Managing Growth or Outgrowing Management? A Nature-Society Perspective in Urban Planning and Land Use Change

Rose Keller

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GENERAL ABSTRACT

"A focus on specific places helps to ameliorate the disciplinary fragmentation of knowledge. A place perspective can help address the capacity limits of top-down, expert-driven knowledge systems by recognizing and capitalizing on the accumulated wisdom of emplaced practitioners acquiring and sharing case-specific knowledge" (Williams 2013: 33)[1].

A focus on place-specific attributes situates this thesis within a paradigm of nature-society research in examining the material forces and the legitimating discourses of land use change. The extent to which place based attributes present an obstacle or opportunity for building sustainable human societies is the primary motivation for my research. Locating interactions between nature and society is important because individuals do not just respond to social facts[2], but to a number of contextual factors. Place is context, and although many disciplines thoroughly explore the social, economic, cultural, psychological context of individuals and societies, these are themselves spatially bounded by landscape that is both physical and social. The discipline of human geography brings these process and place strands together, to examine the co-creation of landscape and society. This thesis concentrates specifically on processes of land use change, either directly by conversion of land, or indirectly by increased household car use and zoning policy in three separate studies. First is a macro-level study of household automobile dependency contingent upon a suite of physical landscape and social context factors. Second is a macro-level study of urban growth in Germany from 2000-2006 explained by a number of landscape, topographical, and social factors. Lastly, a third study is a micro-level examination of urbanization and nature-society linkages in a case study of West Hayden Island in Portland, USA. Land use change is one of the most important global processes of our era because it is the largest factor in driving global environmental change (see for review: Lambin and Geist 2006). A nature-society perspective in research moves empirical work away from a 'domination' perspective, incapable of adapting with dramatic alterations of landscape to a 'co-habitation' perspective, allowing a flexible approach to understanding the complex and shifting metabolism of nature and society.

[1] Williams 2013, 33.

[2] Durkheim School: Social facts (processes) are explained only by other social facts

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GENERAL INTRODUCTION

Analyzing the nexus of production and consumption seems to be the indispensable starting point for understanding the basic causes global environmental change: the material causes, legitimating beliefs, and the formation of fundamental environmental problems. A vast body of work in geography is dedicated to the production of "socio-natures" and consumption of natural resources situated within cultural landscapes (see for example: Swyngedouw 1997, 2000; Bakker and Bridge 2006; Henderson et al. 2005 ; Cresswell 2003; Walker 2005; Rudzitis 1996; Cadieux 2009; Robbins 2001, Howitt 2007; among others). This thesis approaches the active alteration of land and construction of landscapes as an indispensible starting point of how to adapt *with* environmental change, because the focus is rather on the nexus of nature and society. Nature-society research examines the material forces, and the legitimating discourses of land use, land cover change in the formation of fundamental solutions. The need to ascertain the extent to which land use change, management and exploitation of resources present opportunity or obstacle for building sustainable human societies is the primary motivation for my research.

Tackling the subject of 'nature-society' is daunting, because it implicates both human and physical geography. Nature-society research has been stunted due to this divide between human and physical geography, and to a larger degree, natural and social science, despite continual calls for integration and a breaking down of epistemological barriers (Nightingale 2014). The divide confines the ability to think laterally about and shape nature-society questions. Two over-arching theoretical threads in nature-society research also stand at odds with one another and break down the process of integrating knowledge: realism and relativism. The realist tradition assumes a straightforward understanding of the boundaries of society and natural environment. The two domains are separate albeit with a variety of feedback links (Bakker and Bridge 2006). The primary purpose in this tradition is to map society's impacts on nature from society, or conversely, the impacts of natural disasters or loss of ecosystems upon society. The relativist tradition by contrast, begins by examining the socially constructed "imaginings of place" (Robbins 2004), and how these constructions came to be imagined as separate from nature in the first place. Scholars in this vein argue that knowledge is dependent upon how it is generated and thus focus on the framing of environmental issues (Nightingale 2014).

A recent third strand sits between the two traditions, where researchers retain a partial commitment to the categories of society and natural environment but interrogate both the reality, and consequences, of this divide (Nightingale 2014). My thesis takes this third position, because I claim there is a co-production of nature and society, although I maintain a realistic approach to bounding what is 'nature' and 'society.' This somewhat dialectical understanding of the nature and society should not be taken as situating my research framework in a purist position. Rather, dialectical concepts are useful when analyzing particular cases, be it households' local environment in Germany, or a development plan on an island in Portland, USA.

My research is motivated by the desire to understand the extent to which human society is influenced by natural systems and the feedback from society to alter the patterns and, more importantly, the sustainability of natural systems. To achieve this requires a break from the discourse of *management* (or, to use a critical geography/ecology term: *domination*) to one of *cohabitation* that allows for mechanisms of change/influence beyond human determination, direct manipulation or control. While geographies of nature-society encompass work based in realist epistemologies and overlap with conservation science, this thesis also incorporates a social perspective that allows an understanding of how nature and society cohabitate to produce land use change. Society exists in *landscape* the motivating concept of this thesis. Also fundamental to the thesis is *landscape pattern:* an operational, quantifiable conceptualization of landscape. I approach landscape pattern in three ways: 1) a direct examination of surrounding landscape pattern on household decisions regarding private transportation, 2) a direct examination of landscape pattern in urban land use change and, 3) an indirect examination of the importance of landscape pattern in political (social institutions) decisions of land use. Follows is a discussion of the key theoretical concepts that form the base of my nature-society research and that serve to link my three studies.

Literature Review: Key Theoretical Concepts

C1: Landscape:

A cardinal term of human geography, landscape has served as central object of investigation, organizing principle and interpretive lens for generations of researchers. Landscape's constancy lies in its function as a locus for geographical research into nature-society and subject-object (natural resources, land use) relations. Olwig (1996) notes *Landschaft* is common, in various spellings, to all Germanic languages of Northern Europe. "When approached in historical and geographical context, it becomes clear that *Landschaft* was much more than 'a restricted piece of land.' It contained meanings of great importance to the construction of personal, political and place identity at the time" (1996: 32). Thus landscape was conceived as a cultural entity, the distinctive product of interactions between people and topography, an entity that oriented several decades of cultural geography. The rise of regional and spatial science paradigms following the Second World War saw a decline of landscape's purchase as an organizing term in geography, because of the critiques of landscape incorporating both objective and subjective elements (the land and land-as-perceived). A concentration on landscape *pattern* was introduced in this period (see C2). A cultural turn in the 1990s reinvigorated landscape in terms of action and movement, both discursive and material. For example, Mitchell (2003) focused a Marxist understanding of landscape in terms of production and the cultural consumption of landscape as cultural images or social capital. In this vein, the production of material landscapes is a matter of continuing struggle between different political and economic groups. Although various discursive, iconographic, and interpretive approaches have defined geographies of landscape since the 1980s, they have been lately challenged by the "dwelling" perspective, where landscape is defined as a material and perceptual engagement of individuals and the surroundings they dwell within (Wylie 2005). Performative studies of landscape emerged strongly in recent years in human geography, such as in issues regarding mobility and migration (Cresswell 2003), and embodied perception (Wylie 2005). Rose (2002) has cogently identified the epistemological difficulty of presenting landscapes as already structured ideologically, while allowing inhabiting subjects to interpret and change landscapes. The development of actor-network theory and hybrid geographies (such as political ecology) have provided in recent years more stable conceptual platforms where nature-society issues can be understood, thus re-establishing landscape in human geography as constructed in the social sphere, but distinctly topographical.

C2: Landscape Pattern: spatially defined, bounded

Landscape pattern is distinct from the general concept of landscape in its embodiment of *biophysical* and *built infrastructure* on the Earth's surface and immediate sub-surface. Landscape pattern describes the *composition* of land cover types (e.g. forest, wetland) and land use types (e.g. road and rail structures) that comprise a landscape (DeFries, Anser and Houghton 2004). The term was first used in geography in the 1960s as a break by geographers from the ideological, discursive applications of landscape primarily used by cultural geographers (Wylie 2005). Geographic research in this vein needed a term to describe a landscape's topographical and geographical aspects to apprehend issues such as settlement patterns and livelihood change (Paasi 2004) and the dynamism of changing social relations in response to landscape alterations, i.e. via fire regimes (Henderson et al. 2005). Nowadays, landscape pattern incorporates not only the cover types in defining composition, but also the degree to which these types are fragmented, mixed, overlap or are separated from one another (see for example study 1, and Jaeger et al. 2009). Landscape pattern remains distinct from a cultural interpretation of landscape as a 'way of seeing' (Rose 1993) but in contemporary applications also includes somewhat discursive elements in examinations of competing legacies of land use. Competing, because land use decisions and implementation of land conversion are socially and politically situated.

I use landscape pattern to describe physical compositions of land cover types in a *bounded* spatial unit in studies 1 and 2, because I am particularly interested in locating the intersection of pre-existing land cover/natural resources and human response to this composition. The human response, the discursive element, is bound in demographic and economic variables. Whereas a micro examination of landscape would approach its transcription by human experience and interpretation, thereby indirectly affecting response. Study 3 approaches the discursive side of landscape, deploying both the general concept of landscape, and the physical concept of landscape pattern, to assess how the physical composition has bearing on the constructed urban landscape in the land use planning process.

C3: Scale: Spatial vs. Political

Scale has no single definition, and in recent years has been the object of much theorizing (Howitt 2002). The traditional definition refers to map resolution: all maps represent the world by reducing the size and diversity of its component spaces for visual display. How reduced, accurate, or inclusive of spaces a map is, depends on its scale resolution. Cartographic scale expresses the mathematical relationship between the map and the Earth, is denoted as a fraction of the map to the Earth (e.g. 1:500,000, 1 map unit = 500,000 units of Earth space). Thus small-scale (small fraction) maps show more space, but less detail, and large-scale maps show less space and greater detail of information within those spaces. Studies 1 and 2 in this thesis use the concept of scale as capturing more or less detail in *space (spatial) units*.

Spatial Scale

Scale in this sense is the resolution of fixed space (data) within which social processes interact and change across spatial scales. This is distinguished from scale as socially constructed, which I detail later. Landscape pattern is captured by spatial scales. In studies 1 and 2, I use differing spatial scales, and the degree of landscape pattern they capture, to inform the observed social processes enacted within their respective defined space: that is, household car use decisions (study 1), and institutional decisions of urban land use change (study 2). Different social outcomes observed in studies at different spatial scales highlight the Modifiable Areal Unit Problem (MAUP)- a particular kind of ecological fallacy associated with the analysis of spatial datasets, in particular those in which data on individual observation units (households for example) are aggregated into pre-determined areal units, such as counties (Wadell 2002). The MAUP is important in many areas of spatial studies using regression techniques (such as the first two studies of this thesis) because it indicates the need for caution when inferring a relationship between two variables based on a single aggregation at a particular scale. This is why both studies 1 and 2 use different spatial data sources, so that my spatial units are not aggregated at a single scale (refer to study 2 notes for detailed account of the MAUP and my steps to avoid ecological fallacy). The MAUP is important because it means a result identified in one analysis at one spatial scale may not be replicated in another scale. Moreover, it provides a motivation to examine different outcomes according to scales that are not spatially bound: that is, political scale.

Political Scale

A second aspect of scale is its social construction- a scale most often used in discursive landscape research. In this view, spatial scales do not, as implied above, rest as fixed platforms for social activity that connects up or down in a spatial hierarchy, but are instead outcomes of those activities, to which they in turn contribute through a spatially uneven and temporally-dependent dynamic (Swyngedouw 2000). This recursive relationship between socially constructed scales and scales affecting the operation of social processes is one aspect of the socio-spatial dialectic: the idea that social processes and space-and hence scales-mutually intersect, constitute and feedback on one another in an inseparable chain of determinations (Howitt 2007). Key advances in this literature include an acknowledgement of the inherently political nature of the construction of scale (Bulkeley 2009; McMaster and Sheppard 2004), and the need to re-theorize in more complex ways the relationship between social processes and spatial outcomes as power (e.g. decision-making) comes to be understood as dispersed rather than centered among actors. This last point has inspired theorists in the last few years to turn away from "stacked scales" to incorporate more horizontal elements of political scale, allowing a re-emergence of political scale as partially defined by its *space* of operation, rather than a pure vertical construction of scale hierarchy, which is founded on a traditional visioning of state power. Study 3 uses this spatially-oriented construction of political scales in the examination of how distinctions among political scales in planning determine actors' conceptualization of landscape, the evaluation of landscape pattern, and the leverage in which to influence land use change.

Lately, scale has been criticized by geographers for the substantial confusion surrounding the meaning of scale as *size*- scope- and scale as *level*- vertically nested orientation of space (Marston, Jones and Woodward 2005). Marston, Jones and Woodward note the difficulty of disentangling scalar hierarchies from the local-global (in a sense the spatial version of micro-macro) binary. They argue that introducing networks provides some horizontal flexibility to our understanding of scales, but it is not enough to disentangle scales from the binaries of local-global/agency-structure, where both highlight individual action is held opposed to and to be integrated with broadly operating social forces (2005: 273). The authors rather propose a flat ontology that "…problematizes the world in which all contemporaneous processes are linked through the unfolding of intermeshed sites, where humans and objects interact across a multiplicity of social sites" (2005: 282). A flat ontology would secure the "opennesss of the political" allowing multiple entry points and non-linearity which would offer the possibility of enhanced connections, in contrast to vertical scaling, which pre-structures connections in a top-down orientation (2005: 284). This approach, however, has not been without criticism (see Bulkeley 2009; Reed and Bruyneel 2010; Weaver and Bagchi-Sen 2014), and likewise I propose that using a flat ontology blankets social processes, especially in land-use decision making, that *are* structurally limited by spatial and political scale, and moreover, that social processes in many land-use contexts are *spatially* bound and thereby, pre-structured in their "intermeshing" with other social sites. My thesis distinguishes between spatial and political scales, and locates the delineations among the spatial and political that contribute directly to household behavioral and land use change, with the acknowledgement that scale presupposes inherent structure among observations.

C4: Natural Amenities (also called: Natural Resource, Environmental Amenities): what makes a certain landscape pattern desirable

Conventionally, this term refers to biophysical materials that satisfy human wants and provide direct inputs to human well-being. The term may be defined more broadly to include any component of the non-human world that performs a socially valuable function. Natural amenities came into conceptual fruition in geography by the mid-1900s to capture the social functions of natural resources (Hudson 2005, Rudzitis 1996). However, using the term 'amenities' rather than 'resources' does not situate natural resource research outside the social sphere. Natural resources have social origins; that is, the practices of exploration, experimentation and measurement by which these resources came to be known highlights the political and economic forces that influenced their scientific discovery and record. Natural resources are not waiting to be found, rather they are actively *sought* (like the term amenities implies). Recent work in biological sciences have also thrown into question many assumptions that underlie natural resource models, and draw attention to the non-linear behavior of many ecological systems and their capacity to dramatically shift in 'surprising' ways, depending on the social context (Theobald 2001). This leads to another social aspect of natural resources: they are dynamic. Different parts of the non-human world slip into and out of natural "resource" and "hazard" categories across time and place (Hudson 2005). For example, natural gas can be considered a hazardous substance (non-resource) or an amenity (source of energy) depending on the time (the atomic half-life of the gas) and environmental/social context (economic value allotted to gas). This thesis contributes to the vast work in geography in the practical management of natural resources, with the acknowledgement that natural resources are not *naturally* amenities.

C5: Fragmentation/Sprawl: bisected or multi-segmented habitats, low density, fringe land

Fragmentation is less a theoretical concept than a widely used measure of landscape change. Fragmented land is land that was once contiguous undisturbed land that is now broken-up into less-functional patches. McGarigal and McComb (1995) give the most widely used definition of fragmentation: a process in which contiguous habitats are progressively sub-divided into smaller and more isolated habitat fragments. This process is most evident in urbanized or otherwise intensively used regions, where fragmentation is the product of the linkage of built-up areas via linear infrastructure, such as roads and railroads (EEA 2011). Despite legislation throughout EU states to better protect biodiversity and reduce pollution, the construction of new transport infrastructure is increasingly. As a consequence, fragmentation of landscapes is rising and the remaining ecological networks are threatened.

Fragmentation is especially relevant to urban land use change, because it contributes to the destruction of established ecological connections between adjoining areas of the landscape and affects entire communities and ecosystems (Jaeger et al. 2009). Landscape fragmentation is of particular importance to Europe because it affects food production, species survival, healthy urban centers, and tourism, as landscapes are in high danger of being more and more fragmented and of losing much of their remaining natural aesthetics. Landscape fragmentation is also a threat to landscape quality and the sustainability of human use. Most importantly for this thesis, fragmentation changes the *visual perception* of landscapes, and consequently the landscape is not perceived as a single entity any more; a reason for the widely observed association with rapid urban growth in fragmented areas. Fragmented landscapes do not hold the same "preservation value" as they would have as contiguous parcels of natural land.

In Germany, a fragmentation measure is applied as one of 24 core indicators for environmental monitoring to curtail landscape fragmentation in Germany (EEA 2011). In light of the concentrated policy efforts to stem fragmentation, the use of a fragmentation metric in my suite of landscape pattern variables made sense. Typical measures that quantify the area of land cover patches per spatial unit of analysis are indices of fragmentation. Configuration of landscape is important in research regarding land use change, since the fragmentation of habitats is a primary factor leading to worldwide species decline and subsequent resource loss (Rudel et al. 2009).

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Political Ecology: a brief introduction

My thesis is situated in the discipline of geography (generally human geography), and specifically in the field of political ecology. Political ecology is an approach to the complex metabolism of nature and society (see Blaikie and Brookfield 1987 for the foundational work). In other words, political ecology seeks to understand how the physical and perceived natural environment influences the social processes of power, accumulation, sustainable or destructive institutional/individual behavior and land use change. Political ecology has the advantage of seeing land management, institutional and household decision-making in terms of how political economy shapes the forms of access and control of material resources and knowledge. One person's interpretation of landscape value and the choices reflecting it, is different than another's interpretation. Or, to take a Marxist-framing: one person's accumulation (of land) is another's degradation. Studies 1 and 2 highlighted some aspects of the metabolism between nature and society by examining the outcomes of this interface (increased household car use or urban land conversion) linking spatial data to social data. Studies one and two highlight the spatial dynamism of household behavior and urban growth, underlining the material side of political ecology. Underlining the political side, Study three examined how the process of this interface unfolded in a specific spatial context, allowing a better examination of the inter-weavings of social dynamics.

From a material standpoint in political ecology, the forms and patterns of urban land development have garnered attention for nearly a century (see for review: Schneider and Woodcock 2008). Evidence to support the range of theories is rare, however, due to past difficulties of collecting land use data. Recently, satellite data has begun to play a substantive role in investigating alterations of the landscape, and in monitoring these changes (Vance and Geoghegan 2002; Wu and Plantinga 2003; Schneider and Woodcock 2008; Geoghegan 2002). Satellite remote sensing offers a tremendous advantage over historical maps or aerial photos because it provides recurrent and consistent observations over a large area to reveals explicit patterns of land use. More importantly, a proliferation of new methods and publically available data sources, have made monitoring urban changes easier and more rapid than in the past (Anselin 2003; Anselin and Arribas-Bel 2011).

Despite these advances, investigations are consistently completed with little or no comparison performed among studies (Schneider and Woodcock 2008). Urban/land use change research tends to be situated in separate schools of thought with little cross-disciplinary discussion. The interplay of processes at multiple spatial resolutions showcases the hierarchical and evolutionary nature of cities. Such complexities can only be breeched by talking across disciplines and methods of analysis. Through a mixed methods approach, my thesis contributes to an increasing body of empirical research that analyzes the processes of landscape and urban/household change at multiple geographic scales using multiple theoretical concepts. Follows is an introduction to the mixed methods approach, and why employing mixed methods is particularly important in addressing interdisciplinary questions that are inherent to nature-society research.

Thesis Approach: A Mixed Methods Sequential Study Framework

I use mixed methods approach to build upon the growing body of work of urbanization processes with sequential studies of remotely-sensed, material-focused macro studies, and a micro, political process-focused case study. Direct comparison of these studies is not possible, due to scale difference, but the observations of urban development trends and processes are comparable, as called for by Schneider and Woodcock (2008). Mixed methods is the best approach to address research that deals in both spatial and political scales because it employs a combination of quantitative and qualitative methods to inform multi-scalar research questions. This is not without some drawbacks. MM complicates the procedures of research, lengthens the process, and requires the researcher to understand the forms of both quantitative and qualitative data (Creswell and Clark 2007). However, the value gained by linking studies and cross-comparative results outweighs the difficulties, attested by the above authors and myself. I employ mixed methods because, in simple terms, it combines the strengths of the quantitative-spatial, and the qualitative-political research into one thesis. The basic premise of the definition proposed by Creswell and Clark (2007) is that the combination of quantitative and qualitative approaches provides a better understanding of research problems that either approach alone (2007:7). The authors provide six main points that highlight the value of using a mixed methods approach of which four are particularly relevant to this thesis:

1) provides strengths that offset the weakness of both quantitative and qualitative research- quantitative is weak in context, qualitative in generalizability;

2) provides more comprehensive evidence for informing a research question by allowing multiple data sources and mixing of data types;

3) uses multiple paradigms and world views, rather than sticking to dominant theories in one discipline vs. another, and;

4) enables the researcher to use all methods possible to address a research problem (2007: 10).

The multiple paradigms characteristic of mixed methods is evidenced by my use of multiple theoretical concepts stemming from different disciplines to inform my research question. The last point is especially true in my thesis because it is interdisciplinary. I employ both ecology and social science theory and methods of analysis to approach the complex metabolism of land use change and social response. In other words, I had to employ methods from physical geography, spatial econometrics, human geography, political and landscape ecology in order to build working frameworks in my three studies. Moreover, I had to be able to move between ecological and social sciences to know what data to look for and how to define, conceptualize and use it to bring the nature-society nexus to light in my research of urban change.

Employing diverse frameworks through a mixed methods approach lends both an over-arching and context-specific look into inter-and intra-urban change. I specifically employ a sequential study approach to examine the first the general effects of landscape pattern and social processes, identifying key themes, and second, apply these themes to a micro, context specific study. General themes never align completely to specific contexts, thus, my qualitative study uncovered new themes that can be compared with general trends, illuminating overlap with some quantitative findings. Sequential study designs allow macro and micro themes to be compared directly. Therefore, I start with general macro studies to identify and test certain theoretical assumptions before examining these assumptions in a local context. How concepts apply in each scale is important to progressing and enriching theoretical work.

Following a sequential study mixed methods design, I conducted my fieldwork after the quantitative macro studies because direct engagement with a local context requires sufficient background knowledge of the larger observed trends in my previous studies. Solid theoretical background allows reflectivity of my own position and biases in the field, so that a certain *flaneur* is avoided. Reflectivity in fieldwork in turn, allows a concrete theoretical approach to the produced situated knowledge of a case.

Fieldwork has a long history in human geography, because it allows the means to examine the relationships between people and their environment, the material and social productions of landscape, and the sedimentation of power relations and other social relationships situated within a local context (or space-time). Evolving from a natural history tradition, fieldwork focuses on landscapes as evidence of differentiated, sequential and uneven human occupancy; seeking relationships and patterns in their production and persistence. Historically, fieldwork was based purely on observation. More recent feminist geography critiques of the traditional approach to field research as detached observation, point to unstated hierarchies in distancing oneself from subjects. Distancing is assumed to reveal hidden dimensions of the case through objectivity; a false assumption (Sundberg 2003). Regardless if detached or participatory, fieldwork is valuable in any geographical research because it pits the observational against theoretical knowledge. It augments traditional ways of knowing and develops (or revitalizes) theory.

Thesis Structure

This thesis descends from a macro level look at landscape pattern- how, when, if, it is associated with human caused land use change (directly in zoning, or indirectly by increase of car use), to a micro level examination of how landscape pattern both alters and is altered by social institutions in a local context. The macro level subsumes the political scale, missing the distinctions in the social sphere because I generalized the 'social' to a few primary demographic and economic variables. The micro level is situated already within one spatial scale, thereby allowing the intricacies of the social, political, economic to appear.

First, I examine the influence of *landscape pattern* on household car use in Germany, attaching specific spatial profiles to households using remotely sensed environmental data and zip code/county identifiers. This is achieved by linking satellite imagery from the Corine Land Cover database with household data from the German Mobility Panel database to locate the landscape characteristics surrounding a household's geographic location. This study was primarily conducted to assess the salience of landscape pattern in the social process of transport choice.

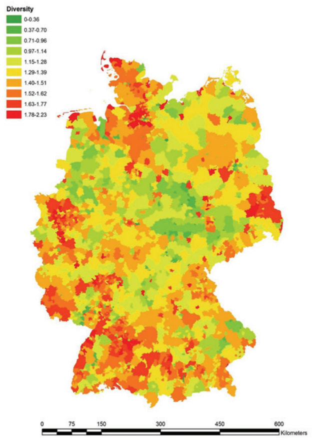
Second, I examine the influence of landscape pattern on urban land use change in Germany from 2000-2006. Again I use zip code spatial units and Corine Land Cover data together with several other environmental data sources to assess the influence of landscape pattern measured in 2000 on urban land use change measured in 2006.

Finally, I examine the nexus of nature-society in the context of urban planning in a micro-urbanization case of West Hayden Island, Oregon (WHI). Urban planning is the policy that creates zoned urban areas to be more or less dense, linking back to the reliance of households on private car use, public transit or other modes of mobility. Urban planning also determines where urban growth will occur, and as such, reflects pre-existing landscape patterns surrounding urban cores, as well as to social, political and economic factors. To better understand how urban planning operates in light of these numerous elements, I conducted interviews and examined supporting documents concerning the specific planning of West Hayden Island. An overview of the main research question and hypotheses, data sources, primary findings and conclusions follows (Table 1).

Table 1. Thesis Structure and Overview of Findings

	Study 1	Study 2	Study 3
Title	**Landscape pattern and car use: Linking household data and satellite imagery**	**Urban growth in the fragmented landscape: estimating the relationship between landscape pattern and urban land use change in Germany, 2000-2006**	**Political geographies of scale, natural amenities, and urbanization: The case of West Hayden Island**
Overview	Econometric analysis of the relationship between various landscape pattern elements and household automobile dependency through two spatial scale identifiers: kreis (county) and 3-digit zip code. Two aspects of dependency are considered: choice to own a car, and contingent upon ownership, how far to drive (km/week).	Natural amenities are relevant to this study because they encompass a broad range of socioeconomic and biophysical factors. This variety allows different data types (e.g., imagery, geospatial and social) that better reflect the context in which the observed urban land use change occurs.	Highlights the largest challenge planners face in cities across the globe: how to plan contested land. WHI is particularly contested because it lies within a land-locked city bursting at the seams. WHI is both a designated Regionally Significant Industrial Area and Significant Habitat; it has good reasons to be developed or left undeveloped. WHI was situated within larger regional and state discourses, from which three main themes can be observed: the role of WHI's natural amenities, the Portland political context, and the tension between the Statewide Planning Goals 5 and 9. The disjunction between goals 5 and 9 causes land use decisions to be highly politicized and wrapped up in themes of sustainability and social equity in the urban landscape. Additionally, how assumptions regarding sprawl shape perceptions of WHI's future and the nature-society dichotomy in sustainable development.
Research Question	What is the relative influence of landscape pattern in an household's area on automobile dependency? How does landscape compare to social and infrastructural correlates of car use?	In what ways are natural amenities and fragmented landscapes associated with observed urban growth in German counties from 2000 to 2006?	How do experts describe the planning process in a proposed sustainable development WHI Plan? Where are the tensions in the process, and are these the same points that ultimately divide perceptions regarding good vs. bad land use planning?
Hypotheses/Motivating Questions	1) Higher shares of fragmented and polluted land surrounding a	1) Landscape pattern, when measured using different spatial data sources gives a	1) Planning is hierarchically structured, which establishes tensions among competing interests

	household, higher levels of open space, geographic location in eastern Germany, higher household income and members increase both forms of dependency. 2) Higher shares of bio-diverse land, business density, rail density, and non-workers in households and higher fuel price decrease dependency.	better understanding of the context in which urban growth occurs. 2) Higher shares of fragmented land per county in 2000 will be associated with higher shares of new urban land in 2006. 3) Higher shares of natural amenities per county in 2000 will be associated with higher urban growth in 2006. 4) Higher shares of GDP per capita per county will be associated with higher urban growth in 2006 relative to lower GDP/capita counties.	for land use. 2) Economic interests often dominate environmental interests. 3) Natural amenities attract development and conservation interests alike, but the measurement and evaluation of natural amenities differs among key stakeholders.
Methods/Models	Two-part model (2PM) that orders observations into two domains defined by whether household owns a car (the selector equation). Conditional on ownership, the second stage (outcome equation) estimates an OLS regression of distance travelled. S* represents a latent variable for the utility gained from car ownership. **(1)** $S^* = \tau' X + \varepsilon$ $\mathrm{S} = 1 \text{ if } \mathrm{S}^* > 0 \; and \; S = 0 \; if \; \mathrm{S}^* \leq 0$ **(2)** $E(Y \mid S = 1, X) = \beta' X + E[\varepsilon \mid Y > 0, X] = \beta' X$	Lagged dependent variable OLS regression & Spatial Regressive model (incorporating spatial interaction effects, demonstrated by a high Moran's I score). **(Global) OLS:** $\Delta Urban_{2000-2006} = \beta_0 + \beta_1 NatLand_{2000} + \beta_2 AgLand_{2000} + \beta_3 Soil_{2004} + \beta_4 RoadRail_{2004} + \beta_5 Frag_{2000} + \beta_6 ProtectedArea_{2004} + \beta_7 Pollution_{2004} + \beta_8 Solar_{1980-2010} + \beta_9 Nondevelopable_{2004} + \beta_{10} StateTax_{2000} + \beta_{11} PopDensity_{2000} + \beta_{12} PerCapGDP_{2000} + \beta_{13} West_{(0,1)} + \varepsilon$ **(Local) Spatial regressive model:** $\Delta Urban_{2000-2006} = \rho W_y + \beta_1 W(NaturalLand_{2000}) + \beta_2 W(AgLand_{2000}) + \cdots \beta_n W(X_n)$	Semi-structured expert interviews with key planners that represent either environmental or business interests, or both. Policy document analysis regarding the case of WHI. Field photography, site visitations and monitoring. Manually transcribed and coded material using a coding framework wrought through Qualitative Content Analysis. Codes recorded in Excel, simple frequencies and coefficients of agreement calculated. Codes, co-occurrences and frequencies compared to uncover patterns within data.

