movement of city residents away from the CBD to the newly developed areas outside of the city due to availability of cheap land, inexpensive building methods, and rapid transportation.[11] These studies have argued that North American cities did not experience de-centralization until the post-war period starting in 1945, attributing much of the flight to new housing policy and a booming economy, while a minority of others have argued that the decentralization of the production process in most of North America's traditional industrial core was a result of class struggle (Gordon, 1975).

Walker and Lewis (2001) re-visited the decentralization question arguing that industrial suburbanization has been an ongoing process since industrializations second wave starting in 1850. Their interpretation goes against the traditional wisdom that suburbanization began nearly 100 years later.

This new interpretation combines three concepts to support the argument. First, is 'geographic industrialization'[12], in which new industry locations are created from old ones which can spur secondary and ancillary industries that may, or may not, attract new labor forces. Geographic industrialization differs from traditional location and mainstream economic theory which suggest that producers are assumed to minimize their total costs, including transportation costs, so the optimal location that a firm will consider depends on distances to raw materials and the final market. Industrial location patterns are created through a process of growth rather than a process of efficient allocation of

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[11] See Kenneth T. Jackson's *Crabgrass Frontier*, 1987.
[12] Attributed to Storper and Walker's, *The Capitalist Imperative,* 1989.

plants and that industry location and regional growth are produced rather than dictated by the placement of resources and consumers. Second, investments in real estate expand the urban proper, producing more space for the city's primary role – to accumulate capital for the industrialists it serves. Third, political guidance by business and government leaders encouraged the out migration of manufacturing industrial processes from the CBD into the hinterland while at the same time attempting to redevelop the CBD for managerial industrial processes.

Industry, as well as the local government and local labor markets of the 19th century and the first half of the 20th century were truly 'locally dependent' on the city to continue their own reproduction (Cox and Mair, 1988). Business and government leaders strived for control of the 'Pittsburgh industrial district' starting in the late 1800's. Early on there was more competition amongst public efforts[13] and private efforts[14]. However, it soon became evident that the public and the private needed each other to achieve their individual goal. But, as Stewman and Tarr (1982) begin their piece, "Although the roots of public-private partnership in Pittsburgh lie in the nineteenth century, the earliest plans issued both by the private sector and by the public-private groups were not always carried out to fruition" (p.59).

These theoretical perspectives and conceptual framework will structure the following narrative analysis of Pittsburgh's 20th century planning history.

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[13] Olmsted, F. L., 1911, *Pittsburgh Main Thoroughfares and the Down Town District, improvements necessary to meet the citys present and future needs, a report.* Pittsburgh: Pittsburgh Civic Commission.
[14] Citizens Committee on City Plan, 1923. *Parks- A Part of the Pittsburgh Plan, Report No. 4* Pittsburgh.

Geographic Industrialization

Walker and Lewis (2001) claim that, "Industry does not locate in a city, it helps create the city" (p. 7). The urbanization process of the Pittsburgh landscape is estimated to have started somewhere around 1790 (Harper, 1988). This urbanization moved rapidly between the years 1870 to 1890 as the number of people gainfully employed as a result of the rise of manufacturing industries went from under 65,000 to nearly 200,000 (MacLaughlin, 1938). By the 20th century, Pittsburgh's economy was already facing decline but the economic base of the city continued to be reliant on the original industries of iron, steel, rail and glass through the mid-century. While studies of the time warned of Pittsburgh's continued dependency on these no-growth industries, the industrial geography continued to be reproduced by the industrial leaders of 'the district'.

In Pittsburgh's case, defining this metropolis has been a 'muddled' task, at best (Muller, 1996). Kellogg (1909) and the other authors of the Pittsburgh Survey never truly defined the spatial limits of 'the district', only referring to its industrial geography as an 'organic' city in which the separate parts made the whole. Industrial investment and disinvestments have historically created patterns of uneven urban development, where some areas grow while others decline (Smith, 1990). This urban development is illustrated by Walker and Lewis (2001);

> *"As cities have grown, layer upon layer of suburban development has been added to the built-up area, leaving former outlying districts well inside the metropolis and often erasing historic patterns of expansion by dispersion in the process"* (p. 7).

The Pittsburgh business elite made great strides in producing and protecting the industrial district as well. Reformist volunteer groups began to inevitably address the deteriorating environmental conditions of the downtown that was a result of heavy

manufacturing. These reforms initially focused on air quality and flood control. Many private groups formed to centralize decision making within the district, which was seen as the only way to address these paramount concerns. This would also benefit the business interests of those making these decisions. Groups such as the Citizens Committee on City Plan, the Chamber of Commerce, the Civic Club and the Allegheny County Planning Commission formed in private circles to establish and stabilize control (environmentally, politically and economically) over the industrial geography of Pittsburgh. Two groups in particular, The Flood Commission of Pittsburgh (formed by the Chamber of Commerce) and the Citizens Committee on Flood Control enjoyed great success.

These groups were formed to address the issue of flooding of Pittsburgh's downtown and surrounding industrial and residential areas located along the riverbanks. The Flood Commission, lead by H.J Heinz, was successful in creating the system of dams and reservoirs that continue to protect the large capital investments of the downtown area today. This operation of channels and locks severely affected the landscape of rural areas for hundreds of miles, displacing an entire Native American settlement in western New York and establishing the Allegheny and Monongahela National Forests in Pennsylvania and West Virginia, respectively, for the purpose of protecting the head waters of the rivers of the same name. This success came about with the Flood Commission persuading the U. S. Army Corps of Engineers (ACE) to assume responsibility for inland flood control (a task they never assumed beforehand, prior to these developments, the ACE's primary purpose was to only to maintain navigable waters) and by also enlisting the US Forest Service to take on the replanting of denuded forestlands in the headwaters.

These successes can be attributed, in some part, to the enlisting of George H. Maxwell as the Flood Commissions executive director. Maxwell had previously worked at the national level and his political influence and networking enabled those aiming to control flooding in and around Pittsburgh to 'jump scales' and partner with Federal agencies in their cause. The early efforts to fortify Pittsburgh's industrial geography was perhaps the first successful attempt by either private or public agents to centralize the decision making process for the Pittsburgh region (Smith, 1975, 1977; Palmer, 1986).

Capital Real Estate Investments

The industrial elite's attempt at centralization by means of organizing the region's landscape was problematic for those same business leaders who further fragmented the local land use. In 1901 the Pittsburgh elite retained Fredrick Law Olmsted, Jr. to produce estates just outside of the downtown industrial core, escaping the social turbulence and creating structured beauty in their own private worlds (Muller and Bauman, 1996; Bauman and Muller, 1997).

The city government addressed the social and environmental turmoil of the downtown by adopting zoning regulations (1923) - a practice that further spatially fragmented the landscape by designating clearly defined usages for land parcels (Daly, 1988). This reformist activity was spreading through out urban-industrial America and arguably created as many problems as it solved. Zoning further organized the industrial space while also providing a mechanism for the emerging middle and upper-middle class residents of the city to create their own private communities (Hoffman, 1992).

While reformist projects such as zoning (re)organized the land-use of Pittsburgh's industrial core (consisting primarily 3 to 4 miles up and down the three rivers from the

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point), other factors, such as labor disputes and advances in technology spurred

expansion beyond this area. An organized, and somewhat militant, labor force had

formed along with Pittsburgh's manufacturing industries. Strikes and violent unrest, such

as those at the Apollo and Homestead Works, resulted in business owners moving their

factories up and down the rivers in order to escape "this cauldron of labor politics"

(Muller, 2001, p.63).

Some of the real estate investments were made by speculative developers who

anticipated industrial expansion while other land grabs were carried out by the magnates

themselves in order to unearth the mineral resources at some sites while other sites were

left intentionally underdeveloped which served their needs by having land available for

expansion, preventing other industrialists from purchasing developable land thus stifling

competition, and speculating on rising real estate prices (Muller, 2001). These patterns of

capital investment and (under)development further fragmented the geography into

localized industrial works and a spatially divided labor force that all functioned under

Pittsburgh's metropolitan economy.

Public-Private Partnerships

Private and public interests of Pittsburgh proper have struggled to gain control of

greater Pittsburgh for most of the 20th century. In 1910 it was Fredrick Law Olmsted,

under the direction of The Committee on City Planning, who completed a plan for

Pittsburgh's downtown district. In this plan, Olmsted claims that the need for

metropolitan governance, whether public, private or a combination of both, was implicit,

> *"The simplest and most logical procedure, if the boundaries of the city and of the boroughs are to remain substantially unchanged, would be to establish a common agency for dealing with the general problems of city planning for all of the municipalities and the related parts of the country outside of them… If the*

difficulty should be met simply by extending the boundaries of the city, it is important that the new boundaries should not merely include those areas which are now seen to have close physical relations with the city, but a great extent of territory within which the beginnings of urban or suburban growth have started, or are likely to start, during the next generation" (Olmsted, 1911, p. 43).

Olmsted's vision of metropolitan planning is also conceptually inviting, as his understanding of the areas outside the political jurisdiction of the city have close economic relations and that there should be some attempt to organize this 'organic' industrial space into a more structured arena suitable for any and all future growth incited by the industrial core of the city.

The civic community's vision was comprehensive, yet powerless. The city government's annexation strategy was facing opposition on many fronts, yet Mayor Magee, also in 1911, introduced a state consolidation bill to unify the "real Pittsburgh" that consisted of "sixty-five square miles of territory" (Daly, 1988, p.109). This bill failed, but Magee's continued message while in office was the need to establish some type of centralized authority of metropolitan Pittsburgh. The private sector's early attempts at organizing metropolitan Pittsburgh, such as the flood control movement, had more success in establishing the physical and industrial landscape of 'greater' Pittsburgh, but this space remained politically fragmented.

What eventually resulted, through various attempts at regional governing and governance, has been the public-private partnership as the vehicle for metropolitan planning and economic development (Stewman and Tarr, 1982). However, this public-private leadership has never been centralized, and each organization has developed strategies to further their own self-interest. The combined efforts of these individual

organizations have resulted in what Ahlbrandt and Weaver (1987) consider as

Pittsburgh's best and only approach to regional development.

CHAPTER 5 – Research Design

The overall goal of this research is to analyze the relationship between local

planning policy and land-use change in the Pittsburgh metropolitan region using remotely

sensed imagery and to analyze this information utilizing statistical methods. The

research design chapter has two sections: remote sensing analysis – change detection, and

statistical analysis – logistic regression model. Each section describes the data and the

methods used to conduct the analysis. The remote sensing change detection analysis

involved the supervised classification of two Landsat scenes and change detection

analysis of the results using an image-to-image technique. The statistical analysis used

the results of the change detection and data that represented which planning tools

municipalities had enacted into a logistic regression model.

Each of these steps is discussed more thoroughly in the remainder of this chapter.

The remainder of this section will discuss remote sensing change detection analysis and

the use of information derived from remotely sensed data with other secondary sources in

urban land-use analysis. Following this section each step of the analysis will be

discussed in more detail.

Research Objectives

As presented in Chapter 1, the research objectives for this research are:

- Identify changes in land-use within the municipalities of the Pittsburgh region by
  means of remote sensing change detection analysis, and

- Identify the relationship between local municipal planning policy tools with particular land-use changes throughout the Pittsburgh region by means of statistical analysis.

Remote Sensing Analysis – Change Detection

Change Detection Analysis Background

There are two approaches for change detection analysis (CDA) using remotely sensed imagery, (1) post-classification analysis – which involves comparative analysis of independently produced classifications for different dates, and (2) simultaneous classification analysis – which involves simultaneous analysis of multitemporal multispectral data (Singh, 1989). Several procedures using digital data exist for examining land use change detection. These methods include image differencing, image ratioing, image regression, vegetation index differencing, principal component analysis, change vector analysis and post-classification comparison (Jensen, 1981; Singh, 1989; Mouat, 1993).

The CDA procedure employed for this research will be a post-classification analysis using the Matrix function in the Erdas Imagine package. Post-classification analysis is the most obvious method of change detection. This method involve supervised categorical classifications of both images using training sites for each of the land-use classes analyzed. Due to the independent categorical classification process of each of the images, radiometric normalization is not necessary. Like all CDA methods, post-classification analysis has advantages and disadvantages. The advantages include; the ability to produce change-maps that show a complete matrix of changes, not needing

to normalize for atmospheric and sensor differences between the two data sets, and reducing the problem of highly-accurate registration of multidate images.

The major disadvantage of the post-classification method is the possibility of producing a large number of erroneous change indicators since an error on either date gives a false indication of change (Singh, 1989). An example of the error possibility is offered by Singh, "two images classified with 80 percent accuracy might have only a 0.80 x 0.80 x 100 = 64 percent correct joint classification rate" (p. 996). Jensen (1981) advises that due to the difficulty in classifying urban land-use with Landsat TM data, extreme care must be exercised when applying classification comparisons. Jensen reports that the heterogeneity of suburban land use produced many 'mixed' pixels and that too much change was consistently identified (i.e., errors of commission).

Analyzing Remote Sensing Information with Secondary Data

The use of remote sensing data with other secondary or ancillary data has been the subject of many facets of urban analysis. Some examples include the planning for urban infrastructure (Jensen, and Cowen, 1999; Kawamura, 1996; Jensen, et al., 1994), change detection analysis with corresponding socio-economic/census data (Masek, et al., 2000; Ryznar and Wagner, 2001), population estimations (Lindgren, 1985; Lo, 1995; Webster, 1996; Haack et al., 1997) and quality of life indices (Webster and Hirsch, 1992; Lo, 1997a, 1997b).

In regards to land-use change and zoning, Croissant and Monroe (2003) used Landsat TM data to analyze the relationship between landscape fragmentation and zoning policy at the parcel level. Using several methods of detecting and assessing land-use

change, the authors found that the slope and size of parcels affected fragmentation, but that zoning was the most significant factor.

Zhoa, et al., (2003) also utilized Landsat TM data to analyze the impact of urban planning on land-use and land cover. Assessing the relationship between land-use in Pudong of Shanghai, China and each of it's functional zones[15], the authors found that the type and pattern of change of land-use / land cover were quite different among the seven functional zones.

Remote Sensing Data

This research used two temporally distinct remotely sensed Landsat scenes. Landsat TM data has been found to be useful and effective when evaluating large areas such as metropolitan areas (Toll, 1985; Khorram, et al., 1987; Vogelmann, et al., 1998; Jensen and Cowen, 1999) and it has been found to be particularly useful when estimating land cover change across large metropolitan areas (Jensen, 1981; Fung, 1990; Masek, et al., 2000; Ryznar and Wagner, 2001; Xiuwan, 2002).

The entire study area is within the Landsat scene Path 17, Row 32 (17/32). Both scenes were downloaded from the World Wide Web from the West Virginia View website (www.wvview.org). The first scene was captured on 10/02/1992 by the Thematic Mapper (TM) instrument onboard the Landsat 5 satellite measuring 7 multispectral bands. The second scene was captured on 10/06/2002 by the Enhanced Thematic Mapper Plus (ETM+) instrument onboard the Landsat 7 satellite measuring 7 multispectral bands and 1 panchromatic band.

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[15] 'Functional Zones' in Shanghai define what type of economic activity is permitted to take place in certain areas (i.e., export processing, finance, free trade, industrial, agricultural, etc.).

Both scenes were processed by the USGS / EROS Data Center using the Landsat processing system called the National Landsat Archive Production System (NLAPS). The 1992 Landsat scene was processed on 06/01/2004 and the 2002 Landsat scene was processed on 02/04/2004. Both scenes were Precision Geocorrected using a 4-point cubic convolution resampling method and then projected to the Universal Transverse Mercator (UTM) projection, zone 17 and the WGS84 horizontal datum (USGS, 2005).

Software

Several software packages were used in this research. Erdas Imagine was used to perform the supervised classification, matrix function, error assessment, summary report and display. ArcGIS 9.0 and ArcView 3.3 were used to spatially assign data by location, query and display. Microsoft Excel was also used for additional formatting, analysis and display.

Supervised Classification

Prior to conducting the CDA, a supervised classification of both Landsat scenes was performed. Supervised training requires a priori knowledge of the study area and what kind of information is desired from the processing, such as the classes to be identified. Training sites are selected through out the scene for each of the classes to be identified. In this instance, a minimum of 10 training sites were chosen per class in order to capture a representative spectral signature for each respective category. The supervised classification of both data sets utilized a parametric, maximum likelihood set of decision rules with the use the probabilities assigned to the signatures. The parametric rule classifies pixels that fall into the overlap region by testing the pixel against the

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overlapping signatures only. The maximum likelihood decision rule is based on the

probability that a pixel belongs to a particular class. The basic equation assumes that

these probabilities are equal for all classes, and that the input bands have normal

distributions (Leica Geosystems, 2003).

A supervised classification is an ideal method for this research because the

information needed for analysis consists of only 5 categorical classes: 1) water, 2) urban,

3) residential, 4) forest, and 5) agricultural pastures and open spaces (AgGrass). Four of

these five classes were further used in the logistic regression model (#'s 2-5). Classes' 2-

urban and 3-residential and classes 4-forest and 5-AgGrass were also recoded into new,

coarser catagorical classes, respectively, in order to represent two very general classes,

'Developed' and 'Less-developed' (Table 1).

Using only these five land-use categories was deliberate for several reasons.

Since there is a large interest in evaluating the reduction of agricultural and forested lands

as a result of urbanization, identifying urban and residential land-uses versus forested and

agricultural pastures and open spaces captures this process. 'Urban' in this context

represents commercial and industrial land-uses which include central business districts,

'downtown' areas, manufacturing, big-box retail locations, shopping plazas, office parks,

universities, hospitals and other predominately paved and impervious areas that are

devoid of vegetation. 'Residential' in this context represents the living spaces of workers

and residents of the region, which includes sub-urban housing development, villages,

mobile home parks and other small settlements identified by lower density housing

patterns. It is understood that residential uses occur in urban areas and vice-versa. The

words used to name the categories are semantic and therefore are interpretations used for

conveying information. In essence, the 'urban' category represents a highly developed

built-environment and the 'residential' category represents a built-environment to a

lesser-degree. The distinction between the two is important, however, as clustered

increases in residential areas can be an indicator of emerging urban areas.

Table 1 - Land-use Categories

<u>**Single Image Classifications:**</u>   <u>**Recoded Classes:**</u>

1. Water *(identified in classification but not included in statistical analysis)*

2. Urban
3. Residential   A = 'Developed'

4. Forest
5. Agriculture/Grass (AgGrass)   B = 'Less Developed'

Overlay Image Differencing (Matrix Analysis)

The Matrix function in Erdas Imagine (Leica Geosystems, 2003) was used to

determine the land-use category change from the classified 1992 scene to the classified

2002 scene. Matrix analysis produces a thematic layer that contains a separate class for

every coincidence of classes in two layers.

The output classes are assigned according to the coincidence of any two input

classes. The resulting class values of a matrix operation are different for each

coincidence of two input class values. Since there were 5 classes in each input image, the

number of output classes as a result of the Matrix analysis produced 25 from-to land-use

classes plus 1 no change class and 1 '0' class representing data outside of the study area.

The category changes that resulted form the Matrix analysis were then assigned to

each of the municipalities (polygons) with the use of a graphic model constructed in

Erdas Imagine where the raster values were summarized within each polygon of the

vector file that represented the municipalities. The output of this summary was a table of

values of each category change per polygon (municipality). The values in this table were

then used as values for the statistical analysis for objective two.

Accuracy Assessment

Accuracy assessment is a general term for comparing the classification to

geographical data that are assume to be true in order to determine the accuracy of the

classification process (Leica Geosystems, 2003).   Conducting an accuracy assessment of

a classified image requires a) a random sample of ground reference points to be used in

the assessment, b) the classified image, and c) ground truth data for the reference image

(captured from fieldwork or from a secondary source). As a result of the accuracy

assessment, several statistics are generated in the Erdas Imagine package in order to

evaluate the classification's accuracy. There is the error matrix, the accuracy totals and

the KAPPA coefficients. Below is a discussion of the ground reference point selection

criteria and the statistics produced in this research's accuracy assessment.

This study used the Erdas Imagine 'equalized random rule' (Leica Geosystems,

2003) when generating the random reference points. The equalized random rule dictates

that each class has an equal number of random points generated. The number of

reference pixels is an important factor in determining the accuracy of the classification. It

has been shown that more than 250 reference pixels are needed to estimate the mean accuracy of a class to within plus or minus five percent (Congalton, 1991).

A total of 256 random reference points were generated for use in each of the accuracy assessments. For each class 51 points were generated plus 1 additional point, for a total of 256 reference points [5 supervised classes; 50 points per class, plus 1 = (5*50) +1=256]. The points were generated within a sub area within the study area for which aerial photos of dates similar to the satellite imagery were available. This sub area encompassed approximately 80% of the total study area. The same reference points that were used in the 1992 error assessment were also used in the 2002 error assessment. Using the same points that were generated using the equalized random rule for the '92 assessment did not represent an equal number of random points generated per class in the '02 classification. This is logical assuming there was a significant amount of land-use change within the study area between 1992 and 2002 (See Tables 2 and 3).

The following descriptions and analysis are fully described by Congalton (1991).

Error Matrix

The error matrixes (Table 2 and 3) represent the accuracy of each category classified. This is done by expressing the number of pixels assigned to a particular category relative to the actual category which is verified from the ground; in this case it is verified using aerial photos acquired at corresponding time periods.

Table 2 – 1992 Error Matrix

		Reference Data					
Category	Classified Data	*Water*	*Urban*	*Residential*	*Forest*	*AgGrass*	Row Total
Water	Class 1	51	0	0	0	0	51
Urban	Class 2	6	29	5	1	10	51
Residential	Class 3	1	3	35	7	5	51
Forest	Class 4	0	0	1	51	0	52
AgGrass	Class 5	0	0	0	7	44	51
	Column Total	58	32	41	66	59	256

Table 3 – 2002 Error Matrix

		Reference Data					
Category	Classified Data	*Water*	*Urban*	*Residential*	*Forest*	*AgGrass*	Row Total
Water	Class 1	42	0	0	0	0	42
Urban	Class 2	10	18	1	0	0	29
Residential	Class 3	1	7	38	5	5	56
Forest	Class 4	2	0	2	64	5	73
AgGrass	Class 5	0	2	4	3	47	56
	Column Total	55	27	45	72	57	256

This error matrix is then used to determine the accuracy totals. Accuracy totals are determined for both the overall classification accuracy and for individual category accuracy (Table 2 and 3). The overall classification accuracy is determined by dividing the total amount of pixels classified correctly (the sum of the major diagonal in the error matrix) by the total number of pixels in the error matrix. Using this technique, the overall classification accuracy for the 1992 supervised classification is 82% (Table 4) and the overall classification accuracy for the 2002 supervised classification is also 82% (Table 5).

Table 4 – 1992 Accuracy Totals

Overall Classification Accuracy =   82%

Class Name	Reference Totals	Classified Totals	Number Correct	Producers Accuracy	Users Accuracy
Water	58	51	51	88%	100%
Urban	32	51	29	91%	57%
Residential	41	51	35	85%	69%
Forest	66	52	51	77%	98%
AgGrass	59	51	44	75%	86%
Totals	256	256	210		

Table 5 – 2002 Accuracy Totals

Overall Classification Accuracy =   82%

Class Name	Reference Totals	Classified Totals	Number Correct	Producers Accuracy	Users Accuracy
Water	55	42	42	76%	100%
Urban	27	29	18	67%	62%
Residential	45	56	38	84%	68%
Forest	72	73	64	89%	88%
AgGrass	57	56	47	82%	84%
Totals	256	256	209		

Accuracy Reports

Individual category accuracies can also be computed in a similar, yet more revealing, way. Unlike the overall classification accuracy technique where the total correct are divided by the total amount of pixels in the cell array, individual category accuracies can be computed to measure the probability of a reference pixel being correctly classified *and* can measure the probability that a classified pixel actually represents the classification in reality. These measures are called *errors of omission* (referred to in the table as *producer's accuracy*), and *errors of commission* (referred to in the table as *user's accuracy),* respectively. Errors of omission are determined by

dividing the total number of correct pixels in a category by the total number of pixels of that category as determined form the reference data. Similarly, the measure of commission error is determined when the total number of correct pixels in a category is dived by the total number of pixels that were classified in that category.

These percentages can initially mislead an interpreter into believing there is an unrealistically high degree of accuracy in all of the categories. However, the generalized overall classification accuracy may differ greatly from individual category accuracies. For example, a discussion of the producers and users accuracy percentages from Table 4 above reveals that the producer of this information/map could have claimed in 1992 that 91% of the time an area that was identified as urban was urban, but that a user of this information/map will find that 57% of the time the actual land-use was urban when the location was visited.

The values used in Tables 4 and 5 are used to compute the overall accuracy of the change transition data that were determined as a result of the Matrix analysis. The overall accuracies from Tables 4 and 5 are multiplied together to display the change transition overall classification accuracy. Therefore, the overall classification of the change transition information is 67%.

KAPPA Coefficient

The Kappa coefficient (Tables 6 and 7) is a discrete multivariate technique used in measuring the agreement of accuracy of classified data. The Kappa coefficient expresses the proportionate reduction in error generated by a classification process compared with the error of a completely random classification. For example, the Residential value of .62 in Table 6 below implies that the classification process is

avoiding 62 percent of the errors that a completely random classification generates

(Congalton, 1991, in Leica Geosystems, 2003).

Table 6 – 1992 KAPPA Coefficients	**Table 7 – 2002 KAPPA Coefficients**

Overall Kappa Statistics = 0.78 Conditional Kappa for each Category		Overall Kappa Statistics = 0.77 Conditional Kappa for each Category	
Class Name	**Kappa**	**Class Name**	**Kappa**
Water	1.00	*Water*	1.00
Urban	0.51	*Urban*	0.578
Residential	0.63	*Residential*	0.61
Forest	0.97	*Forest*	0.83
AgGrass	0.82	*AgGrass*	0.79

Statistical Analysis - Logistic Regression

The relationship between local planning policy and land-use change in the

Pittsburgh metropolitan region is examined by means of a logistic regression model. The

model estimates the relationship between the change in land-use in a given municipality

derived from the remote sensing change detection analysis described above and four

different planning tools adopted by each individual municipality as of 2001. The

planning tools used in the analysis are Comprehensive Plan, Planning Commission,

Zoning, and Subdivision Regulation. The data for the planning tools were obtained from

the Center for Rural Pennsylvania (2001).   The comprehensive plan definition and

guidelines are listed in Article III, Section 301 of the Pennsylvania Municipal Planning

Code (MPC). By definition, a county and municipal comprehensive plan is a "land use

and growth management plan" (Commonwealth of Pennsylvania, p. 2, 2001) prepared by

the county planning commission, either internally or by contract, to be adopted by the county commission or municipal authority and establishes broad goals and criteria for future planning efforts. A Planning Commission or planning agency as listed in Article II, Section 201 and 202 of the MPC, can be created or abolished, by ordinance, by a governing body. A Planning Commission is also granted duties and functions, by ordinance, by the governing body. Zoning is defined in Article VI of the MCP, and the governing body of each municipality "may enact, amend and repeal zoning ordinances to implement comprehensive plans and to accomplish any of the purposes of the MPC (Commonwealth of Pennsylvania, p. 43, 2001). Subdivision regulations are defined under Article V of the MPC and allow for the governing body of each municipality the ability to "regulate subdivisions and land development within the municipality by enacting a subdivision ordinance" (Commonwealth of Pennsylvania, p. 19, 2001).

The logistic regression model also includes six control variables relating to a given municipality's population, income and the 1992 land-use profile to ensure that the estimated relationships between land-use change and the four local planning tools are independent of these basic demographic and land-use factors. The Southwestern Pennsylvania Commission (SPC) provided a vector file of the local municipal boundaries and census data within the study area. The population and income data were obtained from the US Census of Population (2004) and the 1992 land-use profile data were obtained from the change detection analysis.

The logistic model is defined as follows:

$$\text{logit}(p) = \log[p/(1-p)] = \alpha + \beta_1 \text{ COMP} + \beta_2 \text{ ZONE} + \beta_3 \text{ SUB} + \beta_4 \text{ COMM}$$
$$+ \beta_5 \text{ LANDUSE92} + \beta_6 \text{ AVPOP} + \beta_7 \text{ POPCHANGE} + \beta_8 \text{ AVINC}$$
$$+ \beta_9 \text{ INCCHANGE} + \beta_{10} \text{ AVDENSITY} + e \qquad (1)$$

where:

- p is the percent change from one land-use to another
- COMP is a binary variable indicating whether a municipality has a comprehensive plan or not
- ZONE is a binary variable indicating whether a municipality has a zoning ordinance or not
- SUB is a binary variable indicating whether a municipality has a subdivision ordinance or not
- COMM is a binary variable indicating whether a municipality has a comprehensive plan or not
- LANDUSE92 is the proportion of the municipality covered by the original land-use in 1992
- AVPOP is the average size of the population in the municipality between 1992 and 2002
- POPCHANGE is the percent change in the size of the population in the municipality from 1992 to 2002
- AVINC is the average household income in the municipality between 1992 and 2002
- INCCHANGE is the percent change in household income in the municipality from 1992 to 2002
- AVDENSITY is the average population density in the municipality between 1992 and 2002
- α and β_1-β_{10} are parameters to be estimated and e is an error term.

The logistic regression model was used in this research rather than the standard ordinary least squares (OLS) estimation procedure because the land-use change dependent variable is expressed as a percentage. OLS is incapable of restricting the predicted values of the dependent variable to range between zero and one (or one hundred), whereas logistic regression is designed to ensure this constraint.

The logistic regression model was estimated using the PROC LOGISTIC function in SAS. Only those variables with β parameters significant at the 0.01 level are discussed in the results chapter which follows.

CHAPTER 6 – Results

       This section will describe the results of both the remote sensing change detection analysis and the logistic regression analysis. The chapter is structured as follows: first, the results of the remote sensing change detection will be identified. Second, the results of the logistic regression model will be identified and discussed for each of the pertinent land-use transitions classified in the remote sensing analysis. Third, the amount of land-use planning tools enacted, the percent values for the land-use change, and the percent values for the control variables will be used to characterize some of the municipalities in the study area. Fourth, is a discussion of the locations of the municipalities that experienced the most proportional forest and AgGrass to a developed land-use change. Last, is a section that contextualizes these results by applying them with the concepts discussed in Chapters 2, 3, and 4.

Remote Sensing Change Detection

       Table 8 below shows the pixel distribution by class for the 1992 and 2002 Landsat data sets following the supervised classification. It also shows the difference of pixel distribution among the classes between the two time periods. Table 9 shows the same information except the pixel values have been converted to acre values.

Table 8 – Pixel Distribution by Class				

Class	1992	2002	Difference
Water	123,724	128,779	5,055
Urban	719,068	416,236	-302,832
Residential	1,541,087	3,186,169	1,645,082
Forest	9,626,593	10,149,652	523,059
AgGrass	7,438,288	5,567,924	-1,870,364
TOTAL	19,448,760	19,448,760	

Table 9 – Acre Distribution by Class

Class	1992	2002	Difference
Water	27,515	28,640	1,124
Urban	159,916	92,568	-67,348
Residential	342,729	708,585	365,856
Forest	2,140,897	2,257,222	116,325
AgGrass	1,654,231	1,238,273	-415,958
TOTAL	4,325,288	4,325,288	

Tables 10 below shows the class change transition from pixel to pixel among the five land-use categories for the entire study area. Table 11, like table 10 above, shows the same information but in acres rather than pixels for convenience. The colors in Tables 10 and 11 correspond with the color scheme used in the legend in Figure 4; each color representing the same information in both the Tables and the Figure. Each data set was classified into 5 land-use classes, therefore there were 20 different land-use change transitions recorded, with 5 additional classes recorded as no-change. Land-use classes urban and residential were recoded together to represent a 'developed' land-use and forest and AgGrass were recoded together to represent a 'less-developed' land use. The gray cells represent the same class-to-class change (i.e., no change). Land-use changes from and to water were not used in the statistical analysis, therefore reducing the number of categories from five to four to be identified in the change detection resulting in 12 land-use change transitions when excluding the 'no change' transition.

Table 10 – Class Change Distribution by Pixel Count (*Percentage*)

			A Water 1	A Urban 2	A Residential 3	B Forest 4	B AgGrass 5	TOTAL
	2002 1992							
A	Water	1	109,877 (89%)	12,883 (10%)	438 (0%)	90 (0%)	436 (0%)	123,724
A	Urban	2	17,977 (3%)	227,855 (32%)	235,707 (33%)	25,919 (4%)	211,610 (29%)	719,068
A	Residential	3	434 (0%)	57,175 (4%)	1,069,053 (69%)	287,927 (19%)	126,498 (8%)	1,541,087
B	Forest	4	267 (0%)	36,924 (0%)	586,994 (6%)	8,506,123 (88%)	496,285 (5%)	9,626,593
B	AgGrass	5	224 (0%)	81,399 (1%)	1,293,977 (17%)	1,329,593 (18%)	4,733,095 (64%)	7,438,288
	TOTAL		128,779	416,236	3,186,169	10,149,652	5,567,924	

A = Developed	A - B	= Developed to Less Developed
B = Less-developed	B - A	= Less Developed to Developed

Table 11 – Class Change Distribution by Acre (*Percentage*)

			A Water 1	A Urban 2	A Residential 3	B Forest 4	B AgGrass 5	TOTAL
	2002 1992							
A	Water	1	24,436 (89%)	2,865 (10%)	97 (0%)	20 (0%)	97 (0%)	27,515
A	Urban	2	3,998 (3%)	50,674 (32%)	52,420 (33%)	5,764 (4%)	47,061 (29%)	159,916
A	Residential	3	97 (0%)	12,715 (4%)	237,751 (69%)	64,033 (19%)	28,132 (8%)	342,729
B	Forest	4	59 (0%)	8,212 (0%)	130,544 (6%)	1,891,711 (88%)	110,371 (5%)	2,140,897
B	AgGrass	5	50 (0%)	18,103 (1%)	287,773 (17%)	295,694 (18%)	1,052,612 (64%)	1,654,231
	TOTAL		28,640	92,568	708,585	2,257,222	1,238,273	

A = Developed	A - B	= Developed to Less Developed
B = Less-developed	B - A	= Less Developed to Developed

The 12 land-use transitions are displayed in Figure 4 below represented as a 'from – to' relationship.

Figure 4 - Land-use Change Transitions

Study Area	Urban to Residential	Residential to Urban
	Urban to Forest	Residential to Forest
	Urban to AgGrass	Residential to AgGrass
Municipalities	Forest to Urban	AgGrass to Urban
Water	Forest to Residential	AgGrass to Residential
No Change	Forest to AgGrass	AgGrass to Forest
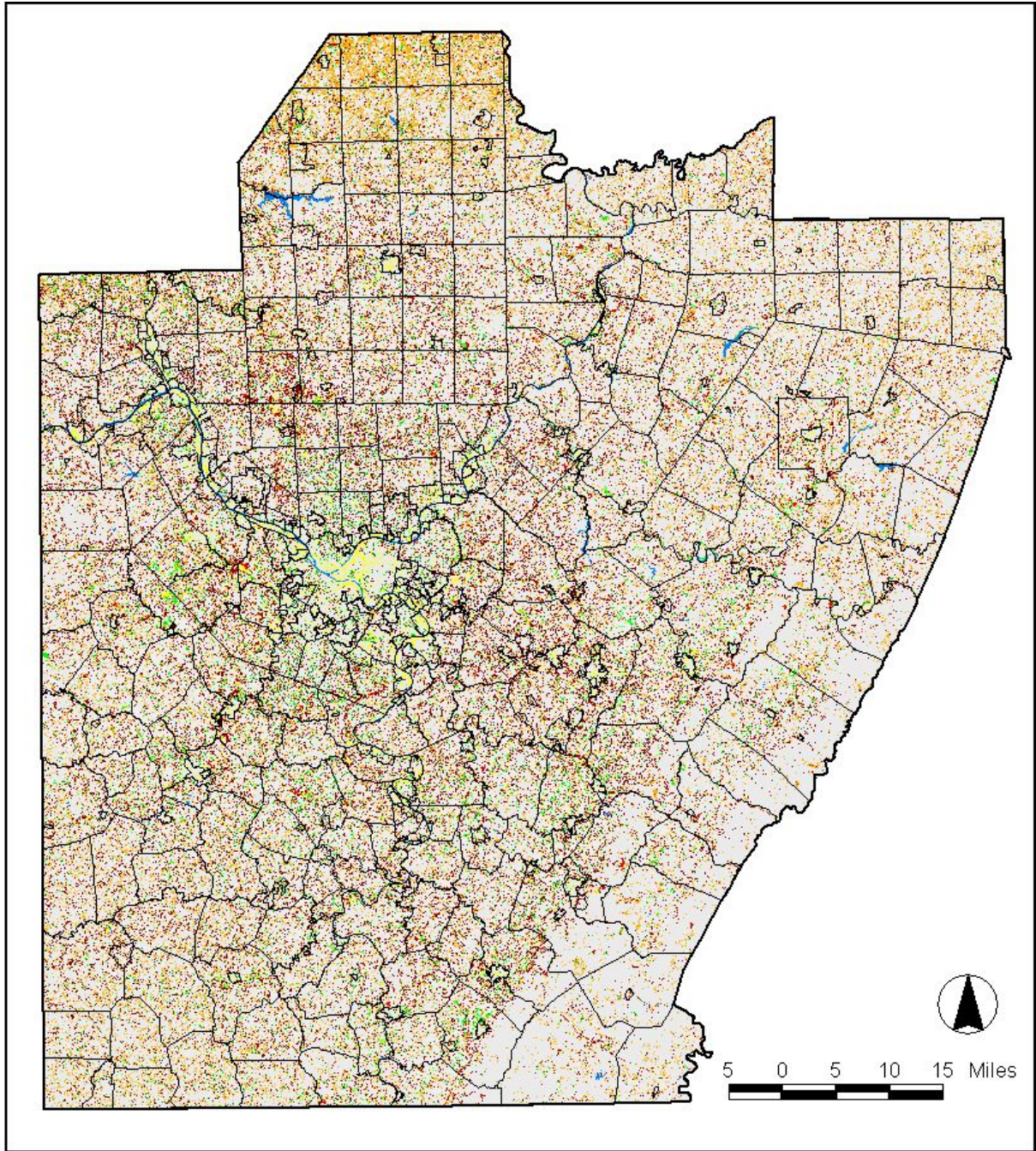
Logistic Regression Model Results

As explained in section 'Statistical Analysis – Logistic Regression' of Chapter 5, the aggregate information represented in Tables 10 and 11 above was spatially distributed to each of the spatially corresponding polygons that represent the municipalities in the study area using the Matrix function. There are 525 municipalities in the study area, but there were 540 polygons due to some municipalities comprising non-contiguous areas. The values for those municipalities that had 2 or more polygons were combined in order to conduct the logistic regression analysis.

Figures 5, 6, 7, and 8 below show the uneven spatial pattern of land-use policies throughout the study area as of 2001. Data on planning tools enacted before the study period (before 1992) were sought but unfortunately were not available. If this data were available it would have been interesting to monitor the spatial diffusion of planning policy throughout the study area. However it is known that most comprehensive plans were enacted in the 1970's and those municipalities that adopted other tools did so shortly after. Of course there is a possibility that some of the municipalities in the sample did enact some of the planning tools during the study period, however, this possibility is expected to be a very small number of the total. It should also be noted than most comprehensive plans and related planning policies were updated in 1989 and in 2000 (Center for Rural Pennsylvania, 2001).

The results of the logistic regression analysis for each type of land-use change are shown in Table 12. Only those coefficients which are significant at the 0.01 level are shown in the table. The sign of a coefficient indicates the direction of the relationship (positive or negative) between the dependent and independent variable, and its size

indicates the extent to which the independent variable numerically affects the dependent variable. Although the coefficients are not standardized in Table 12 (and in subsequent tables in this chapter), the relative importance of the planning policy variables can be gauged by the size of their coefficients because they are all represented in numerically the same way (as binary variables).

The remainder of this chapter is organized as follows. In the next section the logistic regression results for each type of land-use change are presented sequentially. For each land-use change transition discussed, a table of coefficients corresponding to the land-use change is subset from Table 12 and presented as its own table. Following the table is an explanation of the land-use change coefficients. After each explanation, a map is also provided, each depicting the location of the individual land-use changes within the study area. Following this is a discussion of the regression model results with a focus on the relative importance of each planning policy on the different types of land-use change. Finally, there is a discussion of the results from the perspective of individual municipalities, with a focus on those municipalities which experienced the greatest change to 'developed' and urban land uses.