Data 	Corine Land Cover Data (satellite imagery) 2000-2006 & German Mobility Panel (MOP) 1996-2009	Corine Land Cover Data (CLC) (satellite imagery) 2000-2006 & European Soil Data Centre (ESDAC) (GIS soil data) 2004 & Deutsche Wetter Dienst (DWD) (climatic data) 2004 & European Pollutant Emission Register (EPER) (GIS pollution data) 2004 & esri Europe Data (GIS road and rail data) 2004 & German Socioeconomic Panel (G-SOEP) 2000 & 2006	Expert Interviews from the Bureau of Planning and Sustainability, Audubon Society Portland, Urban Greenspaces Institute/Portland State University, Portland Parks and Recreation, Portland Metro, and Port of Portland Authority. & Document analysis & Field photography 
Primary Findings	1) Three of four landscape pattern (land cover) variables are significantly associated with driving behavior: open space, and pollution increase car use, diversity has the opposite effect in the outcome equation. 2) Land use variables: rail density, business density reduce likelihood of car ownership, but not necessarily mileage. 3) Fuel price lowers dependency in outcome equation, household income increases car ownership and use.	1) There are two key landscape factors that are positively associated with urban growth: (1) the level of fragmentation, and (2) the share of designated protected areas. 2) Prime soil, is negatively associated with urban growth. 3) The greater the density of habitat patches, (effective mesh density) in 2000, the greater the change in urban land by 2006.	Three main themes of tension in planning: 1) Natural amenities of WHI make the island highly valuable urban property, deployed as reasons both for and against development; 2) The asymmetry in state goals 5 and 9 underscores the way individuals relate 'best practice' for WHI within and among scales, and; 3) The political context was a key force throughout the WHI process, and served to heighten tensions between environment and development advocates.
Conclusions	Households in less dense and polluted landscapes drive more, whereas households in bio-diverse, dense and with lower income (more responsive to fuel price in car use decisions) drive less. Satellite imagery introduces a new spatial scale in automobile dependency studies that allows better	Results indicate fragmented land is preferable due to fewer development restrictions, and pre-existing infrastructure to lower start up development costs. Designated protected areas- containing high natural amenities- were associated with higher share of urban land use change than other, non-amenity areas. Greater shares of prime soil	This study has highlighted the relations among scales determines the communication of key assumptions for 'best practice' of land, evaluation and planning. Often these assumptions are not effectively transmitted across scales because individuals' tools and methods (e.g. the Planning Goals inventories) are bound by local, regional and state delineations, which in turn restrict nature and economy discourse along scalar lines.

	understanding of mechanisms of increasing household car use in Germany and throughout Europe.	experienced less urban development over the six-year period, but this was a stronger effect in eastern Germany, where the agricultural sector remains large.	
General Implications	Results suggest urban planning decisions to be made with attention to high density development and maintaining bio-diversity in urban centers. The share of households in urban centers will increase on average 1.1% per year, demands for roads and fringe sub-divisions will increase, unless measures taken to manage landscape pattern in ways to reduce household automobile dependency.	There are four compelling implications regarding earlier landscape pattern influence on future urban growth: (1) Fragmented areas that contain a large amount of protected and natural resource rich land are attractive to developers and increase urban growth potential; (2) Increased transit lines in a region increase access to natural amenity areas and allow leap-frog development patterns; (3) Polluted areas and kreis with high state tax display a negative influence on urban growth because they are cost intensive for developers, and; (4) Areas with a large extent of prime soil may limit urban growth within patches, but due to the effect difference between the east and west, this trend should not be overstated.	The sprawl discourse was a theme that was continually referenced throughout the interviews because (avoiding) sprawl is fundamental to the entire planning process. With so much legislation globally aimed at controlling sprawl, a shared assumption of what that exactly is, is important to build effective bridges from discourse to policy. In the political context of pro-property rights, less government and strong individualism that is increasingly visible in Oregon as elsewhere, there is a tension between the individualistic values of private ownership (the parcelization of natural land) and regionally functional sustainable land use. Typical planning frameworks favor job growth/economy because sustainability requires commitments on the part of developers that are non-economic. A stagnant economy is more immediately apparent than a declining ecological system. Sustainability means re-evaluating a necessary and laudable, but non-resilient planning system.

Study One: Landscape pattern and car use: Linking household data with satellite imagery[3]

Abstract:

Landscape pattern has long been hypothesized to influence automobile dependency. Because choices about land development tend to have long-lasting impacts that span over decades, understanding the magnitude of this influence is critical to the design of policies to reduce emissions and other negative externalities associated with car use. Combining household survey data from Germany with satellite imagery and other geo-referenced data sources, we undertake an econometric analysis of the relation between landscape pattern and automobile dependency. Specifically, we employ a two-part model to investigate two dimensions of car use, the discrete decision to own a car and, conditional upon ownership, the continuous decision of how far to drive. Results indicate that landscape pattern, as captured by measures of both land cover (e.g. the extent of open space and landscape diversity) and land use (e.g. the density of regional businesses) are important predictors of car ownership and use. Other policy-relevant variables, such as fuel prices and public transit infrastructure, are also identified as correlates. Based on the magnitude of our estimates, we conclude that carefully considered land development and zoning measures – ones that encourage dense development, diverse land cover and mixed land use – can have beneficial impacts in reducing car dependency that extend far into the future.

Key terms: Landscape pattern, Satellite imagery, Germany, Two-part model

[3] This study is currently published: Keller, R., and Vance, C. (2013). Landscape pattern and car use: Linking household data with satellite 4 imagery. *Journal of Transport Geography* (33), pp. 250-267.

1. INTRODUCTION

The reduction of CO_2 from transportation, which currently comprises nearly a quarter of total CO_2 emissions in the European Union (EU), poses a vexing challenge in formulating policies to protect the climate. While CO_2 emissions in the agricultural-, industrial- and energy sectors all fell in the EU between 1990 and 2009, those from transport increased substantially, rising by 27% over the same period (EEA 2011a). With 12% of total CO_2 emissions in the EU attributed to cars alone, which are already subject to high fuel taxes and legal limits on the CO_2 discharge of newly registered automobiles (Frondel et al. 2011), the question arises as to what additional measures can be availed to buck the trend of steadily increasing emissions.

Urban design, and specifically the implementation of policies that combine compact development with the provision of public transit, is often cited as a promising instrument for reducing automobile dependency. Built-up land currently covers more than a quarter of Europe's territory, leading to calls for denser development predicated on mixed land use (CEC 1990). The European Commission has long designated sprawl as a priority concern, and policy bodies in Europe have repeatedly advocated strong urban policy to steer growth around the periphery of cities and ensure denser development (CEC 1999; EEA 2006a). Nevertheless, while several studies from North America point to a mitigating influence of urban design on car ownership and use (e.g. Bento et al. 2005; Potoglou and Kanaroglou 2008; Van Acker and Witlox 2010), there have been relatively fewer studies that have investigated this linkage in the European context (some exceptions include Vance and Hedel 2008 and Buehler 2011). Given that choices about land development tend to have long-lasting impacts that span over decades, quantification of the influence of landscape pattern on car use is highly significant to the formulation of contemporary planning strategies.

Drawing on a panel of household travel data from Germany, the present paper contributes to this line of inquiry with an econometric analysis of the relationship between various dimensions of landscape pattern and automobile dependency. Germany provides an interesting case study of this topic for several reasons. First, despite having one of the highest car ownership rates in Europe, Germany has – unlike its neighbors – decreased greenhouse gas emissions from transport, which dropped by 6% between 1990 and 2009 (EEA 2011a). Second, the country has a highly heterogeneous landscape; while relatively dense urban agglomerations span across much of the west, large swaths in the east are characterized by extensive diffuse urban sprawl accompanied by population decline and economic stagnation (Schmidt 2011). Finally, the German government has long been committed to reversing trends in landscape fragmentation and sprawl (Bundesminister des Innern 1985), with several

German cities adopting planning guidelines that promote the spatial integration of residential, recreational and commercial land uses to reduce automobile dependency (e.g. Stadtplanungsamt 2002). Germany poses an interesting case to examine, then, if car ownership is high but car *use* varies with divergent landscape patterns across the country.

Two dimensions of dependency are considered in the present paper, the discrete choice to own a car and, conditional on ownership, the continuous choice of how far to drive. The application of a two-part model, which couples a probit and an OLS estimator, allows for an integrated treatment of these choices. A distinguishing feature of the analysis is the linkage of the survey data with satellite imagery, which affords the opportunity to construct land cover pattern metrics whose variation are hypothesized to cue varying degrees of household-level car use. Following the work of Cervero and Kockelman (1997), we are particularly interested in exploring the influence of the "3 Ds," density, diversity, and design, and to this end construct explanatory variables measuring the extent of open space, landscape diversity, and landscape fragmentation in the area of the household's location. Beyond this, our analysis includes several other correlates of car use that control for important aspects of urban design and socioeconomic context, including the density of local businesses, public transit provision, and locally prevailing fuel prices.

The remainder of the paper begins with a description of the data assembly and hypothesized effects of the explanatory variables. Section 3 discusses the modeling framework while Section 4 presents and interprets the econometric estimates. The closing section summarizes and concludes with a discussion of the benefits of expanded spatial coverage and incorporation of diverse geographic information to transportation models.

2. DATA ASSEMBLY AND HYPOTHESIZED EFFECTS

The main data source used in this research is drawn from the German Mobility Panel (MOP), an ongoing travel survey financed by the German Federal Ministry of Transport, Building and Housing. Participating households are surveyed for a period of one week over three consecutive years. Each year, a share of households exits the panel and is replaced by a new cohort who is in turn surveyed for three years, with the cycle continually repeating itself in overlapping waves. The information collected in the MOP includes both individual attributes such as age, gender, employment status, and mode-specific travel as well as household attributes such as income, car ownership, fuel prices, proximity to the nearest transit stop, and other neighborhood features. The dependent variable is derived from the survey data and is comprised of two parts, a binary indicator of whether the household owns at least one car, and a continuous variable measuring the distance driven by the household conditional on car ownership.

The data spans 14 years, from 1996 to 2009, and is limited to the car travel undertaken by households over the 5-day work week. Of these, 2,612 participated in all three years of the survey, 1,471 participated in two years, and 1,890 participated in one year, yielding a total of 12,668 observations on which the model is estimated. To correct for the non-independence of repeat observations over multiple time points in the data, the regression disturbance terms are clustered at the level of the household, and the presented measures of statistical significance are robust to this survey design feature (Deaton 1997).

The MOP has two variables that can be used to approximate the household's location, a 3-digit zip code and a county identifier, referred to in German as a Kreis. The average size of a 3-digit zip code, of which there are 671 units, is 532 square kilometers. There are 439 Kreise having an average size of 814 square kilometers. Although either of these variables could be used individually to locate the household, we found that greater spatial accuracy could be achieved by combining them. Specifically, we employed a Geographic Information System (GIS) to overlay two maps of the zip code and Kreis boundaries on top on one another, and used the polygons created by this overlay to identify the household's location. This process created a layer having a total of 1413 polygons across Germany with an average size of 253 square kilometers.

We used this map to merge in several other data sources with the MOP, two of which are available for download from the web site of the European Environmental Agency (EEA 2012a, EEA 2012b). The first of these is a European-wide coverage of satellite imagery that distinguishes 26 land cover classes and is available for the years 2000 and 2006.[4] The Corine Land Cover imagery data (COordinate INformation on the Environment) is Landsat MSS raster data collected at a resolution of 100 x 100 meter pixel size. ArcGIS was used to calculate four variables from the imagery, each measured at the level of the polygon in which the household is situated: the share of open space, the share of area covered by mines, dumps and construction sites, the degree of landscape fragmentation, and the degree of landscape diversity.

The share of open space, whose spatial distribution is shown in the left panel of Figure 1, is calculated by adding up the areas classified in the imagery as forest, natural vegetation, and agricultural land cover and dividing this by the area of the polygon.

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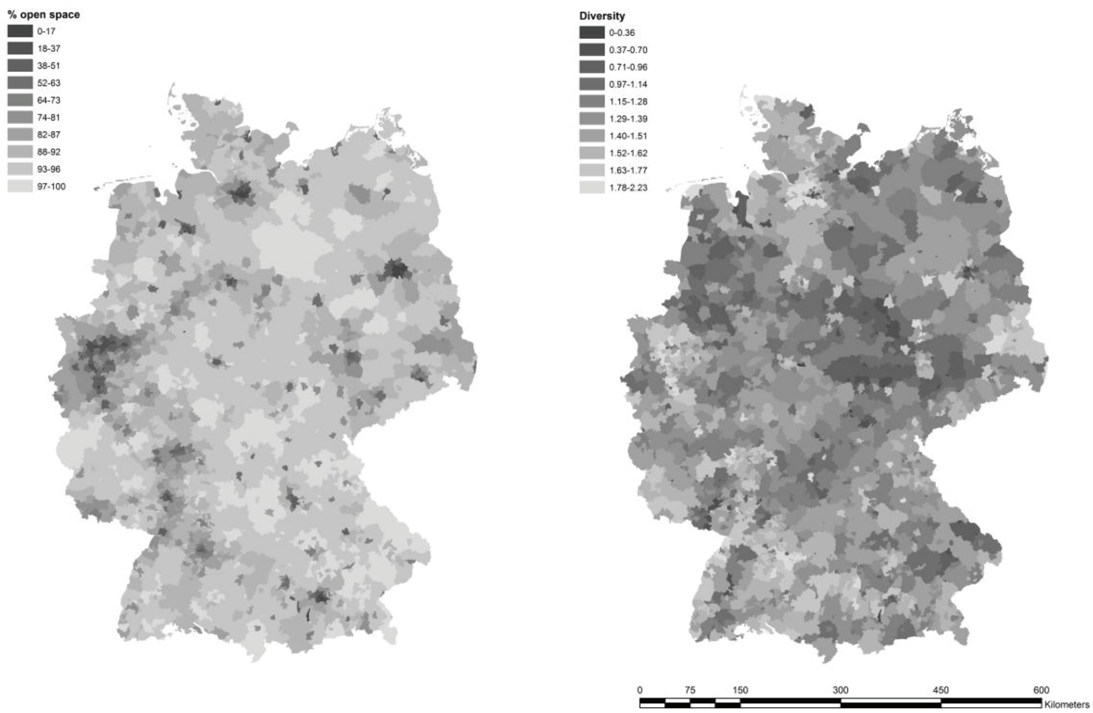
[4] An assessment undertaken by the European Environmental Agency (EEA 2006b) of the 2000 imagery found its thematic accuracy to be 87%, thereby exceeding the target threshold of 85%.

Contrasting with other commonly used measures of density employed in the literature, such as population per square kilometer and measures of accessibility to jobs and shops, this measure directly captures the physical configuration of land cover, a feature over which policy-makers are likely to have more direct leverage through, for example, zoning regulations. We hypothesize that households located in areas characterized by a larger share of open space are more dependent on the automobile because of the longer travel distances separating origin from destination for standard activities like shopping, recreation and work (Ewing et al 2011).

FIGURE 1: Landscape pattern in Germany



Another form of landscape configuration that is repeatedly implicated as a determinant of car use is sprawl. Travisi and colleagues (2010) investigate the relationship between sprawl, simply defined as urban fringe, and commuting using data from Italy, but otherwise little evidence on this issue exists from the European context. Recognizing that the meaning of sprawl is notoriously difficult to define, much less formally quantify, we instead employ a measure of landscape fragmentation used in ecology that can serve as a proxy for sprawl (Turner 1996). Specifically, fragmentation is measured as the inverse of the effective mesh size, a metric based on the probability that two points chosen randomly in a region are connected (EEA 2011b): $\textit{effective mesh size} = \frac{1}{A_{total}} \sum_{i=1}^{n} A_i^2$. The subscript i indexes each contiguous patch of land having a particular land cover classification and A_i measures the area of the patch. A_{total} gives the area of the polygon in which the household is situated. As described further in Jaeger (2000, 2002), the effective mesh size provides a quantitative expression of landscape connectivity, one that has been widely implemented by various European countries as an indicator for environmental monitoring (EEA 2011b). We hypothesize that this variable is positively associated with car travel, given that highly fragmented landscapes typically necessitate longer travel distances over circuitous routes.

In developing the measure of diversity, whose distribution is presented in the right panel of Figure 1, the aim was to simultaneously account for both the variety and prevalence of different land covers in the region that could influence mobility. Following the work of Cervero (1989) and others (e.g. Waddell 2002; Stead and Marshall 2001; Ewing et al 2001, 2011), we draw on an entropy-metric commonly employed in the biological sciences, referred to as Shannon's diversity index, which is based on information theory (Shannon and Weaver 1949). The index is defined as:

$diversity = -\sum_{j}^{Q} p_j \ln p_j$, where Q is the total number of land covers in the polygon and p_j is the share belonging to the j^{th} land cover class. To the extent that a diverse landscape is one characterized by mixed uses that reduce the need for car travel through an increased array of services and amenities, we hypothesize a negative effect of this variable.

The fourth measure obtained from the satellite imagery, the share of area covered by mines, dumps and construction sites, is calculated by summing the area under these three covers and dividing by the area of the polygon. As such sites fragment the land and are a disamenity that would discourage non-motorized travel, we expect their prevalence to increase car use.

The influence of commercial activity is captured by a measure of business incidence obtained from the data provider infas GEOdaten for the year 2001. This data set includes a count of the total number of businesses in a zip code across sectors, including retail, entertainment, and service establishments. We expect this variable to be associated with lower car use as close proximity to businesses would limit the need to travel long distances.

The costs of fuel, as well as the availability of alternative travel modes, are other potentially important determinants of car dependency that may be correlated with land use and whose omission from the model could consequently bias the results. It is plausible, for example, that fuel costs vary systematically between densely settled and rural areas. Three variables obtained directly from the MOP survey are included to capture these influences: the walking minutes from the home to the nearest transit stop, which is self-reported, a dummy variable indicating whether this stop is serviced by rail transit, and the real price paid for petrol. This latter variable, which is deflated using a consumer price index for the year 2000, is surveyed for every household and for each year of the data, so that it varies over both time and space (see Frondel and Vance 2011). Increased walking distance to the transit stop is expected to increase car use while rail service is expected to decrease it owing to the greater speed and comfort associated with this mode. Higher fuel prices, to the extent they increase operation costs, are expected to reduce car use.

A final measure of geographical influence is defined by a dummy variable that equals one if the household is located in the east on the territory of the former German Democratic Republic. We ascribe no a priori expectation to this variable, but use it to explore the variation in car use owing to differences in development patterns between the West and the East.

Socioeconomic influences are captured by a suite of variables that measure household demographic composition and wealth. Household size is measured using four size dummies that distinguish between two, three, four, and five or more person households, with single-person households set as the base case. Employment status and the presence of children are measured by two dummies: one indicating homes with no working members and the other homes in which children under 10 years of age are present. The model also includes the household's monthly net income, as well as two dummies indicating households with two cars and with three or more cars. With the exception of the dummy for non-working households, the socioeconomic variables can be seen as demand shifters that increase car use. The specification is completed with the inclusion of year dummies to capture macro-level influences that affect the sample as a whole.

Table 1 presents the descriptive statistics of the dependent- and explanatory variables included in the model, including the units of measurement and the years over which the variable is observed. The descriptive statistics are presented in two columns to distinguish households sampled from the West and East of the country, which serves to illustrate the rather pronounced differences in landscape and socio-demographic features prevailing on both sides of this former political boundary. The final column presents a t-test of a difference in the means. These differences are seen to be statistically significant for all of the variables. Perhaps most striking in this regard is that, notwithstanding a slightly lower incidence of car ownership, the mileage of households in the East is, at 270 kilometers per week, 8% higher than the mileage in the West. This may partly owe to the East's lower density of development, as evidenced by the higher share of open space and the substantially lower degree of business density. The relatively depressed state of the economy in the East is also evident from the figures. Household income is some 13% lower and the share of households with no working members is 42%, compared with 36% in the West.

Table 1: Descriptive statistics

Variable	Units	Years observed	West	East	T-test, difference in the means
Dependent variables					
Car ownership	Binary	1996-2009	0.841	0.802	4.49
Mileage*	Kilometers	1996-2009	250.935	270.641	-2.81
Explanatory variables					
Openspace	Percent	2000, 2006	71.892	81.869	-18.20
Fragmentation	Dimensionless	2000, 2006	0.120	0.045	29.96
Diversity	Dimensionless	2000, 2006	1.429	1.361	10.01
Dumps, mines, construction sites	Percent	2000, 2006	0.447	0.708	-10.38
Business density	Businesses/km^2	2001	118.092	48.582	14.30
Minutes to transit	Minutes	1996-2009	5.595	6.106	-4.60
Rail service	Binary	1996-2009	0.128	0.090	4.99
Fuel price	€ /liter	1996-2009	1.019	1.050	-11.37
2-person house	Binary	1996-2009	0.362	0.410	-4.27
3-person house	Binary	1996-2009	0.141	0.175	-4.01
4-person house	Binary	1996-2009	0.151	0.106	5.61
5-person house	Binary	1996-2009	0.048	0.024	4.91
Children under 10	Binary	1996-2009	0.169	0.103	7.77
Non-working household	Binary	1996-2009	0.360	0.421	-5.38
Income	1000s €	1996-2009	2.246	1.983	13.46
2 Car*	Binary	1996-2009	0.267	0.243	2.31
3+ Car*	Binary	1996-2009	0.041	0.055	-2.97
Number of observations			10441	2227	

* The presented means for these variables are based on the subsample of car-owning households.

3. MODELING APPROACH

As seen in Table 2, roughly 16% of the households in the West and 20% in the East do not own a car and for whom the observation on distance driven is consequently recorded as zero. This feature of the data suggests conceptualizing car use as a two-stage decision process comprising whether to own a car and, conditional on ownership, how far to drive. To model this process, we employ a procedure called the *two-part model* (2PM) that orders observations into two regimes defined by whether the household owns a car. The first stage, referred to as the selector equation, defines a dichotomous variable indicating the regime into which the observation falls:

$$S^* = \tau' X + \varepsilon_1 \qquad (1)$$

$$S = 1 \text{ if } S^* > 0 \text{ and } S = 0 \text{ if } S^* \leq 0 \qquad (2)$$

where S^* is a latent variable indicating the utility from car ownership, S is an indicator for car ownership status, the X denote the determinants of this status, τ' is a vector of associated parameter estimates, and ε_1 is an error term having a standard normal distribution. After estimating τ using the probit maximum likelihood method, the second stage, referred to as the outcome equation, involves estimating an OLS regression of distance traveled conditional on S = 1:

$$E(Y \mid S = 1, X) = \beta' X + E[\varepsilon_2 \mid Y > 0, X] = \beta' X \qquad (3)$$

where Y is the dependent variable, measured here as the total kilometers driven by the household for all trip purposes over a 5-day week, and ε_2 is the error term, again assumed to be normally distributed.

Because the distribution of Y has a long tail resembling that of the log-normal, we follow other authors (e.g. Axisa, Scott, and Newbold, 2012) in transforming it as a natural log. The prediction of this dependent variable then consists of two parts. The first part results from the probit model, $P(Y > 0) = \Phi(\tau' X)$, where Φ denotes the cumulative density function. The second part is the unconditional expectation, $E[Y]$, which, when Y is logged, is given by:

$$E[Y] = \Phi(\tau' X) \cdot \exp(\beta' X + .5\sigma^2) \tag{4}$$

where σ^2 is the mean squared error of the second stage OLS regression.

The 2PM is one of several limited dependent variable models that have been availed in the literature on mobility decisions, others of which include the Tobit model (Golob and Van Wissen 1989; Johansson-Stenman 2002; Schwanen and Mokhtarian 2005) and Heckman's sample selection model (Kayser 2000; Vance and Iovanna 2007). Our selection of the 2PM was guided by three considerations. First, as noted by Maddala (1992: 341), the Tobit model is applicable only in cases where the underlying dependent variable can, in principle, take on negative values that are unobserved owing to censoring. This case clearly does not apply in the present example as the distance driven cannot be negative. Second, like the Heckman but unlike the Tobit, the 2PM allows different variables to affect both the discrete and continuous decisions pertaining to car ownership and use, and additionally allows the sign on variables included in both stages to differ. Finally, compared with Heckman model, the 2PM has less onerous identification requirements. Specifically, the 2PM does not require the specification of so-called exclusion restrictions, explanatory variables that are theoretically supported to determine the first-stage probit model of car use but not the second-stage OLS model of distance traveled.

With respect to the interpretation of the estimates from the 2PM, which will be presented here as elasticities, some clarifications are warranted. First, unlike in linear models, the elasticities cannot be directly derived from the coefficients themselves but rather must be calculated by differentiating equation (4), yielding a unique elasticity for every observation in the data. For cases when the dependent variable is logged and the continuous variables are measured in levels, this differentiation is given by (Dow and Norton 2003):

$$\frac{\partial E[Y]}{\partial X_k} \times \frac{X_k}{E[Y]} = \left[\beta_k + \tau_k \frac{\phi(\tau' X)}{\Phi(\tau' X)} \right] X_k \tag{5}$$

where ϕ denotes the density function from the standard normal distribution. If the variable is a dummy, D_k , it instead makes sense to take the difference in the expected value function when the dummy is set to 1 and 0, thereby capturing the discrete change in Y. Referring to equation (4), this yields:

$$(E[Y \mid D_k = 1] - E[Y \mid D_k = 0]) / E[Y] \tag{6}$$

The statistical significance of the elasticities is calculated using the Delta method, which yields an estimate of the standard error corresponding to the elasticity of each observation in the data.

4. RESULTS AND INTERPRETATION

Table 2 presents the results from the selector and outcome equations of the two-part model of car use. Columns 1 and 3 contain the coefficient estimates, whereas columns 2 and 4 contain the associated elasticities as calculated from Equations 5 and 6, averaged across all the observations used in the model of distance driven.[5] In discussing the results, the focus is on the latter effects because they are more readily interpreted.

Three of the four land cover variables derived from the imagery – open space, diversity, and mines – have statistically significant elasticities whose magnitude suggest economically relevant associations with driving behavior. Consistent with expectations, a one percent increase in open space is associated with a 0.20% higher probability of owning a car and a roughly 0.42% increase in the distance driven over a five-day week. The elasticity of diversity is negative but statistically significant only in the outcome equation. A one percent increase in diversity is associated with a 0.19% decrease in driving, suggesting that landscapes characterized by mixed coverage lower automobile dependency. As expected, the share of mines, dumps, and construction sites has a positive effect but is also only statistically significant in the outcome equation, with a relatively smaller elasticity of about 0.015%.

In appraising these results, it should be borne in mind that they represent mean effects that potentially mask substantial heterogeneity across the individual observations. An impression for the degree of this heterogeneity can be gleaned by plotting the magnitude of the individual elasticities, as is illustrated in the top three panels of Figure 2. These panels show the scatter of elasticities for the variables open space, landscape diversity, and mines over the horizontal axis and their associated Z-statistic on the vertical axis. The dotted horizontal lines indicate Z statistics of 1.96 and -1.96; points that fall beyond these bounds are statistically significant at the 5% level or higher. Below each plot, a histogram is additionally

[5] The code used for calculating the elasticities, written using the Stata software, is available from the authors upon request.

included to indicate the density distribution of the estimates. For all three variables, the range in statistically significant estimates is seen to vary considerably, spanning 0.1 to 1.87 for open space, –0.01 to –0.56 for diversity, and 0 to 0.42 for mines, dumps and construction sites. These patterns highlight how the estimated elasticities for each of the considered variables are fundamentally dependent on the values assumed by the other explanatory variables in the model, especially the overall landscape pattern of the household's polygon.

Turning to the land use variables, business density has the expected negative influence, decreasing both the likelihood of owing a car and the distance driven contingent on ownership. The two measures of public transit service, captured by the walking minutes from the household to the transit stop and the availability of rail service, also have the expected signs. Walking time has a statistically significant positive elasticity only in the ownership model, supporting the view that proximity to transit service be regarded as a fixed cost that only bears on the decision to own a car but not how far it is driven. The dummy indicating whether the nearest stop is serviced by rail is statistically significant only in the model of distance driven. As expected, the estimated effect is negative: households serviced by nearby rail drive 0.12% less than those with only bus service. Evaluated at the mean driving distance, this corresponds to a reduced distance of roughly 16 kilometers per week. As with the land cover variables, the lower panels of Figure 2 illustrate a high degree of heterogeneity in the individual estimates of the elasticities of the public transit variables. In the case of minutes to transit, for example, the elasticities vary nearly six-fold, from a minimum close to 0 to a maximum of just under 0.6%.

The dummy capturing residence in the East has opposite signs in the selection and outcome models, decreasing the probability of car ownership while increasing the distance traveled. Although in the latter case the mean elasticity is not statistically significant, the bottom right panel of Figure 2 reveals a sizeable share of observations, about 42%, whose Z-statistic crosses the threshold of 1.96. That these households drive roughly 0.05% more kilometers per week than those in the West may partially reflect the higher concentration of employment centers in the more sparsely populated East and correspondingly longer commutes, one of the legacies of centralized planning prior to reunification of the country. The lower likelihood of easterners to own a car is more difficult to explain, particularly given that the model controls for the effects of household income and landscape features. One possibility is that there are higher fixed costs of owning a car in the East because of a higher incidence of crime, including car theft, with correspondingly higher insurance premiums.

TABLE 2: Results from Two–Part Model

	Probit: Car ownership (1, 0)		OLS: Distance driven	
	Coefficient	Elasticity	Coefficient	Elasticity
Openspace	0.012**	0.204**	0.004**	0.420**
	(0.001)	(0.021)	(0.001)	(0.066)
Fragmentation	–0.039	–0.002	0.117	0.011
	(0.220)	(0.009)	(0.115)	(0.014)
Diversity	–0.113	–0.045	–0.111*	–0.189*
	(0.088)	(0.035)	(0.049)	(0.080)
Dumps, mines, construction sites	0.006	0.001	0.030**	0.015*
	(0.021)	(0.003)	(0.010)	(0.006)
Business density	–0.0003*	–0.020*	–0.0002*	–0.028*
	(0.0001)	(0.009)	(0.0001)	(0.011)
Former east	–0.158*	–0.048*	0.080*	0.049
	(0.066)	(0.021)	(0.034)	(0.041)
Minutes to transit	0.020**	0.029**	0.002	0.032*
	(0.006)	(0.008)	(0.002)	(0.016)
Rail service	–0.150*	–0.045*	–0.100**	–0.124**
	(0.067)	(0.021)	(0.036)	(0.038)
Fuel price	–0.794*	–0.237*	–0.390*	–0.558*
	(0.335)	(0.101)	(0.180)	(0.211)
2–person house	0.529**	0.142**	–0.060	0.044
	(0.058)	(0.015)	(0.036)	(0.043)
3–person house	0.678**	0.149**	–0.040	0.070
	(0.101)	(0.017)	(0.049)	(0.059)
4–person house	0.940**	0.180**	–0.062	0.075
	(0.168)	(0.020)	(0.052)	(0.067)
5–person house	1.037**	0.182**	–0.119	0.016
	(0.340)	(0.031)	(0.069)	(0.087)
Children under 10	–0.231*	–0.073	0.075*	0.027
	(0.115)	(0.040)	(0.036)	(0.050)
Non–working household	–0.288**	–0.082**	–0.427**	–0.470**
	(0.051)	(0.014)	(0.030)	(0.034)
Income	0.826**	0.334**	0.210**	0.755**
	(0.046)	(0.018)	(0.019)	(0.065)
2 Car			0.596**	0.699**
			(0.030)	(0.042)
3+ Car			0.851**	1.302**
			(0.054)	(0.122)
Constant	–0.665		4.762**	
	(0.393)		(0.208)	
Year dummies	55.76		22.41	
Log likelihood	–3,685			
R^2			0.24	
Number of observations	12,668		10,559	

Robust standard errors in parentheses; ** and * denotes significance at the 0.01 and 0.05 levels.

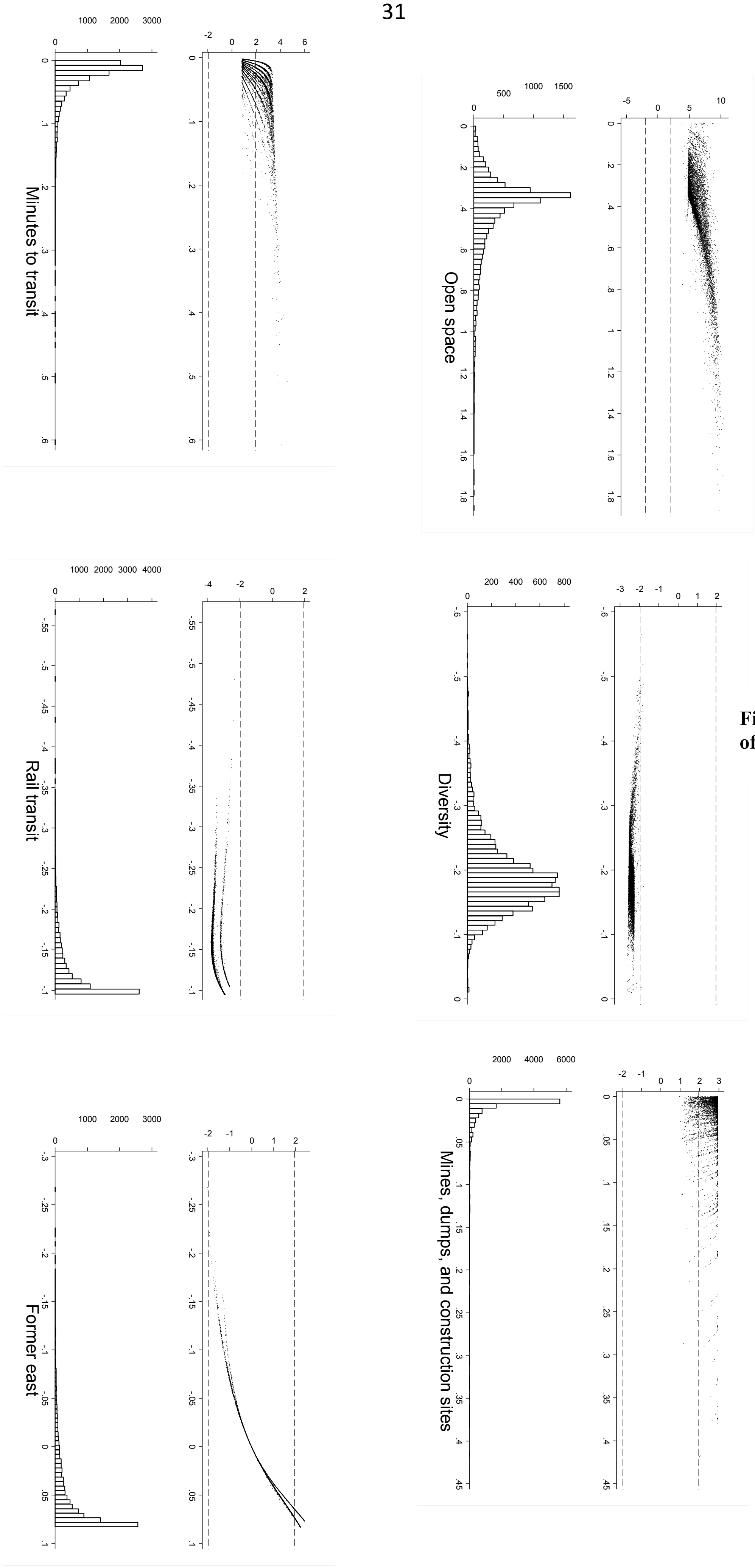


Figure 2: Distribution of elasticities

Household driving behavior is also clearly responsive to fuel prices, as evidenced by the magnitude and statistical significance of the fuel price variable. The price elasticity, at -0.56, is of roughly the same magnitude as that obtained by Frondel and colleagues (2008, 20012, 2013) in a series of studies from Germany using panel methods,[6] but considerably higher than the estimates drawn from U.S. based studies, which typically range between less than 0.1 and 0.3 (e.g. Small and Van Dender 2007; Hughes, Knittel and Sperling 2008). One explanation for this discrepancy may be the greater array of transport alternatives and shorter trip distances in Germany than in the US, which gives German motorists greater flexibility in coping with high fuel prices. We additionally estimated models that included interaction terms to allow for differential effects of the fuel price by landscape features and socioeconomic attributes. It is plausible, for example, that households living in dense areas or those serviced by rail transit would exhibit greater sensitivity to fuel prices than remote households. The coefficients on the various interactions tested, not presented here, were uniformly statistically insignificant. This contrasts with work by Wadud et al. (2010), who find using U.S. data that the magnitude of the fuel price elasticity varies by the household's location, income, and number of vehicles owned. The absence of such differential effects in the present study has relevance for fuel taxation policy, suggesting that the distributional effects of fuel price changes in Germany are likely to be relatively uniform across income levels and geography.

The dummies for household size have the expected positive influence but are statistically significant only in the probit model of car ownership, while the hypothesized negative effect of non-working households is confirmed for both parts of the model. Referencing the final column, nonworking households are seen to drive about 47% less per week than households with at least one working member.

As with the dummy for residence in the East, the coefficients on the dummy for the presence of children under 10 have opposite signs in the two stages of the model, decreasing the probability of car ownership while increasing distance driven. The former effect is unexpected, but could be indicative of a life-cycle pattern by which young families forgo ownership of a car. The corresponding elasticities on this variable are in any case relatively small and statistically insignificant in both stages of the model.

[6] The data here is drawn from a different sub-set of the MOP data that focuses specifically on car travel, which is recorded over a six week period during which time motorists record their mileage and the fuel price with every trip to the gas station.

Among the wealth indicators, income has the expected positive effect, with a 1% increase in income corresponding to a 0.76% increase in the distance over the week. Finally, the dummies for two- and three-car households have positive, statistically significant, and very large effects on car mileage. Relative to one-car households, the ownership of two cars results in a roughly 70% increase in distance traveled. For three-car households the elasticity nearly doubles to 130%.

5. CONCLUSION

Satellite imagery provides a rich source of information on landscape patterns and their evolution over time, but one that has been rarely exploited for investigating how such patterns affect transportation behavior. The use of satellite imagery in transportation research affords several advantages, among them being extensive spatial coverage at a fine grain of resolution as well as a high degree of flexibility with respect to the construction of spatial metrics and the scale of their measurement. As Ewing and colleagues (2001, 2011) note in their discussion of sampling and construct validity, landscape characteristics and boundaries are often defined by individual regions and countries that lack sufficient spatial coverage, and therefore may not precisely align in cross-regional analyses. One solution to these validity issues is improved spatial coverage by data from satellite imagery, where the land-cover classes are not already predefined per region. Additionally, researchers can combine the imagery with other GIS data sources in transportation models to move beyond the typical focus on uni-variate measures (such as distance to road or transit center) to also explore landscape pattern measures such as open space and fragmentation (Cervero 2003; Ewing and Cervero 2010).

This study has demonstrated some of these advantages by linking satellite imagery with household survey data from Germany to explore the relationship of landscape pattern with automobile ownership and use. Based on results from a two-part model, we find that both the extent of open space and the diversity of the landscape have strong and statistically significant associations with driving behavior. Households located in regions where density is low drive more; our results suggests that a one percent increase in the share of open space increases driving by an average of 0.42% over a 5-day week. For a household that drives 255 kilometers per week, roughly the average of the sample, this corresponds to an additional 55 kilometers over the course of a year. Conversely, households located in regions characterized by a highly diverse landscape pattern drive less. As measured by Shannon's diversity index, a one percent increase in this metric reduces driving by 0.19%, or roughly 25 kilometers over a year. Taken together, these results suggest that urban planning decisions be made with an eye toward encouraging high density development in urban and residential zones that combine a mixture of land uses and maintenance of diverse land cover. In this regard, planners can harness the momentum of ongoing urbanization of German society through, for example, policies offering preferential tax rates on property ownership in downtown areas. According to one recent estimate in a study commissioned by the government, the share of households living in urban areas will increase on average by 1.1% per year through to 2030 (IER, RWI, ZEW 2010), suggesting the existence of an autonomous demand for high density residential locations.

Looking ahead, there are several possible avenues to extend on the research reported here, one of which would be to explore the robustness of the results to the scale of measurement. This could be facilitated by creating buffers of different sizes surrounding the centroid of the polygon in which the household is situated, rather than constructing the spatial variables based on the polygon, itself, as was done in the current analysis. Beyond scale, there may also be pockets of heterogeneity in the effect of the landscape variables that were undetected owing to the constraints imposed by the functional form of the econometric model. It is conceivable, for example, that the impact of density is moderated by household demographic composition and residence in the East, a possibility that could be readily tested by additional exploration using interaction terms.

Study Two: Urban growth in the fragmented landscape: estimating the relationship between landscape pattern and urban land use change in Germany, 2000-2006[7]

Abstract: The expansion of urban land into natural landscapes has resulted in loss of ecosystem services throughout Europe. Understanding why the share of urban land has increased will be important for managing urban growth and maintaining ecosystem services. Building on earlier research, I develop a model of landscape change that integrates geospatial and socioeconomic data in a spatial autoregressive model to explain the variance in urban growth observed in Germany, 2000-2006. The results show that despite the vast spatial heterogeneity in land cover and land use in Germany, urban growth occurs when fragmented land and/or environmental amenities are prevalent. Three key landscape factors were found to correspond with urban land-use change: (1) the level of fragmentation; (2) the share of protected areas; and (3) transit density. Given that international comparative studies are vital for understanding urbanization, the methodology employed here is exportable to land use research in other areas.

Key Terms: *Urban land use change; environmental amenities; fragmentation; spatial regression models, satellite imagery, Germany*

[7] This study is currently under review

1. INTRODUCTION

Locating mechanisms of urban growth[8] has long been a focus of landscape research. Several studies point to specific drivers of land use change, such as land cover characteristics (An et al. 2011; Rudel et al. 2009; Lambin and Geist 2006), land use (Robinson et al. 2005; Geoghegan 2002), natural amenities (Graves 2012; Lake 2003, 2005; Wu et al. 2006), economy (Compas 2007), transportation structure (Hanson and Guiliano 2004; Cervero 2003) and population characteristics (Schmidt 2011; Irwin and Bockstael 2001). Generally, the focus of this urban land use change research is on one of two factors: policy or landscape pattern[9], in which the detrimental effects of urban growth are explored. Economic growth via new development is most often considered of primary importance to decision-makers regardless of ecological costs (Caid et al. 2002); therefore, studies that combine geophysical and socioeconomic data on regional and national scales that locate the forces of land use change detrimental to ecological and human health are needed (Turner, Lambin & Reenberg 2007; EEA 2011b). Scientists have increasingly taken up this call in recent years, notably, Rudel and colleagues (2009) who use variables drawn from national level landscape pattern and socioeconomic characteristics in international stochastic models to assess the effects of conversion of agricultural to urban land over time.

Land cover data advancements from remote sensing and geographically (spatial) weighted regression analyses have provided scientists an unparalleled opportunity to understand land-based dynamics (Theobald 2001). Satellite imagery and other remote sensing methods offer good alternatives to time-intensive field data collection in country level studies of land use change (Kit, Lüdeke & Reckien 2013). Additionally, by virtue of its uniformity over time, satellite imagery is a useful tool to address large scale, comparative studies of urban growth.

Aside from spatial effects, socio-economic dynamics also lead to territorial and landscape changes. In post-World War II Europe especially, social and cultural dynamics produced a rich vein of research in European urban geography concerning production and manipulation of landscapes (Salvati 2014). Because urban geography encompasses both biophysical and social factors of landscape change, it is especially suited to develop

[8] Urban growth is defined here as the land consumed for urban uses, (e.g. transit, housing, ports etc.,) rather than economic market or urban population growth.

[9] Landscape pattern indicates the manner in which biophysical attributes of the land are distributed and manipulated.

conceptual frameworks based on empirical and exploratory case studies necessary for sustainable land management policies (Salvati 2014). In this paper my aim is to uncover factors of urban growth across German *kreis* from 2000 to 2006 (the equivalent of counties in North America), building on the work of Salvati (2014), Rudel et al. (2009), Keller and Vance (2013), and Radeloff et al. (2009).

In studies of landscape change, it is important to define the overarching terms of land cover and land use. *Land cover* is the composition of different types of surface and immediate sub-surface biophysical attributes that compose an area. *Land use* is human manipulated land cover to create a landscape to satisfy societal needs (EEA 2011b). I combine land cover, land use, and socio-demographic variables in a spatially explicit regression model. Until recently, spatial stochastic models without sophisticated remote sensing data sets were not accurate enough to harness the explanatory power of their social counterpart (non-spatial) multivariate models (Elhorst 2010; Anselin and Arribas-Bel 2011). Primarily this was a consequence of using inappropriately defined spatial units which lead to generalized linear models' understating spatial effects because these 'spatial effects' were aggregated and generalized to match the scale of social variables, a problem noted by Park and colleagues (2009) in their study of rural sprawl in England. Following Rudel et al. (2009), I created a dependent variable of urban land use change from 2000 to 2006 regressed on a suite of spatially lagged landscape and socioeconomic variables. I employed both a non-spatial model and a geographically weighted regression model defined by a strict spatial weights matrix. Given the complex and largely collinear nature of spatial data, I advanced my models in a step-wise fashion, and tested for potential data shrinkage issues with a split-half cross validation check[i].

The following sections of this paper cover the literature of environmental amenities and landscape fragmentation that frame my analysis (section 2); data assembly, key measures and hypothesized effects (section 3); the modelling approach (section 4); results and interpretation (section 5); implications and issues for further research (section 6).

2. LITERATURE REVIEW

Urban land use change is a highly complex, context dependent process. I primarily rely upon the environmental amenities discourse of land use change because this discourse frames urbanization using a region's biophysical and social context. It is well known that a functional transformation is underway in North American and European landscapes (Salvati 2014; Weber et al. 2008; Mitchell 2004, 2013). Landscapes that were once devoted to providing the resources for large-scale production activities, such as farming and logging, are now hosting resorts, business parks, and housing subdivisions (Mitchell 2013). What is common to most contemporary urban development is that built-up areas are increasingly located in or near areas with a wealth of environmental amenities.

Environmental amenities are commonly characterized as a combination of ecosystem services, natural resources, and natural aesthetics that increase the value of a patch of land[10]. These resources serve to attract development demand to the region, and typically the more "protected" (or the more unique the natural area) the stronger the effect (Schmidt and Courant 2006; Castle, Wu and Weber 2011). The degree to which these resources attract development varies according to the physical compositions and social reality of the landscape in question.

A central tenet of contemporary geographic scholarship is that urban space is socially produced (Proudfoot and McCann 2008). Although the role of social norms in the manipulation of built environments has been well documented (see for example, Harvey, 1989; Logan and Molotch, 1987; Heynen and Robbins 2005) this same social tenet can be applied to amenities as well: what is considered a resource value and aesthetically pleasing is socially constructed. The environmental amenity theory is commonly used in studies of land use change because the designation of developable land is the juncture between practical construction costs and socially constructed norms of natural beauty. Environmental amenities as a force for urban change has received increasing attention because they encompass the pursuit of socially constructed beauty and biophysical suitability (Proudfoot and McCann 2008; Mitchell 2004; Purcell 2001). I consider designated protected areas and natural parks to be environmental amenities. Rudzitis (1996), Schmidt and Courant (2006), and Radeloff et al. (2009) found that the level of protected natural resources in a region significantly corresponded to urban growth into these areas compared to other, less pristine areas in the United States. Likewise, studies in Europe find similar trends in increased demand for development near natural parks, and agrarian areas (Salvati et al. 2013; Weber 2007).

Although it is difficult to disentangle the relationship between regional economic health and number of designated protected areas, Radeloff et al. (2009) found during times of healthy housing markets, sprawl occurs most frequently in protected areas. Compas (2007) found the rate of remote, large individual plot subdivisions has increased exponentially since 1995, a trend he attributes to wealthier individuals relocating (or purchasing second homes) in areas with high natural amenities. In post-WWII Europe, urbanization primarily occurs in sub-divided or abandoned farm areas, contributing to a growing urban fringe (Salveti 2014;

[10] See for example: Graves (2012; 2003), Gustafson et al. (2005); Lewis, Plantinga and Wu (2009); Wu and Plantinga (2003); Lambin and Geist (2006) (Anselin & Arribas-Bel, 2011)

Jongman et al. 2011). Nowadays, urbanization continues at an increasing rate in rural areas rich in natural resources, altering the traditional livelihoods and attracting new development (Salvati 2014; Schmidt 2011; Opdam and Wascher 2004).

Economic studies also indicate a positive effect of environmental amenities on development demand. Primarily, these studies find that urban growth occurs in areas that have greater access to natural land (Gustafson et al. 2005; Wu et al. 2006; Lake 2003). Homebuyers are drawn to natural amenities that, coupled with increasing willingness to commute long distances and work-at-home schedules, has resulted in strong housing growth in areas that are accessible from metropolitan centers but close to wildlands (Radeloff, Hammer & Stewart 2005; Nelson 2006). These studies attribute growth in high environmental amenity areas to a substitution effect: urban fringes near natural areas are developed because individuals with higher income substitute this private real estate good for the public goods (e.g., parks, nearby school and work institutions) in urban cores. Graves (2012; 2003) and Dong (2013) argue that urban growth can be generalized to this same argument; that is, urban growth is a supply side satiation of environmental amenities demand. This is not necessarily negative; responding to demand is not in itself the concern, rather it is the land-consumptive, inefficient nature of urban growth and the subsequent loss of critical natural resources (Schmidt 2011; Glaeser and Kahn 2010, 2003; Hesse and Lathrop 2003; EEA 2011a, 2012).

LANDSCAPE FRAGMENTATION. Built-up areas that fragment landscapes contribute to the decline of wildlife populations and affect the water regimes and recreational quality of landscapes across Europe (EEA No 2/2011). Institutional urban planning decisions are partially based on the qualities of landscape pattern (see for example: Keller and Vance 2013; Vance and Iovanna 2006, Geoghegan, Wainger & Bockstael 1997; Geoghegan 2002; Walker and Hurley 2011). Landscape fragmentation in particular changes the landscape's appearance and as such leads to a different perception of the landscape by land use planners (Beckmann et al. 2010, EEA 2011b). Walker and Hurley (2011) found a common thread through their interviews with planners in Oregon where natural areas with a minor fragmenting element, (for example, a single track dirt road) are regarded as having less environmental value and easier to zone for development. I confirmed this with my own interviews with planners for a qualitative case study of Oregon planning[11]. A newly fragmented landscape may give the impression that, being broken in land, is better for new development than more continuous

[11] See Keller (2014). The competing legacies of environment and industry on West Hayden Island: The political ecology of natural amenities and scale, *University of Bremen Geography Dissertation*

land patches regardless of ecosystems' health in these respective areas. New roads, industrial centers or business parks are quickly followed by further development projects, increasing the fragmentation of the landscape to the detriment of native species (Geist and Lambin 2001; Beckmann et al. 2010). The amount of fragmented land is associated with the location choice of commercial/industrial and housing development around urban centers (Dong 2013; Rudel et al. 2009; Robinson et al. 2005; Fahrig and Nuttle 2005). If urban processes are found to correspond with particular patterns of landscape configuration, then pre-urbanization configuration of the landscape should be considered a factor of land use change.

Studies of fragmentation that include socioeconomic data show the extent and pace of land use change are inversely related to distance to urban centers (Turner et al. 1996; Munroe et al. 2005). Rural sprawl is increasingly problematic in Europe where built barriers such as roads and business parks in essence "prep" the landscape for greater growth (EEA 2011b). Urban development tends to follow fringe areas created by roads, leap-frogging to new sites. Thus, the association between amount of fragmentation in an area and amount of new urban growth should be strong. Areas with more patchy landscapes are zoned as "urban," in less time and are less costly to develop because these areas typically have fewer environmental restrictions (Walker and Hurley 2011). Consequently, greater fragmented land may stimulate wider development (EEA No 2/2011; Lewis, Plantinga and Wu 2009). I continue in this vein of research, but I do not assume fragmentation to be solely a latent consequence of other land use decisions, occurring only at the urban fringe. Rather, the amount of fragmentation overall in 2000 per kreis across Germany should be associated with the observed change in urban land in 2006.

The extent of fragmented land is a large issue in Germany (see Figure 2), as elsewhere in European nations. As early as 1985, the German government established a political goal of preserving large un-fragmented, low traffic landscapes which has contributed to the rise of EU-wide protected area networks (Jaeger, Esswein & Schwarz-von Raumer 2006), such as the European Environmental Agency (EEA) Natura2000 habitat protection program, and the Common Database on Designated Areas (CDDA). However, fragmentation in Germany has increased as rapidly as before due to new roads and rails, enhanced traffic volume and dispersed development along these lines (Jaeger, Esswein & Schwarz-von Raumer 2006). The former East Germany in particular experienced a 5.1% population decline, but a 12% increase in land devoted to urban uses between 1995 and 2005 (Schmidt 2011). While urban cores remain dense, they are being built "out" rather than "up" despite little to no economic growth

(Salvati 2014). The question remains, therefore, why does development follow development, even when there is less population, fewer jobs, and functioning urban cores.

3. DATA and HYPOTHESES

DEPENDENT VARIABLE. While a variety of pattern measures have been used to describe aspects of urban land use (see Hasse and Lathrop 2003, An et al. 2011; Geoghegan 2002; Theobald 2004 for review), I created a dependent variable that follows a definition of urban development as the change in urban land from 2000 to 2006 (Rudel et al. 2009). The aim here was to capture the dynamic of rising urban land and declining non-urbanized land in a straightforward, single measure. Simply put, the lagged independent variables (kept at 2000 levels) are associated with the change in urban land observed between 2000 and 2006.

I used the 2000 and 2006 Corine Land Cover (Coordinate Information on the Environment Land Cover- CLC) satellite imagery for my dependent variable of urban change. Satellite images are reflectance of various wavelengths off the earth's surface, stored as a grid of pixels. The data is interpreted using various software (e.g., ERDAS, ArcGIS) and specified parameters. The original CLC 100m x 100m pixels were smoothed and manually improved (for example, pixels within a metropolitan area received the urban classification regardless of reflectance value) to create seamless polygons with a minimum mapping unit size of 25 hectares. The CLC data is classified into 26 land cover types, including discontinuous and continuous urban; two classes of which I combined to represent urban land.

One difficultly with remotely sensed urban land is determining what extent of impervious land is, in fact, urban. With remotely sensed data, urban is often best defined as the percentage of impervious surface greater than 50% of an image pixel (Weng 2012). This likely under-bounds actual urban cover, particularly in cases of low density, dispersed subdivisions in rural areas (Schneider and Woodcock 2008). I combine both urban types to better counteract the inherent underrepresentation of urban cover by low- resolution satellite imagery (100m). However, the change in urban land shares I use is effective despite the low resolution and inherent under-representation, because I use urban from 2000 to 2006 with the same data source and do not seek the change in urban in absolute hectares of land.

There is also the danger of over-representing urban land if the total area of the kreis is used rather than the net land available for development (Clark et al. 2008; Wolman et al. 2005); that is, without controlling for non-developable land, urban growth may appear more intense on certain parcels, effectively biasing my results upward. Because Germany does not have a country planning system that would create non-developable land by policy, I am not concerned with restricted land created by country-wide zoning laws, apart from the Natura 2000 and CDDA protected areas, which would lower the total area per kreis available for development. In Germany, zoning decisions are determined by individual municipalities, which use differing definitions of what is and is not developable land. Regardless, I control for non-developable land in my model by using land classified as having steep terrain and/or high water table factors. I used GIS data from the European Soil Data Centre (ESDAC), selecting polygons with slopes greater than 25% or wet within 40cm of topsoil for over 11 months of the year to represent land too unstable upon which to build. I intersected the undevelopable land with the kreis in Germany and calculate hectares. The distribution looks reasonable, with very steep terrain in the south and saturated land in the north (see Figure 4).

In order to model both spatial and socioeconomic features of urbanization, a spatial link is required between the GIS and socioeconomic data. Both the socioeconomic and spatial data I used have a kreis identifier, which provided the spatial link. I used kreis polygons obtained from German public domain data. There are 439 kreis and the average size is 814 square kilometers. Using ArcGIS, I conducted a spatial union of the various geospatial landscape data, intersected the result with the kreis polygon base layer, then calculated hectares and share per kreis. The GIS data tasks were exported and brought into Stata (11.3) along with the socioeconomic data for the regression analysis. The specific variables are described in more detail below.

INDEPENDENT VARIABLES. In line with the relevant landscape factors proposed by Hesse and Lathrop (2003), my key independent variables represent important natural resources associated with urban land use change. I modify Hesse and Lanthrop (2003) detailed landscape ecology categorization and group my independent variables into three broad categories: landscape composition, landscape configuration, and land use. I aggregated CLC land cover types, and used other geospatial data types to create unique variables that represent the three broad categories. With the exception of the land use/human influence category, all independent variables are spatial. In the land use category, I include socioeconomic variables to measure the influence of demographic effects most often cited in environmental amenities research.