Figure 5 – Municipalities with a Comprehensive Plan in 2001
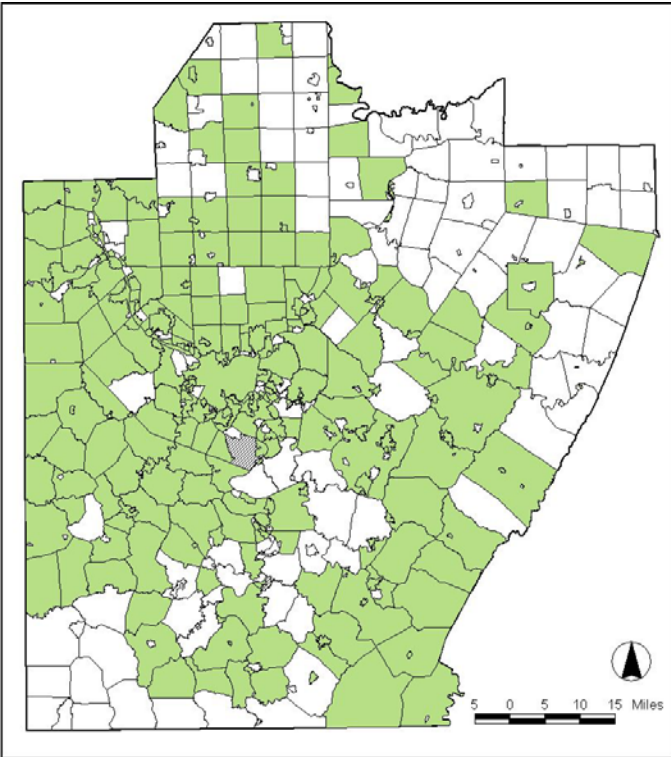

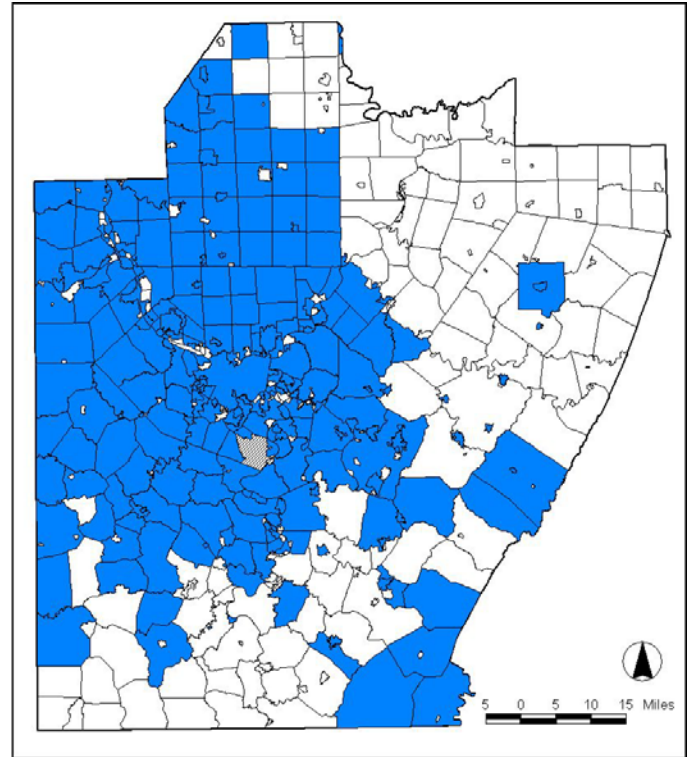**Figure 6 – Municipalities with a Subdivision Regulation in 2001**

Figure 7 – Municipalities with a Zoning Ordinance in 2001
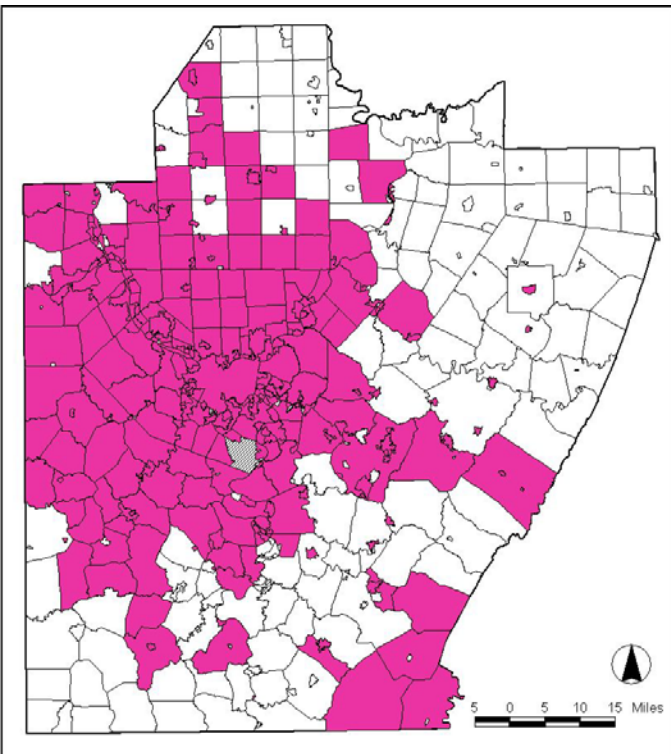
Figure 8 – Municipalities with a Planning Commission in 2001

= No Data

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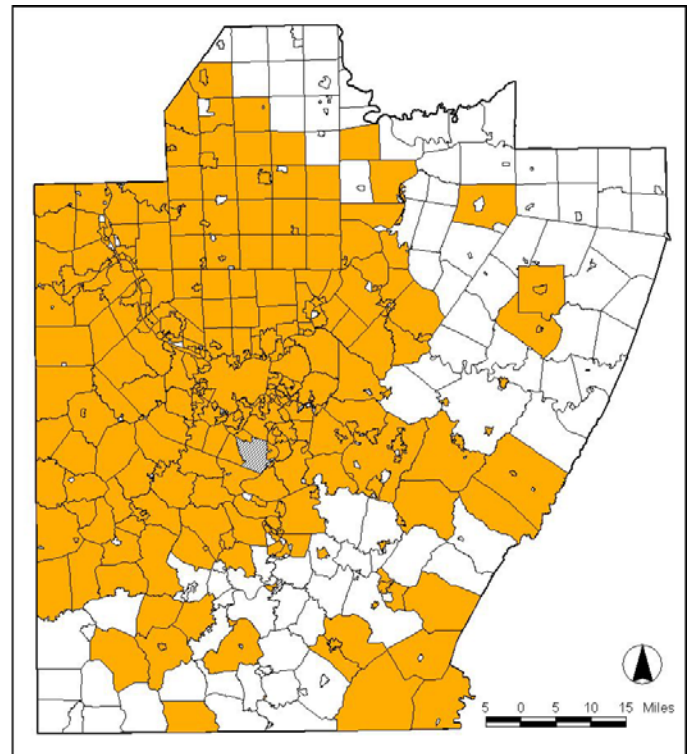
Table 12 – Logistic Regression Results[1]

Land-use Change Transition	Policy Variables				Control Variables					
	Comprehensive Plan	Zoning Ordinance	Subdivision Regulation	Planning Commission	Percent Existing Land-use	Average Population	Change in Population	Average Income	Change in Income	Average Population Density
Developed to Less-developed	-0.13950000	-0.20540000	0.02640000	-0.06060000	-0.03430000	-0.00000023	-0.00176000	0.00000279	0.20830000	0.00007000
Less-developed to Developed	0.07700000	-0.05630000	0.13430000	0.07940000	-0.03620000	0.00000080	0.00076700	0.00001100	-0.33420000	-0.00026000
Urban to Residential	0.02130000	0.12950000	0.18830000	0.04380000	0.01670000	-0.00000051	-0.00206000	0.00001900	0.23200000	0.00015500
Urban to Forest	-0.16900000	0.09740000	-0.14320000		-0.13180000	0.00000102	0.00157000	-0.00002000	0.71590000	-0.00018000
Urban to AgGrass	-0.13200000	-0.15400000	0.16640000	-0.14290000	-0.10010000	0.00000416		-0.00000862	-0.06530000	-0.00061000
Residential to Urban	0.11600000	0.34510000		-0.20510000	0.00623000	-0.00000031	0.00778000	-0.00002000	-0.16980000	
Residential to Forest	-0.18080000	-0.27320000		0.09570000	-0.02430000	0.00000029	0.00053600	0.00000765	0.10500000	-0.00003000
Residential to AgGrass	0.05260000	-0.05910000		-0.11430000	-0.02040000		-0.00227000	-0.00000399	-0.06250000	-0.00009000
Forest to Urban	0.13080000	0.48910000	-0.10330000	-0.56190000	-0.01360000	-0.00000150	0.00888000	0.00001100	-0.96320000	0.00018300
Forest to Residential	0.14320000	0.08210000	0.17360000	-0.03450000	-0.02070000	-0.00000122	-0.00379000	0.00001400	0.11610000	0.00015700
Forest to AgGrass	0.14250000		-0.04380000	-0.02180000	-0.00922000	0.00000052	-0.00589000	-0.00000089	0.03960000	-0.00016000
AgGrass to Urban		0.18930000	0.10750000	-0.23680000	-0.00554000	0.00000125	0.00885000	0.00001100	-1.01070000	0.00018100
AgGrass to Residential	0.08280000		0.22070000	0.07430000	-0.01080000	-0.00000153	-0.00169000	0.00001500	-0.06880000	0.00036800
AgGrass to Forest	-0.17020000	0.01610000	0.02900000	-0.19920000	0.00777000	-0.00000588	0.00995000	-0.00000904	0.42650000	0.00006700

[1]Only coefficients significant at 0.01 level shown.

Indicates no statistical significance.
Black numbers indicate positive relationship.
Red numbers indicate negative relationship.

Land-use Coefficients

1. Change transition Developed to Less-developed

Table 13 - Developed to Less-developed Coefficients

Policy	Comprehensive Plan	Zoning	Subdivision	Planning Commission		
	-0.13950000	-0.20540000	0.02640000	-0.06060000		
Control	Percent Existing Land-use	Average Population	Change in Population	Average Income	Change in Income	Average Population Density
	-0.03430000	-0.00000023	-0.00176000	0.00000279	0.20830000	0.00007000

Policy Variables-

A positive relationship is observed between developed to less-developed land-use changes and the policy variable subdivision regulation. A negative relationship is observed with the policy variables comprehensive plan, zoning, and planning commission. This means that subdivision regulations are more likely to be present in municipalities that experienced this kind of land-use change during the study time period, and comprehensive plans, zoning, and planning commissions are less likely to be present in these municipalities.

Control Variables-

The negative coefficient value of the percent existing land-use control variable suggests that the developed to less-developed land-use change was less likely to occur in those municipalities with larger amounts of the existing land-use during the study time period. The negative coefficient for the average population and change in population control variables suggests that this value is relatively lower in the

municipalities that experienced this type of change than the rest of the sample during the study time period. The positive coefficients for average income; change in average income and the average population density suggest these values were relatively higher in the municipalities that experienced this type of change.

Figure 9 - Developed to Less-developed Change Transition
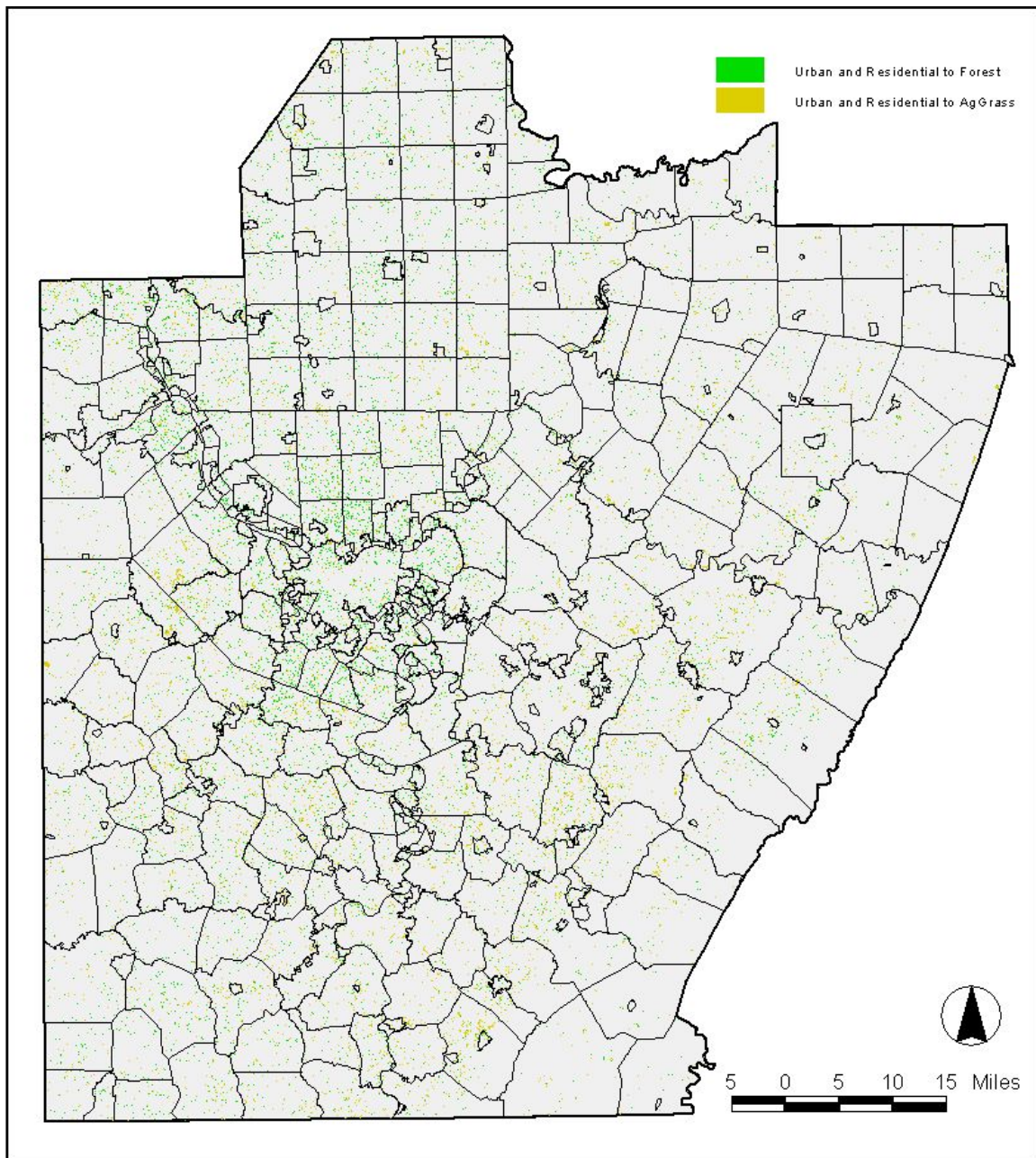
2. Change transition Less-developed to Developed

Table 14 - Less-developed to Developed Coefficients

Policy	Comprehensive Plan	Zoning	Subdivision	Planning Commission		
	0.07700000	-0.05630000	0.13430000	0.07940000		
Control	Percent Existing Land-use	Average Population	Change in Population	Average Income	Change in Income	Average Population Density
	-0.03620000	0.00000080	0.00076700	0.00001100	-0.33420000	-0.00026000

Policy Variables-

A positive relationship is observed between less-developed to developed land-use changes and the policy variables comprehensive plan, subdivision regulation and planning commission. A negative relationship is observed with the policy variable zoning. This means that a comprehensive plan, subdivision regulation, and planning commission were likely to be present in municipalities that experienced this kind of land-use change during the study time period, and zoning was less likely to be present in these municipalities.

Control Variables-

The negative coefficient value of the percent existing land-use control variable suggests that the less-developed to developed land-use change was less likely to occur in those municipalities with larger amounts of the existing land-use during the study time period.   The positive coefficients for average population, change in population and average income control variables suggests that these values are relatively higher in the municipalities that experienced this type of change than the rest of the sample during the study time period. The negative coefficients for change in average

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income and the average population density suggest these values were relatively lower in

the municipalities that experienced this type of change.

Figure 10 - Less-developed to Developed Change Transition

3. Change transition Urban to Residential

Table 15 - Urban to Residential Coefficients

Policy	Comprehensive Plan	Zoning	Subdivision	Planning Commission		
	0.02130000	0.12950000	0.18830000	0.04380000		
Control	Percent Existing Land-use	Average Population	Change in Population	Average Income	Change in Income	Average Population Density
	0.01670000	-0.00000051	-0.00206000	0.00001900	0.23200000	0.00015500

Policy Variables-

A positive relationship was observed between urban to residential land-use changes and all four planning policy variables: comprehensive plan, zoning, subdivision regulation, and planning commission. This means that of all of the planning tools were more likely to be present in municipalities that experienced this kind of land-use change during the study time period.

Control Variables-

The positive coefficient value of the percent existing land-use control variable suggests that the urban to residential land-use change was more likely to occur in those municipalities with larger amounts of the existing land-use during the study time period. The negative coefficient for the average population and change in population control variable suggests that this value is relatively lower in the municipalities that experienced this type of change than the rest of the sample during the study time period. The positive coefficients for average income, change in income and average population density suggest these values were relatively higher in the municipalities that experienced this type of change.

Figure 11 - Urban to Residential Change Transition
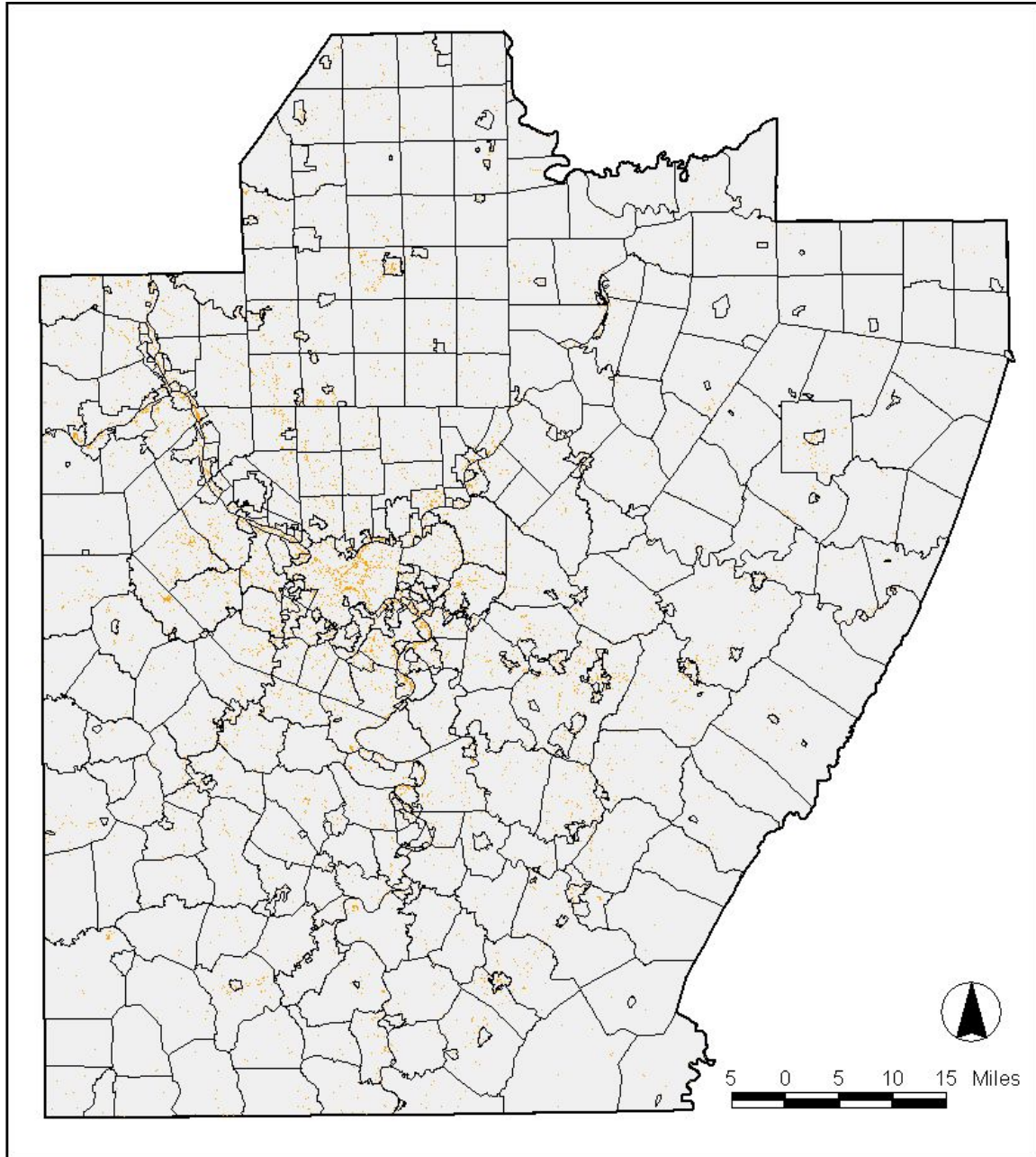
4. Change transition Urban to Forest

Table 16 - Urban to Forest Coefficients

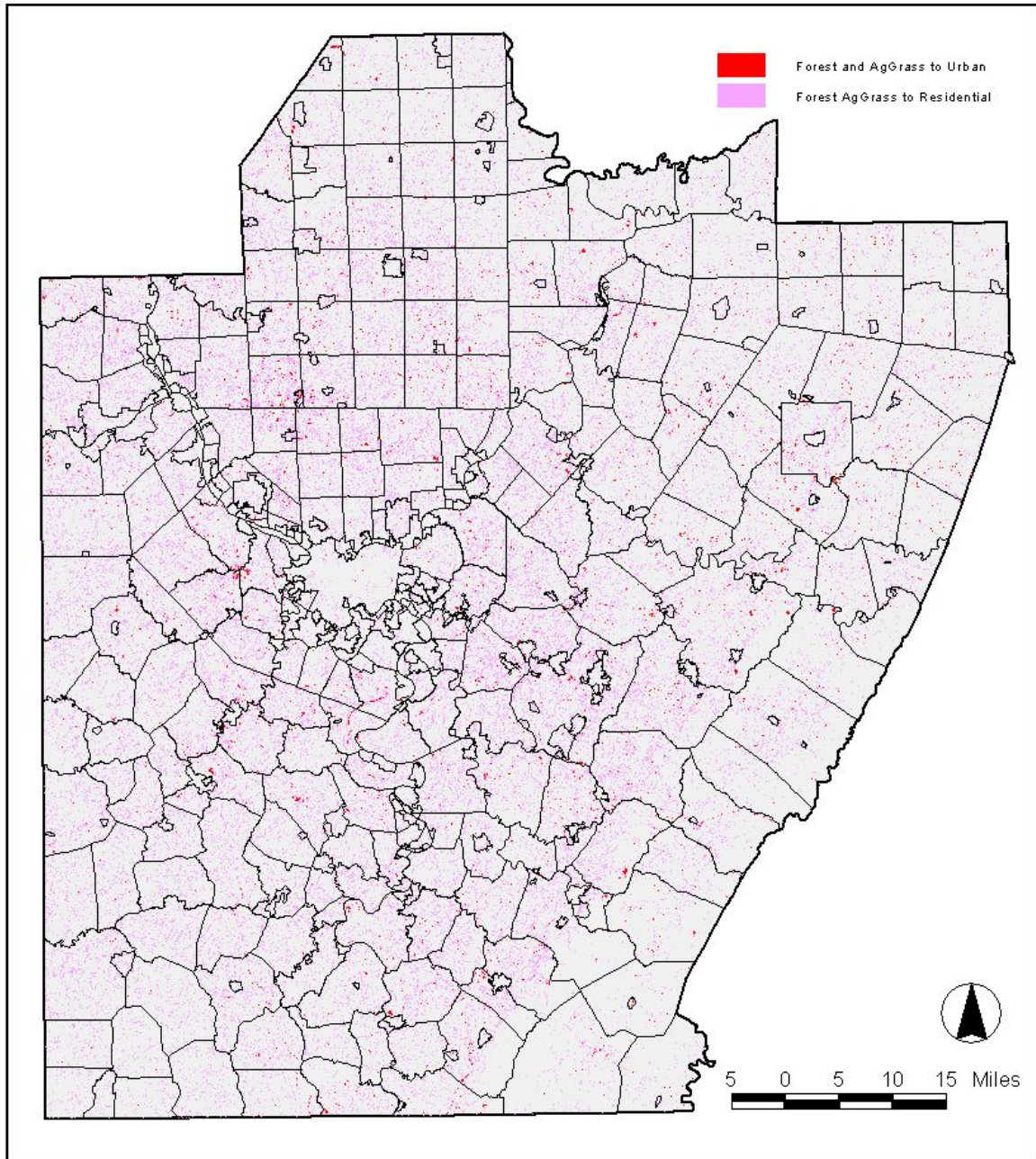| *Policy*	Comprehensive Plan	Zoning	Subdivision	Planning Commission		
	-0.16900000	0.09740000	-0.14320000			
Control	Percent Existing Land-use	Average Population	Change in Population	Average Income	Change in Income	Average Population Density
	-0.13180000	0.00000102	0.00157000	-0.00002000	0.71590000	-0.00018000

Policy Variables-

      A negative relationship was observed between urban to forest land-use changes and the policy variables comprehensive plan and subdivision regulation. A positive relationship was observed with the policy variable zoning. This means that the presence of a comprehensive plan and subdivision regulation were less likely to be present in municipalities that experienced this kind of land-use change during the study time period, and zoning was more likely to be present in these municipalities. The presence or absence of a planning commission was not statistically significant with this land-use change transition.

Control Variables-

      The negative coefficient value of the percent existing land-use control variable suggests that the urban to forest land-use change was less likely to occur in those municipalities with larger amounts of the existing land-use during the study time period. The positive coefficient for the average population, change in population and change in income control variables suggests that these values are relatively higher in the

municipalities that experienced this type of change than the rest of the sample during the study time period. The negative coefficients for average income and average population density suggest these values were relatively lower in the municipalities that experienced this type of change.

Figure 12 - Urban to Forest Change Transition
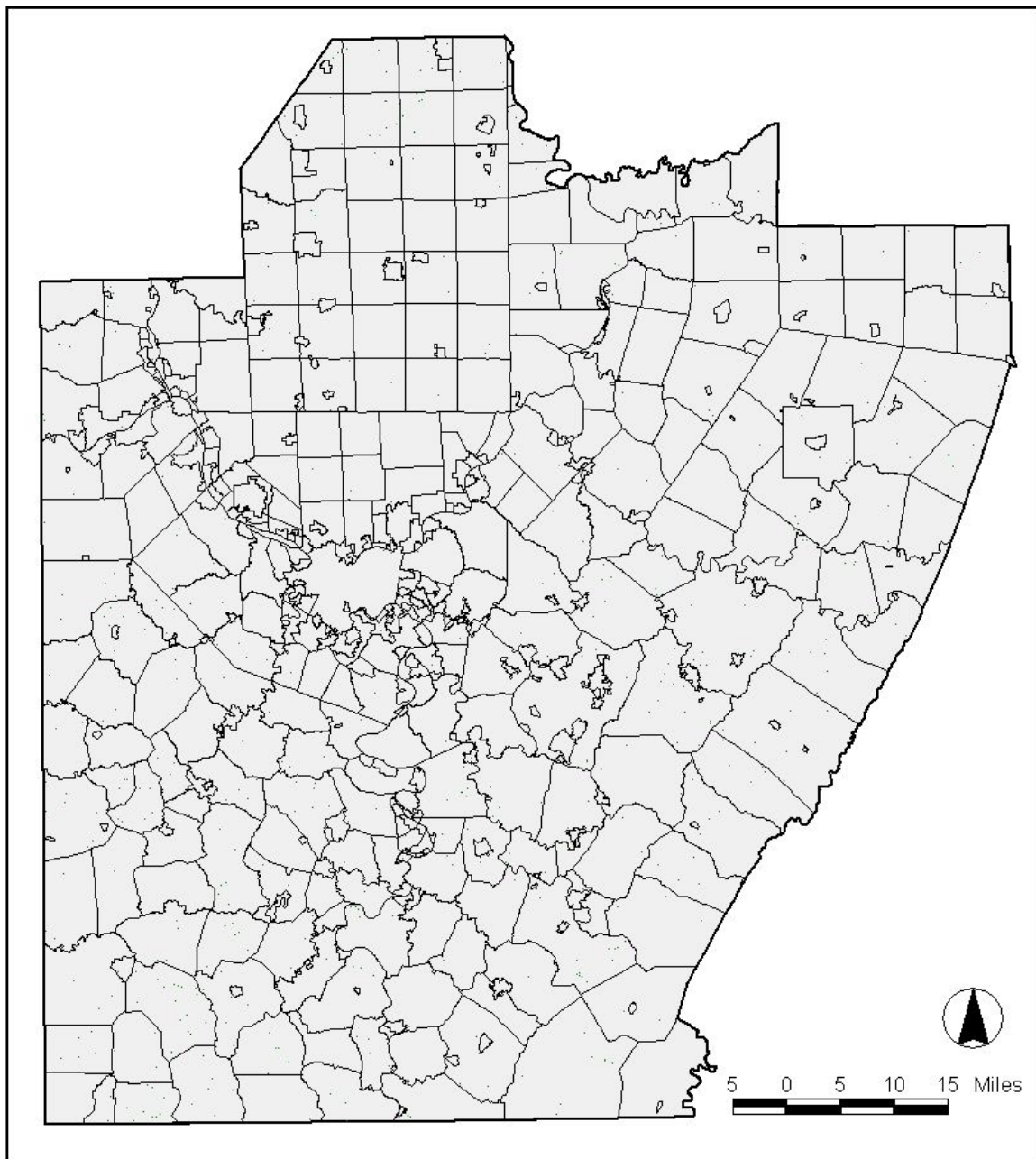
5. Change transition Urban to AgGrass

Table 17 - Urban to AgGrass Coefficients

Policy	Comprehensive Plan	Zoning	Subdivision	Planning Commission		
	-0.13200000	-0.15400000	0.16640000	-0.14290000		
Control	Percent Existing Land-use	Average Population	Change in Population	Average Income	Change in Income	Average Population Density
	-0.10010000	0.00000416		-0.00000862	-0.06530000	-0.00061000

Policy Variables-

A negative relationship was observed between urban to AgGrass land-use changes and the policy variables comprehensive plan, zoning and planning commission. A positive relationship was observed with the policy variable zoning. This means that the presence of a comprehensive plan, zoning and planning commission were less likely to be present in municipalities that experienced this kind of land-use change during the study time period, and zoning was more likely to be present in these municipalities.

Control Variables-

The negative coefficient value of the percent existing land-use control variable suggests that the urban to AgGrass land-use change was less likely to occur in those municipalities with larger amounts of the existing land-use during the study time period. The positive coefficient for the average population control variables suggests that this value is relatively higher in the municipalities that experienced this type of change than the rest of the sample during the study time period. The negative coefficients for average income, change in income and average population density suggest these values

were relatively lower in the municipalities that experienced this type of change. The

control variable change in population was not statistically significant.

Figure 13 - Urban to AgGrass Change Transition
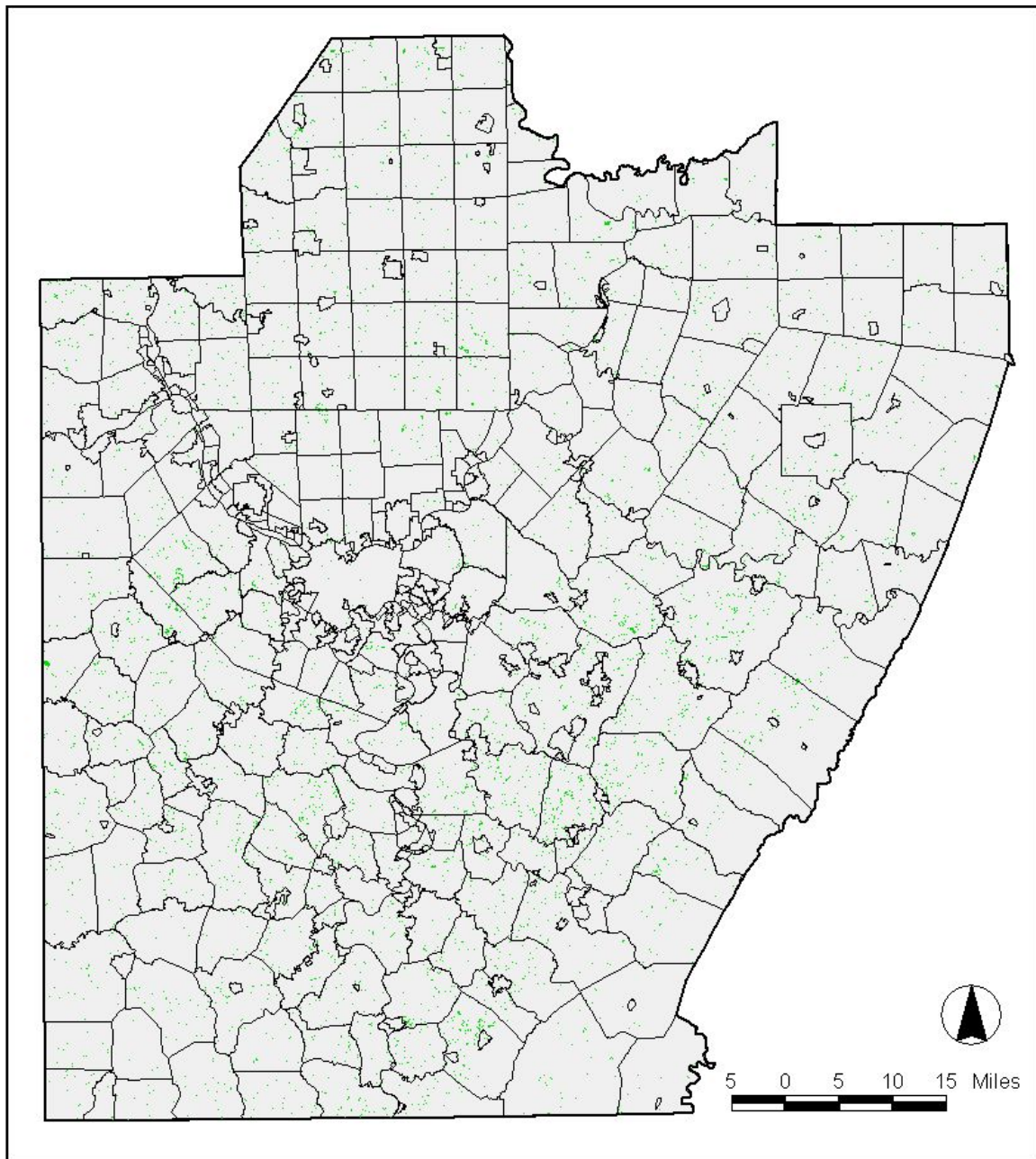
6. Change transition Residential to Urban

Table 18 - Residential to Urban Coefficients

Policy	Comprehensive Plan	Zoning	Subdivision	Planning Commission		
	0.11600000	0.34510000		-0.20510000		
Control	Percent Existing Land-use	Average Population	Change in Population	Average Income	Change in Income	Average Population Density
	0.00623000	-0.00000031	0.00778000	-0.00002000	-0.16980000	

Policy Variables-

A positive relationship was observed between residential to urban land-use changes and the policy variables comprehensive plan and zoning. A negative relationship was observed with the policy variable planning commission. This means that the presence of a comprehensive plan and zoning were more likely to be present in municipalities that experienced this kind of land-use change during the study time period, and a planning commission was less likely to be present in these municipalities. The presence or absence of subdivision regulation was not statistically significant with this land-use change transition.

Control Variables-

The positive coefficient value of the percent existing land-use control variable suggests that the residential to urban land-use change was more likely to occur in those municipalities with larger amounts of the existing land-use during the study time period. The negative coefficient for the average population, average income and change in income control variables suggests that this value is relatively lower in the municipalities that experienced this type of change than the rest of the sample during the

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study time period. The positive coefficient for change in population suggests these

values were relatively higher in the municipalities that experienced this type of change.

The control variable average population density was not statistically significant.

Figure 14 - Residential to Urban Change Transition
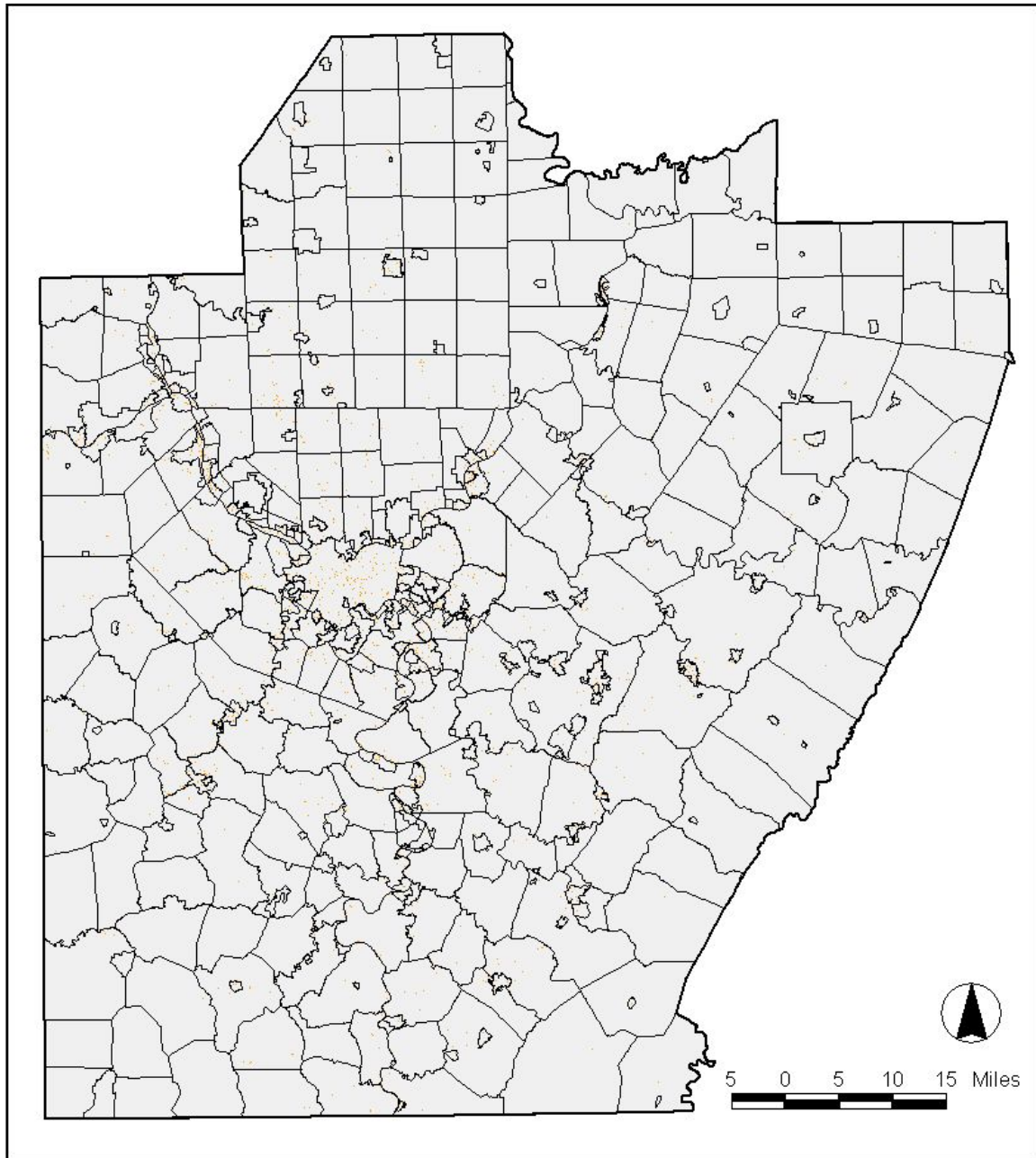
7. Change transition Residential to Forest

Table 19 - Residential to Forest Coefficients

Policy	Comprehensive Plan	Zoning	Subdivision	Planning Commission		
	-0.18080000	-0.27320000		0.09570000		
Control	Percent Existing Land-use	Average Population	Change in Population	Average Income	Change in Income	Average Population Density
	-0.02430000	0.00000029	0.00053600	0.00000765	0.10500000	-0.00003000

Policy Variables-

A negative relationship was observed between residential to forest land-use changes and the policy variables comprehensive plan and zoning.. A positive relationship was observed with the policy variable planning commission. This means that the presence of a comprehensive plan and zoning were less likely to be present in municipalities that experienced this kind of land-use change during the study time period, and a planning commission was more likely to be present in these municipalities. The presence or absence of subdivision regulation was not statistically significant with this land-use change transition.

Control Variables-

The negative coefficient value of the percent existing land-use control variable suggests that the residential to forest land-use change was less likely to occur in those municipalities with larger amounts of the existing land-use during the study time period. The positive coefficient for the average population, change in population, average income and change in income control variables suggests that these values are

relatively higher in the municipalities that experienced this type of change than the rest of

the sample during the study time period. The negative coefficient for average population

density suggests these values were relatively lower in the municipalities that experienced

this type of change.

Figure 15 - Residential to Forest Change Transition
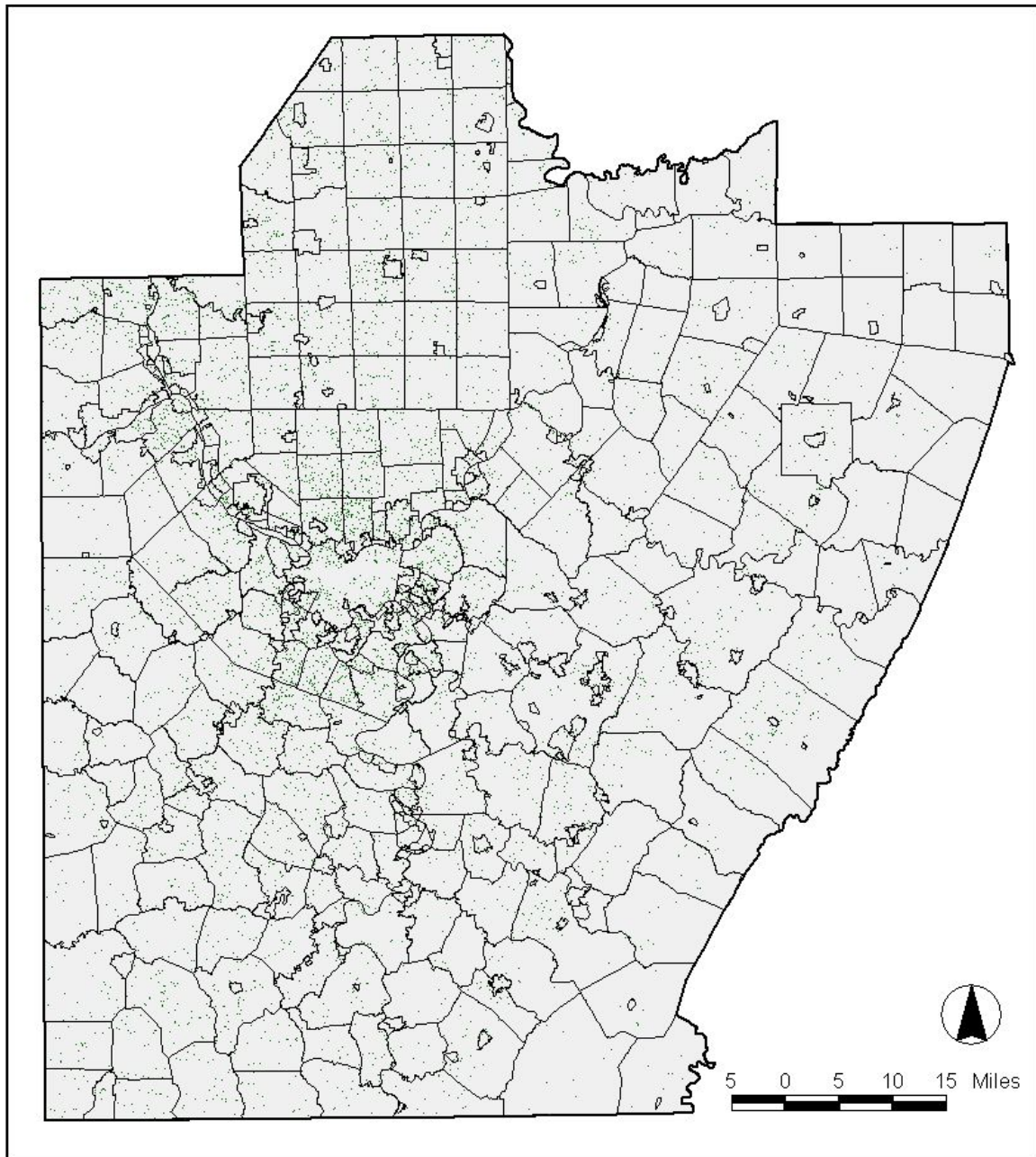
8. Change transition Residential to AgGrass

Table 20 - Residential to AgGrass Coefficients

Policy	Comprehensive Plan	Zoning	Subdivision	Planning Commission		
	0.05260000	-0.05910000		-0.11430000		
Control	Percent Existing Land-use	Average Population	Change in Population	Average Income	Change in Income	Average Population Density
	-0.02040000		-0.00227000	-0.00000399	-0.06250000	-0.00009000

Policy Variables-

A positive relationship was observed between residential to AgGrass land-use changes and the policy variable comprehensive plan. A negative relationship was observed with the policy variables zoning and planning commission. This means that the presence of a comprehensive plan was more likely to be present in municipalities that experienced this kind of land-use change during the study time period, and zoning and a planning commission were less likely to be present in these municipalities. The presence or absence of subdivision regulation was not statistically significant with this land-use change transition.

Control Variables-

The negative coefficient value of the percent existing land-use control variable suggests that the residential to AgGrass land-use change was less likely to occur in those municipalities with larger amounts of the existing land-use during the study time period. The negative coefficients for the control variables change in population, average income, change in income and average population density suggest these values were relatively lower in the municipalities that experienced this type of change during the

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study time period. The control variable average population density was not statistically

significant.