LANDSCAPE COMPOSITION. These variables represent the biophysical layout of every kreis. Landscape composition includes prime soil, sun intensity, CLC (natural) forestland, and CLC arable land. Prime soil are polygons selected from the ESDAC data base described earlier, defined as soils with no obstacle to roots between 0 to 80cm, not wet within 80cm for longer than three months, and having a gentle slope.

I use prime soil because it gives us a sense of the actual value and longevity of ecosystem services such as filtering contaminants for clean water and air.

Existing research shows soil quality influences the timing and type of development in two main ways: (1) parcels with less productive soil are easily accessible as farmers sell off unproductive land for more large scale, or industrial development (Salvati 2014; Dong 2013; An et al. 2011), and (2) parcels with scattered good soil patches are attractive for smaller high-income housing developments because these parcels have fewer land revitalization costs and are typically more aesthetically pleasing (Salvati et al. 2013; EEA 2011b; Irwin et al. 2003). Rudel and colleagues (2009) noticed a threshold in their study of global agriculture and development, where areas with a large extent of prime soil are reserved for agriculture while areas of poor to scattered good soil patches are quickly zoned for new development. However, Rudel et al. (2009) also found areas with little to no prime soil is less attractive for large-scale subdivisions and agricultural firms because the soil quality will not support biodiversity and multiple land uses. Given that my aim is not to distinguish between development types but overall urban land use change, I hypothesize a general negative effect of prime soil, where large swaths of prime soil are actively reserved for food production or environmental mitigation by local/regional policy.

Annual average solar short wave radiation/m^2 was used for my amenity variable of sunshine. Clark et al. (2009) note in their review of environmental amenity migration that individuals are likely to move to sunnier areas given the means to do so, thereby increasing development demand. I downloaded average annual solar radiation data for 1981-2010 from the Deutsche Wetter Dienst (DWD, German Weather Service), intersected these polygons with the kreis layer to create a solar intensity variable by kreis. Figure 4 shows the annual average solar radiation across Germany classified as low, medium, or high. Two additional landscape composition share/kreis variables I included in the model were CLC (natural) forestland, and CLC arable land.

LANDSCAPE CONFIGURATION. Typical measures that quantify the area of land cover patches per spatial unit of analysis are indices of fragmentation. Configuration of landscape is important to consider, since the fragmentation of habitats is a primary factor leading to worldwide species decline and subsequent resource loss (Rudel et al. 2009). McGarigal and McComb (1995) give the most widely used definition of fragmentation: a process in which contiguous habitats are progressively sub-divided into smaller and more isolated habitat fragments.

A fragmentation metric provides the configuration of land patches in every kreis, beyond that of the composition of land per kreis. A commonly used measure of landscape fragmentation is the effective mesh, which is the overall likelihood that a patch of land cover type *i,* adjoins patches of the same type *i,* (Herold et al. 2002; Parker and Meretsky (2004), Hasse 2002). As described further in Jaeger (2000) and Jaeger and colleagues (2008), the effective mesh *size* is a quantitative spatial expression of landscape connectivity, widely implemented by various European countries as an indicator for environmental monitoring (EEA 2011). The effective mesh size ($mesh_{eff}$) is based on the probability that two points chosen randomly in a region will be connected; that is, the path between the points is uninterrupted by a physical barrier, such as a road or urban patch. By multiplying this probability (the effective mesh) by the total area of a region, it is converted into the size of each land cover patch created by the physical barriers: the effective mesh size (Jaeger et al. 2008). Thus, more barriers in the landscape lower the probability that two points will be connected and lower the size of the connected patch types- the size represents the probability. The effective mesh size is given by:

$$mesh_{eff} = \frac{1}{A_{total}} \sum_{i=1}^{n} A_i^2 \qquad \text{(Eq. 1)}$$

where the subscript *i* indexes the patch and *A* denotes its area. The smaller the $mesh_{eff}$ index, the greater the fragmentation. I use the inverse of the $mesh_{eff}$ (otherwise known as the effective mesh density: the number of equal sized patch types per 100km^2), because it makes more sense in this study to compare the increasing fragmentation to increasing urban shares.

In line with Wu and Plantinga (2003), Geoghean et al. (2002), and numerous other studies (e.g., Rudel et al. 2009; Wu et al. 2006; Waddell 2002; Xian, Crane and Su 2007; DeFries et al. 2007) that point to the high demand of new development along urban fringes, I hypothesize a positive correlation of fragmentation with urban growth. This trend I would expect to diminish as urban patches grow, indicating decreasing landscape diversity.

LAND USE VARIABLES. The final broad category combines land use policy, demographic and economic attributes of Germany. Because demographic and built environmental characteristics are often cited as the primary drivers of urban growth, this is an important category for accurate models of urban change. Concerning land use policy, one way in which societies influence landscape change is the demarcation of protected areas. This land use policy reflects a combination of both ecological (preservation of endangered resources) and cultural (traditional livelihoods) forces.

A protected area is defined as a clear geographical space, managed to achieve the long-term conservation of nature with associated ecosystem services and cultural values (EEA No5/2012). This is a broad term that can include any area of sea, lakes, rivers or land that have been identified as important for conservation of nature, and environmental amenities. It is important to note then, that protected areas differ in the extent to which human activity is limited within them. Some protected areas allow industry, extensive agriculture or fishing to occur within their boundaries, while others prohibit all of these activities Regardless, all these designations are intended to limit urban encroachment.

In Germany, protected areas cover 28.5% of the country's land surface (EEA 2012c). The overall aim of protected areas in Germany is to maintain or restore the functioning of the ecosystem for the sustained usability of natural assets that are scientifically or culturally significant (EEA 2012c). The general protected area measure I used was nationally designated areas, CDDA. I included the lands set aside in the CDDA because they are established to maintain provisional ecosystem services (maintaining floodplains, healthy ecosystem functioning for agricultural production) and cultural ecosystem services (traditional livelihoods and rural "idyll" landscapes). Urbanization of landscapes in Germany has led to reduced profit of food and timber on increasingly smaller parcels, reduced quality of agricultural products alongside roads (provisional services) and loss of rural livelihoods and recreation (cultural services), (EEA 2011b) Ecological researchers in Germany claim it is especially important to maintain Germany's protected land because it provides invaluable habitat for native flora and fauna seeding and migration patterns (Klar et al. 2012). The early consideration of landscape framework plans to save natural gaps for wildlife between urban and industrial areas can replace costly conservation tools, such as reintroductions, in the future (Klar et al. 2012; Grantham et al. 2009; Possingham 2000).

Land-use policy also shapes landscape in dramatic ways through decisions regarding transit and pollution. I used industrial waste site data from the European Pollutant Emission Register (EPER) 2004 Facility, Pollutant and Emission Spreadsheets. I selected facilities labelled as metal, chemical, mining, fuels and paper processing or waste treatment/disposal, and buffered the points to 1 km circles (dissolving overlap). A 1 km buffer radius I deemed large enough to represent neighborhood effects without overrepresentation. I intersected the resulting polygons with kreis polygons to obtain the share. Pollution sites are considered negative externalities that restrict development in two ways: (1) the revitalization costs of brownfields (polluted sites) must be partially borne by the developers; and (2) the local environmental is not attractive to homebuyers (Park et al. 2009). I propose a negative correlation of this variable with urban land from 2000 to 2006, following the findings of Dong (2013), Graves (2012), and Plantinga and Wu (2007).

Due to the tendency of development projects popping up along new roads, I used a transit density measure to capture these urban lifelines. I hypothesize a positive effect of this variable, in line with the numerous studies that point to the positive effect of roads and rails on urban growth (Schmidt Curant, Mitchell, ETC; Brueckner 2005; Waddell 2002; Wu et al. 2006; Cervero 2002a,b, 2003; Lambin and Geist 2006). I downloaded GIS data for major road and rail lines from Esri's data for Europe available on their website. I used a buffer size of 50m and dissolved overlap to obtain a reasonable combined footprint without double counting adjacent lines. I intersected the resulting polygons with each kreis to obtain the share.

CONTROL VARIABLES. My socioeconomic variables control for the effects of population density, GDP per capita, purchasing land value, state tax, and whether the kreis is located in west or Former east Germany. I downloaded these data from the German Socioeconomic Panel (G-SOEP) managed by the Deustche Institut für Wirtschaftsforschung (DWI) from their website. In line with the findings of Salavti et al. (2013), Irwin and Bockstael (2001), and Schmidt (2011) that point to population densities, GDP per capita, land value and lower state tax contributing to urban growth, I hypothesize positive effects of these variables. The kreis in the former east typically display lower levels of all the previous socioeconomic indicators, thus I expect the kreis in the west to correspond more with urban growth. The dichotomous variable of west vs. east Germany captures the potential effect of the GDR legacy on development projects in the former East Germany. The descriptive statistics of all the variables used in this study are displayed in Table 1 (see Appendix), including the difference in variable distribution between Germany's east and west.

4. MODEL DERIVATION

I regress urban land use change from 2000 to 2006 using a simple OLS analysis of the data, predicated on landscape and socioeconomic factors measured in 2000. Following the OLS base model, I ran my analysis a second time with a spatial regressive model to look for interaction effects of the surrounding kreis' landscapes. Eq. (2) and (3) below exhibit neither problems of multi-collinearity nor spatial autocorrelation of the model residual terms. Thus, I assume the base model is well defined to account for large spatial interaction effects. The model specification is:

$$\Delta Urban_{2000-2006} = \beta_0 + \beta_1 NatLand_{2000} + \beta_2 AgLand_{2000} + \beta_3 Soil_{2004} + \beta_4 RoadRail_{2004} + \beta_5 Frag_{2000} + \beta_6 ProtectedArea_{2004} + \beta_7 Pollution_{2004} + \beta_8 Solar_{1980-2010} + \beta_9 Nondevelopable_{2004} + \beta_{10} StateTax_{2000} +$$

$$\beta_{11} PopDensity_{2000} + \beta_{12} PerCapGDP_{2000} + \beta_{13} West_{(0,1)} + \varepsilon$$

(Eq. 2)

where, ΔUrban is the change in the share of urban land per kreis from 2000 to 2006, β_0 is the model constant, βn are the coefficients corresponding to the lagged independent variables (as measured in 2000), and ε is the error term, assumed normal distribution due to no significant spatial clustering of model residuals.

The results of the base model are shown in Table 2, column 1 (see Appendix). Due to the significant difference between east and west Germany in both socioeconomic terms and rate of urban growth as found by Schmidt (2011). I added interaction terms of the substantive independent variables to the model to assess the effect of the kreis location in east or west. The comprehensive model results with the interaction effects are shown in Table 2, column 2. The OLS model coefficients remained stable through several additional sets of multivariate analyses. Although the model residuals are not spatially clustered, I conducted a global Moran's I test for all model parameters to account for a potential overstatement of OLS results without robust spatial weights, an aforementioned issue (Anselin 2003; Anselin and Arribas-Bel 2011; LeSage and Pace 2009; Brueckner 2005). Because the Moran's I index scores of the independent variables ranged from 0.334 to 0.739, I constructed a spatial autoregressive model and corresponding row-standardized nearest neighbors weights matrix to assess the robustness of my substantive conclusions. The spatial regression model is detailed in the notes, hereto follows in brief:

$$\Delta Urban_{2000-2006} = \rho W_y + \beta_1 W(NaturalLand_{2000}) + \beta_2 W(AgLand_{2000}) + \cdots \beta_n W(X_n) \qquad \text{(Eq.3)}$$

where, y is a N x 1 vector (row) of observations on urban change from 2000 to 2006, W is the 6 x 6 nearest neighbors spatial weights matrix, ρ is the spatial autoregressive parameter, W_y relates the value of $\Delta Urban_{2000-2006}$ in a target kreis to the values at neighboring kreis, X is the N x K (row by column) matrix of observations on the explanatory variables as measured in the year 2000, with associated K x 1 coefficient vector ($\beta_1 W$), and ε is the N x 1 vector of the residuals.

The substantive patterns and significance of Models 1 and 2 (columns 1 and 2) remained the same despite the expected improvements of the model using a 6 x 6 kreis nearest neighbors matrix[ii]. The overall similarity of the findings with and without the spatial weighting matrix suggests the associations found in my analysis are robust at the country level.

5. RESULTS

Overall, urban land grew 6% across Germany during the 2000 to 2006 period. The kreis that did not grow were all located in the eastern half of Germany, likely a result of the continued emptying of the east to the stronger, less agrarian economy of the west (Schmidt 2011). Despite the slow urban change in the east, an increase in urban land of 6% is significant. The models are distinguished along two factors: either a model accounts for (1) spatial dependence, or (2) interaction effects with the west Germany binary variable. Model 1 is the base model, Model 2 includes the interaction effects, Model 3 accounts for spatial dependence, and Model 4 accounts for both interaction effects and spatial dependence. I include all four models in Table 2 to demonstrate the stability of the model coefficients and significance from Model 1 to 4. For brevity, I discuss the most substantial results from Model 4 unless otherwise stated.

FRAGMENTATION. The results show the positive effect of fragmentation on urban growth: an increase in the share of fragmentation in 2000 corresponds with a 0.000054 increase in share of urban land. This result is most likely a consequence of the relative speed of development along urban fringes where it is easily accessible and the zoning is already in place. Consequently, fragmented land could be considered urban reserves, where growth is expected to eventually occur (Clark, McChesney, Munroe & Irwin 2009). Less regulated land translates to fewer restrictions on development, making fragmented areas attractive for different types of development depending on how developers realistically account for the landscape topography. The topography in a kreis may include non-developable land and, though insignificant, the model shows a negative association with urban growth as expected.

The results point to a significant negative effect of state tax, where an increase in the marginal tax rate per person per kreis corresponds to about a .085 decrease in urban land. Costs accrued by developers because of an increase in tax due to new development projects plays an important role in land use change. According to Schmidt (2011), and Walker and Hurley (2011), the effect of "real estate capitalism" (tax incentives for new business/development) significantly contributes to higher land consumption, especially when the costs of infrastructure are taken on by the state, rather than taxed to the developers. In the east especially, the marginal tax rate is artificially depressed for developers, though the results do not point to a significant effect difference between east and west.

PROTECTED AREAS. Results show that a greater share of protected areas per kreis corresponds to a .0088 increase in urban land use from 2000-2006. The magnitude of this effect is large compared to the other landscape factors in the model, which corroborates the empirical evidence found in North American and European studies of environmental amenity-driven growth (see for example: Visas and Carruthers 2005; Schmidt and Courant 2006; Castle, Wu and Weber 2011; Wu and Plantinga 2003; Irwin 2002; Wu and Irwin 2008; Hesse and Lathrop 2003; DeFries et al. 2007).

PRIME SOIL. The soil quality predominantly found in a kreis is an important determinant of land use. To a great extent, soil quality determines whether a parcel of land will be reserved for agriculture, floodplains (among other natural disaster buffer zones) or urban reserves. The results display the expected negative association with prime soil and urban growth, corroborating the findings of Salvati (2014) and Rudel et al. (2009). Models 2 and 4, however, which interact prime soil with the west dummy, indicate that the magnitude of this negative effect is stronger in the east.

According to Model 4, the share of prime soil is associated with a 0.0055 decrease in the share of urban land in the east, with a corresponding decrease of 0.005 in the west. This suggests land use planning in the west perhaps assumes the eastern regions of Germany should provide food security and environmental mitigation, allowing western jurisdictions a supply of easily developed land to accommodate projected job and population growth. This correlation aligns with similar findings of An et al. (2011), Rudel et al. (2009), and Schmidt (2011). Figure 3 shows that the highest urban growth occurred in kreis with better soil in the west. The CLC arable land variable I used was positively correlated with urban growth in models 2 and 4 but not significantly when interacted with the west variable. This finding is related to the prime soil in that the east's agricultural tradition and primary production sector supresses what could be a much stronger pull of open, easily developable land for new subdivisions. Two variables from very different spatial data sources show in essence the same association: good land is attractive for new development. Prime soil actively reserved by policy or ownership restricts infill, but, like the association with protected areas described above, the partially fragmented, flat agricultural land around these patches are attractive as areas into which cities can expand.

POLLUTION and TRANSIT DENSITY. Results indicate that higher shares of polluted land per kreis corresponded with less urban land. Models 2 and 4, specifically point to a strong relationship, where an increase in the share of polluted land per kreis is associated with a 0.19 decrease in the share of urban land. This finding highlights a trend found in the literature that one reason urban development occurs in valuable *greenfields* (natural or agricultural areas) is the lack of remediation costs (Theobald 2004; Wu and Irwin 2008; DeFries et al. 2007). On the other hand, attracting development to *brownfields* (polluted areas) is difficult due to a number of constraints to developers, including liability costs, extent of contamination, and environmental zoning constraints.

I found a difference in effect of transit in east versus west Germany. Higher transit densities correspond with urban growth, but in the west the magnitude of this effect is small compared to the east. Despite this effect difference, the relationship corresponds with other studies findings that point to leapfrog development patterns along new transit arteries (Waddell 2002; Jaeger, Esswein & Schwarz-von Raumer 2008; Cervero 2003; Ewing and Cervero 2010). This finding suggests expansive road and rail networks in kreis correspond with urban growth along these network corridors. In the west, these corridors have already been long established to link cities and industrial centers. Thus, new road and rail lines would most likely be a tool for city infill, rather than serving to expand inter-city connections and exurban growth.

SOCIOECONOMIC FACTORS. Population density, per capita GDP, and state tax rate are unlikely to change drastically in a six-year time interval, but the stability and significance of these variables across models suggests they would have a great influence on urban growth in the future. The most strongly significant predictor in this group is the marginal tax rate per kreis, associated with a decrease in urban land as described above. This finding suggests an elastic relationship between development costs incurred by tax and completed development projects.

Another significant socio-economic result is the per capita GDP per kreis. Higher per capita GDP corresponds to a .000076 increase in the share of urban land. This result reflects the observation that stable regional economies are found in areas with a larger natural resource base (Park et al. 2009; Schmidt and Courant 2006; Graves 2012), pulling both business and amenity-seekers. Kreis with stable regional economies and a greater influx of wealthier individuals corresponds with increased residential space, services, business, and transportation (Schmidt 2011; Wu 2006; Waddell 2002, Irwin 2002). The implications of these findings for policy makers is large, given some socio-economic policies, such as state tax levels, may be easier to manipulate than systemic land use change and revitalization of brownfields.

6. DISCUSSION

This study has added to the building evidence in land use studies that economy is not the only determinant of where and how land use is converted from natural or primary production activities to urban land. Although urban growth surely depends in part upon economic conditions, exurban development has been substantial in every decade, even in economic downturns. A good example is despite the strong downturn in the housing market over the last decade, the templates of how we build up, use, and consume land on a large scale did not fundamentally change (Walker and Hurley 2011).

The results reveal two key landscape factors that are positively associated with urban growth: (1) the level of fragmentation, and (2) the share of designated protected areas. Another key landscape factor, prime soil, is negatively associated with urban growth. First, the greater the inverse $mesh_{eff}$ (effective mesh density) measured in 2000, the greater the change in urban land by 2006. Second, designated protected areas display an effect of hastening urbanization. Third, greater shares of prime, productive soil experienced less urban development over the six-year period, but this was a stronger effect in eastern Germany, where the agricultural sector remains large. This finding suggests the presence of deeply rooted and influential agrarian tradition and incentives to reserve prime soil for future agricultural use (Castle, Wu and Weber 2011).

The results point to a trend where natural, open land is attractive for developers primarily because of environmental amenities, and fragmented land is preferable due to fewer development restrictions. This may explain why growth is more common in areas with larger shares of fragmented land rich in natural resources. There are four compelling implications of these results:

(1) Fragmented areas that contain a large amount of protected and natural resource rich land are attractive to developers and increase urban growth potential;

(2) Increased transit lines in a region increase access to natural amenity areas and allow leap-frog development patterns;

(3) Polluted areas and kreis with high state tax display a negative influence on urban growth because they are cost intensive for developers, and;

(4) Areas with a large extent of prime soil may limit urban growth within patches, but due to the effect difference between the east and west, this trend should not be overstated.

Concerning implication (1), I used a broadly defined protected land variable. The protection may exclude development, as for areas designated to monitor species decline; or the protected area may allow some development. They are areas that have received special designation due to their important natural or cultural resources assets. Overall, protected areas were associated with more urban growth over the six-year time frame than fragmented, sunny, or densely populated with high GDP per capita areas combined. This has critical implications for the quality of life in Germany and Europe, where urban growth has increased extensively in sensitive areas over the last decade, despite strong policy efforts to "…halt biodiversity loss and the degradation of ecosystem services in the EU by 2020," (EEA 2012c, 3). A recent study by Salvati et al. (2013) highlights this issue, showing the significant correlation between extensive exurban growth in southern Europe and loss of natural areas since 1950. New subdivisions are a response to demand to be near, or in, natural areas and follow one another easily because they are more easily justified to municipal planning authorities depending on the landscape's existing degree of fragmentation. Natural fragmenting elements (such as burnt or flooded areas) can be just as influential as human made fragmenting elements (such as new transit lines) in creating a landscape that appears already suited for new subdivisions. Areas altered by natural disasters are not often seen as worth protecting as pristine, high functioning areas are (Rudzitis 1996; Jaeger, Esswein & Schwarz-von Raumer 2006). If these altered, fragmented, landscapes border pristine areas the attracting effect of environmental amenities for new development is likely compounded.

Implication (2) goes further and suggests why this urban growth may be seen in attractive designated lands. Increased transit networks that are built out of dense urban areas increase access to these natural areas. This in turn, increases the likelihood of leap-frog developments along these lines as traffic volume increases (Jaeger, Esswein & Schwarz-von Raumer 2006).

Implication (3) refers to the combined effect polluted areas and high state taxes have to create high development costs that push developers to seek areas that are less expensive overall to develop while still attractive on the demand side[12]. This suggests policy makers should concentrate their conservation efforts in already designated protected areas. That is, strengthen restrictions on development near protected areas, due to the significant "push" factors of pollution and tax, and "pull" factors of fragmented land with high environmental amenities.

Regarding implication (4), prime soil in the former east has a negative influence on urban growth, most likely because good soil correlates with high agricultural yields. The majority of prime soil is found in the former east, and corresponds with a larger traditional agricultural base (Schmidt 2011). Therefore, the large-scale farms in the east stand to benefit more from the German agricultural cost support policies as compared to the relatively small farms in the west. This could explain the difference in prime soil's effect from former east to west. Prime soil land may be highly attractive for both farmers and developers, but the cost of

[12] See for examples of this trend in North America, Robinson et al. (2005); An et al. (2011); Irwin and Bockstael (2005; 2007).

purchasing these plots is relatively higher for development projects than for reserving these patches for future food production.

Finally, when examining the climate amenity factor of sunshine, I found mixed results. Although U.S. regions with warmer winter climates have been shown to attract a greater proportion of decentralized settlement the past few decades (Clark, McChesney & Irwin 2009), my result was inconclusive. This may be explained by the little variance in climes across Germany. Forestland was also surprisingly negatively associated with urban growth. Contrary to environmental amenity expectations, less urban growth was observed in kreis with greater forestland. This result is perhaps due to forestland subsumed by the effect of protected land and to the high correlation of forestland with (non-developable) steep terrain in Germany.

Regarding land use policy that aims to contain urban growth and sprawl, the results suggest that policy makers concentrate their conservation efforts on pre-existing fragmented land with high shares of protected areas in Germany to effectively stem urban encroachment. The findings of this and earlier research (e.g. Clark et al. 2009; Salvati 2014) suggest urban planners face a challenge regarding how to hinder exurban growth in regions that still possess a large extent of natural land surrounding urban core areas.

ISSUES for FUTURE RESEARCH. Some caveats of my study are (1) the dearth of temporal variation in the geospatial data; and (2) the lack of differentiation between urban development types. First, data constraints limit my model only to a single transition in land use from 2000 to 2006. With the increasing availability of satellite imagery (a new seamless vector image for 2012 will soon be available) this constraint can be relaxed. With greater temporal variation in spatial data, I can isolate the tipping points of fragmentation- when in the process of urbanization does level of fragmentation act as an additional stimulant. Second, I did not differentiate between development types to determine intensity of growth. Future research is needed that builds on the work of Clark, McChesney, Munroe and Irwin (2009) Robinson et al. (2005) and Schmidt (2011) who distinguish among the types of urban growth observed, particularly the differences observed in rural sprawl.

I recognize that the model applied here has its limitations regarding the omitted variables. For example, prevalence of rural commuting, regional-level employment prospects, building templates and other built environment characteristics. Although I am confident that my model set-up controls for much potential endogeneity[13], in future research I would test this relationship further using a simultaneous framework with dependent variables on both sides (e.g. urban growth and fragmentation) similar to the model used by Park et al. (2009). Park and colleagues (2009) used a framework comprised of two equations in which the dependent variables of population and employment interact simultaneously with both equations' explanatory variables to explain spatial heterogeneity of regional economies in England.

Another interesting avenue of research would be a survival analysis approach, similar to Vance and Geoghegan (2002) and An et al. (2011), that exploits both temporally rich social data and fine resolution geospatial data, rather than keeping either social or spatial terms fixed. Thus far, data limitations and poor spatial links between landscape and social data sources force researchers to use fixed terms, or purely distance-to-urban measures, in land use models (Schmidt and Courant 2006). Better temporal and fine resolution spatial data would also open another interesting avenue for research: to test Partridge's (2010) assertion that Europe will mirror the U.S. experience in amenity driven growth after another decade. This would allow enough time for the compilation of the CLC images of 2012 to assess if urban growth "hotspots" coincided with the most valued natural land.

An issue for future research is the need for an established guideline to generate appropriate spatial weights matrices. As called for by Anselin (2003), Anselin and Arribas-Bel (2011), LeSage and Pace (2009), Park et al. (2009), creating spatial weight matrixes that are appropriate to both type of spatial unit and research question should be a primary goal of future landscape research. Guidelines for building spatial weights matrices are crucial because the matrixes define the influence of spatial effects, and in so doing partly determine the significance and magnitude of model coefficients[iii]. Poorly fitted spatial weight matrixes could result in the same issue of understating spatial effects as was the case prior to the explosion of techniques around geographically weighted regression (Park et al. 2009).

In conclusion, urban landscape studies should aim to highlight resolution and scale differences between social and biophysical processes in order to locate the driving mechanisms of urban change. As called for by DeFries et al. (2007) and Parker and Meretsky (2004), models that reveal such relationships between human and environmental systems facilitate more concrete communication between ecological research and policy, and may shed light on how to modify policy to move towards urban and ecological sustainability. The

[13] Endogeneity is a problem which arises when a dependent variable in one equation could appear as explanatory variables in another equation. As a result, bias may arise because unmeasured factors may by systematically occuring together

interactions between geophysical, ecological and anthropogenic factors are still poorly understood, in part because anthropogenic response based on geophysical change is less readily studied than environmental degradation caused by human decisions. This study adds to a growing body of research that hopes to understand not only how human institutions influence landscape change, but also how altered landscapes in turn influence our decisions. Ultimate progress in urban and ecological sustainability will only be made with insights from both social and natural scientists.

7. TABLES

Table 1. **Model Variable Descriptive Statistics**

	Units	**Source**	**Years Observed**	**Mean**	**Min.**	**Max.**	**West**	**East**
Dependent Variable Urban Growth	Percent	CLC	2000-2006	0.3	-3.1	4.6	0.5	0.08
Independent Variables								
Natural and Forest Land	Percent	CLC	2000	28.37	0	69.3	29.1	26.2
Agricultural Land	Percent	CLC	2000	34.24	0	84.8	29.7	47.1
Prime Soil	Percent	ESDAC	2004	32.64	0	95.2	31.2	35.6
Road and Rail Networks	Percent	ESRI Europe	2004	3.85	0.76	15.8	4.1	3.4
Fragmentation	Patches/100 km^2	Metric created from CLC	2000	13.48	0.60	172.7	14.52	10.49
Non-developable Land	Hectares/kreis	ESDAC	2004	7733.95	0.0	80347.7	5688.2	3553.7
Average Annual Sunshine	Short-wave radiation/m^2	DWD	1981-2006	1458.0	1285	1631.0	1388.0	1469.0

Protected Areas	Percent	CDDA	2004	31.32	0.13	97.21	30	34
Industrial Pollution	Percent	EPER	2004	1.27	0	15.74	1.4	0.6
State Marginal Tax Rate	Percent	G-SOEP	1990-2012	0.509	0.47	0.5376	0.514	0.506
Population Density	Population/km^2	G-SOEP	2000-2006	508.5	40.7	3896.5	565.4	344.5
Per Capita GDP	Share of kreis GDP/person	G-SOEP	2000-2006	23.16	11.5	77.13	25.51	16.53

Table 2. OLS and Spatial Model Results

Independent Variables	***Model 1 OLS***	***Model 2 Expanded Model***	***Model 3 Spatial Regressive Model***	***Model 4 Expanded Spatial Model***
Natural and Forest Land	-.0053* (.0020)	-.0062** (.0020)	-.0047** (.0020)	-.0058** (.0019)
Agricultural Land	.0022 (.0025)	.0030* (.0021)	.0024 (.0020)	.0030* (.0021)
Prime Soil	-.0018 (.0011)	-.00591** (.0019)	-.0016* (.0147)	-.0055*** (.0019)
Road and Rail Networks	.0171 (.0266)	.1460*** (.0377)	.0210 (.0260)	.1468*** (.0369)
Fragmentation	.000043 *** (.000010)	.000055*** (.000010)	.000042*** (.000014)	.000054*** (.000015)
Protected Areas	.00122* (.0014)	.0089*** (.0029)	.00142* (.0014)	.00888*** (.0029)
Industrial Pollution	-.0256* (.0151)	-.1933*** (.0654)	-.0264* (.0147)	-.1903*** (.0639)
Avg. Annual Sunshine	-.0000009 (.0000033)	-.0000020 (.0000032)	-.0000021 (.0000033)	-.0000025 (.0000032)

Non-Developable Land	-.00000001 (.00000002)	-.000000005 (.00000002)	-.00000003 (.00000002)	-.000000007 (.00000002)
State Tax	-.0325 (.0446)	-.0888** (.0442)	-.0297 (.0436)	-.0846** (.0432)
Population Density	-.0000005 (.0000009)	-.0000001 (.0000009)	-.0000006 (.0000009)	-.00000011 (.0000009)
Per Capita GDP	.00016*** (.00004)	.000077** (.00003)	.000147*** (.000036)	.000076** (.000038)
West	.0064** (.0019)	.00626*** (.0020)	.0060** (.0019)	.0061*** (.0020)
West Road/Rail Networks		-.1060** (.0334)		-.1062** (.0327)
West Prime Soil		.0054** (.0022)		.0051** (.0022)
West Industrial Pollution		.1668** (.0673)		.1642** (.0658)
West Protected Areas		-.0075** (.0032)		-.0074** (.0031)

N = 439 *R sq= .13* *R sq= .22*

*p < .1. ** p< .01. ***p< .001

Notes

i. Cross validation is a model evaluation method that indicates how well a model can make predictions on half of the data from which it was not specified (Starkweather 2010). In random spilt-half sample validation, half the cases are removed before the data is modeled (the 'testing sample'). After the model is specified using the remaining cases (the 'training sample'), the 'trained' model is projected to the testing sample to see how well it predicts similar coefficients. This process involved selecting a random training sample of the kreis in Germany, generate model coefficients using these data points, then project these specified model coefficients to the testing sample to evaluate how well the model fitted from the training sample generalizes coefficients in the testing sample. Between the training and testing samples, model coefficients displayed little variation. This added level of model validation suggests that it could potentially project urban land use change in new cases. To verify that the findings are not the dependent upon the Stata 12.1

specific geographic weighted regression package, I additionally ran the same model using ArcGIS 10.2 that now includes a geographically weighted regression toolbox, to directly test stochastic spatial relationships within the viewer. The overall similarity in significance, and the same direction of relationships of the explanatory variables to urban change suggests that the conclusions below and observed changes in urban land are robust.

ii. I found the maximum likelihood spatial autoregressive model to be most appropriate for the type of spatial weighting matrix and the change in share of urban land dependent variable. The spatial autoregressive model (SAR) is a specification for substantive spatial dependence in the sense that it is a formal expression of the equilibrium outcome of a spatial interaction process, in this case interaction between local and surrounding areas of natural land, protected areas, road and rail density etc., (Anselin and Arribas-Bel 2011; Anselin 2003; Brueckner 2005). The SAR model is good for dependent variables that measure a change in spatial area, and the explanatory variables are a combination of spatially lagged and other spatial features.

iii. In empirical spatial econometric models, the selection of a spatial weights matrix is key, because it quantifies the structure of spatial dependence between observations. In other words, the spatial weights matrix used will, to a large extent, determine what the model results will be, because the matrix weights determine how strongly spatial features are likely to influence/be influenced by surrounding spatial features. Although there exists a wide range of literature that has proposed several approaches to creating appropriate spatial matrices, there is not a formal guidance on how to select the “optimal” matrix for each model type. Typical approaches include inverse distance (or distance decay), distance thresholds, and contiguity (or nearest neighbor) matrices. Following LeSage and Pace (2009), I began with a row-standardized contiguity nearest neighbors matrix W that reflects spatial relations among the n kreis regions that surround the target (local) kreis. In this case, the average number of neighbors (spatial spillover “links”) is 5.3, attained from the mean of links from the contiguity matrix. In order to robustly account for spatial spillover effects, the matrix constructed here allows for links above the mean, that is, it accounts for 6 neighboring kreis.

Study Three: The competing legacies of environment and industry on West Hayden Island: The political ecology of natural amenities and scale

Abstract:

Urban land use research typically concentrates on the why and where of urban land use change, rather than on the process by which it unfolds. This paper examines the "how" of urban land use change by focusing on the case of a sustainable port project on West Hayden Island (WHI), embedded within the constructed urban-ecological ideal of Portland, Oregon. The WHI plan garnered consent from Portland's City Council in October 2013 after nearly five years of an arduous planning process that included environmental, public agency, and business representatives on the WHI planning commission. The WHI Plan was shelved two months later however, because the developer (the Port of Portland) saw the final plan as uneconomic and the political climate as uncompromising for business. The WHI process represented an ongoing struggle between the economic and environmental future of Portland Metro. I chose the atypical case of WHI because it represents the largest challenge planners face in a land-locked city. WHI is a highly contested piece of land because it is both a designated Regionally Significant Industrial Area *and* Significant Habitat; it has good reasons to be developed or left undeveloped. **This study highlights how WHI was situated within larger regional and state discourses, using qualitative content analysis to locate key themes that come to the surface in qualitative text data. I observed three main themes: the role of WHI's natural amenities, the Portland political context, and the tension between the Statewide Planning Goals 5 and 9.** I end with a discussion of how assumptions regarding sprawl shape perceptions of WHI's future and the nature-society dichotomy in sustainable development.

Key terms*: Statewide planning, geographies of scale, political ecology, natural amenities, West Hayden Island*

Introduction

Portland has long been seen as an example of ecological urban planning, with its strong focus on mixed land use, tight urban growth boundary, relatively little sprawl, and abundance of green corridors and patches. The Portland metropolitan (metro) area is attractive because of its environment as much as its surviving middle-class. Urbanite mid (and high)-income amenity seekers and industry both demand the shrinking reserves of open, natural, cheap land in the metro area. The constructed Portland ideal of a sustainable 'green' and middle-class city is volatile, because individuals demand to own green space, industry needs to use it, and Oregon's planning legacy through its 19 Statewide Planning Goals, while laudable, politically drives land use decisions. Two goals in particular stand out as driving the planning process, goals 5 (environment) and 9 (economy). Goal 5 primarily mandates the inventory of natural resources in a local area before development and necessarily limits environmental planners to a smaller scale. It encourages but does not require habitat conservation. Goal 9 requires the provision of developable land for economic growth. Two political and scalar tensions are set up: one, between environmental stakeholders who have identified functioning habitats in a local area because often those areas are the only large open spaces (i.e. developable) land within a larger region, and two, industrial stakeholders on a state scale have greater influence because they must find land to meet the needs of the whole metropolitan and state economy. In Portland, open land surrounding the metro is now filled, and the first major challenges to maintaining functioning ecosystems while accommodating projected industrial, job and population growth are foremost in Portland planning. I argue that because the goals 5 and 9 have inherently different starting methodologies of *how* land is valued, an imbalance is created which establishes tension among planning stakeholders. The disjunction between goals 5 and 9 politically drives the evaluation of economic and natural resource need, justified by arguments for 'equity' in land use.

The WHI development plan for a new marine grain port terminal at the confluence of the Columbia and Willamette Rivers began as typical planning process: three key stakeholder groups- environmental, industry/economy, political- contend for land use decisions (Marston 2004). The decision ultimately rested on whether to change the zoning on WHI to be industrial use or left as an urban habitat. West Hayden Island is designated as a "Regionally Significant Industrial Area (RSIA)[14]," that is, land having "site characteristics that are relatively rare in the region that render them especially suitable for industrial use" (Metro

[14] A RSIA designation is not the same as zoning that land for industrial use, though following a RSIA designation by Metro, a jurisdiction will, in nearly all cases, zone that land industrial.

2004). As such, the Metro Code gives RSIAs protection against conflicting non-industrial uses, including habitat restoration or recreation uses and, while not required, zoning as industrial is expected. The outcome of WHI makes it an atypical case: it was **not** zoned freely to industry, despite an industrial lands shortfall indicated by the goal 9 inventory and Metro's RSIA designation. Rather, goal 5 was deemed more important politically by the City's approval of the large environmental mitigation package the environmental analysis reported would be needed to develop sustainably. The contested expansion of Portland's urban growth boundary (UGB) in 2040, combined with the need to fulfill industrial land requirements of goal 9, WHI in the near future will likely cycle back into Portland as zoned for industry.

Oregon's planning framework has long experienced cyclical tensions between state and local stakeholders regarding urban restructuring. This is not necessarily bad, as contestations (and compromises) would not arise without the planning goals' inherent checks and balances. The State can intervene against unfettered market forces allowing local assessment of 'best practice': where and when to zone for particular land use that meets local needs and vice versa, local government has some authority to prevent development that is politically popular statewide, but bad for their environment. Political ecology typically splits planning stakeholders among three political scales: local, regional and state (Marston 2004). My aim here is to highlight the ways in which local, regional and state scales are stacked according to their corresponding goals in Oregon planning and highlight the WHI process as an atypical case of scalar planning. WHI is an atypical case in the sense that environmental stakeholders had a larger leverage point in the process than is typically the case in urban planning. This case study exemplifies a potential future trend in planning. We are entering an era where urban centers are rapidly growing, with a simultaneous explosion of urban sustainable development projects and overall popularity of pursuing green/eco-friendly policy. WHI highlights potential common tension points in planning that focuses on truly balancing development with environmental restoration.

I focused my interviews according to Robbins' (2001) key themes in political ecology: who has what kinds of environmental access and control (and who is excluded from environmental access and control), how they talk about nature (landscape, value of land), and what problems they identify. Relating these themes to WHI, who has the most access to land use decision making process, how do these stakeholders assess and value nature relative to development, and what issues are most salient, recurring, for them in land use planning. I found three main themes of scalar tensions that bear upon the experience and evaluation of WHI:

1) Natural amenities of WHI make the island highly valuable urban property, deployed as reasons both for and against development;
2) The contestation among scales of state goals 5 and 9 that determine 'best practice' for WHI, and;
3) The political context was a key force throughout the WHI process, and served to heighten tensions between environment and development advocates.

Generally, scalar tensions are resolved by large environmental compromises in order to fulfill goal 9 requirements. By and large people want to 'make it work' together, but how it 'works' is predicated upon the fulfillment of economic needs over ecological (goal 9 over 5) which works against effective communication in scaled planning (Gosnell and Abrams 2009). The political context of Portland at the time allowed "all options on the table[15]" which may prove to be an example for future projects: when goals' relative importance is somewhat equalized, scales can claim balanced ownership to the process. Balanced scale participation and true consensus to a project plan has implications for the long term success of a project and regional development strategy.

I structure the paper as follows: first with a review of the political ecology and natural amenity literature that comprise my framework. Second, I discuss Oregon's planning legacy. Third, I describe my methods of data collection and evaluation using qualitative content analysis (QCA). Fourth, I provide the background of WHI and why I chose WHI to illuminate scalar planning. Fifth, I discuss the history of planning WHI using material from expert interviews to contextualize the recent WHI Plan. Sixth, I present my results and the implications of my findings regarding the different scalar perspectives of WHI's natural amenities, the role of the statewide planning goals, and the role of politics. Lastly, I conclude with a discussion of WHI's future, implications for sustainability, and topics for future research.

1. Literature Review: Political Ecology and Natural Amenities

Planning entails far more complexity than simply weighing the costs and benefits of development over open space. Planning is as political as it is ecological, concerned with equity as it is with business efficiency and *defined* by landscape while defining landscape use. How landscape 'works' in providing meaning (Crouch 2010), how landscape 'representations are performed' by certain social groups (Dewsbury et al. 2002), or conceptualizing landscape as 'inescapably political' (Mitchell 2001) are all essential strands in political ecology. In

[15] Portland Bureau of Planning and Sustainability. January 14, 2014, Interview 3

general terms, political ecology seeks to synthesize political economy, distributions and dynamics of power, with the study of biological processes and the shaping of environmental relationships. Landscape in political ecology tends towards the realization of application or expression of power that has significant material consequences for individual and collective livelihoods (Neuman 2011; Walker and Formann 2003; Robbins and Sharp 2003). During the past decade, a subfield of urban political ecology has emerged that focuses on how representations of urban landscapes shape and are reshaped by political contestations of land use, relying to a great extent on how the demand for natural amenities in an area contribute to such landscape change (Robbins and Sharp 2003; Keil, 2003, 2006; Heynen, Kaika and Swyngedouw 2006). Eschewing the "crude binary ruling of city versus the environment" (Heynen, Kaika and Swyngedouw 2006: 3) researchers have studied the transformations of urban and rural landscapes through material flows and amenity migration (Gosnall & Abrams 2012; Wu and Plantinga 2003; Rudzitis 1996), that point to the level of natural amenities as a primary force in future landscape alterations, as more and more people demand their own piece of nature. The urban landscape transformation is of particular importance in research regarding the discourse of nature vs. city (Hurley 2005; Cadiuex 2009), and the contextuality of planning domains, politics and scale (Quastel 2009; Meadowcroft 2002; Bulkeley 2005; Walker & Hurley 2011).

Geography of Scalar Planning

Key human geography concepts such as scale, place, and landscape are critical concepts in political ecology studies because they are analytical foci from which struggles over landscape meaning, land use change, and cultural production of nature under policy and capitalism can be assessed (see for example: Zimmerer 1999; Robbins 2001, 2004; Walker and Hurley 2011; Cadieux and Hurley and Hurley 2009; see Neuman 2011 for an extensive review on the political ecology of landscape). Driven by a central interest in socio-ecological transformations, most political ecology studies have highlighted the material aspects of landscape from multiple angles, including how hierarchies among political scales effect land use change (Bulkeley 2005) and landscape effects macro-economic policy (Zimmerer 1999). A common thread in this literature is the perceived shift in environmental governance, that is, the (nation)-state has been "hollowed out" (Reed and Bruyneel 2010) with its environmental management functions redistributed downwards (to state/regional/local authorities) and outward (to citizen actors). These new *geographies of governance* (Meadowcroft 2002) require that scale and scalar hierarchies, be re-conceptualized. This has specific implications to WHI planning, because the while there is a downward shift in environmental governance to be local and outside of the state, the framework to work with in planning is vertically predicated. Human geographers and political ecologists are likely to perceive scale as "continuously defined, contested and reconstructed based on power relations between actors across political and economic levels" (Silver 2009: 925). Societal and ecological processes work together to articulate different scalar forms of organization (e.g. planning commissions) in order to frame environmental problems and their resolutions (Reed and Bruyneel 2010, Heynen, Kaika and Swyngedouw 2006). Neuman's (2009) broad review of political ecology's notion of scale suggested that to understand environmental policy, attention should be paid to the power asymmetries embedded in networked relations within and between scales. The asymmetry of goals 5 and 9 is embedded in the relation among planning scales which in turn produces a material consequence of differing land use evaluations.

Underpinning an interpretation of the politics of scale as a *geography of scale* (Quastel 2009; Bulkeley 2005) is an acknowledgment of the importance of ecological context in the defining of social relations in particular scales. This suggests that two of the most common metaphors for describing relations between scales, detailed by Bulkeley (2005), that of a 'ladder' (stacked scales), or 'Russian dolls' (discrete scales are nested within one another) no longer suffice (Bulkeley 2005: 884). Consequently, in conceptualizing scales in planning, it should be recognized that "scales evolve relationally within tangled hierarchies and disperse inter-scalar networks, so that the articulation of social processes [e.g. planning decisions] hinges upon its embeddedness within dense webs of relations to other scales and *spaces*" (Brenner 2001: 605, in Bulkeley 2005, emphasis original, [author's note]). The very process of enrolling particular actors and networks into scalar constructions is part of the politics and geography of scaling (Bulkeley 2005).

I defined the scalar planning of WHI with the recognition that what constitutes the state, regional, and local is materially and socially constructed, but also with an acknowledgement that although these three scales are composed of both vertical ('ladder') and horizontal ('network') elements, they are more strongly delineated by the vertical relationship between them. Due to the Oregon's strategic planning goals and strong regulatory structure, against which state, regional and local scales are defined, a scale's ability to negotiate new evaluations of place (e.g. cost-benefits of development) is somewhat limited.

Towards a Political Ecology of Natural Amenities and Scale

Unlike scale, Blaikie and Brookfield (1987) did not explicitly invoke the concept of landscape in their seminal work in the 'basis for theory construction' in political ecology (Neuman 2011). Nevertheless, there are many ways political ecologists engage with landscape: through contested built environments, struggles over the meaning of nature in the city, the clash between amenity-livelihoods and traditional agriculture or forestry livelihoods in rural landscapes, and the social and material forces of land use change (Neuman 2011). Natural amenities research is brought into a framework of political ecology in two main ways: first, by a recognition that unique or attractive biophysical settings move human institutions to make decisions about a certain landscape. All land use decisions- so the entire planning process- starts first with observing and assessing the attributes of the land (Visa and Carruthers 2009). Land use change (via zoning and building) is shaped by people, but people first respond to the materiality of the landscape[16]. Abrams and Gosnell (2012) argue that the inherent value of place to stakeholders in planning decisions is difficult to make explicit because it is highly subjective- therefore natural amenities are economically quantified and evaluated so that land use decisions are consistently made to reflect market behavior. Natural amenities are experienced subjectively and come laden with assumptions of ownership of nature. Explicit discussions of what stakeholders mean by the value of natural amenities, not just in dollar terms, may improve the framing of land use issues.

Tensions between the environment and the realities of a market society are most apparent in planning, because decisions are made in the process that determine how landscape resources will be consumed, how used. Political ecologists and critical geographers have argued urban planning is a strategy to ease tensions between environment and market, and to construct "subjectivities conducive to the often contradictory demands of nature and city" (Brand, 2007: 617, see also Bulkeley 2005; Walker 2005; Cadieux and Hurley 2009). Often research in natural amenities in political ecology focus on the individual consumption of attractive landscapes, buying and parceling natural land to have their 'own piece' of the rural idyll. Indeed, WHI experts also focused to a great extent on how this attitude creates and exacerbates the problem of rural sprawl, and low intensity development inside the UGB. A demand for non-regulatory, individualized, approaches to conservation of natural resources is most often reflected in the local scale, which maps back to the widely observed downward

[16] see for example: Walker and Hurley 2011; Robbins 2001; Keller and Vance 2013 regarding landscape pattern influence in institutional or household behavior

shift in environmental governance (Reed and Bruyneel 2010). Ironically, this scale is also associated with strong opposition to the neo-liberalization of land use, parcelization of land driven by elite interests exempt from regulation (Robbins 2001, Heynen, Kaika and Swyngedouw 2006). This may appear to be a contradiction of interests, but makes sense in certain contexts, such as WHI. Moving ownership of WHI into local environmental manager hands means it does not need to move through official channels to justify urban habitat, and in fact environmental NGOs in the region have proposed a coalition to purchase WHI for conservation[17]. In the long term, this method is less secure than having a conservation ethic built into a scaled planning system, and thereby continually reconstructed and reinforced by scale so that new owners are also held accountable to the environment (Walker and Hurley 2011).

2. Oregon's Planning Legacy

The Development of Oregon Planning

Until 1969, urban growth in Oregon, as elsewhere in the U.S. was haphazard and largely unregulated, and zoning as a planning tool only used in cities (Walker & Hurley 2011). By the mid-1960s, farmers and foresters in the state faced major threats to their livelihoods by uninhibited sprawl into prime natural resource land. Surrounded by the state's richest farmland and most valuable forestland, cities in the Willamette valley (Portland included) became the center of Oregon's growing economy.

Although Oregon is justly recognized for leading in environmental policy and for environmental awareness in general[18], the Oregon planning system was more a product of economic concerns from farmers and foresters, who wanted livelihood security, and of developers and homebuyers who wanted to avoid "not-in-my-backyard" (NIMBY) lawsuits from neighbors via a system that regulates land use in more predictable, accountable ways. Economic reasons, seeded in the burgeoning environmentalism movement paved the way for regulated land use planning in Oregon in the form of Senate Bill (SB) 100, signed into law by Governor Tom McCall in 1973, which established land use planning as a statewide regulated, mandated process via the use of tight urban growth boundaries. A UGB is a line drawn around a metropolitan area that delineates where urbanization is allowed. Nowadays, local jurisdictions must plan for and contain urban development in a manner acceptable to the

[17] Audubon Society Portland. January 10, 2014, Interview 1.

[18] As described further by Walker and Hurley (2011), political leaders have long pointed to Oregon as a model for the U.S. of enlightened planning and energy policy, and it is no coincidence that Oregon is fictionalized as the center of environmental-utopias (such as Callenbach's 1975 book, *Ecotopia).*

SB100 established Land Conservation and Development Commission (LCDC).

While the Oregon system is comprehensive in its approach to planning, only the Portland metropolitan area has worked in principled regional planning, through its own elected regional government known as Portland Metro (Metro). Metro has oversight of 25 separate municipal jurisdictions, including Portland. Established in 1977, Metro remains the only regional government in the U.S. (Walker and Hurley 2011). Metro has been among the fastest and most continuously growing urban centers in Oregon, and one of the fastest growing in the US Pacific Northwest. All individual planners and local stakeholders (e.g. within local city jurisdictions) must find a way to accommodate land requirements in the Metro forecasts while providing adequate efforts in urban infill strategies.

3. Methodology

Design

For this case study, I drew from a wide range of qualitative data sources: expert interviews, WHI plan documents, other planning documents, editorials, presentations in WHI meetings, and field photography. Key among these sources that underpin the case study and show WHI to be an atypical, illustrative case were the expert interviews. Participants were chosen selectively as representatives of the WHI Advisory Council (local scale actors), or as representatives of the Bureau of Planning and Sustainability (BPS), WHI planners (regional scale actors), or as district-level representatives of the BPS or Portland Metro (state scale actors). The participants were also selected on grounds for their past involvement in planning projects in Portland, experience with the Port of Portland, relative concern for goal 5 and 9, and their level of involvement with the WHI planning process (see Table 1 below).

I chose WHI as my case study because it is a highly valuable piece of land, with apparent far-reaching negative consequences for either development or non-development: a situation not uncommon to many urban areas in the world. Therefore, the atypical result of WHI (non-development) serves as an illustrative example to alternative outcomes in similarly contested patches of land in urban areas besides Portland.

Data Collection

I conducted ten semi-structured expert interviews with eight individual stakeholders in the planning of WHI and/or Portland Metro area. Additionally, I reviewed documents pertaining to the WHI Plan, including official city and Metro documents, the 2040 Growth Strategy-Comprehensive Plan of Portland, newspaper articles, editorials, and participating in the WHI working group from the Portland State University National Science Foundation's Integrative Graduate Education and Research Traineeship (NSF-IGERT). The interviews were conducted from January to March 2014, after completing an Institutional Review Board (IRB) for Protection of Human Subjects in Research process[19].

The interviews were an average of an hour and a half in length, recorded, and guided using an interview guide (see Appendix C, I). I manually transcribed the interviews and segmented all qualitative text data into units which were coded under specific themes (the same theoretical concepts of scale and landscape used to draft the interview guide).

Table 1. Participant Background and Role in WHI Plan

Participant	Representative of BPS	Representative of Regional Public Agency	Representative of Environmental NGO	Member of WHI Advisory Council/Planning Commission	Past Experience with Port of Portland	Goal 5 Oriented	Goal 9 Oriented	Scale: **L**ocal/ **R**egional/**S**tate	**D**irect/**In**direct Involvement with WHI Plan
1			X	X	X	X		L	D
2		X		X	X	X		L	D
3	X			X	X	**X****	X	R	D
4	X			X	X	X	**X****	R	D
5	X				X		X	R	I
6		X			DK *		X	S	I
7	X				X		X	S	I
8			X	X	X	X		L	D

DK* = answer not given. **X**** = more oriented towards

Data Analysis

The qualitative text data I coded and analyzed using the method of qualitative content analysis (QCA). Content analysis is a general term for a method that systematically approaches qualitative data to reduce its mass into smaller themes that can be counted, related, and fit into patterns that explain a research question. The themes (findings) are then re-contextualized to relate to observed phenomena. Content analysis was widely used first in quantitative research, with a focus on themes or other indicators' frequencies and differentiation of content (Schreier 2012). Later, when first introduced in the social sciences, content analysis was applied to exploratory research questions with a focus on the interrelations of textual categories (Schreier 2012: 13). In Qualitative Content Analysis (QCA), this systematic feature has remained as its most distinctive feature, but approaches instead the complex constructed

[19] The IRB process included a letter of consent and purpose of research given to each participant prior to the interview. Example of letter in Appendix C, II.

meanings that comprise qualitative data in order to reduce implicit and explicit layers of meaning into categories that inform a research goal. By subsuming specific text or other material under a category, the specific information is transformed to represent a general concept, while simultaneously producing new information about how cases compare (Schreier 2012: 9). Other qualitative approaches to analyzing qualitative data, such as open coding, semiotics, discourse analysis etc., while invaluable for grounded theory, are cumbersome and sometimes leave the researcher without concrete direction, because there are no explicit a priori theoretically derived assumptions about the data. These approaches form a holistic view of the qualitative data. QCA also allows new concepts to emerge but the research question determines how the data will be examined in a way that is confined to a theory-derived framework (Schreier 2012).

After an initial review of the data, the relevant material is selected and a coding frame is constructed to explain the material. A review of the relevant data allows sub-themes to emerge from the data that pertain to a particular context, process, or other phenomena the researcher is interested in building into the coding frame. Thereby, a coding frame is generated that *directly* informs a research question from both guided constructs to define, and data derived concepts to refine the material. Using QCA, my coding frame began with a theoretical main themes in order to frame the relevant material for my analysis. I then transcribed the material and generated subthemes from the text that appeared in a data-derived iterative process (Schreier 2012; Hsieh and Shannon 2005). After the segmentation of all material into coding units, I used a portion of this material as a pilot coding run, to test my coding frame. The coding framework was first tested for validity on a pilot run of half the interview material and one editorial piece. To test for reliability, a second coder was given the pilot coding framework and asked to code one of the interviews, segmented into the coding units I created. At this stage, usually a revision of the coding frame is necessary to better fit the material (see Schreier 2012 for detailed coding stages). The resulting inter-coder reliability (53%) warranted a revision of the coding frame's subcategories, but all main categories matched. A second blind coding test was made with the improved framework, and resulted in an acceptable inter-coder reliability coefficient (70%). The coding frame is provided in full in Appendix C, III. I then coded all material using the improved QCA framework, and because I was the only coder, conducted two rounds of main coding, two weeks apart to improve the validity of the coding process.

The results I compiled in a coding matrix to look for patterns and count coding unit frequencies. I then created the overall code matrix to assess frequencies and co-occurrences of codes (see Appendix C, VI). Afterward, I compiled codes according to scale typology: local, regional and state. I then created a text matrix (see Appendix C, V for example) according to scale that paraphrased participant's typical (most frequent) quotes from the interviews that relate to each code. The text matrix allowed easier comparison of participant's and other material's themes, while at the same time allowed re-contextualization of the themes into the larger picture of WHI, and planning in Portland. My analysis is based on the central themes of scalar planning, adapted from the foci in the geography of scales identified by Robbins (2004), Bulkeley (2005), and Reed and Bruyneel (2010). Specifically:

1) Who has what level of environmental access and control? and;

2) Does this discourse of environmental governance differ among scales?

Through the interviews, I found that participants talk about nature- the value of land and environmental issues- differ according to scale. I applied codes from my coding frame to the interviews and documents. After compiling these codes into an overall coding matrix (see Appendix C V) I was able to see an assemblage of codes that were particular to local, regional and state scales.

To summarize, QCA is a method that reduces the mass of rich qualitative data gathered from the field to a manageable, organized structure. This structure is built first by conceptual themes from theory I used to frame my interviews, but after the transcription of interviews, QCA allows the derivation of a coding frame that is expanded and enriched by inductive, data-derived themes the interview participants bring up themselves. The conceptual themes focus the material, but the majority of categories that are inducted make up the body of the coding frame, and therefore the majority of findings. In the following section I discuss the ecological, economic and historical context of WHI. Additionally, I provide a 'chain of events' for the WHI Plan and other contextual information regarding the planning process of WHI and the region taken from the interviews. I present the results and interpretation after the case background.

4. Case Background

Figure 1. Crossing Columbia River after passing through Hayden Island.