Figure 16 - Residential to AgGrass Change Transition
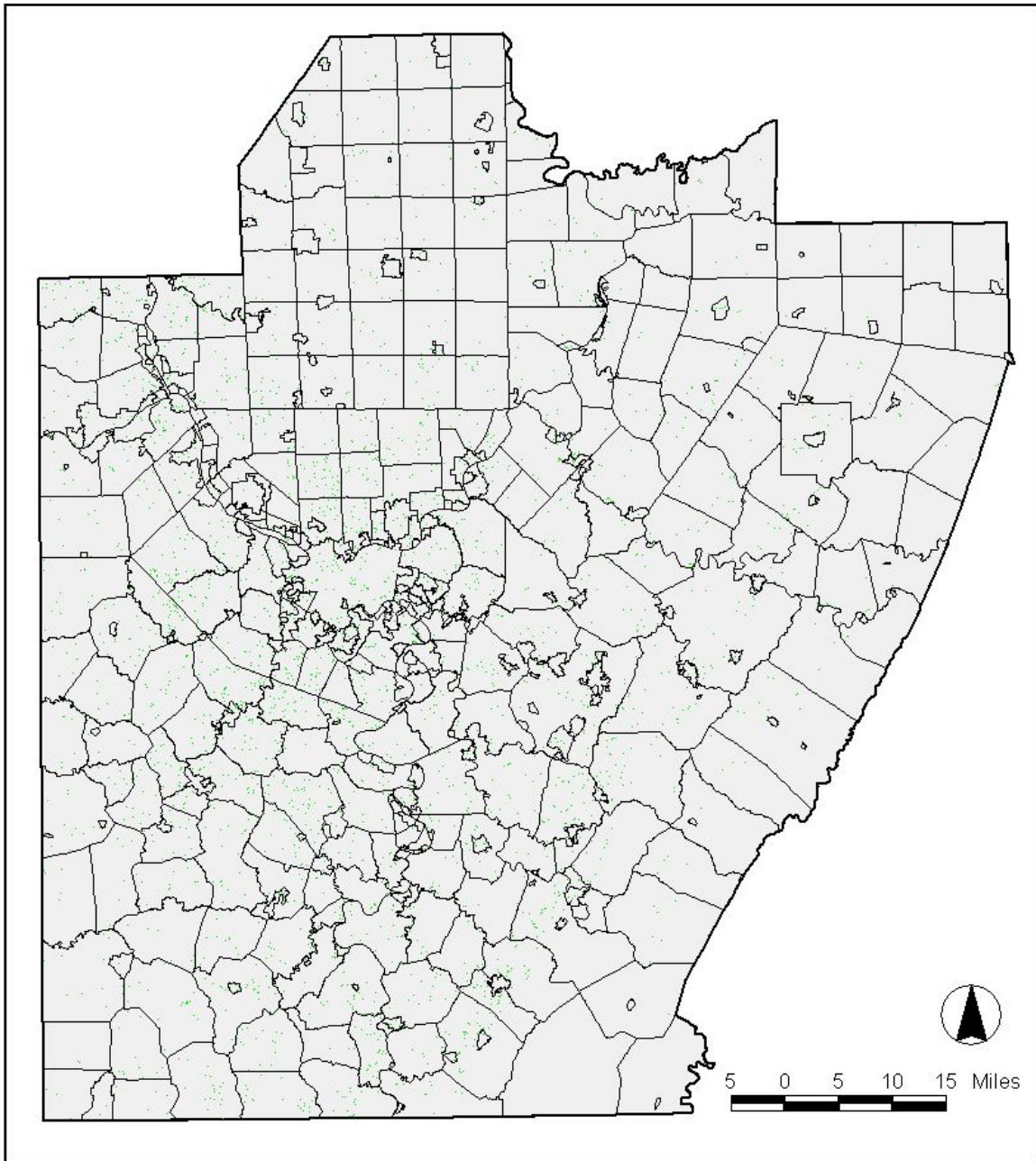
9. Change transition Forest to Urban

Table 21 - Forest to Urban Coefficients

Policy	Comprehensive Plan	Zoning	Subdivision	Planning Commission		
	0.13080000	0.48910000	-0.10330000	-0.56190000		
Control	**Percent Existing Land-use**	**Average Population**	**Change in Population**	**Average Income**	**Change in Income**	**Average Population Density**
	-0.01360000	-0.00000150	0.00888000	0.00001100	-0.96320000	0.00018300

Policy Variables-

A positive relationship was observed between forest to urban land-use changes and the policy variables comprehensive plan and zoning. A negative relationship was observed with the policy variables subdivision regulation and planning commission. This means that the presence of a comprehensive plan and zoning were more likely to be present in municipalities that experienced this kind of land-use change during the study time period, and subdivision regulation and a planning commission were less likely to be present in these municipalities.

Control Variables-

The negative coefficient value of the percent existing land-use control variable suggests that the forest to urban land-use change was less likely to occur in those municipalities with larger amounts of the existing land-use during the study time period. The negative coefficient for the average population and change in income control variables suggests that these values are relatively lower in the municipalities that experienced this type of change than the rest of the sample during the study time period.

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The positive coefficients for change in population, average income and average

population density suggest these values were relatively higher in the municipalities that

experienced this type of change.

Figure 17 - Forest to Urban Change Transition

10. Change transition Forest to Residential

Table 22 - Forest to Residential Coefficients

Policy	Comprehensive Plan	Zoning	Subdivision	Planning Commission		
	0.14320000	0.08210000	0.17360000	-0.03450000		
Control	Percent Existing Land-use	Average Population	Change in Population	Average Income	Change in Income	Average Population Density
	-0.02070000	-0.00000122	-0.00379000	0.00001400	0.11610000	0.00015700

Policy Variables-

A positive relationship was observed between forest to residential land-use changes and the policy variables comprehensive plan, zoning and subdivision regulation. A negative relationship was observed with the policy variable planning commission. This means that the presence of a comprehensive plan, zoning and subdivision regulation were more likely to be present in municipalities that experienced this kind of land-use change during the study time period, and a planning commission was less likely to be present in these municipalities.

Control Variables-

The negative coefficient value of the percent existing land-use control variable suggests that the forest to residential land-use change was less likely to occur in those municipalities with larger amounts of the existing land-use during the study time period. The negative coefficient for the average population and change in population control variables suggests that this value is relatively lower in the municipalities that experienced this type of change than the rest of the sample during the study time period. The positive coefficients for average income, change in income and average population

density suggest these values were relatively higher in the municipalities that experienced this type of change.

Figure 18 - Forest to Residential Change Transition
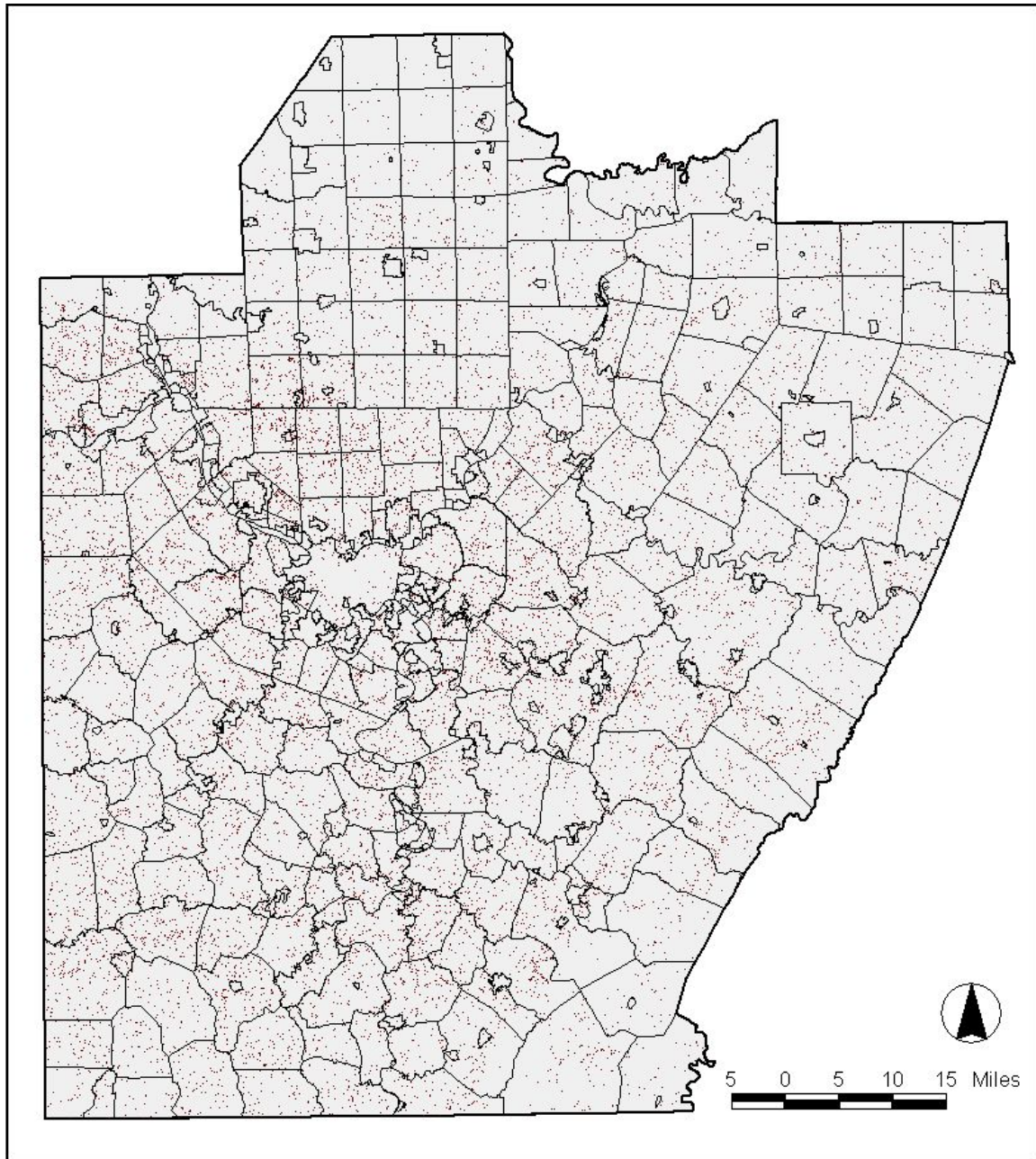
11. Change transition Forest to AgGrass

Table 23 - Forest to AgGrass Coefficients

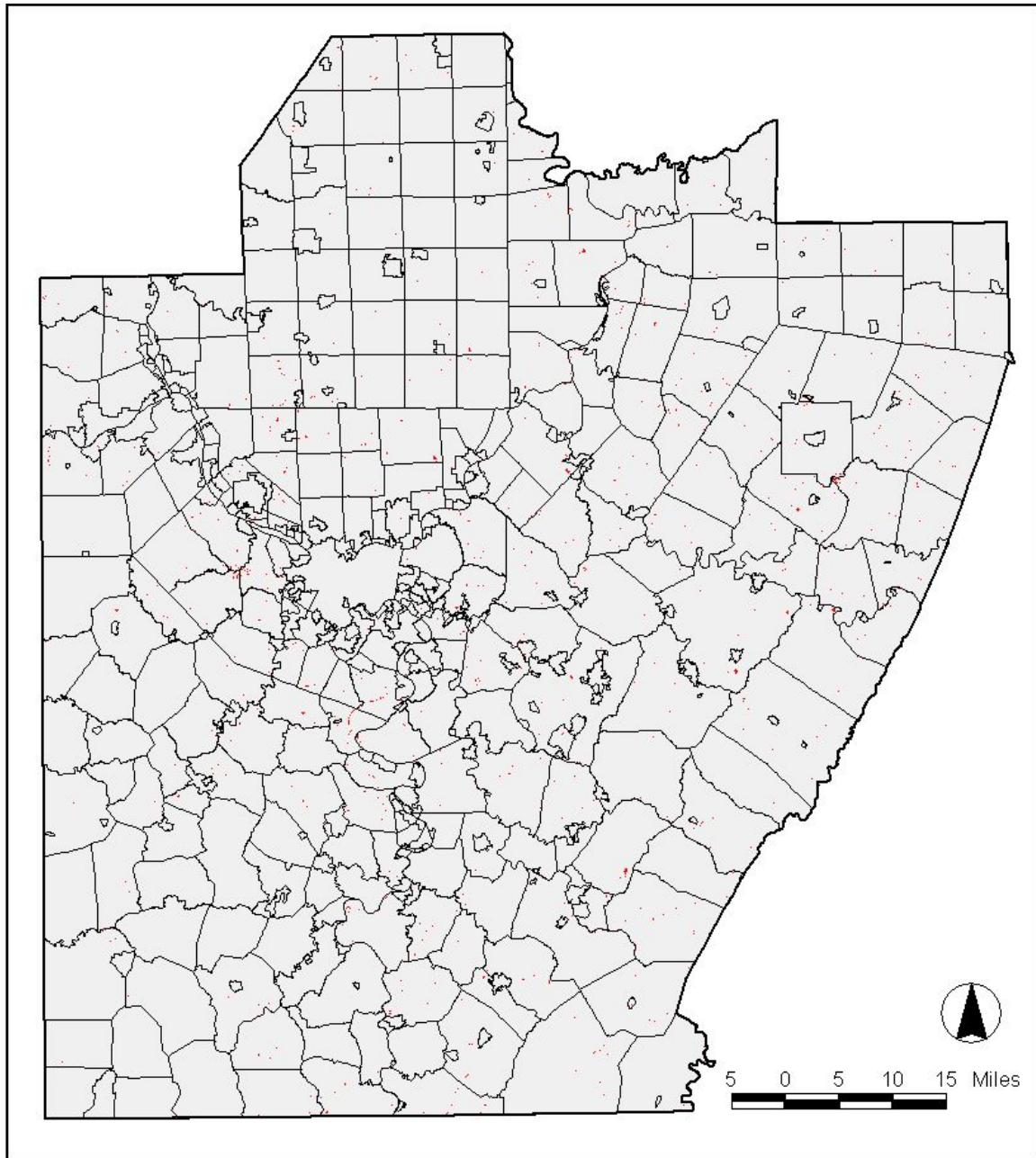| *Policy*	Comprehensive Plan	Zoning	Subdivision	Planning Commission		
	0.14250000		-0.04380000	-0.02180000		
Control	Percent Existing Land-use	Average Population	Change in Population	Average Income	Change in Income	Average Population Density
	-0.00922000	0.00000052	-0.00589000	-0.00000089	0.03960000	-0.00016000

Policy Variables-

A positive relationship was observed between forest to AgGrass land-use changes and the policy variable comprehensive plan. A negative relationship was observed with the policy variables subdivision regulation and planning commission. This means that the presence of a comprehensive plan was more likely to be present in municipalities that experienced this kind of land-use change during the study time period, and subdivision regulation and planning commission were less likely to be present in these municipalities. The presence or absence of zoning was not statistically significant with this land-use change transition.

Control Variables-

The negative coefficient value of the percent existing land-use control variable suggests that the forest to AgGrass land-use change was less likely to occur in those municipalities with larger amounts of the existing land-use during the study time period. The positive coefficient for the average population and change in income control variables suggests that this value is relatively lower in the municipalities that experienced

this type of change than the rest of the sample during the study time period. The negative

coefficients for change in population, average income and average population density

suggest these values were relatively lower in the municipalities that experienced this type

of change.

Figure 19 - Forest to AgGrass Change Transition
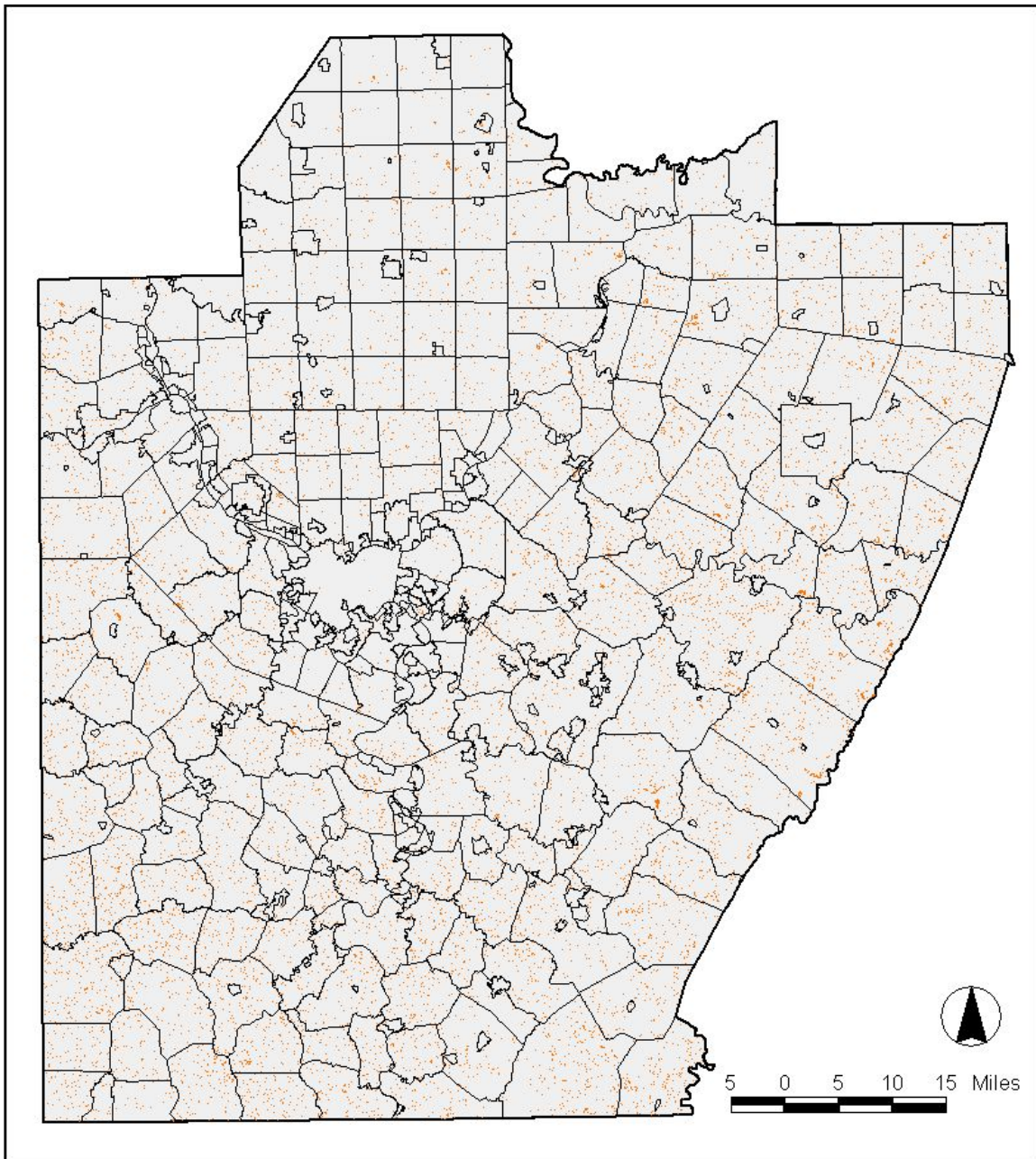
12. Change transition AgGrass to Urban

Table 24 - AgGrass to Urban Coefficients

Policy	Comprehensive Plan	Zoning	Subdivision	Planning Commission		
		0.18930000	0.10750000	-0.23680000		
Control	Percent Existing Land-use	Average Population	Change in Population	Average Income	Change in Income	Average Population Density
	-0.00554000	0.00000125	0.00885000	0.00001100	-1.01070000	0.00018100

Policy Variables-

A positive relationship was observed between AgGrass to urban land-use changes and the policy variables zoning and subdivision regulation. A negative relationship was observed with the policy variable planning commission. This means that zoning and subdivision regulation were more likely to be present in municipalities that experienced this kind of land-use change during the study time period, and a planning commission was less likely to be present in these municipalities. The presence or absence of a comprehensive plan was not statistically significant with this land-use change transition.

Control Variables-

The negative coefficient value of the percent existing land-use control variable suggests that the AgGrass to urban land-use change was less likely to occur in those municipalities with larger amounts of the existing land-use during the study time period. The positive coefficient for the average population, change in population, average income and average population density control variables suggests that this value is relatively higher in these municipalities that experienced this type of change than the

rest of the sample during the study time period. The negative coefficient for change in

income suggests these values were relatively lower in the municipalities that experienced

this type of change.

Figure 20 - AgGrass to Urban Change Transition
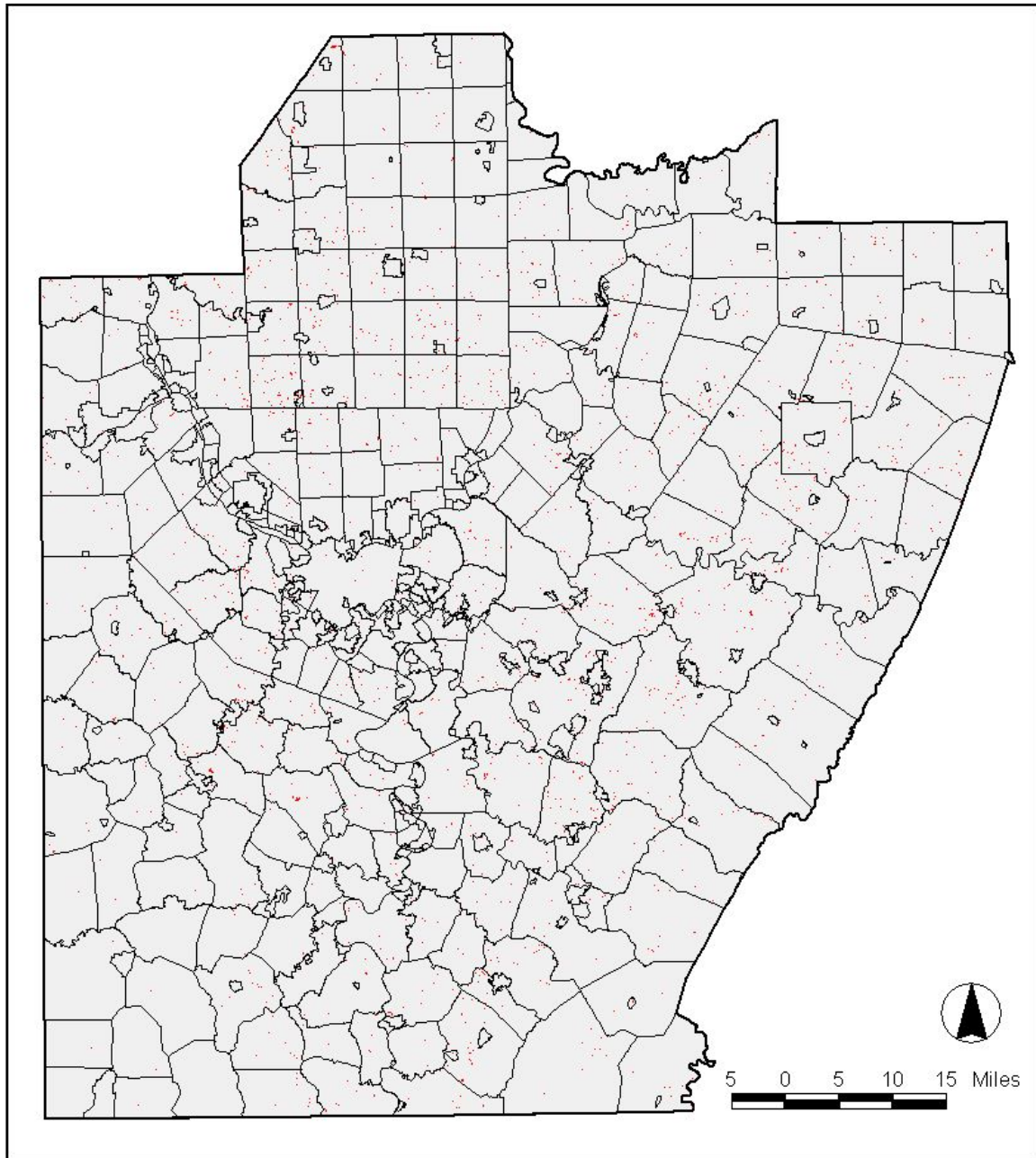
13. Change transition AgGrass to Residential

Table 25 - AgGrass to Residential Coefficients

Policy	Comprehensive Plan	Zoning	Subdivision	Planning Commission		
	0.08280000		0.22070000	0.07430000		
Control	Percent Existing Land-use	Average Population	Change in Population	Average Income	Change in Income	Average Population Density
	-0.01080000	-0.00000153	-0.00169000	0.00001500	-0.06880000	0.00036800

Policy Variables-

A positive relationship was observed between AgGrass to residential land-use changes and the policy variables comprehensive plan, subdivision regulation and planning commission. There were no policy variables that experienced a negative relationship with this kind of land-use change transition. This means that comprehensive plan, subdivision regulation and planning commission were more likely to be present in municipalities that experienced this kind of land-use change during the study time period. The presence or absence of zoning was not statistically significant with this land-use change transition.

Control Variables-

The negative coefficient value of the percent existing land-use control variable suggests that the AgGrass to residential land-use change was less likely to occur in those municipalities with larger amounts of the existing land-use during the study time period. The negative coefficients for the average population, change in population and change in income control variables suggests that this value is relatively <u>lower</u> in these

municipalities that experienced this type of change than the rest of the sample during the

study time period. The positive coefficient for average income suggests these values

were relatively higher in the municipalities that experienced this type of change.

Figure 21 - AgGrass to Residential Change Transition
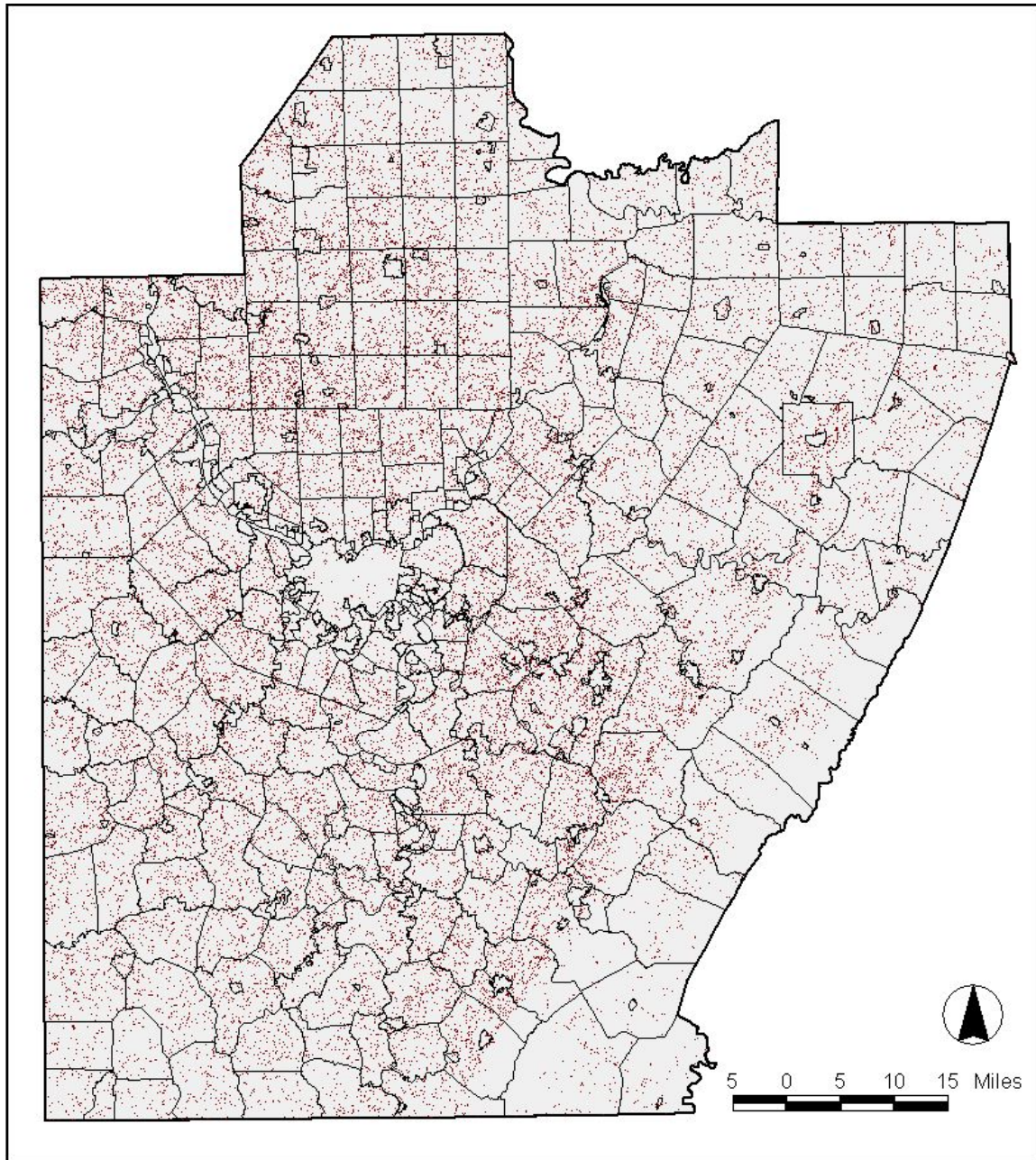
14. Change transition AgGrass to Forest

Table 26 - AgGrass to Forest Coefficients

Policy	Comprehensive Plan	Zoning	Subdivision	Planning Commission		
	-0.17020000	0.01610000	0.02900000	-0.19920000		
Control	Percent Existing Land-use	Average Population	Change in Population	Average Income	Change in Income	Average Population Density
	0.00777000	-0.00000588	0.00995000	-0.00000904	0.42650000	0.00006700

Policy Variables-

A negative relationship was observed between AgGrass to forest land-use changes and the policy variables comprehensive plan and planning commission. A positive relationship was observed with the policy variables zoning and subdivision regulation. This means that comprehensive plan and planning commission were less likely to be present in municipalities that experienced this kind of land-use change during the study time period, and zoning and subdivision were more likely to be present in these municipalities.

Control Variables-

The positive coefficient value of the percent existing land-use control variable suggests that the AgGrass to forest land-use change was more likely to occur in those municipalities with larger amounts of the existing land-use during the study time period. The negative coefficients for the average population and average income control variables suggests that this value is relatively lower in these municipalities that experienced this type of change than the rest of the sample during the study time period.

The positive coefficients for change in population, change in income and average

population density suggest these values were relatively higher in the municipalities that

experienced this type of change.

Figure 22 - AgGrass to Forest Change Transition
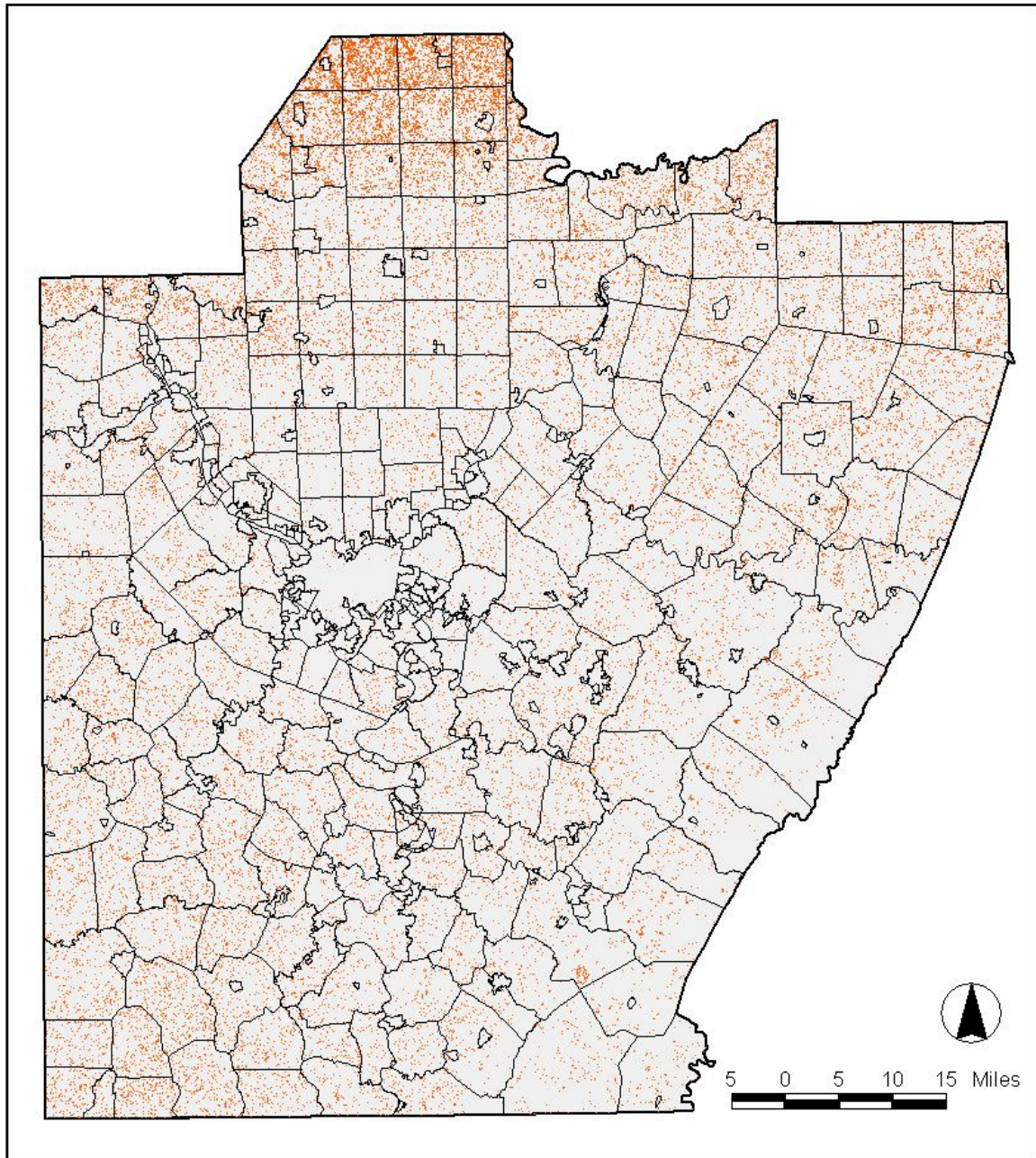
Discussion

Tables 27, 28, 29, and 30 below contain the same values as Table 12, but each ranks the coefficient significance level of each policy from highest to lowest regarding each land-use change transition. Using these tables together, each transition can be analyzed. The two most obvious relationships are, 1) the municipalities that experienced land-use change from forest to *any* of the other three possible land-uses were highly likely to have a comprehensive plan (Table 27), and 2) that subdivision regulations were not statistically significant in those municipalities that experienced land-use change from residential to *any* of the other possible land-uses (Table 29). The remainder of this discussion will examine the land-use change transitions represented from forest to urban, residential and AgGrass land-uses, and AgGrass to urban and AgGrass to residential land-uses. These transitions were chosen because they best represent urbanizing areas.

The change transition from forest to other land-uses exhibits several interesting relationships. Forest to urban and forest to residential land-use changes represent the land-use transition from a less-developed to a developing land-use, while forest to AgGrass can represent a transitional land-use from a less-developed to a developing land-use; the assumption being that agricultural practices in the study area are declining as the built-environment is increasing.

The coefficients in Tables 27, 28, 29 and 30 represents the significance of these changes. Forest to urban represents the most extreme land-use change. The likelihood of a comprehensive plan and zoning and less likelihood of subdivision regulation and a planning commission is an interesting finding; however, the fact that the positive coefficient for zoning is the most likely (highest value in Table 28) and the negative

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Table 27 – Comprehensive Plan Ranked Coefficients

Land-use Change Transition	Comprehensive Plan
Forest to Residential	0.14320000
Forest to AgGrass	0.14250000
Forest to Urban	0.13080000
Residential to Urban	0.11600000
AgGrass to Residential	0.08280000
Less-developed to Developed	0.07700000
Residential to AgGrass	0.05260000
Urban to Residential	0.02130000
Urban to AgGrass	-0.13200000
Developed to Less-developed	-0.13950000
Urban to Forest	-0.16900000
AgGrass to Forest	-0.17020000
Residential to Forest	-0.18080000
AgGrass to Urban	

Table 28 – Zoning Regulation Ranked Coefficients

Land-use Change Transition	Zoning
Forest to Urban	0.48910000
Residential to Urban	0.34510000
AgGrass to Urban	0.18930000
Urban to Residential	0.12950000
Urban to Forest	0.09740000
Forest to Residential	0.08210000
AgGrass to Forest	0.01610000
Less-developed to Developed	-0.05630000
Residential to AgGrass	-0.05910000
Urban to AgGrass	-0.15400000
Developed to Less-developed	-0.20540000
Residential to Forest	-0.27320000
Forest to AgGrass	
AgGrass to Residential	

Table 29 - Subdivision Regulation Ranked Coefficients

Land-use Change Transition	Subdivision
AgGrass to Residential	0.22070000
Urban to Residential	0.18830000
Forest to Residential	0.17360000
Urban to AgGrass	0.16640000
Less-developed to Developed	0.13430000
AgGrass to Urban	0.10750000
AgGrass to Forest	0.02900000
Developed to Less-developed	0.02640000
Forest to AgGrass	-0.04380000
Forest to Urban	-0.10330000
Urban to Forest	-0.14320000
Residential to Urban	
Residential to Forest	
Residential to AgGrass	

Table 30 – Planning Commission Ranked Coefficients

Land-use Change Transition	Planning Commission
Residential to Forest	0.09570000
Less-developed to Developed	0.07940000
AgGrass to Residential	0.07430000
Urban to Residential	0.04380000
Forest to AgGrass	-0.02180000
Forest to Residential	-0.03450000
Developed to Less-developed	-0.06060000
Residential to AgGrass	-0.11430000
Urban to AgGrass	-0.14290000
AgGrass to Forest	-0.19920000
Residential to Urban	-0.20510000
AgGrass to Urban	-0.23680000
Forest to Urban	-0.56190000
Urban to Forest	

coefficient for a planning commission the least likely (lowest value in Table 30) is particularly revealing. Revealing because a comprehensive plan is a guidance document that is prepared to serve an approximate 10-year period and is sporadically updated nor authoritative in most instances. Yet a planning commission is a group of local citizens that meet on a monthly basis to discuss and review proposed land-use issues within their jurisdiction and have some authority to approve or deny land-use propositions. Therefore, the data suggests that those municipalities that desire to maintain forested land-use should form a planning commission to adhere to the recommendations made in their comprehensive plans.

Also interesting about the forest to- land-use change is that when the four land-use categories (urban, residential, forest, and AgGrass) were recoded into two land-use change transitions (developed to less-developed and less-developed to developed), the relationships that existed with the Forest to Urban transition that are explained above are no longer the same when combined. This change in statistical significance could be attributed to the modified areal unit problem (MAUP). The MAUP refers to the fact that the results of statistical data will be different depending on the zoning system used to report aggregated data. Therefore, it is very possible that the aggregating of the values within the units resulted in different coefficient values than expected and is the cause of the discrepancy noted above (Rogerson, 2004).

The change transition from AgGrass to other developed land-uses also exhibits several interesting relationships. For example, the most significant coefficient in Table 29, subdivision ranked coefficients, is AgGrass to residential and the relationship between AgGrass to urban is also positive with this planning tool. This is unlike the

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relationships shown in Table 27 , comprehensive plan ranked coefficients, and Table 30, planning commission ranked coefficients. There are positive relationships with AgGrass to residential with both comprehensive plans and planning commissions; a statistically insignificant relationship with AgGrass to urban with a comprehensive plan; and a negative relationship with AgGrass to urban with planning commission. Like the relationships shared with comprehensive plan, zoning also had one positive and one statistically insignificant relationship shown, but the nature of the relationships was reversed; where AgGrass to Urban was positive and AgGrass to residential was not significant. These are significant findings that warrant further research in order to determine why these relationships exist and to identify what and what kind of local dynamic occurs that causes these results.

Municipalities

This section shifts the focus from the coefficients of the global statistic results of the logistic regression to individual municipalities that experienced particular types of land-use change. What follows is a descriptive analysis of the policy variables, percentage of land-use change, and percentage of change in the control variables for a selection of the sample that fit certain criteria. It should be noted here that this research is not intended to advocate the adoption, use or application of one particular land-use tool over another, the intent of the research is clearly stated - to analyze the relationship between local planning policy and land-use change in the Pittsburgh metropolitan region during the study period.

While each and every one of these municipalities have their own story to be told, the criteria used for the characterization of municipalities in this section are the 20 municipalities over 5 square miles in area that experienced the most land-use changes from; forest to 'developed', AgGrass to 'developed', and residential to urban.

The decision to use municipalities over 5 square miles in area was made arbitrarily as a control for municipal size and to ensure that an adequate amount of pixels were represented in order to detect the land-use change transitions. For each of the three transitions discussed there is first a graph that shows the 20 municipalities over 5 square miles that experienced the greatest proportional land-use change transition ranked in order at the top of the graph from most to least going left to right (secondary x axis); the number of planning tools enacted in each municipality are along the bottom (primary x axis); and the percent change in control and policy variables are shown on the sides (y axis). Following the graph is a table that ranks the top 20 municipalities in the same

manner as the preceding graph and displays the real values for each variable in the graph.
Last is a map that identifies all of the municipalities characterized in this section marking
which municipality experienced the greatest degree of the three land-use change
transitions discussed.

Forest to development

The municipalities that experienced the most forest to urban or residential change
were existing urbanized or suburban areas. The proportional percent change from forest
to urban was not large in any of the top 20 municipalities over 5 square miles (Figure 23).
The change ranged from a high of 3% to a low of 1% (Table 31).

Forest to residential change was much larger with a high of 29% and a low of 2%.
Interestingly, the two municipalities that experienced the most forest to residential change
were Mount Lebanon (29%) and Bethel Park (23%). These municipalities also
experienced the least amount of population and income change of the 20 municipalities
during the study period, both with incomes rising slightly and populations actually
dropping. Both municipalities had all four planning tools enacted. Two other
municipalities that are on this list that have zero planning tools are Manor Township and
Mercer Township. Both of these municipalities experienced loss of forested land to
urban land-uses (Figure 23) and both surround smaller, urbanized boroughs (Ford City,
Ford Cliff and Manorville Boroughs near Manor Township, and Harrisonville Borough
near Mercer Township). These townships are candidates for continued development and
should adopt some, if not all, of the planning tools listed here to ensure local control.