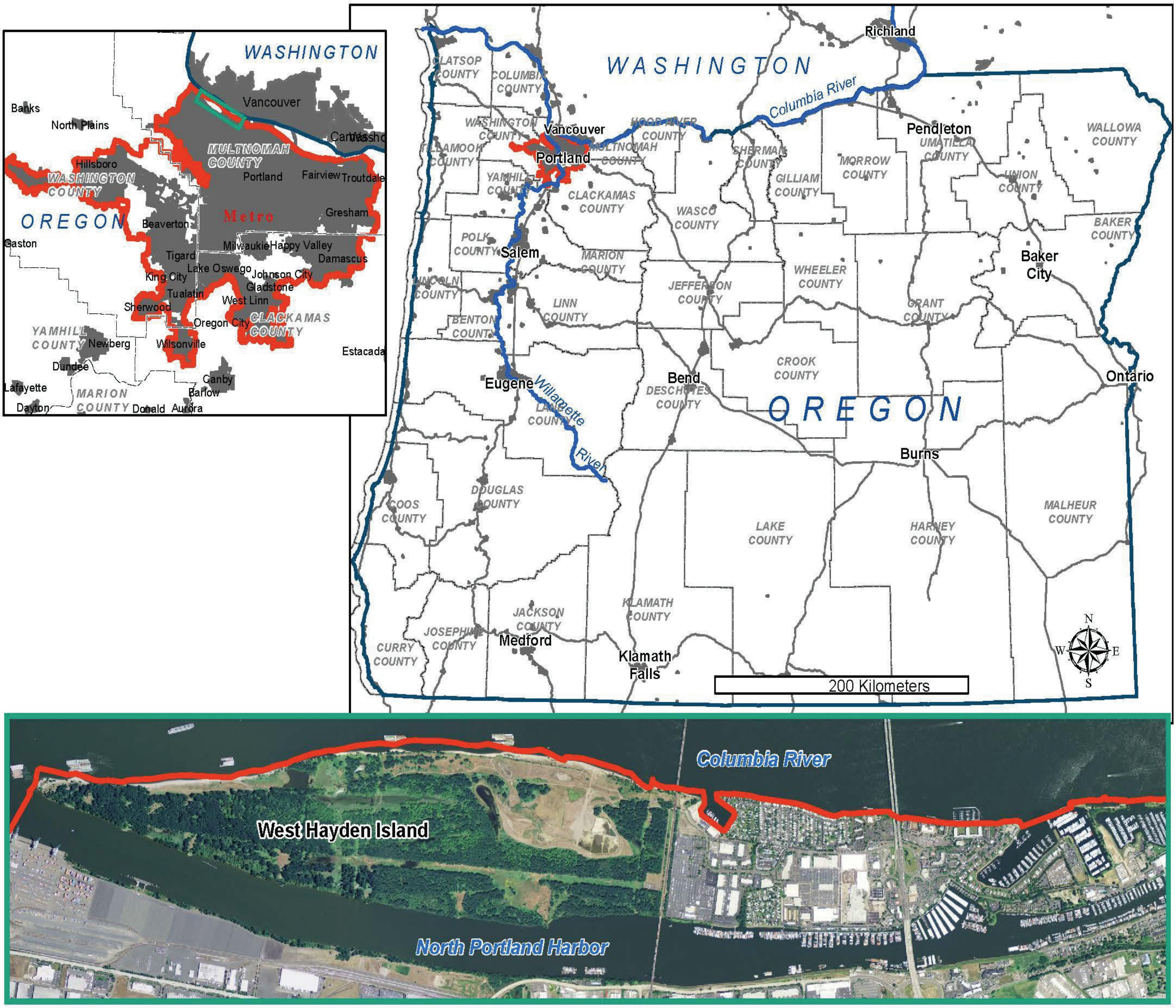
Figure 2. East Hayden residents.

Figure 3. West Hayden residents and Port property.

Setting

West Hayden Island (WHI) is the western part of Hayden Island, divided physically, socially, and economically by an Interstate-Highway (Figure 1). WHI is located at the northern fringe of the Metro (refer to Map 1, below). East Hayden Island has long been a residential zone populated by mid-to high-income individual households (house*boats*, rather) with a smaller residential zone to its west consisting of a mobile home park and low-income households (see Figures 2 and 3, respectively). West Hayden Island was not annexed as a part of Portland until 1983, brought into the UGB with a specific intent of potential industrial port development, as it was deemed by Metro to "satisfy a long term regional need for water-dependent, marine terminal and industrial facilities" (Metro 1983). Later, in 2004, it was identified as a Regionally Significant Industrial Area (RSIA) by Metro, defined as a site with unique characteristics suited for industry that are rare in the metro area. Shortly after, in 2005, it was designated as a Moderately Significant Habitat, again by Metro, for it's unique and to a great extent, irreplaceable habitat as an important ecological link to the region. As the interviews will show later, the designation of "moderate" rather than "high" was likely a strategic decision by Metro, because WHI already had the RSIA designation and the development intent by the Port of Portland. The same landscape pattern of the island, its composition of species, terrain, and location at the confluence of two major rivers near the Pacific Ocean was used to justify its uniqueness as a habitat reserve or industrial marine port. Likewise, WHI's low income community was used to justify the need of family wage jobs industry would bring (though, there was no hiring preference clause of the local community in any of the plans). A counter point to this, the local scale demanded a community health analysis that undermined the position of the Port because it demonstrated a clear health risk to local residents, and little to no community aid (WHI Commissioner letter, PSC Recommended Draft 2012). I chose WHI as my case study because it is a highly valuable piece of land, with apparent far-reaching negative consequences for either development or non-development: a situation not uncommon to many urban areas in the world. Figure 6 (see page 75), displays the history, land acquisitions and planning process of WHI.

Map 1. Portland Metro and West Hayden Island



Ecological relevance

Hayden Island originated as a mid-channel bar in a shallow portion of the Columbia and grew into a series of islands, shoals and channels, based on early survey maps of the region. One of the earliest survey maps is from the explorers Lewis and Clark in 1805, and called the network of sandbanks, "Image Canoe Island" (Historical Society Portland, 2011). Subsequent dikes placed along the island, placement of fill on the island, the dredging of areas for boats and other construction to stabilize the bank have been instrumental in forming the single land mass it is today. Despite being largely built, it hosts a highly bio-diverse landscape, provides important habitat, environmental risk reduction and pollution filtering services. WHI is situated at the confluence of the Columbia and Willamette Rivers (nine miles north of central Portland). The rivers are part of the Columbia River drainage, a 414,400-km^2 basin that includes territory in seven states (Oregon, Washington, Idaho, Montana, Nevada, Wyoming, and Utah) and British Columbia. The Columbia River flows for more than 1,200 miles, from the base of the Canadian Rockies in southeastern British Columbia to the Pacific Ocean at Astoria, Oregon, making it a vital salmon and other endangered aquatic species river (BPS 2012). WHI is 800+ acres of relatively undeveloped land. Wildlife habitats on WHI support a variety of mammal, bird, reptile, amphibian and insect species. A number of studies in the 1990s identified seven species of mammals, 81 species of birds, two amphibian species, nine butterfly and moth species and six aquatic insect species. There are meadows, wetlands, open sandy fill areas, beaches, and shallow water areas (BPS 2012). WHI is an important stopping ground for salmon, steelhead and lamprey as they migrate past Hayden Island to upstream spawning grounds and for their offspring going back to the Pacific Ocean. During this migration, the salmon depend on the combination of the deep channel and shallow water habitat of which Hayden Island is a vital part. Many endangered species have been observed on WHI, including the bald eagle, willow flycatcher, and painted turtle (BPS 2012). It also has endangered habitats: the last remaining contiguous patch of black cottonwood forest along

Fig. 4 WHI forested interior

the entire length of the Columbia River, and a large portion of the remnant Willamette prairie. Both are vital for these listed species, roosting, nesting, feeding and dwelling. Regionally Hayden Island is part of a network of islands and mainland riparian corridors vital for a healthy Lower Columbia Estuary.

Economic relevance

WHI was originally owned by Portland General Electric (PGE) Company for potential industrial uses. In 1983, while under PGE's ownership, the island was included in Metro's UGB to serve marine industrial needs, and in 1984 was deemed more significant as a port than the unique aspects of the Island's habitat. "Given the great importance of marine industrial facilities to the social and economic growth and vitality of the region, and that there are no alternative sites for deep draft marine industrial facilities, the positive social and economic consequences of an urban designation clearly outweigh the environmental consequences" (Metro 1983).
Ten years later, the Port of Portland purchased the PGE properties for marine industrial development, after PGE had already completed an Environmental Impact Statement in 1987 for future development of WHI.

Portland has a long legacy of being industrial, and much of its image is bound in maintaining this "gritty side" of a port city. Beyond image, industry in the region provides important mid range- family wage- jobs, which enables the city to maintain its slight majority in mid-income households in the income distribution of the city. Like elsewhere in developed nations, the trend is increasingly towards a shrinking middle class, with the most growth in the very low income and highest income brackets. Adding to this, Portland's population is forecasted to double by 2040, with only a moderate increase in jobs, and even fewer of those in industrial/manufacturing. To accommodate any growth in industrial and manufacturing jobs, Portland needs to zone 625 acres of vacant land to industrial- the calculated industrial lands need from the Goal 9 process. Because "half of our short fall is just for this marine industrial land,[20]" the economic value of using WHI as a marine industrial zone is clear. An economic/land use planner explained that new investors

Fig. 5. Railroad bridge on Hayden Island

[20] Bureau of Planning. February 5, 2014, Interview 7

(industry) will not locate in already damaged sites, elevating the value of a greenfield like WHI:

> "…400 was the shortfall calculation for 2040. WHI has 300 acres of potential marine industrial land, the reason it's designated a RSIA, is we have a shortfall there in the harbor access lands. The vacant land has been built out, so what's left, is brownfields. Try to get an investor to locate on brownfields- it's too expensive, and a large constraint for Portland" (7.20)

The Port is situated in the regional scale in my analysis, because it is a major regional landowner and developer, and as such directly influences regional planning in the Metro. The Port is so often and highly involved in regional planning, that they have become a quasi-public agency (their employees are on federal pensions, and the Port can sometimes use federal funds), which is one of the primary reasons they seek and gain support of the City for its plans.

Figure 6. WHI Timeline

1805	Lewis & Clark *Image Canoe Camp*
1920s	Renamed *Portland* from *Stumptown* to reflect the city's role as major shipping hub for grain and lumber
…	Columbia increasingly sandy, dredging, building banks
1940s	WHI one land mass
1960s	High-tech industry moves in
1969	Senate Bill 100, Oregon Statewide Planning established
1973	19 State Planning Goals; 1000 Friends of Oregon established
1977	Metro established
1979	Portland's first UGB
1983	PGE purchase
1984	WHI included in UGB for industry
1990s	Update on Metro area natural resources
1994	Port of Portland purchase
2004	WHI designated RSIA
2005	WHI designated *Moderate Habitat Significance*
2011	Third UGB expansion, 2040 Growth Strategy process begins
2012	WHI process in full, Port signs Intergovernmental Agreement to manage WHI; WHI Natural Resource Inventory
Sept-Oct 2013	Final WHI Plan
Jan. 2014	Port withdraws, WHI plan shelved

5. WHI Plan background

A plan was drafted to attempt an unprecedented strategy to strictly limit port development while enhancing the local environment. In the process, many different stakeholders were enrolled as either part of the Bureau of Planning and Sustainability Commission, or a special Advisory Committee for WHI. WHI was intended to be a legacy project: a case where a sustainable development plan succeeded in bringing the economy and environment together. Sustainability, however, meant a very costly environmental mitigation obligation for the Port in the first WHI drafted plan.

To the natural resource managers in the region this decision was laudable, because WHI represented an irreplaceable habitat; its ecological functions that service the region could not be made up for by environmental restoration elsewhere. The Port of Portland also saw this island as irreplaceable, but for vital industrial land. There is no other site large enough along the river with a channel next to it deep enough for ocean-going vessels[21]. Adding to this is the Port's own perceptions of its role as the economic sustainer of the region.

After an election of a new mayor, Charlie Hales, the developer stakeholders in the process saw the motivation for port development was no longer a strong supporting force. "Sticker shock[22]" from the environmental mitigation needed for a true cohabitation of nature and industry moved the Port to draft an alternative plan, that was to comply with federal and state regulations only, and not the additional restoration demanded by local scale advocates.

Due to the now extensive transmission of local scale concerns to the regional scale (Bureau of Planning and Sustainability, BPS), the Planning Commission produced a natural resource inventory analysis that, in 400 pages, demonstrated the high value of WHI ecologically and countered the Metro evaluation of WHI as 'moderate' habitat. This natural resource inventory had input by a panel of federal, state, and local natural resource experts and economic managers, including representatives from the U.S. Fish and Wildlife Service, two primary Oregon universities, Audubon Society (environmental NGO) and the Port of Portland. This report concluded that WHI is highly valuable because it is natural open space in a highly urbanized area. Without it, species would not be able to move through the urban landscape, environmental risks associated with flooding, water and soil quality would increase, and local community health impacted (BPS 2012b). One frustrated expert highlighted this problem of determining the value of WHI:

> The Port has claimed: this island has no value, it's all surrounded by urbanization, it's just a open space to be used. In fact, USFW has come through to say that WHI would be valuable where-ever it would be located, but because of where it's located its even more valuable, due to it's surrounding by mostly urban landscape, for migratory species (1.29)

[21] This is disputed, see for example: Audubon Society Portland, WHI Letter 2013.

[22] Bureau of Planning and Sustainability: January 28, 2014, Interview 4.

When the Port announced it would shelve its plans for WHI in January 2014, some local and regional stakeholders saw this turn of events as a nod to the real cost of the environment, that when environment is valued in real dollars, the costs rival that of brownfield and/or vacant lot revitalization that discourage developers. If that were the only reason, development would not occur in many places that are developed. Additionally, the Port may have had access to some federal funds to comply with the extensive mitigation[23]. Rather, this was a reflection of the scalar politics of planning. The decision was made outside of economic and environmental reasons, it was a political decision made that, on the one hand, reflected a current ideal of the city as “green” over (industrial) “gritty,” and on the other, to halt a politically contested, resource-intensive process that would likely resurface a few years later:

> So this is the second time it’s failed, to annex it, and through all this, there’s been a tremendous amount spent on the process, and no tangible results (1.7)

6. Results and Interpretation

I found two over-arching scalar tensions that bear upon the experience and evaluation of WHI:

1) Natural amenities of WHI make the island highly valuable urban property, deployed as reasons both for and against development;

2) State goals 5 and 9 underscores the way individuals relate ‘best practice’ for WHI, corresponding to scale hierarchies.

By far the most frequent problem discussed from local stakeholders, was the lack of access and control they had to appropriate land use decisions compared to their colleagues in regional or state scales whose interests aligned more closely with ensuring economic efficiency. The frequency of this theme appearing in a coding unit was 189 out of 470 total coding units, compared to the second highest frequency (the goal 5 sub-theme, that relates to the asymmetry of the Planning Goals) of 110/470. This recurrent conflict between environmental and economic stakeholders is unsurprising, given it is a tension noted globally in urban planning (Reed and Bruyneel 2010). Tensions between environmental and economic

[23] Speculation based on past Port experience in environmental mitigations: Portland Parks and Recreation. January 13, 2014, Interview 2.

stakeholders are heightened especially in Portland with its widely circulated eco-city image:

> …air quality, water quality, and we have a system in Portland that's failing, we have a super fund site, we have listed salmon, we have just dealt with our CSO problems, we have tremendous problems for a "green city" (1.53).

Given this, it is clear why some planning stakeholders strongly favor preserving WHI as a natural area within the city, to alleviate environmental risks and maintain working ecosystems in the city. However, further contextualization of these issues related to a nature/city dichotomy is necessary to understand WHI's value as part of the city.

Theme 1. Natural Amenities of WHI

The different scales have different operating assumptions about urban ecosystems and their function in the city. Because the scales have different abilities to leverage their influence on policy, agreement is difficult to achieve due to the frustrations that arise when individuals start from differing underlying assumptions of natural features. The natural features of WHI: size, location and ecology, translates to each scale it's suitability for development of a port terminal (state scale), both development and targeted environmental mitigation (regional scale), and maintenance/enhancement of this large island habitat in an urban ecological system (local scale).

> The Pacific N.W., in a national system, the rail and shipping lines are interested mainly because of heavy cargo, grain and dry bulk. The railroads come here and where the make the biggest profits. And to a great extent the harbor is here because the railroads are here. The Columbia offers an at grade way through the cascades- very advantageous for the heavy stuff. So these new marine terminals tend to be 100 acres or larger in size because the railroads want a unit train rail loop: so big sites. We don't have any big sites left here for a rail loop. So the only opportunity, inside the UGB is WHI, and that's why Metro included it in 1983 (7.05, state)

> we have this limited supply of land we can pick from to develop a big port. And, it's all on the river. It's all impacting habitat. It's not like you get to choose someplace that's not going to have impacts. They all have impacts. And, so automatically you've set up, just by virtue of what it is, that really difficult rub: you're going to have impacts on habitat, you're going to have impacts on people that live there, and there's no other place to do it, so we try to balance as best we can the resource and economics of the place. (3.37, regional)

> A big focus of ours is restoring the river, and Hayden Island is a critical part of this, our argument: [WHI's] size, location, complex habitat mosaics is simply irreplaceable. You can't

> mitigate for this somewhere else, because you need these acreage sites to connect ecosystems; it doesn't make sense to mitigate elsewhere (1.28, local)

One of the central ways that nature discourses come into tension has to do with the value of natural amenities in relation to the UGB (refer to Table 2 Appendix C, IV). This meaning is often not specified in planning, demonstrated above. There is also disagreement among scales of how natural amenities in the city are assessed for land use decisions. The extent of nature, or amount of natural amenities, needed inside the UGB is not agreed upon across scales.

Theme 2. The Statewide Planning Goals

The planning system in Oregon is built upon 19 Statewide Planning Goals, each goal representing a specific land use issues. While most Goals have bearing on development processes in Oregon, Goal 5 "Natural Resources, Scenic and Historic Areas, and Open Spaces" and Goal 9 "Economy of the State," are most relevant: after transcribing the interviews I found they were the only two goals discussed. In a follow-up interview with one regional planner, it became clear that in most planning projects for the larger cities in Oregon, it is these goals that divide the issues and individual stakeholders.

In Oregon's largest city, the weight of these two goals in particular is heavy. Goals 5 and 9 relate to very different possibilities for land use change, so are in a sense, inherently divisive. Goal 5, the goal environmental stakeholders are most active in reporting, is an inventory goal with the aim of protecting significant resources in Oregon. Goal 5 plays a key role in providing recommendations of how to balance land use (extraction of resources) and conservation of natural and historical areas. Local governments then designate and prepare a strategy to address significant sites (which can range from complete protection to none), but no implementation tools or need behind a drafted strategy.

Goal 9 plays a key role in mixed industrial and commercial land use to achieve economic growth. Goal 9 is not an inventory goal, rather, a requirement to actually go out and find available land that can be developed for industry to provide a base for a region's economic growth. In fact, Goal 9 has four requirements that pertain to: (1) conducting economic analyses of a region, (2) ensuring economic development opportunities in policy, (3) providing an adequate supply of sites for a variety of industrial and commercial uses, and (4) limit mixed use of these sites, in other words, industrial zones are for industry *not* industry with other land uses (DLCD 2011). Regional and economic planners in Portland metropolitan area consistently run against shortages of available land (without rezoning land, or revitalizing brownfields), but are still required to plan for adequate acreage for economic development.

The frequency of the sub-themes related to goals 9 and 5 highlights the tensions that arise in the asymmetry of the goals. Goal 5 is a process goal, and Goal 9 is a needs goal; goal 5 inventories the land that is, in fact, “open space,” along with the habitat and resources that inhabit this space, and goal 9 seeks to fulfill its acreage needs through such “open space.” Goal 5 will not generate (at least in the short term) jobs, while the aim of Goal 9 is to provide land now, to achieve economic growth. The imbalance between the goals is reinforced because scales responsible for one goal or the other, operate with different methods and political leverage (refer to Table 5, below). Many environmental stakeholders point to the very foundation that has made Oregon planning a long term success, as a reason why goal 5 is inherently ‘weaker’:

> This goes back to: there’s no place for nature in the city. Holding the UGB to protect farmland and forestland in particular. That’s the thing, the state planning program was founded on the basis of protecting farmland, not protecting natural resources. They didn’t give a shit about natural resources (8.44)

An asymmetry in the goals may lead certain stakeholders to perceive they have differing degrees of influence in the decision-making process depending on the current economic and political context (Bulkeley 2005). For example, the account below points to the different scale perceptions of how goal 5 advocates are valued in regional planning:

> I was discredited in a public meeting…and I learned a few things from this, I learned that federal agencies can work with corporate interests in this, that even people that were in the know about ecological value wouldn’t say it publically (1.11, local).

> So there is a stronger focus on goal 5, that has a nice feel to pull right in to…because I come from more of a natural resource background where it’s *good* to manage this for the birds and *good* to see this dollar amount with it that (justifies) is on par with some of the economic factors. This is certainly important in many cases, to see it on par with economic factors (3.18)

On the other hand, a stronger focus on goal 5, may lead to misguided urban growth, described at the state scale:

> Most of the problem of not having enough industrial land is all the rezoning to open space. But it’s to stop that trend, that loss, no more conversion of prime industrial, protection of these designations (7.29)

Table 2, below, highlights the relative roles of Goals 5 and 9 in the process of planning in Portland Metro. The salience of the goals to each stakeholder in the local, regional and state scales I infer from their corresponding goal discussion frequency (how many times the participant returned to the subject) throughout the interview. The perceived difference and imbalance of goals was also inferred from the context surrounding each time the goal was mentioned and co-occurance of 'tension' codes, such as "Enviros vs. Econs ," and "Clash of Portland Image," (refer to the coding frame in Appendix C, III for other tension codes).

Table 2: Influence of State Goals

Scale/ cases	Goal 5 count*	Goal 5 salience**	Goal 9 count*	Goal 9 salience **	Perceived difference in importance in planning	Perceived imbalance in stakeholder involvement	Interplay of Goals 5 & 9 in WHI
Local							
1	37	High	5	Low	High: 9 over 5	High	5 "won"
2	15	High	9	Medium	High: 9 over 5	High	More env. motivation than econ.
8	24	High	6	Low	High: 9 over 5	Medium	5 showed value, political move
Regional							
3	21	High	7	Medium	Relatively Balanced	Medium	More flexibility in goals
4	10	Medium	9	Medium	Relatively Balanced	Low	Raised the bar of 5
5	2	Low	11	High	Relatively Balanced	Low	Less economic need than originally thought
State							
6	0	Low	4	High	Low: 5 over 9	Low	Reflection of jobs/nature cycle-value nature more in this timeframe
7	1	Low	18	High	High:	Low	Political

					5 over 9		move to make no comprom ises for 9

* frequency in interview goal is at length discussed.
** the importance of goal to participant, most involved in goal inventories.

Theme 2. Political Context of State Goals

Experts' emphasis on the political aspect of WHI concerned how assumptions of need are policy based, which sets some local scale stakeholders at odds with the regional and state scales. It was a scalar shift that allowed goal 5 inventories equal footing to goal 9 needs. In other words, the mitigation package was calculated for *all* lost resources before these losses are "balanced out" by the expected gain in industrial land. If land use was balanced out first (e.g. satisfying goal 9, then looking to environment) the net cost of mitigating for environmental damage would have been lower:

> It tended to shock a few people about how expensive that actually would be, and I think on the community side too, an emerging part of the land use planning is bringing thatpublic health aspect into it too, it's not something that has been a part of it in the past, so tightly pulled in as we did in WHI. Cataloging all the impact and calculating the values for those- has a sticker shock to it (3.23)

> I guess my biggest input as a PSC was to really say: look, as a sustainability commission, we can really not allow development on WHI, that does not take into account **all** environmental impacts. And that, "penciling out" cannot be made on the backs of the environment and the local community (8.17)

The state scale saw this evaluation as overzealous, and that the Port expected exemption from much environmental mitigation, given the industrial lands need in Portland, its own envisioned role as a sustainer of the economy in Portland and that the package required 'above and beyond' federal mitigation requirements

> there's a regional interest in this Port, because we are a regional job core. Metro has said: we've exempted WHI from their title 3 obligation for floodplain mitigation. We've done our part to make this marketable, the City took a different stance on this, and required full mitigation for all these different types of environmental impacts and variations within those for riparian, upland, midland forest, floodplain, etc., and different mitigation for each that adds

> up to a lot of money. So different perceptions of importance. You don't hear that from Portland. It's not a "Portlandia[24]" view (7.59, state)

Individuals across the scales recognized this was an extensive mitigation package, though from the local scale the emphasis was on the actual ecological value of WHI was 'proved' to exceed economic benefits, whereas regional scale emphasis was on a mitigation package to maintain functioning habitat is not cheap.

A break among the scales occurred when it became clear the plan had a high mitigation package the state and regional scales would by and large not support. The larger scales found it too costly, but that the local scale (and environmental planners in the regional scale) found it to be accurate. Mayor Hales played a direct role because he did not want to question the work done by the City, nor be the one to uphold a deal created by the former Mayor Adams:

> I think, what people have lost sight of is, the port of Portland, didn't initiate this process. Sam Adams did. The last mayor, it was his legacy: he wanted to be able to say he brokered the deal that did the environment and the development together (8.31)

> I don't think Charlie Hales wanted to open. that. door. I don't think he wanted to put the city work that had been done up to the consultant work (2.61)

Although across scales generally it was seen as being largely politically driven, only the local scale saw the entire process initiated, sustained and ended by political force. The regional and state scales were more likely to describe Mayor or City involvement as 'tacit affirmations,' or that decisions are 'left in elected politicians hands.' This maps on to the tension in scalar planning because the local scale often lies outside higher decision-making, and thus perceives application of force more often than "communication of policy" (Reed and Bruyneel 2010).

Theme 2. State Goals' Conflict

Conflict in planning among scales that are expressed as goal imbalance actually stems from a perception of consistent bias towards economists and their recommendations:

The politics of needing to do an ecological analysis is not on par with the view of the need to do an economic analysis. The fascinating part of this though, the economic analyses are a lot of arm-waving, pretty loose in their projections and forecasting. Whereas in natural resources, we've identified, we've mapped, we know where everything is and needs to be, we've done the science: at every turn we need

[24] Refers to popular TV series in the U.S. about life in the zany, eco-local-organic white liberal Portland.

to justify why we may want to protect a piece of land, so the onus has been much greater, on the negative side, for us: you need to prove you need x number of trees, x number of feet of riparian habitat…whereas in the economic projections, it's pretty macro scale. There's a double whammy there for the natural resource side (8.42, local)

Primarily, issues regarding 'best practice' for land inside a diverse city arise from the so-called "chicken and egg" problem, because long term planning (20+ years) requires assumptions about future land needs wrought in contemporary urban contexts that vary in their temporal stability. In other words, a good decision today, may not be tomorrow. For example, these zoning decisions are made well in advance of ecological considerations (as was the case with the designation of WHI as a future industrial zone, before evaluating its resources). This is done because the opportunity to develop needs to be present before developers are interested in investing in a plot. However, this also presents local scale environmental stakeholders at a disadvantage in planning, because scale interests that align with developers can employ the land use designation, made a decade or more before, to justify their need, whereas scale interests aligned with environmental health must both discredit such designation and 'prove' a better use for that land:

> So I don't care what Metro did 15 years ago. First of all, I think you know, I testified in 1984 against bringing it into the UGB to begin with (8.19)

> And so in a lot of ways you have to make these decisions in the face of uncertainty of when you're going to get that client and actually develop it, Or not. Because economic forecasting, reading some of that stuff its like WOW, that is really challenging and you have to make a lot of assumptions about it. But also we can't wait to do long range planning to when you have a client, there has to be a way to set up an intention, and then market a site or an entire area for particular use. And that comes back to the rub, what do we want this to *be* in the future, and can we make all those things happen? (3.53)

For regional and state scales, the tension arises from perceived misrepresentation of what in reality is actually needed in order for a city to function and equitably support its residents:

> There's this image of white, highly educated, young Portland, and that's what's growing definitely. But still, there are diverse publics in the city. We have a lot of immigrants in the cities, and large portion of that diversity is in industry. The job workers are often not considered Portlanders, if they don't live here. But that's our big role as a city, as a *core* city. So-different perceptions of importance. Portland is more than that: Portland is multiple Portlands" (7.39)

Equity is a common term thrown about in plans, but is operationalized differently among the scales. In the state scale, often equity refers to supporting the state economy, supporting threatened livelihoods in other parts of the state that acts as ‘a rising tide’ that reverberates in the metro area, improving quality of life and alleviating income gaps. The regional scale operationalized equity as supporting middle-wage jobs in Portland, and so the Port’s lack of local community hiring preference was a sticking point for some regional experts. The local scale operationalized equity ironically quite like the state scale, though the concern was supporting the region and state *environmental* health as a foundation for a functioning, sustainable economy and moreover, human population. Additionally, it did not seem ‘equitable’ to the local scale if the terminal development increased the environmental risk for local residents, while not accruing immediate mid-wage jobs and profits. This scale was more likely to cite a U.S. Geological Survey report about the consequences of further island development in Portland as an example for equity concern. The USGS reported that undermining the functioning ecology of the metro area has far reaching and long term consequences for both the health of urban dwellers due to a large loss of species biodiversity, water quality, renewable resources, increased pollutant contributions to the rivers and superfund site and other environmental risks: especially flooding, high earthquake potential and the implications of the city’s ill-prepared infrastructure (USGS 2010).