Figure 23 - Top 20 municipalities greater than 5 square miles in area that experienced from Forest to 'Development'
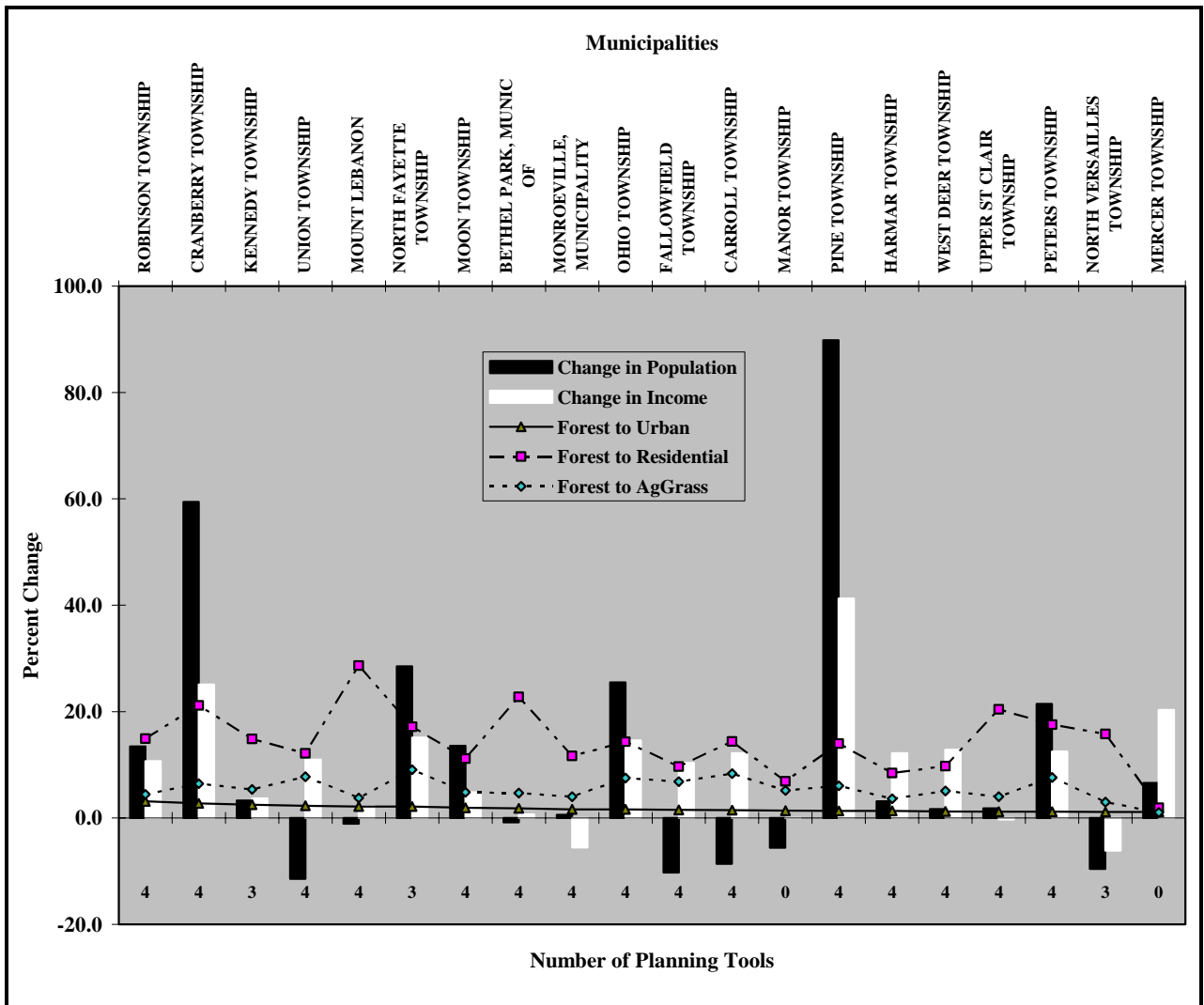
While the forest to AgGrass class is not considered a 'from less-developed to developed' land-use change, it is an indicator of a direction of change from the most extreme less-developed land-use change (forest) to a more developed land-use. This is because it is assumed that during this time period within the study area the clearing of forest is less anticipated to be for agricultural activity and more likely due to residential or urban development. Interestingly, of the 20 municipalities discussed in this group, all

of the proportional change from forest to AgGrass fell between both the forest to urban

change and the forest to residential change, as shown in Figure 23 above.

Table 31 - Top 20 municipalities greater than 5 square miles in area that experienced from Forest to 'Development'

County	Municipality	Square Miles	% Change Pop	% Change Income	% Forest-Urban	% Forest-Res.	% Forest-AgGrass	Comp Plan	Zoning	Sub-division	Planning Comm.	Tools Total
ALLEGHENY	ROBINSON TOWNSHIP	15	13	11	3	15	4	1	1	1	1	4
BUTLER	CRANBERRY TOWNSHIP	23	59	25	3	21	6	1	1	1	1	4
ALLEGHENY	KENNEDY TOWNSHIP	6	3	4	3	15	5	0	1	1	1	3
WASHINGTON	UNION TOWNSHIP	16	-11	11	2	12	8	1	1	1	1	4
ALLEGHENY	MOUNT LEBANON	6	-1	2	2	29	4	1	1	1	1	4
ALLEGHENY	NORTH FAYETTE TOWNSHIP	25	28	15	2	17	9	0	1	1	1	3
ALLEGHENY	MOON TOWNSHIP	24	14	5	2	11	5	1	1	1	1	4
ALLEGHENY	BETHEL PARK, MUNIC OF	12	-1	1	2	23	5	1	1	1	1	4
ALLEGHENY	MONROEVILLE, MUNICIPALITY	20	1	-6	2	12	4	1	1	1	1	4
ALLEGHENY	OHIO TOWNSHIP	7	25	15	2	14	8	1	1	1	1	4
WASHINGTON	FALLOWFIELD TOWNSHIP	21	-10	10	2	10	7	1	1	1	1	4
WASHINGTON	CARROLL TOWNSHIP	14	-9	12	1	14	8	1	1	1	1	4
ARMSTRONG	MANOR TOWNSHIP	17	-6	0	1	7	5	0	0	0	0	0
ALLEGHENY	PINE TOWNSHIP	17	90	41	1	14	6	1	1	1	1	4
ALLEGHENY	HARMAR TOWNSHIP	6	3	12	1	8	4	1	1	1	1	4
ALLEGHENY	WEST DEER TOWNSHIP	29	2	13	1	10	5	1	1	1	1	4
ALLEGHENY	UPPER ST CLAIR TOWNSHIP	10	2	0	1	20	4	1	1	1	1	4
WASHINGTON	PETERS TOWNSHIP	20	21	12	1	18	8	1	1	1	1	4
ALLEGHENY	NORTH VERSAILLES TOWNSHIP	8	-10	-6	1	16	3	0	1	1	1	3
BUTLER	MERCER TOWNSHIP	13	7	20	1	2	1	0	0	0	0	0

AgGrass to development

The municipalities that experienced AgGrass to urban or residential change were

also existing urbanized or suburban areas. Similar to the municipalities that experienced

forest to urban land-use change described above, the proportional percent change from

AgGrass to urban was not large in any of the top 20 municipalities over 5 square miles.

The change ranged from a high of 7% to a low of 2% (Figure 24 and Table 32). AgGrass

to residential proportional percent change was much higher with a high of 59% and a low

of 15%. The municipality that experienced the most AgGrass to residential change was

North Versailles, which also had experienced the highest losses of population and income during of the 20 municipalities during the study period. North Versailles had three planning tools enacted (Figure 24).

Fifteen (75%) of municipalities that experienced AgGrass to developing land-use changes (represented by AgGrass to urban and AgGrass to residential) had all four planning tools, and three municipalities (15%) had three planning tools.

Figure 24 - Top 20 municipalities greater than 5 square miles in area that experienced from AgGrass to 'Development'
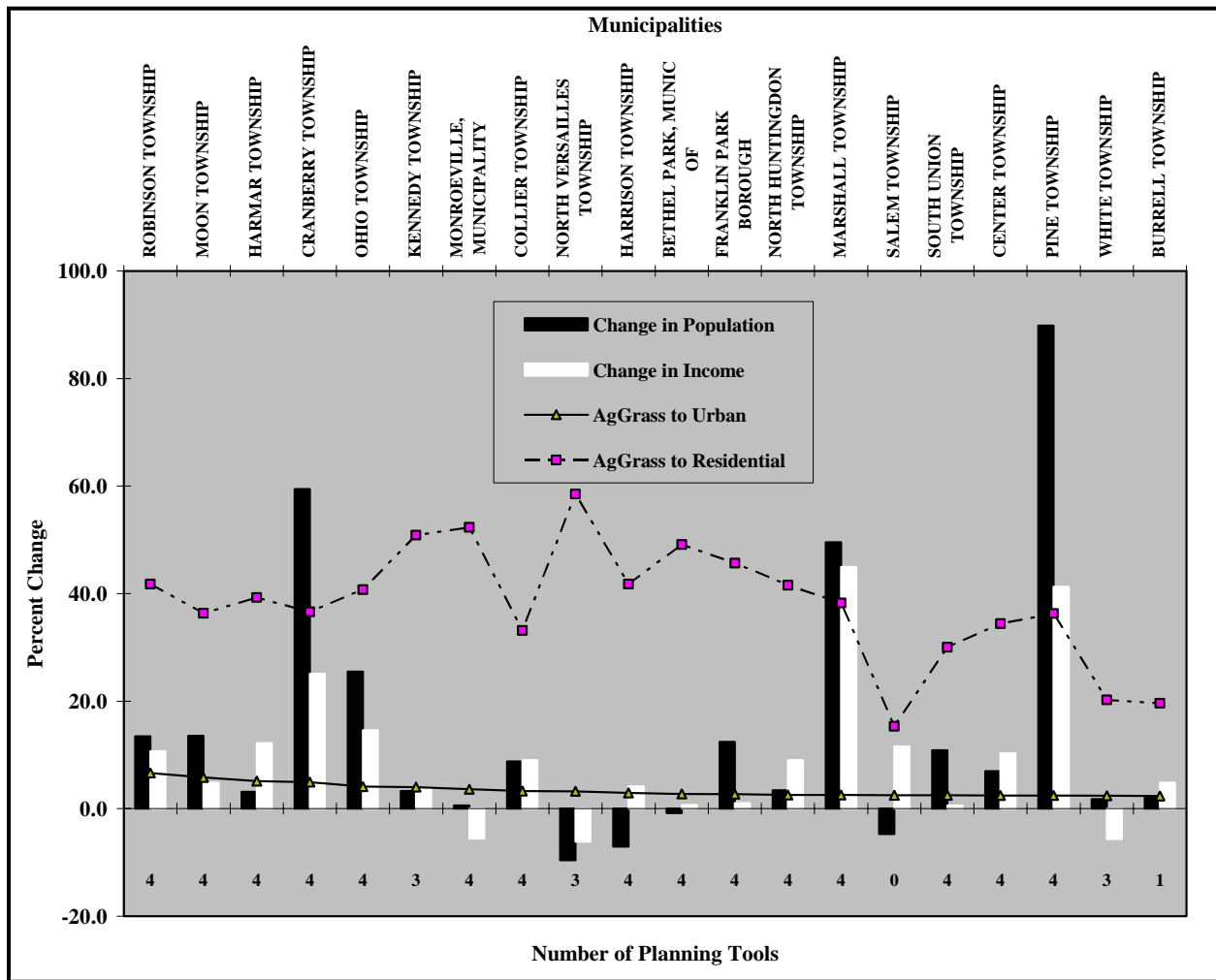
The two remaining municipalities (10%) in this group were Salem Township.

with zero planning tools and Burrell Township. with one planning tool (Figure 24).

Salem and Burrell Townships were the 15th and 20th ranked municipalities in this group,

respectively. Table 32 also shows that these two municipalities had the least amount of

AgGrass to residential land-use change of the group. Interestingly, Salem Township had

a population loss but income gain during the study period. Together these values identify

Salem Township as an area that experienced both a socio-economic and physical

transformation during the study period. Also, the fact that Salem Township did not have

any planning tools enacted suggests that this area many have experienced locally

undesirable development patterns during this time.

Table 32 - Top 20 municipalities greater than 5 square miles in area that experienced from AgGrass to 'Development'

County	Municipality	Square Miles	% Change Pop	% Change Income	% AgGrass-Urban	% AgGrass-Res	Comp Plan	Zoning	Sub-division	Planning Comm.	Tools Total
ALLEGHENY	ROBINSON TOWNSHIP	15	13	11	7	42	1	1	1	1	4
ALLEGHENY	MOON TOWNSHIP	24	14	5	6	36	1	1	1	1	4
ALLEGHENY	HARMAR TOWNSHIP	6	3	12	5	39	1	1	1	1	4
BUTLER	CRANBERRY TOWNSHIP	23	59	25	5	37	1	1	1	1	4
ALLEGHENY	OHIO TOWNSHIP	7	25	15	4	41	1	1	1	1	4
ALLEGHENY	KENNEDY TOWNSHIP	6	3	4	4	51	0	1	1	1	3
ALLEGHENY	MONROEVILLE, MUNICIPALITY	20	1	-6	4	52	1	1	1	1	4
ALLEGHENY	COLLIER TOWNSHIP	14	9	9	3	33	1	1	1	1	4
ALLEGHENY	NORTH VERSAILLES TOWNSHIP	8	-10	-6	3	59	0	1	1	1	3
ALLEGHENY	HARRISON TOWNSHIP	8	-7	4	3	42	1	1	1	1	4
ALLEGHENY	BETHEL PARK, MUNIC OF	12	-1	1	3	49	1	1	1	1	4
ALLEGHENY	FRANKLIN PARK BOROUGH	13	12	1	3	46	1	1	1	1	4
WESTMORELAND	NORTH HUNTINGDON TOWNSHIP	27	3	9	3	42	1	1	1	1	4
ALLEGHENY	MARSHALL TOWNSHIP	15	50	45	3	38	1	1	1	1	4
WESTMORELAND	SALEM TOWNSHIP	48	-5	12	2	15	0	0	0	0	0
FAYETTE	SOUTH UNION TOWNSHIP	17	11	1	2	30	1	1	1	1	4
BEAVER	CENTER TOWNSHIP	16	7	10	2	34	1	1	1	1	4
ALLEGHENY	PINE TOWNSHIP	17	90	41	2	36	1	1	1	1	4
INDIANA	WHITE TOWNSHIP	43	2	-6	2	20	1	0	1	1	3
INDIANA	BURRELL TOWNSHIP	25	2	5	2	20	1	0	0	0	1

Residential to urban

Figure 25 graphs the top 20 municipalities greater than square miles that experienced residential to urban land-use change in a slight different manner than the previous two graphs. The addition of a secondary y-axis on the right side of the graph represents the percent change in residential to urban land-use, and the primary y-axis on the left represents only the percent change of the control variables.

Figure 25 – Top 20 municipalities greater than 5 square miles in area that experienced from Residential to Urban
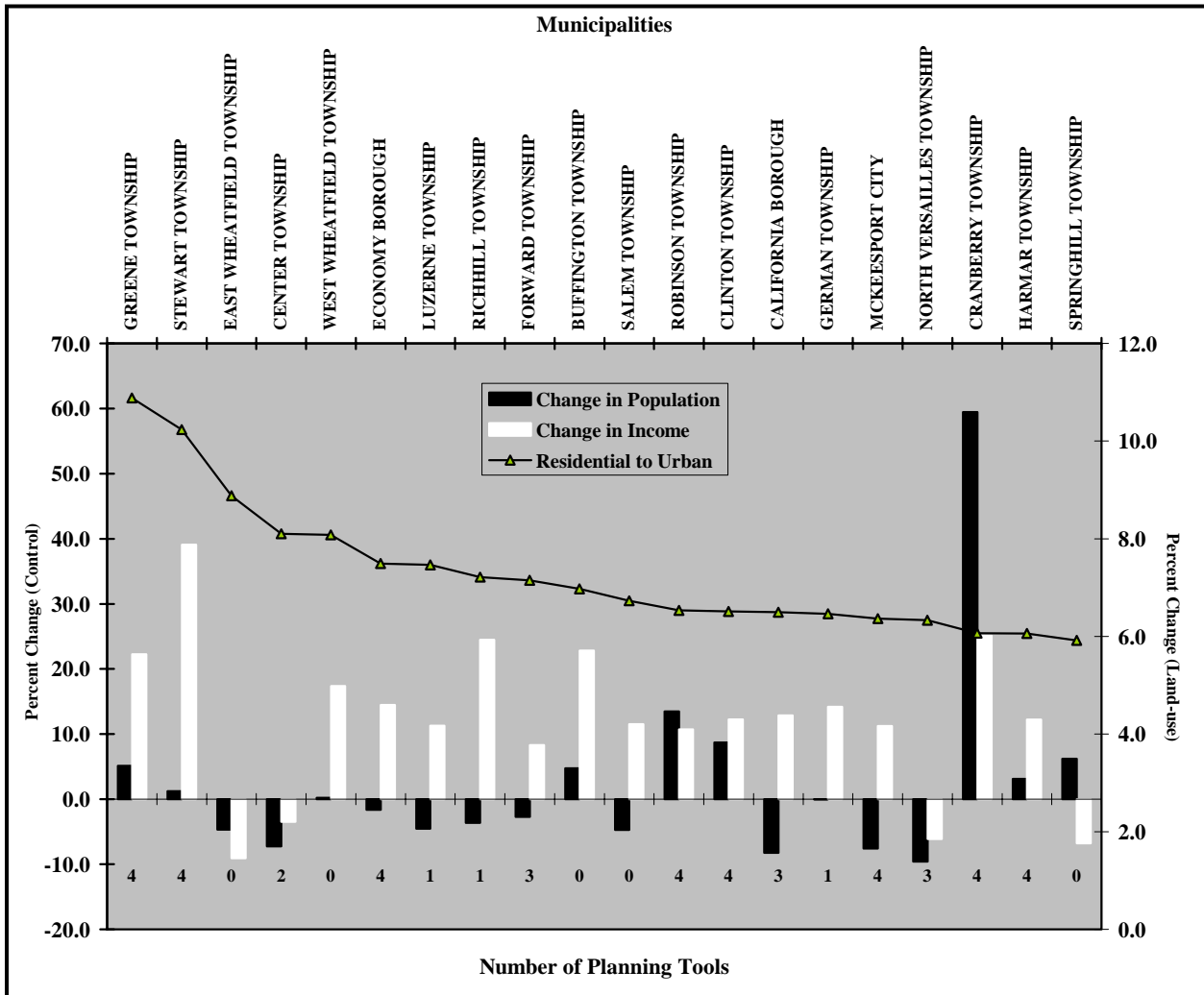
This variation in display was performed because there is only one land-use change shown and because the addition of the second y-axis depicts the percent land-use change more clearly in relation to the control variables.

Of the residential to urban group, four municipalities (20%) exhibited negative changes in income, and ten municipalities (50%) exhibited negative changes in population. Nine of these municipalities (45%) experienced population gains with one municipality (German Township) showing zero change in population (Table 33). The majority of municipalities experienced much higher rates of income change as opposed to population change.

Table 33 - Top 20 municipalities greater than 5 square miles in area that experienced from Residential to Urban

County	Municipality	Square Miles	Change Pop	Change Income	Res-Urban	Comp Plan	Zoning	Subdiv	Planning Comm	Tools Total
BEAVER	GREENE TOWNSHIP	26	5	22	11	1	1	1	1	4
FAYETTE	STEWART TOWNSHIP	51	1	39	10	1	1	1	1	4
INDIANA	EAST WHEATFIELD TOWNSHIP	27	-5	-9	9	0	0	0	0	0
INDIANA	CENTER TOWNSHIP	40	-7	-3	8	1	0	0	1	2
INDIANA	WEST WHEATFIELD TOWNSHIP	32	0	17	8	0	0	0	0	0
BEAVER	ECONOMY BOROUGH	18	-2	14	7	1	1	1	1	4
FAYETTE	LUZERNE TOWNSHIP	31	-5	11	7	1	0	0	0	1
GREENE	RICHHILL TOWNSHIP	56	-4	24	7	0	0	1	0	1
ALLEGHENY	FORWARD TOWNSHIP	20	-3	8	7	0	1	1	1	3
INDIANA	BUFFINGTON TOWNSHIP	31	5	23	7	0	0	0	0	0
WESTMORELAND	SALEM TOWNSHIP	48	-5	12	7	0	0	0	0	0
ALLEGHENY	ROBINSON TOWNSHIP	15	13	11	7	1	1	1	1	4
BUTLER	CLINTON TOWNSHIP	24	9	12	7	1	1	1	1	4
WASHINGTON	CALIFORNIA BOROUGH	11	-8	13	6	1	1	1	0	3
FAYETTE	GERMAN TOWNSHIP	34	0	14	6	1	0	0	0	1
ALLEGHENY	MCKEESPORT CITY	5	-8	11	6	1	1	1	1	4
ALLEGHENY	NORTH VERSAILLES TOWNSHIP	8	-10	-6	6	0	1	1	1	3
BUTLER	CRANBERRY TOWNSHIP	23	59	25	6	1	1	1	1	4
ALLEGHENY	HARMAR TOWNSHIP	6	3	12	6	1	1	1	1	4
FAYETTE	SPRINGHILL TOWNSHIP	34	6	-7	6	0	0	0	0	0

The most notable exception to this observation is Cranberry Township. Cranberry Township ranked 18th in this group and experienced a 60% increase in population and a 25% increase in income during the study period. Cranberry Township also had all four of the planning tools enacted.   It should also be noted that Cranberry Township also ranked 2nd among the forest to development group and 4th among the AgGrass to development group. This data suggests that Cranberry Township developed at a disproportional rate than other municipalities in the study area and that it has managed this growth with local control due to its adoption of all four planning tools.

Unlike the forest to developed and AgGrass to developed municipalities, several (40%) of the residential to urban municipalities in this group had one or zero planning tools. Three (15%) of these municipalities had only one planning tool and five (25%) of these municipalities had no planning tools enacted. This data suggests that these municipalities experienced development without the utility of local land-use tools, and may have experienced less-informed decision making resulting in unwanted land-use changes.

Figure 26 below shows all of the municipalities discussed in the *Municipalities* sub-section above. However, only the land-use changes 'to urban' are mapped, as this transition was used to identify and rank the top 20 municipalities for each group. Each of the three land-use change transitions are represented distinctly. Forest to urban is represented by a solid gray color, AgGrass to urban is represented by a simple hatch pattern, and residential to urban is represented by stippling.

The spatial pattern of each of these land-use change transitions is revealing. Allegheny County continues to urbanize around its perimeter, mostly losing forested land to development. The construction of the new airport and the big-box retail phenomenon of the 1990's are thought to be significant factors in this transition. The proportional change in Washington County is also interesting, as the dominant change was also from forest to urban in municipalities that are adjacent to the Monongahela River Valley and those that are adjacent to similarly changing municipalities in Allegheny County. Fayette and Indiana Counties continued to urbanize, experiencing more residential to urban land-use changes, and Westmoreland County appears to be losing some of its agriculture communities to urbanization, as a few of its municipalities shared both residential to urban and AgGrass to urban transitions. The movement of development is clear along the 279 north corridor, north and west of the Ohio River, that leads from downtown Pittsburgh towards Cranberry Township, as the northwest corner of Allegheny County the southwest corner of Butler County and the southeast corner of Beaver County experienced significant development. The residential to urban land-use change depicted in Richhill Township, Greene County is thought to be mining activity, not urban activity.