7. Conclusion and Implications for Future Research

The future of WHI is disputed. The Port owes much to the City and region already in environmental mitigation for it’s contribution to the superfund site in the river, dredge spoils and other clean up issues from the Portland Harbor project. Many experts point to the potential as a huge mitigation bank, restoring the environment on WHI as a credit to development projects elsewhere. The Port could use it to mitigate for other developers, and thus has the potential to be profitable. A mitigation bank would not be as profitable as a shipping port, thus most experts believe that the Port will come back to the City to develop it in a more favorable political and economic context. On the one hand, the rigid asymmetry of economic over environmental aims in the planning goals and planning system almost guarantees future development of the island:

> 1 or 2 years later, we’ll see. There may be pressure on the Portland side of things, “hey be more reasonable, we do need jobs, we do need some good jobs…or pressure on the Port “you know you can afford a little more than 40 million, maybe 60 million…” everything is a dynamic, it changes (6.19, state)

> In a couple years, they'll come back. As long as they own a portion of it they'll come back asking to develop it…they don't want to lose that valuable land in the city, but they don't want to be in the land management business either- the *natural* land management business (2.39, local)

Concerning Goal 9, with WHI "off the table" as industrial land, the city is faced with an industrial lands shortfall, Goal 9 compliance issue, and a rigid planning framework in which to work. Small adjustments, exceptions, and quick 'fixes' to a system are easier than a system reconceptualization, despite a cross-scalar agreement that the Statewide Planning Goals need to be re-evaluated and adjusted to contemporary urban issues. Where and how to meet this shortfall will become increasingly heated as Portland approaches its 2040 Comprehensive Plan deadline, and may re-open the discussion of WHI suitability as port development.

On the other hand, the outcome after a future long zoning process may be the same. The "environmental side" has a strong report to refer to in a future process: a natural resource inventory conducted by the local and some regional scale stakeholders that demonstrates and updates WHI's ecological value from the original "moderate" designation from Metro done in the 1980s. The Port may therefore face exactly the same difficulties and political force, according to the local scale:

> We won on the cold hard facts of: is this going to benefit the region for the future of environment and health? No. That's why I feel like this isn't coming back, it won't be developed because the facts can't be avoided (1.46)

Additionally, a similar planning project in the area, the Columbia River Crossing (CRC), has been an on-again, off-again process for over a decade. Granted the CRC Plan involves discussions with different U.S. State planners (Washington and Oregon), but this is a case where all agree a new Columbia Plan is needed that more efficiently and safely links the two cities that span the river (Vancouver in Washington, Portland in Oregon). With the CRC Plan currently "off" again, the WHI Plan had less urgency to it for development. If the CRC moves "on" again, and succeeds, WHI will likely be re-opened for discussion. Most planners and environmental stakeholders see a cooperation of the two states as the best way forward for land use change in the region:

> …to really be successful, port of Portland, Vancouver, all the ports on the lower Columbia should be collaborating together. There's a lot of land out there that's already been degraded, already developed, that would be suitable for the kind of facility we were talking about on WHI, and that was never seriously addressed (8.37, local)

> The best outcome would be a regional economic center, a regional port, between the states. But that would require so large an analysis, so much time, that won't happen, So the ports compete, use land less efficiently (4.39, regional)

As indicated by the CRC, Hayden Island, and WHI plans, North Portland may be geographically cursed (or blessed, depending on the perspective) with it's access to the rivers, deep channels, large green spaces, and as UGB-fringe land that impedes stakeholder agreement and long term planning. Land use change research is needed in other high amenity, eco-oriented cities to assess how competing legacies of environment and industry contribute to the making of planning stalemates.

Implications for Sustainability

A problem expressed across scales is the need to re-evaluate ecological health as a common need. In the political context of pro-property rights, less government and strong individualism that is increasingly visible in Oregon as elsewhere, there is a tension between the individualistic values of private ownership (the parcelization of natural land) and functional, sustainable land use. Many attribute this to a clash between the "American dream of owning a large plot in which to build a large house and yard[25]", and the realities of contemporary urban ecological planning:

> Our neighbors aren't willing to set aside land, they feel like, if we have some parcel, then we account for the environment on theirs. Because of our tight UGB, land is a common good only when owned by public agencies (2.44, local)

> I'm curious, what the comparison is with Europe, Germany, because in America, you certainly have more pro-property rights, but also sense of this is my piece- I need my own space. In Europe you hear a lot more of these successes of common greens and all the kids play there. And everyone takes ownership of it. Unlike this 12X20 spot is mine. That's another issue, even the community space here is responsible to no one, and these areas are just, empty. No one uses them (4. 48, regional)

This has implications for how natural amenities, like WHI, are to be evaluated and communicated in future planning. If nature is interpreted as a common and *necessary* good, according to the local scale, the planning program may adapt to bring more lands under

[25] Bureau of Planning and Sustainability. January 28, Interview 4.

natural resource management use within the city. Co-habitation of nature and the city is key to ensuring regional ecosystem functions, which is integral to the region's sustainability:

> Any definition of sustainability has to include ecosystem function as its baseline- we have to do more than building green and actually retroactively redevelop our landscapes in ways that allow healthy ecosystem functions first and foremost, and in an era of global climate change, that's absolutely necessary. We're learning the hard way in Louisiana and New York for example, I mean, this is what happens when you do not deal with ecosystem functions. That's where any definition of sustainability and eco sensitively need to begin: Air quality, water quality, flooding, landslides, biodiversity all those- how do you create an interconnected system, that functions? (1.62)

Including more natural resources in the city does not necessarily make the entire urban system sustainable. Ensuring community health and dedication to local ecologies is also a key element of sustainability (Heynen, Kaika and Swyngedouw 2006; Zimmerer 1999). Thus, Portland's commitment to maintaining a middle class, equitable housing and jobs is important for the long term livability of the region. There does need to be, as state scale planners often referred to, a jobs/economy-quality of life/nature balance for an urban system to function: a "three legged stool" upon which the city rests on environment, economy, and community equity:

> The hope is, that you can balance economy and nature. You've got to have an economy, I mean, I've got two kids I'd like them to have jobs in future here etc., and yeah you hear that and you hear people say: yeah, I want that but I don't want it at the expense of degrading the natural environment (6.4, state)

> I feel like we can get there. But we can't get there on the same trajectory that we are undertaking. That is my opinion. I feel like it's like the whole logging situation- where, this is our way of life, this is how we've always done it, and you are taking this away from us, therefore, we are losing out, your economy is losing out. My thing is, well, with the Port, what is new and different here? I don't care how green you tell me you're going to build this terminal, because I've been in too many situations where green gets value engineered out, so it's all in the planning (2.48, local)

> Portland likes to talk about a three legged chair, and I use this analogy a lot, probably worn out, but that's a chair I wouldn't want to sit on, because the environmental and community legs get shorted- And what's interesting at Hayden island, is we got close to actually having that environmental leg as long as the economic one. We actually valued in real terms the cost

> to the environment, to the community and what it would take to make an even stool. And you Port, or you Port, City and State, you need to come up with that money. And suddenly, that project collapsed (1.5, local)

The planning framework as it is now limits co-habitation because it is still an economically driven planning system. The local and regional scales demand adaptable goals that correspond more closely to local contexts. This would allow exceptions of unique landscapes, like WHI, to exist within delineated urban areas. Sustainability means re-evaluating a necessary and laudable, but non-resilient planning system.

> there has to be flexibility in the goals too, and a lot of exploration is happening with our economic folks because they are exploring what goal 9 requires, and what flexibility there is within it (3.41)

Interestingly, another point that highlights difference in scales' interpretation of what entails the sustainability of cities is the language used to describe the environment of WHI and ecology of the region; what Cadiuex (2009) calls an individual's "nature discourse" (2009: 342). Whilst the regional and state scale used terms such as *patch*, *matrix*, or *corridor* to describe WHI's fit into the larger landscape, this typology of landscape terms presents a very anthropocentric view of the environment. These elements are the same as those identified in political landscape ecology as those that limit landscape to a human scale, managed for human use (McIntyre and Hobbs 1999). The regional and state scale discourse is one of "nature as urban management domain" (Cadieux 2009: 351). The local scale described the habitat in the city as a *link*, *system*, and *network,* which is in line with the "urban as integrated in nature domain discourse" (Cadieux 2009: 349) Seen this way, a patch can be mitigated for, or replaced with another patch or corridor somewhere else to be effectively managed. A 'vital link in a system' on the other hand, is something that if lost, affects an entire urban-ecological system. Again this depends on scale, regional and state scale individuals are likely to describe and attribute value to plans, projects, and value land according to built infrastructure. Because state and regional scales operate in a more anthropocentric sphere, these scales are less likely to incorporate the interdependencies of humans and environment in policy (Quastel 2009, Walker 2005). At the local scale, non-anthropogenic factors may play a more salient and prevalent role in the daily lives of individuals (Zimmerer 1999). People may not always be the most important element in a local scale, but they are always important at the regional and state scales. Therefore, what is vital to sustainably manage a region's society and ecology is transmitted through different language, where agents of change are interpreted to be either individual or collective.

Implications for further research

As the broad review articles by Taylor (2009) and, Gosnell and Abrams (2009) demonstrate, the majority of literature on transformations of landscape in urban and exurban settings has been oriented toward assessing policy and management considerations, whether in terms of ecological impacts or infrastructural needs. The focus of this literature has been on urbanization as a process that transforms landscapes in ways that produce a particular kind of place. I contributed to recent work in political ecology by extending the *process* of planning to incorporate aspects of landscape suitability for development and individuals' assessment of landscape. However, research is needed that use the perspectives of both process and more specific, biophysical, elements of place to develop examinations of urbanization as a co-created process that arises from landscape pattern and the experiences of planners. Specifically, are there cases where certain natural attributes demand a wider net of stakeholders to a planning process because they are more widely valued? How are certain values negotiated and transmitted through networks that operate up and down scale hierarchies? Uncovering how the process of planning is more or less tied to the place it is embedded within demands further case specific research in varied contexts to bring them into a global dialogue of urbanization.

Building on the work of Walker and Hurley (2011), Bulkeley (2005), Neumann (2009), Robbins and Sharp (2003) among others, further research is needed regarding the composition of scales in planning. Specifically seeking certain contexts (political, economic and environmental aspects) that serve to entrench or dislodge scale hierarchies in planning. This study has highlighted the relations among scales determines the communication of key assumptions for 'best practice' of land, evaluation and planning. Often these assumptions are not effectively transmitted across scales because individuals' tools and methods (e.g. the Planning Goals inventories) are bound by local, regional and state delineations of power. One particularly hot topic in recent decades has been the less-than-rigorously- defined idea of sprawl, a term referring to any- thing from low-density urban development to dispersed forms of urban expansion (Schneider and Woodcock 2008).

The sprawl discourse was a theme that was continually referenced throughout the interviews because (avoiding) sprawl is fundamental to the entire planning process. When so much energy is put into policy controlling sprawl, a shared assumption of what that exactly is, is important to build effective bridges from discourse to policy. Across the scales when asked to specifically define sprawl the definitions in general fell along terms such as "inefficient, horizontal, land extensive, low intensity development." All typically gave the same examples of "bad growth" in the city as the low intensity suburbs of Portland whose residents demand larger plots at the fringes of the boundary. When asked to define sprawl in their own terms, individuals found it challenging to define exactly:

> To me, I guess I would define sprawl by identifying the opposite of sprawl, which would be compact, multi-storey, urban development that mixes uses and is land efficient to the degree possible….But, overall I would say, sprawl is inefficient horizontal, use of land. A non-intense use of land. But when I'm thinking of it really I am of just the commercial and residential aspects of it, more than the industrial aspects of it. Was that a trick question? (laughs) (5.37)

Further research is needed that exemplifies how varied definitions of sprawl among key planning stakeholders is not made explicit when making decisions concerning growth policy. Different starting assumptions of sprawl may contribute to a mismatching of anti-sprawl policy, thereby undermining its applicability. Mismatched ideas of what exactly sprawl looks like and how it occurs likely speeds the process of fragmentation of rural landscapes, low-density transit and other sprawl related issues.

Studies of sprawl however, have focused primarily on the US, where land use data have proliferated in the past few years to corroborate that new growth is often discontinuous and extensive (Hasse and Lathrop, 2003). Research outside the US has begun to emerge using North American concepts of sprawl to describe trends in Europe and elsewhere (Antrop, 2004; Kasanko et al., 2006). As called for by Schneider and Woodcock (2008) direct comparisons need to be made between American metropolitan areas and those around the world, so as to assess whether the types of land conversion witnessed in the US are appropriate models for other regions/cultures of the world.

Further research is needed into how representational practices of landscapes underscore the significance of social, scaled relations of power at work in the making of land use decisions (Mitchell 2002; Ekers 2009; Neumann 1999, 2011). Scale- specific interests determine specific landscape representations, and thus stacks landscape representations-and their inherent value-hierarchically (Walker and Fortmann 2003). Understanding the ways such landscapes are represented in planning and policy—as well as how they are experienced- is necessary to growing a functional, sustainable city.

The planning of WHI has demonstrated how land use policy and consequential land use change is highly contested. Acreage calculations, land use needs and building types are all bound by rigid assumptions of how economy should function- reinforced and instituted within an extensive planning system. Ideals of urban landscapes, and the how to achieve a co-habitation of nature and society however, are fluid and highly responsive to contemporary political and environmental contexts applicable to unique *places*. Planning aims to reconcile place with economy, the local with the state, and contemporary with institutional. Oregon planning has a solid foundation and a good framework through which to move proposed development projects. State goals that include both industrial and environmental aims, to be hashed out among scales' stakeholders is necessary to communicate ideal, balanced urban landscapes. The problem arises when these ideals are not given equal footing in planning, because the system was founded to facilitate economic, resource production interests over resource conservation. Contemporary planning must conduct and assess cost-benefit analyses that capture both accurate costs to the environment, and accurate benefits of producing a different kind of place.

GENERAL CONCLUSION

Summary of most important findings

The aim of the first half of the dissertation was to locate quantifiable, significant factors from the natural systems in which we live. Studies one and two do not include intensive qualitative research into specific examples of household and/or community perceptions and activity the specific places in which they are located, because my framework demanded the intensive qualitative work to be at the end, after locating indirect influential mechanisms of natural systems. In the first half of the dissertation I located quantifiable, significant factors from the landscape that bear upon the social processes observed in these landscapes.

The first study found that people in Germany respond to larger landscape pattern factors such as open space or polluted land by driving more, but they drive less in highly diverse landscapes. Business density and distance to rail service had effects on car use that were significantly negative, however, this effect was small in comparison to fuel price. Though the magnitude of landscape pattern effects were certainly smaller than the well documented effects from economic and built environment factors (e.g. rail service frequency and fuel price), *ceteris paribus*, landscape mattered. This means that the relationship between even superficial processes such as willingness to drive or own a car are also influenced, directly and indirectly both, by the environment in which individuals live and work. Individual households self-locate in landscapes with similar household demographics while simultaneously responding to the environment in ways that reflect topographical limitations. Implications from this research point to the local landscape context as important to designing policy to reduce CO_2 emissions in Germany, as well as understanding increased car-use behavior in demanding more roads, and long-term land use consequences.

Motivated by the issue of urban sprawl and loss of ecosystem services in Europe, the second study found urban land in Germany increased by 5.7 percent in only six years despite no significant change in population size or density, GDP or other standard indicators of market growth that have been assumed to be the primary drivers of urban expansion. Urban growth occurred (1) because natural amenities are attractive for developers, (2) because fragmented land changes the perception of a single, worthy-of-conservation contiguous landscape to one that is already somewhat degraded and easy to develop. Urban growth is also correlated with socioeconomic indicators of GDP/capita, tax, and economic land value, but to a lesser extent given the small time frame of 2000-2006. Surprising then, is how much landscape matters in this context of driving urban land use change. Concerning among the findings is that urban growth is observed even in areas that are designated *Natura* sites, and reserves. It did not occur in areas (or less likely) that have calculable hazards and associated costs such as polluted land.

The first two studies point to a general influence of the immediate environment on individuals and communities in environmental decision making such as private car use, and zoning natural open land for development. An interesting connection to note: open land (open space) was most significantly correlated with increased household car use in study one, and most likely to correlate with urban growth in study two. Increased car use requires new road construction. Open natural land is increasingly characterized by new roads and by new sub-divisions; households located in these landscapes in turn demand greater urban services. Fragmentation in these landscapes (such as business parks, that increasingly dot the European landscape) services greater access, and stimulates greater conversion of natural to urban land. In my third study, the planners themselves pointed out that pre-existing fragmentation in certain parcels of land decreases the value of the land either as large industrial sites or urban habitat, and frees it to be zoned for smaller sub-divisions and business centers. Indeed, one participant pointed out that increased car use in households in these areas tend to service the sprawling pattern. I am not claiming a causal relationship here, which would be difficult to extricate from endogeneity, but rather an interesting connection between the two macro studies and micro study evidenced by my sequential study mixed-methods approach.

The third study highlighted the political and social contexts of land use change in a case study of West Hayden Island. This small area is situated within large politically-driven discourses, from which I observed three main themes. First, the natural amenities of WHI were highly attractive for development, but the evaluation of how to 'best use' those natural amenities was contested among planners and environmental and business stakeholders. Second, the political context of Portland under Mayor Sam Adams was conducive for port development, whereas the change in administration to Mayor Charlie Hales brought with it a different idea of 'suitability' for WHI. Third, the standards and evaluations required by the Statewide Planning Goals 5 and 9 are stacked in decision-making power (5 lower than 9) which serves to inherently divide environmental-leaning and economic –leaning planners in the drafting of 'best practice' development plans.

Overall, human society responds to salient characteristics of the environment, depending on the type of 'human response' being measured. The findings from both my macro-oriented studies and the case study of WHI in Portland inspire three general avenues for nature-society future research:

(1) Natural amenities have long been documented in the U.S. and a growing body of empirical research in Europe, as driving mechanisms of urban growth. However most amenities research remains focused on built environment characteristics, including distance to work, good schools and transit networks. Have urban planners in cities besides Portland noticed trends of urban growth in and around green areas, even if they are located further away from urban centers?

(2) How we plan growth and development on the land to a great extent depends on how we *see* the land and see ourselves as part of or partial to the environment. Do these perceptions of nature-society that we see shape Portland's planning and conservation programs, similarly shape planning in other urban contexts? Are there any similarities of city vs. nature discourse that may add explanatory power to wider scale models of urban growth?

(3) Urbanization is a global process. Where do we see wide scale urban growth processes intersecting in micro-scale development trends? Do planning experts refer to similar natural amenities that are widely observed in the land use change literature?

Concept Review

CI: Landscape

Landscape, as the discursive and culturally situated concept, was found to be especially important in framing the discourse scales used in planning WHI. In macro studies, landscape was not a dominant concept, because the social aspect of landscape was compared directly to the physical aspect. In other words, landscape was not "socialized" but rather was a space over which social processes hovered.

C2: Landscape Pattern

All studies used the concept of landscape pattern- it can be associated with increased urban growth and, depending on the composition, an increase or decrease in household car use. At the micro scale landscape pattern was primary in the planning of WHI- it would never have been so contentious if its landscape composition and location were not ideal for all political scales. Landscape pattern; was at the root of all tensions because of WHI's suitability both as a port or as urban habitat. Because of WHI's landscape pattern, the Port of Portland will likely try to develop it under different political and economic circumstances.

C3: Scales

In the macro studies the spatial scale was the primary concept under consideration. The size or scope of the scale affected how strongly associated landscape and social phenomena were. The more closely defined to individual households or local contexts the stronger the association. The take home message is: at the macro level- using land cover and other physical environmental data, the association of landscape pattern with social processes is clear. At the micro- level the focus shifts to how these social processes are distinguished from one another. This implies there are different kinds of political scales layered within spatial scale. The nature-society nexus observed at the macro-level (small spatial scale maps) is subsumed at the micro-level (large spatial scale maps) by the complexities of competing social factors. Given this complexity, it is easy to lose sight of landscape pattern unless it is directly addressed (asked about), as in the case of my WHI interviews. The political scales determined how landscape is valued. The political scales and actors, moreover, have distinct spatial relations. The local-political scale functions in smaller spatial scales, while the state-political operates in larger spatial scales.

C4: Natural Amenities

As part of the landscape pattern, natural amenities are associated with individual and institutional decisions that affect land use change. The natural amenity of open natural land is particularly associated with urban growth, illustrated in both study two where growth was significantly associated with natural open space and protected areas, and study three where WHI was most attractive for its contiguous green-space for habitat and development. Interestingly the level of biodiversity (an amenity) in study one is associated with less car use, though this effect is small. Likely, particularly rich, bio-diverse areas are strictly protected, and thus limit new road construction. Indeed, in study two I tested a "strict" protected land variable (classified German protected areas I & II, which correspond to "no" or "very restricted" development policy) and found it to negatively correspond with urban growth, as expected. These areas, off limits to development because of their valuable bio-diversity, would consequently have less household car use.

That natural amenities are associated with greater urban growth or demand for new development projects is generally supported in the literature (see Klar et al. 2012; Visas and Carruthers 2005; Wu and Plantinga 2003; Zimmerer 1999; Compas 2007; Clark et al. 2009; Dietz et al. 2007; Rudzitis 2009; Graves 2012). However, my thesis is, to the best of my knowledge, unique in demonstrating a concrete link of natural amenities at the micro-level (city neighborhood) up to the macro-level (country-wide) in amenity-driven demand for land use change. In planning for growth, a strategy for re-using, and moreover, revitalizing non-amenity land should be followed. This counteracts the line of least resistance, sprawling development model that maximizes efficiency of business operations, first and foremost.

C5: Fragmentation/Sprawl

The concept of fragmentation was important throughout the studies. In study one, fragmentation was significantly associated with increased driving because new roads are often the first fragmenting elements in a landscape. A primary finding of this thesis is that fragmentation is not just a consequence of urbanization- it is in fact an element of landscape pattern that can further intensify and encourage sprawl. Fragmented land is easier to develop because it is easier to gain building permits. Fragmented land is desirable to develop because it is *fringe land* that is desirable to amenity seekers, who will pay large sums for giant plots in sub-divisions near or within relatively natural land. Fragmented land already has some infrastructure, so building is easier. Fragmented land lowers the premium attached to natural land, because it is no longer contiguous, making it more difficult to justify a fragmented area's use as a large-scale "worthy" natural preserve. Fragmented natural land is different than the fragmented land that is brownfields because polluted areas have a strong negative association with re-development and use, as highlighted in all three studies.

The level of fragmentation of a landscape is also of interest to micro-scale planners, who recognize that pre-existing fragmented land actually facilitates zoning for development, increasing the problem and pressure to have sprawling development patterns:

> It is clear to me that if you don't have some sort of really strong policy basis for not building out fringe areas- its gonna happen. It's the next likely place. And it can go both ways, from the larger regional area out towards satellite, or satellite in. I think that's the one aspect of the Oregon planning system that's pretty strong. I think long and hard about where we're going to expand that line. But I do think it continues to be completely market driven, so that's why you end up with…hey, here's the next subdivision! the question then is, how do we then extend transportation so more people can access this area? I think often it's retroactively provided- we adapt the transportation system to serve the sprawl (5. 30)

> In Oregon, we're trying to drive development types that are in general build up rather than out. Especially in the metro, we're trying to maintain a reasonably tight UGB rather than continue to push it out to accommodate sprawl. And certainly there are examples of that not happening, in areas that are already dominated by too many roads, or the pressure that comes from the small plots inside the UGB relative to the 5 acre lots on the other side of the line- people want more space and so demand is out there to push that line. Have you been to Houston? Try that sometime. It looks a lot different than here doesn't it? Primacy of the car. There's a distinguishing difference (6.44)

This thesis was the first to implicate fragmentation at a macro level (in study two) as a predictor of urban growth. This encountered some resistance from reviewers, who were justifiably concerned regarding the endogeneity of a fragmentation-urban growth-fragmentation chain. However, the tautology of urban growth as always the *cause* of increasing urban growth is a larger threat: how can we claim to know how urban growth effects landscape pattern change, if we do not know the pre-existing composition of landscape? This thesis contributed to the work done concerning sprawl and fragmentation in three ways:

1) assessing fragmentation's association with car use;
2) assessing a pre-existing level of fragmented landscape association with observed urban growth in the pre-fragmented area, and;
3) asking planners if fragmentation of landscapes actually encourages sprawl.

It is interesting to ponder how salient the "look and feel" of a landscape pattern is to individuals who make decisions of land use change. In the experience of planners in Oregon, fragmentation of land at the fringes of urban centers and in rural satellite cities tends to encourage sprawling development patterns as seen in Oregon, California and other parts of North America. The macro study in urban growth in Germany also demonstrates a positive association with fragmentation and increased growth in newly fragmented counties. The macro study that implicates fragmentation and car use points to an increase in driving which- to go back to a quote from an Oregon planner- may "serve the sprawl." I am not claiming a direct link between the Oregon and German experience, but it is significant that similar experiences of fragmentation can apply in both macro and micro levels, across large cultural and political differences.

Future Research

Land use change is one of the most important global processes of our era because it is the largest factor in driving global environmental change (see for review: Lambin and Geist 2006). From a normative perspective, it may be chalked up as the most important and unifying issue of our time. Land use change, and by extension, global environmental change, is only one of the many socio-environmental issues to which geographers have much to contribute. The diversity of work brings to the front line questions of social justice, power, intersectionality and the importance of considering non-humans (Nightingale 2014). Contemporary and future research that brings social theory to bear on environmental issues, requires careful attention to scale and the politics of environmental analyses- highlighted in the WHI case. Research that brings ecological processes to bear on social issues requires careful attention to the environmental dynamism that increasingly shocks our social systems out of our traditional nature vs. society spheres. Moreover, a nature-society perspective in research moves empirical work away from a 'domination' perspective, incapable of adapting with dramatic alterations of landscape to a 'co-habitation' perspective, allowing a flexible approach to understanding the complex and shifting metabolism of nature and society.

In an applied sense, research that contributes to a working definition of sprawl is needed. Sprawl is notoriously difficult to define, as demonstrated in all three studies, but a definition of sprawl that is recognized among planners, other agents, and across contexts is necessary in order to create effective strategies to halt sprawl. I argue, along with Kasanko, Barredo, and Lavalle (2006), Salvati et al. (2013)- for examples of European research- that key to the problem of sprawling development is that no one appears to *recognize* sprawl when land is up for zoning. Planners, politicians, and academics alike all find common ground in the so-called universal definition of sprawl as low-intensity, large plot development types, development of land along transit corridors. However, when approached in local urban contexts, sprawl behaves differently, and this universal definition has no validity to hold up to potential development schemes, leaving planners without a foundational argument against varied forms of sprawl. For example, large plot business parks are increasingly found in the rural and traditional landscapes of Europe. While dense, compact and often with sustainable building designs, these parks are easily justified to municipal or state authorities for development (Salavti et al. 2013). However, business parks break into new open land, fragmenting natural landscapes, increasing traffic and increasing demand for widened and new roads and begin to blur the line between 'urban' and 'rural.' This, by the universal default definition of sprawl would not qualify as a sprawling development pattern- but the latent effects are the same. Another example is found in Appendix C (part VII) regarding Portland's four growth scenarios. Three of the four scenarios would fall under the basic definition of sprawl: growth only along transit corridors, dispersed growth pockets that pull growth away from city core, etc. However, all four scenarios are officially not classified as contributing to a sprawl pattern, because all scenarios lie within a proposed extension of the urban growth boundary. Defining sprawl vs. operationalizing sprawl is not a new issue, and was one of the key tensions to the planning of West Hayden Island. When asked whether WHI would classify as sprawl if developed, all regional and state scale participants said it would not, due to the intent of the city 30 years ago by pulling WHI into the UGB as a significant industrial area. However, all local scale participants saw WHI as a definitive example of sprawl, because it would be a low-intensity, degrading development on open land- while there are other places already used and vacant in Portland that could be developed for the purpose of a port. Moreover, one state scale participant stated, in effect, there is no sprawl- because developers respond to demand. It's not about who has a more 'correct' definition and corresponding operationalization of sprawl. The point is, it is not possible to address sprawl (and other development issues) without a working definition that is specific to undesirable development templates and at the same time, flexible enough to fit to varied urban/rural contexts.

A large contributing factor to the ambiguity of sprawl, noted by many land use scholars (Salvati et al. 2013; Schmidt 2011; Schneider and Woodcock 2008; Jongman 2002; Hasse and Lathrop 2003, among others), is that studies of sprawl have focused primarily on the U.S., due to the wider accessibility of land use data. Although research outside the US has emerged in recent years (notably Jongman 2002, Klar et al. 2012; Salvati 2014; Salvati et al. 2013), this research relies on North American concepts of sprawl to describe trends found in Europe, China, and even Africa (Schneider and Woodcock 2008). Direct comparisons have not been made between U.S. metropolitan areas and others around the world, so it is not apparent if the sprawl experienced in Europe and elsewhere is appropriately defined by a (oversimplified) U.S. model (Ewing et al. 2011). The scientific community would benefit greatly from cross-comparative case studies of metro areas across nations at a macro level *and* a micro level, to refine specific local characteristics of what constitutes sprawl.