Figure 26 - Developing (Urbanizing) Municipalities

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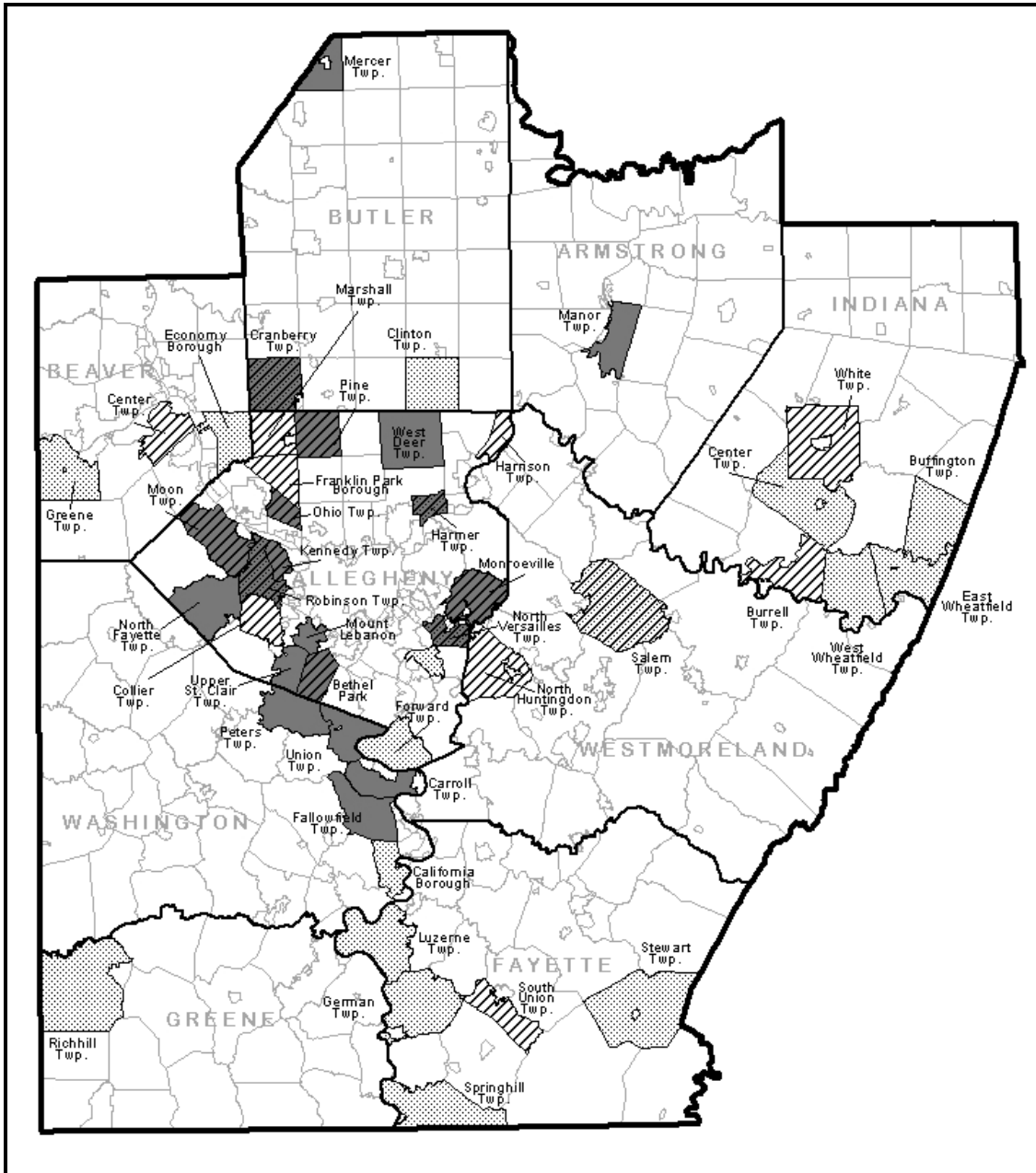
Comprehensive Viewpoint

In order to discuss the relevance of this research as a whole, it is impossible to do so unless it is viewed comprehensively; and to research metropolitan regions adequately, one must approach urbanization as a process and this approach must be comprehensive in scope. Chapter 2 has shown that the urbanization process is an uneven one, as economic development see-saws throughout the region not only jumping scales but also producing, reducing and reproducing scales as various regimes and modes of production rise and fall – only to have new regimes and modes of production to take their place.

Chapter 3 reminds us that land-use planning theories and practices also rise and fall, often in a dialectic pattern of change that parallels the changes of regimes and production. Further, the objectives of planning practice changes too; where at times planning has been used as a tool to preserve modes of production by some political regimes in effort to stabilize, or spatially fix, large urban-economic districts, and other regimes used planning to facilitate changing social structures affected by economic restructuring. Chapter 4 should be read as a story that describes the changing role of land-use planning in the case study (Pittsburgh) by competing interests during most of the twentieth century.

Using the results of the remote sensing change detection analysis and the particular planning tools enacted by each of the 525 municipalities as inputs into the logistic regression model provided global statistics explaining the quantitative relationship between the individual land-use changes identified and particular planning policies. However, the descriptive analysis in the latter part of Chapter 6

provided local qualitative and contextual interpretation of the statistics, which is

necessary in order to turn this data into information. It is the hope of this author that

this information is relevant and of interest to those individuals wanting to learn more

about urban land-use, planning policy, uneven development and/or Pittsburgh.

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CHAPTER 7 - Conclusion

This research has shown that there were significant relationships between land-use policies and land-use changes in the Pittsburgh metropolitan area between 1992 and 2002. Other contextual and local events that occurred in each location are also presumed to have influenced types of development and rates of development during the study period. It should be noted again that this research is not intended to advocate the adoption, use or application of one particular land-use tool over another, the intent and goal of the research is clearly stated. However, by using the method performed in this research, metropolitan planning organizations and other planning bodies can access, visualize and interpret large amounts of data variation across hundreds of municipalities which enable decision makers to identify past changes and forecast future trends in land-use development and underdevelopment.

Examples of the utility of this research are evident in the analysis of the relationships between particular land-use policies and land-use changes. For instance, comprehensive plans were more likely to be found in those municipalities that experienced forested land-use change to any of the other three remaining land-uses (Table 27). These positive relationships indicate that where forested land-use was lost to other land-uses, such transitions should have been in agreement with the goals set forth in the comprehensive plan adopted by these municipalities.

The most significant positive coefficient value in the sample is the relationship between zoning and the forest to urban land-use change transition (Table 28). In fact, there is a high likelihood that zoning is in place in those municipalities where any land-use change to urban took place. This is logical as these values tell us

that urbanizing areas are more likely to have zoning, as zoning is a planning tool that is found most in existing urbanized areas (Figure 7).

The most evident relationship between subdivision regulations and land-use change in the study area was the positive relationship with land-uses changing from residential to any of the remaining three land-uses and vice versa, where urban, forest and AgGrass changed to residential. The highest valued coefficients represented AgGrass to residential, urban to residential, and forest to residential. The relationship between subdivision regulations and the opposite land-use change transitions (from residential to any of the remaining three land-uses) were insignificant in the statistical analysis. These polar relationships between subdivision regulation and changes to and from residential land-uses are interesting and yet expected as most subdivision of land parcels is done for the expansion of residential land use. Municipalities transitioning to residential land-uses are assumed to have already experienced some land-use changes prior to the study period that led to the adoption of subdivision regulations, and in these instances subdivision regulation begets subdividing land parcels. Inversely, the statistically insignificant relationships between subdivision and municipalities transitioning from residential to any of the remaining three land-uses informs us that more municipalities transitioned to residential land-uses and not out of residential land uses.

The most alarming relationships between subdivision regulations and land-use changes were the three transitions that experienced a negative relationship; forest to AgGrass, forest to urban, and urban to forest. Most interesting are the forest to AgGrass and forest to urban because these negative values tell us that those

municipalities that experienced a loss of forest cover to AgGrass and to urban were less likely to have subdivision regulations in place. This analysis suggests that subdivision regulations are present in municipalities that experienced land-uses transitioning to residential, but the change from forest to urban or AgGrass changes were not influenced by subdivision regulations.

There is a majority of negative relationships between land-use changes and planning commissions, meaning that more variety of land-use transitions occurred in municipalities where planning commissions were absent. Again, the transition from forest to urban stands out and in this instance exhibited the highest negative relationship with municipalities that had planning commissions, suggesting that more forest areas were lost to urban uses in those municipalities that did not have a planning commission in place as opposed to those municipalities that did have a planning commission in place.

The five broad land-use categories used in this research represent the most general land-use classes important to local and regional political offices and economic developers. The choice and names of these categories were determined by the author based on his experiences in local and regional land-use planning in the study area over a five year period. These choices were based on the questions and comments made by different local political figures and citizens that attended dozens of public meetings. Most often, local decisions that were made using land-use data as a source of information were based on these five basic and colloquial categories.

Following this broad classification of the region's land-uses, closer examination and detection of other land-uses and land-covers within these broad

categories would be useful for local decision making at the municipal unit. A major and evident weakness of this schema that may have greatly affected classification results was not considering surface mining as a land-use category. Surface mining should have been introduced as a target class because it is a prevalent land-use in the study area, especially in the southwest portion of the study area in Greene and Washington Counties, and it is often misrepresented as urban or residential land-use when classifying satellite imagery.

Weaknesses in the remote sensing approach are also noted. Using alternative remote sensing methods and techniques could have also produced better data for this analysis. For example, the classification of the remote sensing images could have benefited from additional image processing techniques. Absolute, or hard, classifiers such as the maximum likelihood technique used in this research are necessary when the need to classify every pixel is required. However, classifications using hard classifiers of satellite images representing urban areas are known to have lower accuracy levels than those classifications of the physical environment using the same date types (Mesev, 2003). Therefore, it is possible that by modifying the maximum likelihood technique by considering contextual, textural and spatial properties, or using other statistical operations would have produced more accurate results (Mesev, 2003). The adoption of other change detection analysis methods may have also yielded better results.

Future research will involve addressing the weaknesses explained in the remote sensing approach above, adding other socio-economic, environmental, and policy variables to the statistical analysis, and also distributing and investigating the

results of the land-use changes by county boundaries instead of municipal boundaries, and by watershed boundaries instead of municipal boundaries.

Analysis at the county level would permit the use of other economic indicators reported at the county level as variables in the statistical analysis, such as county-wide economic development initiatives like Keystone Development Zones, county industrial park locations and utilization statistics, and other indicators such as public assistance and employment statistics. Aggregating the land-use change information at the county level instead of the local municipality would provide similar and relevant information for county and regional decision-makers.

The addition of more environmental indicators and policies when examining the results at the watershed unit is anticipated as being the most interesting future research. By statistically analyzing the land-use change information distributed at the watershed unit with temporal water quality data collected by the Pennsylvania Department of Environmental Protection, results should indicate where specific land-use changes that occurred may have direct relationships with changes in water quality over the same time period.

The major contribution gained from this empirical study is the conceptual understanding of how regulatory action results in development reaction. More abstractly, these results reveal how the urbanization process produces contradicting forces of public and private interests. Public forces are created to regulate land development for the 'public interest' and private forces develop land for the expansion of economic interests.

In the Pittsburgh metropolitan area, scale is critical element in the regulation and exploitation of land resources. Pittsburgh's extensive political fragmentation has led to extensive land-use policy fragmentation which has further led to extensive land-use fragmentation. The adoption of local municipal policy for local municipal land-use planning creates a regional land-use patchwork that represents the disconnect between regional land-use planning knowledge and regional land-use planning practice. Overall, this research provides empirical results regarding the interplay between land-use policy and land-use change. The significant results were informative and greater than expected. These results are not absolute or definitive, but they do provide a foundation for further analysis of the effect and consequence of land-use policy in relationship to land-use change.

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Education

8/99 - present   Ph.D. in Geography *(Regional Development and Planning)*,
West Virginia University (WVU). .

8/97 - 6/99   M.A. in Geography *(Geographic Information Systems & Remote Sensing)*,
WVU.

8/91 - 12/92   B.A. in History *(Environmental & Industrial)*,
University of Pittsburgh.

8/88 - 5/91   Penn State University.

Research Specialties

- *Land-use Planning Theory and Practice*
- *Regional Development*
- *Geographic Information Systems and Remote Sensing*
- *Watershed Management*
- *Urban & Economic Development*

Professional Employment

3/05 – present   Geospatial Manager, Canaan Valley Institute.

7/04 – 3/05   Geospatial Coordinator, Canaan Valley Institute.

12/03 – 6/04   Strategic Planner / GIS Analyst, Schwan's Food Company.

5/00 – 8/03   Land-use Planner / GIS Specialist, Skelly & Loy, Engineers and Consultants

8/00 – 12/01   Instructor, Department of Geology and Geography, WVU.

8/98 - 4/00   Graduate Teaching Assistant, Department of Geology and Geography, WVU.

Teaching Experience

8/01 – 12/01   <u>Instructor,</u> *Climate and Environment.*

1/01 – 4/01   <u>Instructor,</u> *Urban Geography.*

8/00 - 12/00   <u>Instructor,</u> *World Regional Geography.*

1/00 - 5/00   <u>Teaching Assistant</u> for two courses: *Introduction to Human Geography*, and *Rural and Regional Development.*

8/99 - 12/99   <u>Lab Instructor</u> for *Remote Sensing of the Environment.*

8/98 - 8/99   <u>Teaching Assistant</u> for five courses: *Urban and Regional Planning, Economic Geography, Geography of Europe*, *Introduction to Remote Sensing*, and *Climate and Environment*.

Awards

Endowed Doctoral Teaching Fellowship. Eberly College of Arts and Sciences, 2001.

Endowed Doctoral Teaching Fellowship. Eberly College of Arts and Sciences, 2000.

Outstanding Graduate Teaching Assistant. Department of Geography, Eberly College of Arts and Sciences, 2000.

Outstanding Graduate Teaching Assistant. Department of Geography, Eberly College of Arts and Sciences, 1999.

External Funding Awards

Commonwealth of Pennsylvania Growing Greener Program Grants:

2002   4 projects, total grant awards: $150,000
2001   2 projects, total grant awards: $87,000
2000   2 projects, total grant awards: $86,000

Conference Presentations

Hoch, R. J. 2005. Panelist in session entitled: *Making Your Own Way: Grant Proposal Writing for Graduate School and Beyond* (sponsored by the Jobs in Geography Committee). Annual meeting of the Association of American Geographers, Denver, Colorado.

Hoch, R. J. 2004. *Assessing the Relationship Between Local Land-use Policy and Land-use Change in Metropolitan Pittsburgh.* Annual meeting of the Association of American Geographers, Philadelphia, PA.

Hoch, R. J. 2000. *Uneven Development of Nature: An Historical Geography of Ohiopyle State Park.* Annual meeting of the Association of American Geographers, Pittsburgh, PA.

Hoch, R. J. 2000. Panelist in session entitled: *Developing Geographies, Graduate Research on Regional Development and Planning* (sponsored by Regional Development and Planning Specialty Group). Annual meeting of the Association of American Geographers, Pittsburgh, PA.

Hoch, R. J. 1999. *Producing a Nature Landscape: A Case Study of Ohiopyle State Park.* Annual meeting of the Middle States Division of the American Association of Geographers, West Chester, PA.

Invited Presentations

2nd Annual Appalachian Remote Sensing Conference, 2005. Coordinated presentation entitled, *LiDAR Operations, Processing and Applications.*

West Virginia Department of Environmental Protection, 2003. Presentation entitled, *Stormwater Management and Asset Assessment Utilizing Geographic Information Systems: Preparing for the EPA MS4, Phase II Requirement.* Invited to speak at stormwater program's statewide forum for municipal officials to introduce the merits of adopting a GIS for day-to-day management.

Connellsville Area High School, 2003. *New Methods in Teaching Ecology in the Classroom: A GIS Approach.* Invited speaker for faculty in-service day.

Service

Board of Directors (Secretary), Mountain Watershed Association.
Contact: Beverly Braverman (2002 – 2003).

Volunteer, *The Institute for the History of Technology & Industrial Archaeology.* Serve on an as-needed volunteer basis for GIS and RS project needs. Worked on GIS projects for the National Road (US Route 40) and the Northbend Rail-trail through central West Virginia. Contact: Daniel Bonenberger.

Volunteer, Ohiopyle State Park. Contact: Barbara Drbal Wallace.

Graduate Representative, Geography Graduate Program Committee, WVU, (8/98 – 5/02).

Graduate Representative, Graduate Student Council, WVU, (8/98 – 5/00).

Graduate Representative, Search Committee for Geography Program GIS and Natural Resources faculty position, (Spring, 2002).

Co-Organizer of field trip (w/ Lizabeth Pyle) for national meeting of American Association of Geographers, Pittsburgh, April 5, 2000. Field trip title: *Recreational Retreats and Rural Landscapes in the Laurel Highlands;* involved with all aspects of organizing event. Field trip's focus was to compare different interpretations of nature - from private (Fallingwater) to public (Ohiopyle State Park) to communal (New Meadow Run Bruderhof) to elite (Nemacolin Woodlands Resort).

Natural Stream Channel Design / Applied Fluvial Geomorphology (Rosgen I), April 2005. Wildland Hydrology Consultants.

REALM Survey Suite and ALTM Digital Aerial Camera, Data Processing Training Program
March 2005. Optech Incorporated.

Presenting Data and Information, September, 2004. Edward Tufte.

International Watershed Remote Sensing Workshop, sponsored by the European Union and the US Department of Education, May 2001. Involved the use of satellite imagery to monitor land-use practices within watersheds; held in Xanthi, Greece.

Technical Documents

Raccoon Creek Watershed Abandoned Mine Drainage (AMD) Survey and Preliminary Restoration Plan, EPA Section 104(b)(3) Document. <u>Primary Investigator</u>. Prepared for Raccoon Creek Watershed Association, Washington, PA, 2000.

Indian Creek Watershed River Conservation Plan (RCP). <u>Primary Investigator</u>. In compliance with the Pennsylvania DCNR Watershed Management Registry. Prepared for the Mountain Watershed Assoc., Melcroft, PA. Successfully listed on the Pennsylvania Rivers' Registry. Entire plan prepared integrating GIS.

Upper Chartiers Creek River Conservation Plan (RCP). <u>Primary Investigator</u>. In compliance with the Pennsylvania DCNR Watershed Management Registry. Prepared for Chartiers Creek Nature Conservancy, Washington, PA. Entire plan prepared integrating GIS.

Cross Creek Watershed Assessment, Protection and Restoration Plan. <u>Project Manager and Primary Investigator</u>. Prepared for the Cross Creek Watershed Association, Avella, PA. Entire plan prepared integrating GIS.

Garrett County, MD Landfill. <u>Project Manager and Primary Investigator</u>. Contracted to produce mapping of landfill project area.

Indian Creek Watershed Acid Mine Drainage and Abandoned Mine Land Mapping. <u>Project Manager and Primary Investigator</u>. Acquired agency and field data to produce high quality, accurate and precise map of AMD and AML sites throughout the watershed atop a USGS 1:24,000 topographic base map.

Fuel Survey (Confidential). <u>Primary Investigator.</u> Produced maps and spreadsheets depicting all coal refuse from abandoned mine lands that had potential as a fuel resource for proposed power plant. Determined traveling distance from refuse pile to proposed site.

Mill Run Creek, PA Fluvial Geomorphology Survey and Assessment. Created GIS application for production of high-quality field maps for survey crew by fusing data from DOQQ's, DRG's and stream data from the Southwestern Pennsylvania Commission (SPC).

Upper Indian Creek Fluvial Geomorphology Assessment. Performed fieldwork to survey stream health using Rosgen protocol and USDA Visual Assessment guidelines. Delineated stream reaches and types and displayed results on 1:24,000 Digital Raster Graphs.

MTBE (*methyl tertiary-butyl ether) Study of Northern West Virginia.* Created maps to indicate shortest traveling distance between water intake sampling sites. This use of GIS in the budgetary stage of proposal writing enabled firm to estimate with a much higher degree of accuracy, the costs associated with traveling.

Hinton, WV Area Fluvial Geomorphology Study for Highway Upgrades. Determined areas of special concern by applying project scope criteria. Provided maps and analysis for project by determining minimum distance buffers of stream channels from road surfaces. Performed by applying buffers to streams and roadways over a digital elevation model. Prepared for WV DOH.

Environmental Assessment, United States Department of Energy, Pittsburgh PA and Morgantown WV. Primary Investigator. Prepared Environmental Assessment (EA) for both facilities, utilizing federal guidelines necessary when preparing NEPA documentation. Prepared for US DOE / NETL.

Donohoe Creek Watershed Assessment, Hempfield Twp., Westmoreland County. Prepared a set of maps using local, state, county and field-collected data to present the physical and cultural characteristics of the watershed. Also analyzed impervious surface areas to determine areas of concern to high-flow runoff. Prepared for Westmoreland County Conservation District. This watershed is to be used as a model for the WCCS to educate citizens on the benefits gained through conservation efforts.

Computer Skills

Hardware: PC (Windows) and Macintosh platforms, Trimble Geo-Explorer III GPS, ALTM 3100.

GIS Software: ArcGIS 9, Arc View 3.x, ArcView extensions *Network Analyst, Spatial Analyst, 3-D Analyst,* ArcIMS, MapInfo Professional 7.0.

Remote Sensing / Image Processing Software: ERDAS Imagine 8.x, IDRISI Kilimanjaro, Adobe Photo Shop, REALM Survey Suite, TerraScan/TerraModeler, POSPac, QT Modeler

Other Software: Microsoft Office Suite, Corel Word Perfect, Minitab, SAS, Bentley Microstation.

Professional Organizations

- Association of American Geographers
- American Planning Association
- Pennsylvania Planning Association
- Pennsylvania Geographical Society
- Pennsylvania Mapping and Geographic Information Consortium (PaMagic)