Cities (and their sprawl) are complex, volatile systems that are composed of comparably complex individuals who are sorted into certain decision-making roles concerning nature and society. The social and spatial environments create a sizable mass of complications for researchers whose aim is to generalize the processes of urban and rural change (Weaver and Bagchi-Sen 2014). However, building a general understanding of how land use change unfolds is crucial to managing growth and real-world ecological decline. Most empirical work to date remains bound by disciplinary defined and narrow theoretical foci, that proves too rigid a framework for use by land use managers and community leaders

(Interview 2, January 14 2014). Therefore, a multi-scalar framework is needed that takes into account endogenous and exogenous forces that bear upon processes of urban and rural landscape change. Weaver and Bagchi-Sen (2014) present an interesting solution for quantitative land use change research in their recent study of neighborhood decline in the U.S. The authors use a framework grounded in evolutionary multilevel selection theory (MLS) to demonstrate how households respond to specific topographical, other landscape elements and individual social ties over a 20 year period that results in significantly altered land use *and* social composition of neighborhoods in Milwaukie. Further research following Weaver and Bagchi-Sen (2014) that employ two-part probit and spatial lag models through a multi-scalar framework (in a sense, combining the models I used in the first and second studies) would provide some insight into key turning points in the process of urban and rural change. Over time, and across contexts, these turning points can be compared, fit into certain landscape and urban condition typologies and eventually, used by researchers and policy makers to find and address urban and environmental decline.

Future work in land use change would be best served by studies using a mixed method approach. Multi-scalar frameworks by default require mixed quantitative and qualitative data. Through multi-scalar frameworks, case studies of land use change can be compared, aggregated and re-examined; used for their potential to revitalize, not just qualify, theory. Case studies and remotely sensed spatial data, as exemplified in this thesis, not only contextualize large scale trends identified in quantitative, studies- they also re-conceptualize macro-level theory. Land use change theory can only progress in understanding the complex metabolism between society and nature if local scales are evaluated in light of macro scales. Likewise, macro-level urban change research can only progress by incorporating elements found to be important in local contexts. If this thesis could claim one take-home message, it is this: landscape *changes* scale, so that land use change is never limited to one scale alone.

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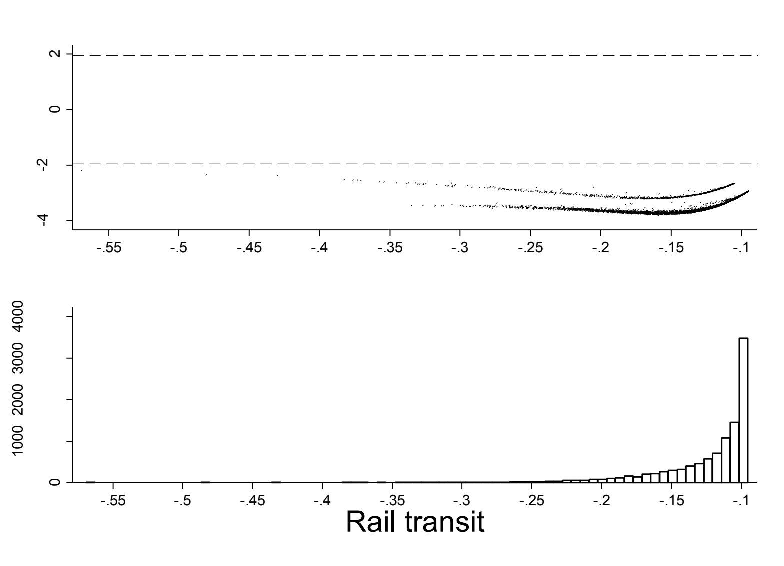
APPENDIXES

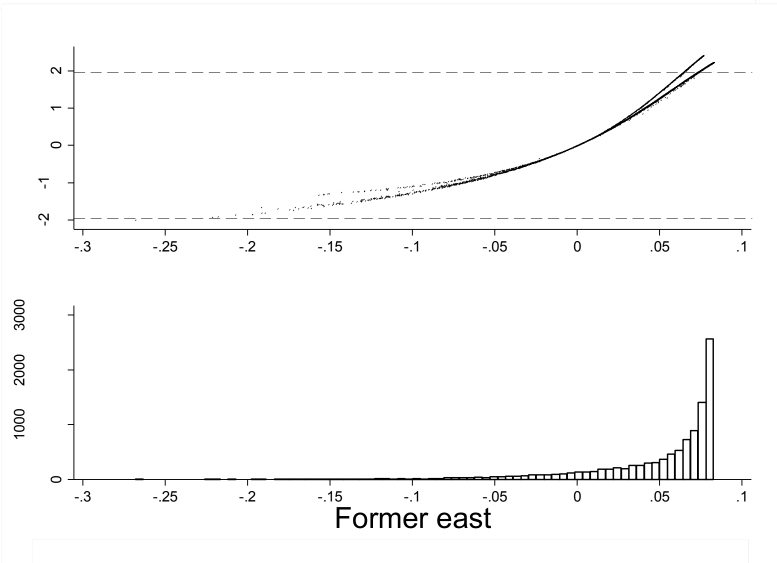
Appendix A.

Landscape pattern and car use: Linking household data with satellite imagery

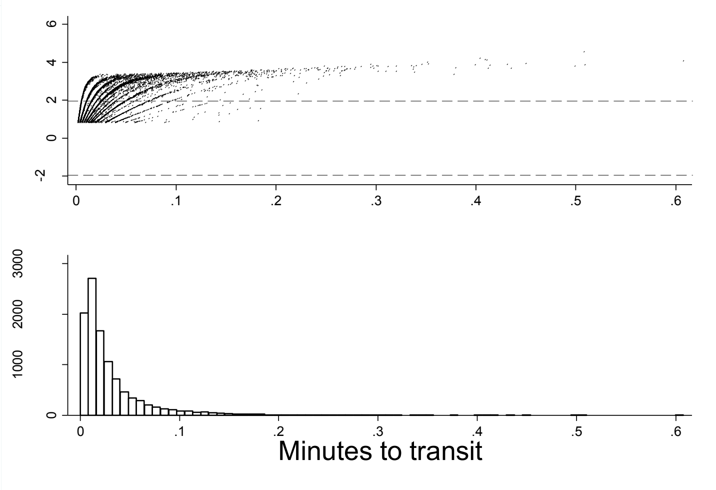
I. Distribution of Elasticities



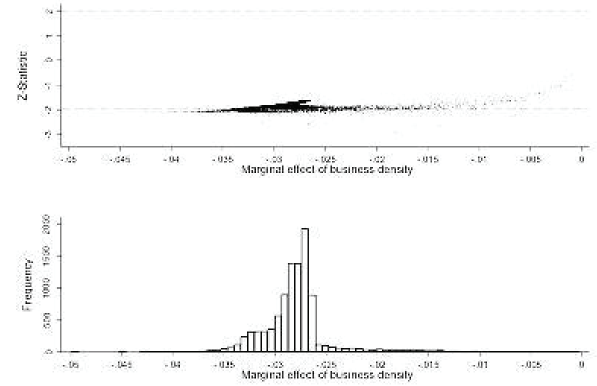
1. Share of rail service surrounding household



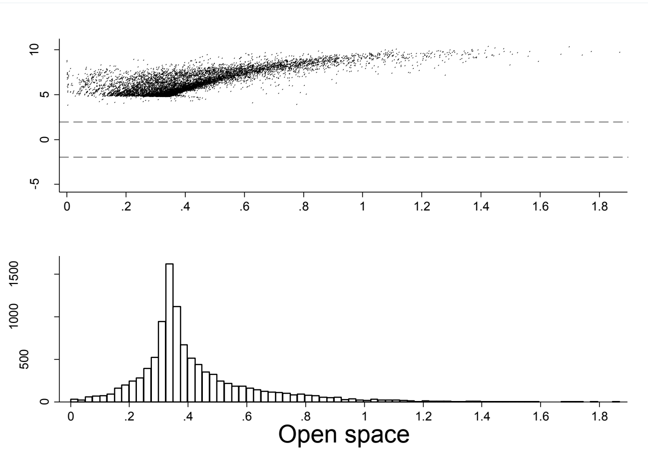
2. Household geographic location in former East



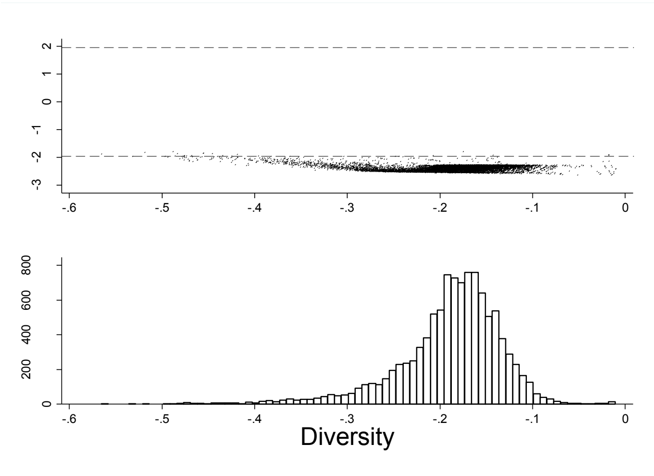
3. Minutes (walking) to public transit service



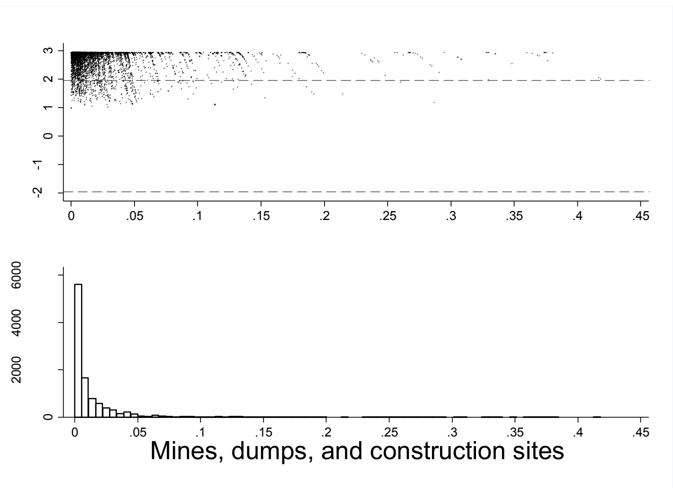
4. Business density surrounding household



5. Share of open space surrounding household



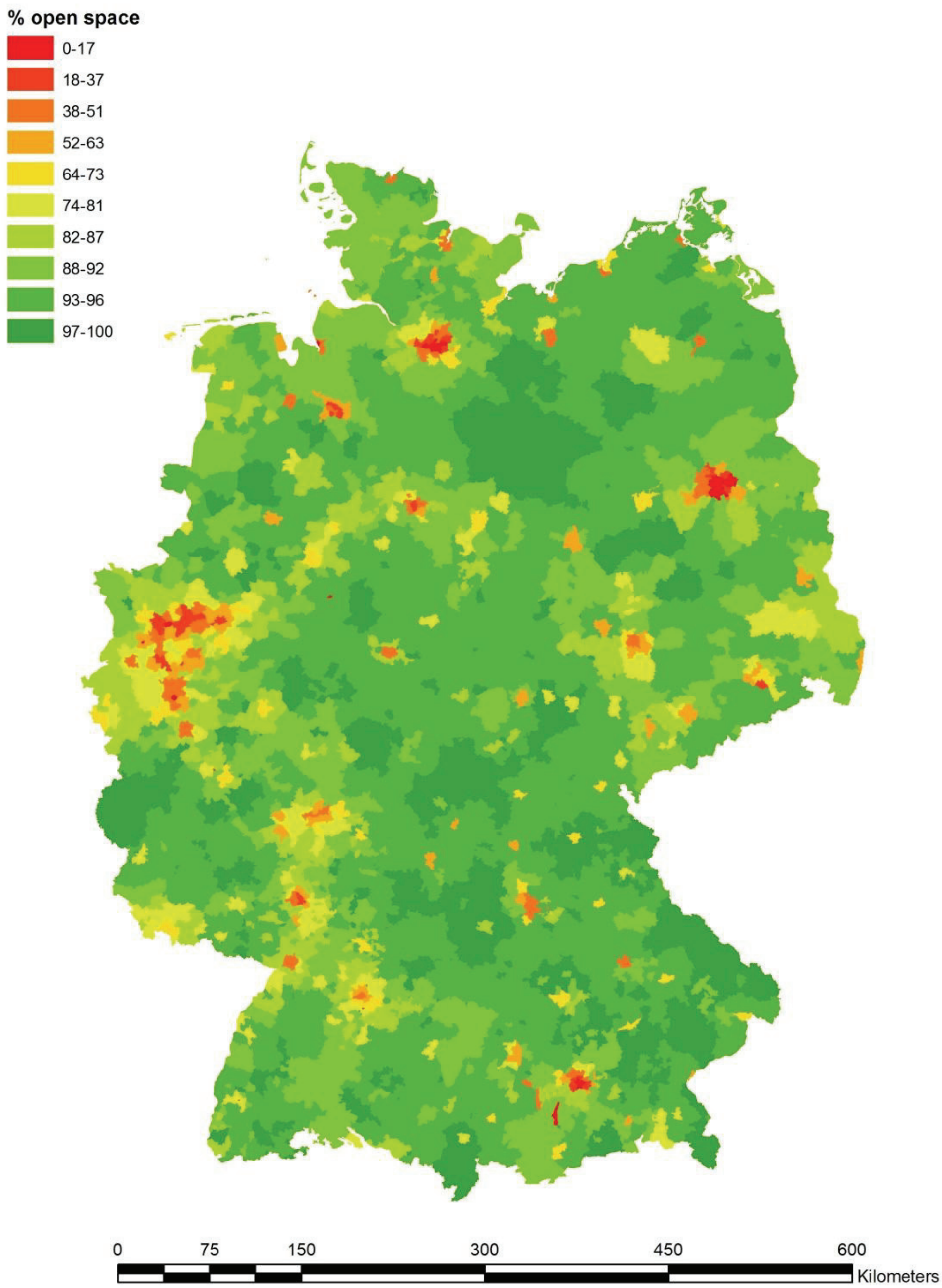
6. Level of bio-diverse habitats surrounding household



7. Share of dis-amenities surrounding household

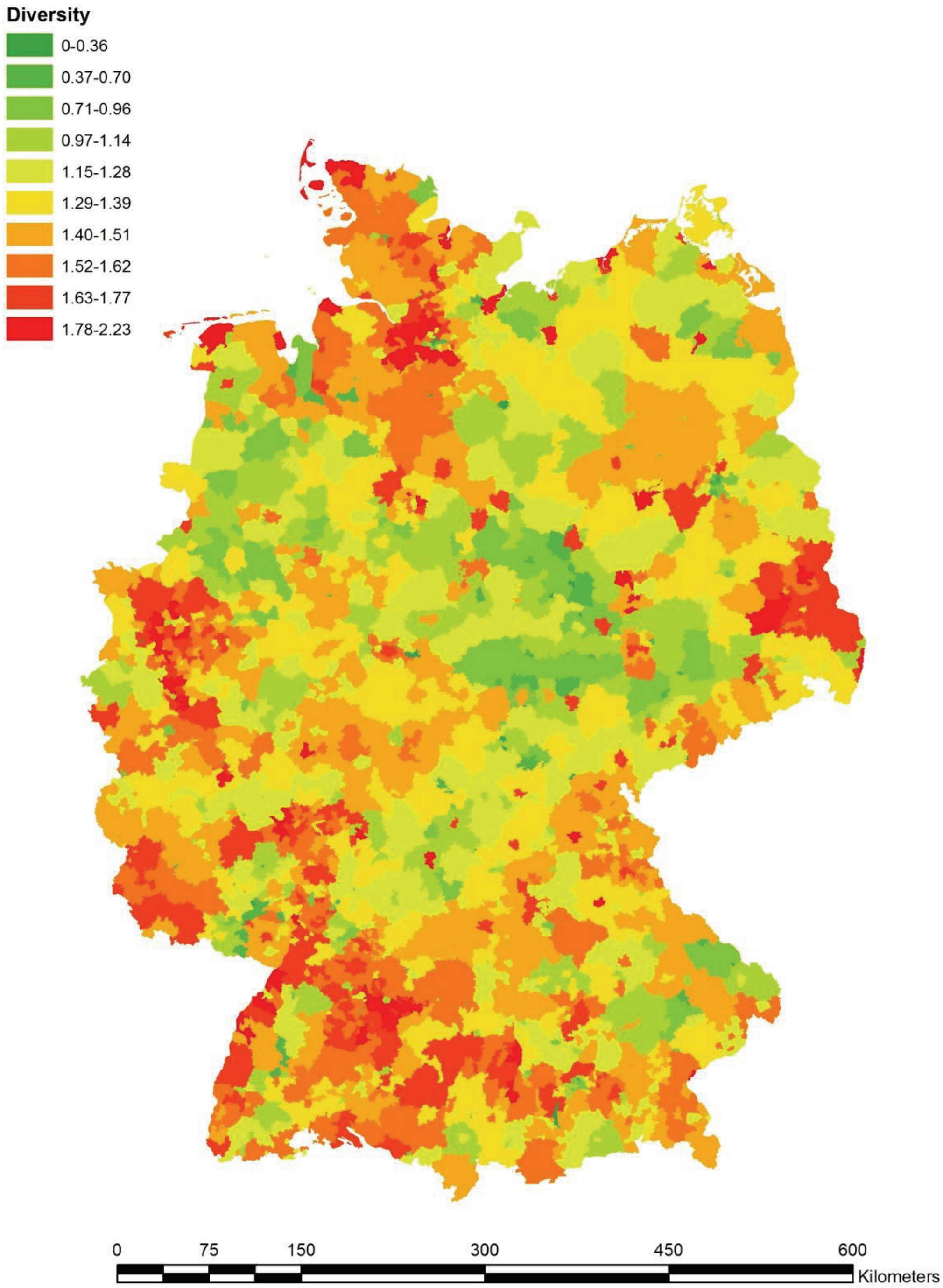
II. Maps

Map 1. Share of open space across Germany

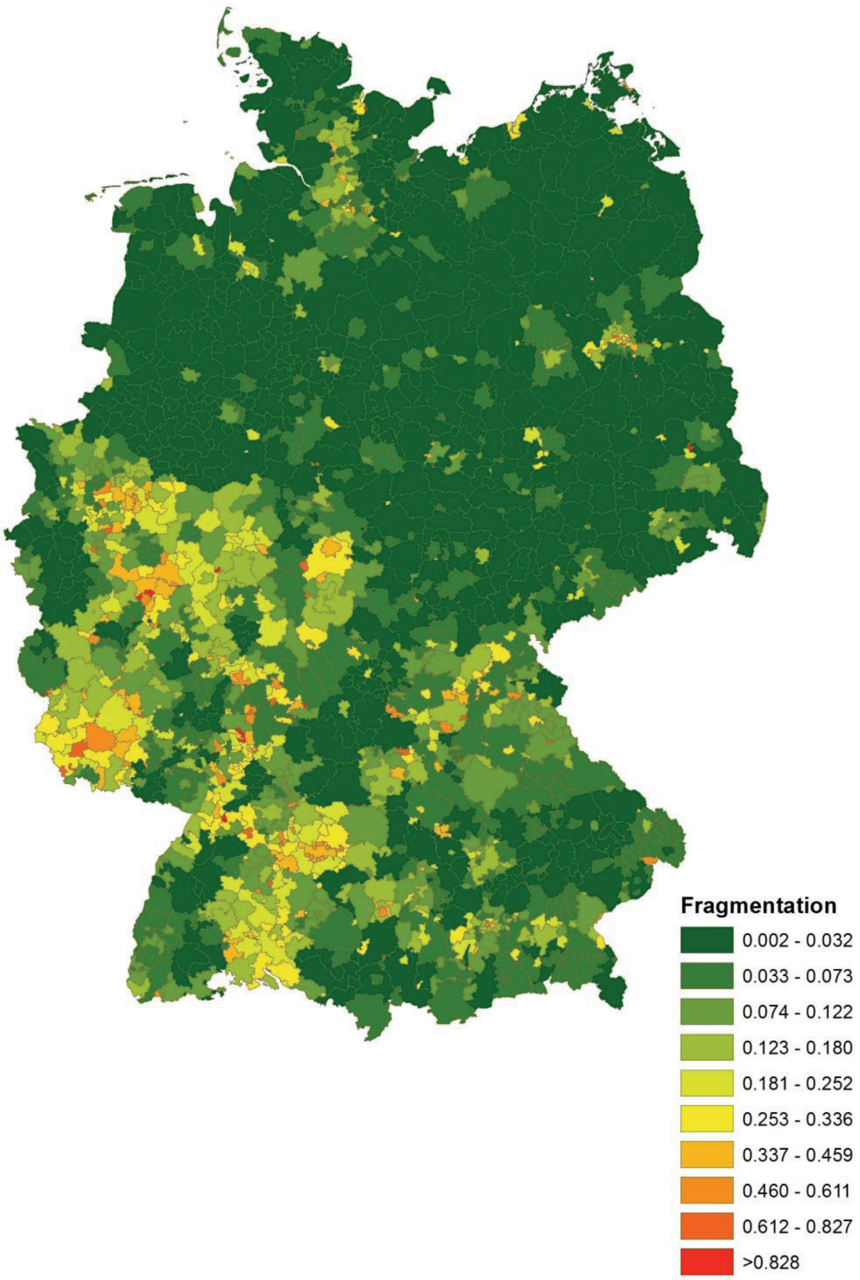


I

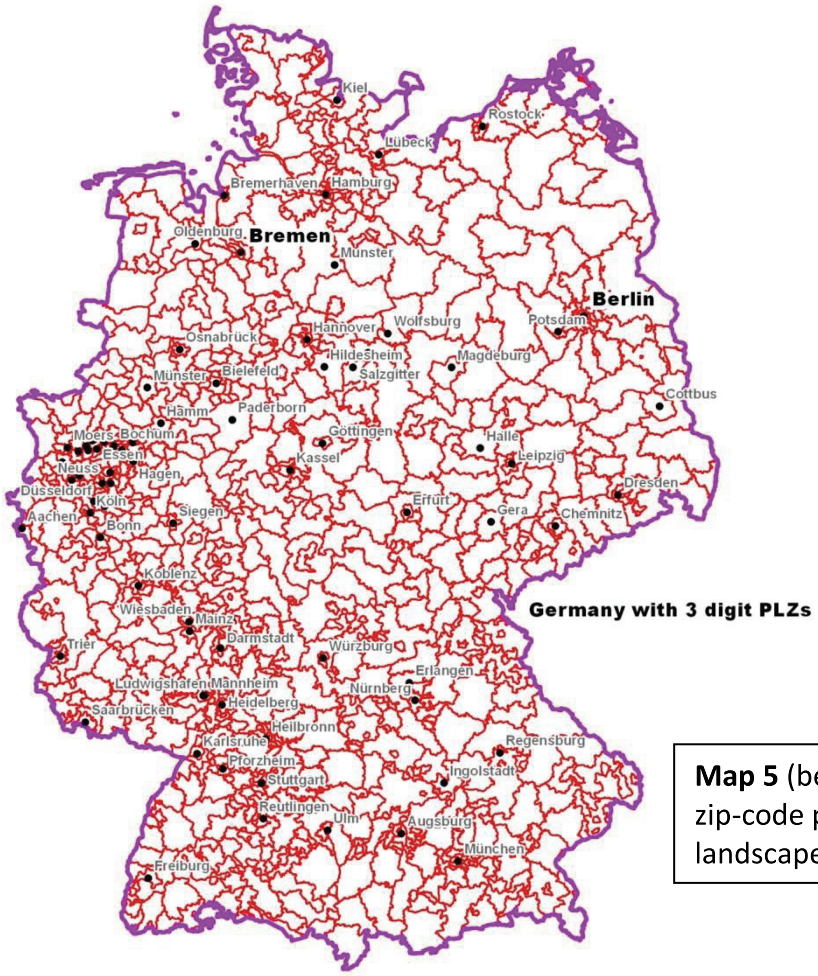
Map 2. Level of diverse land covers per spatial unit (zip-code & county) across Germany



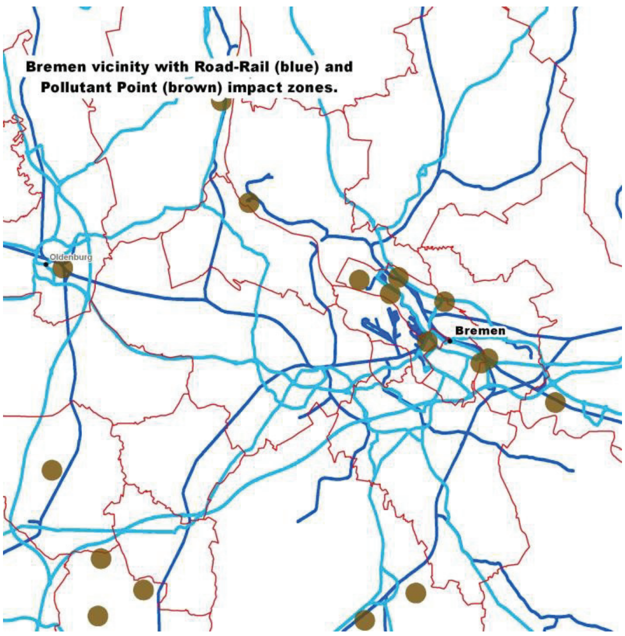
Map 3. Level of Fragmentation (effective mesh density/100km2) across Germany



Map 4. German 3-digit zip code polygons



Map 5 (below). Bremen vicinity showing zip-code polygons and corresponding landscape pattern composition



Appendix B.

Urban Growth in the Fragmented Landscape: Estimating the relationship between landscape pattern and urban land use change in Germany, 2000-2006.

I. Maps

Figures 1, 2, 3, 4 & 5

Figure 1. Change in urban land in Germany, 2000-2006

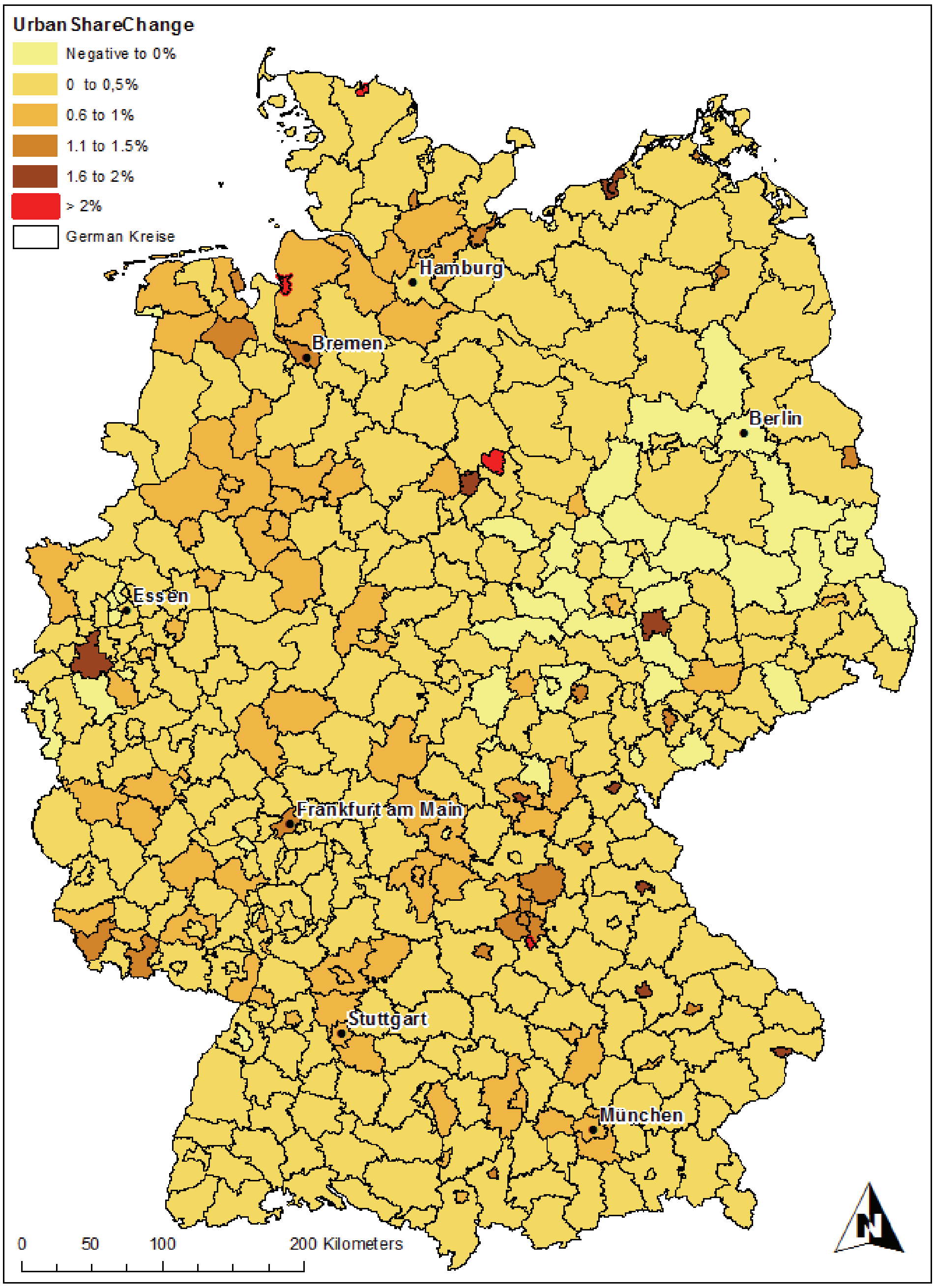


Figure 2. Degree of Fragmentation (number of effective meshes/100km2) across Germany

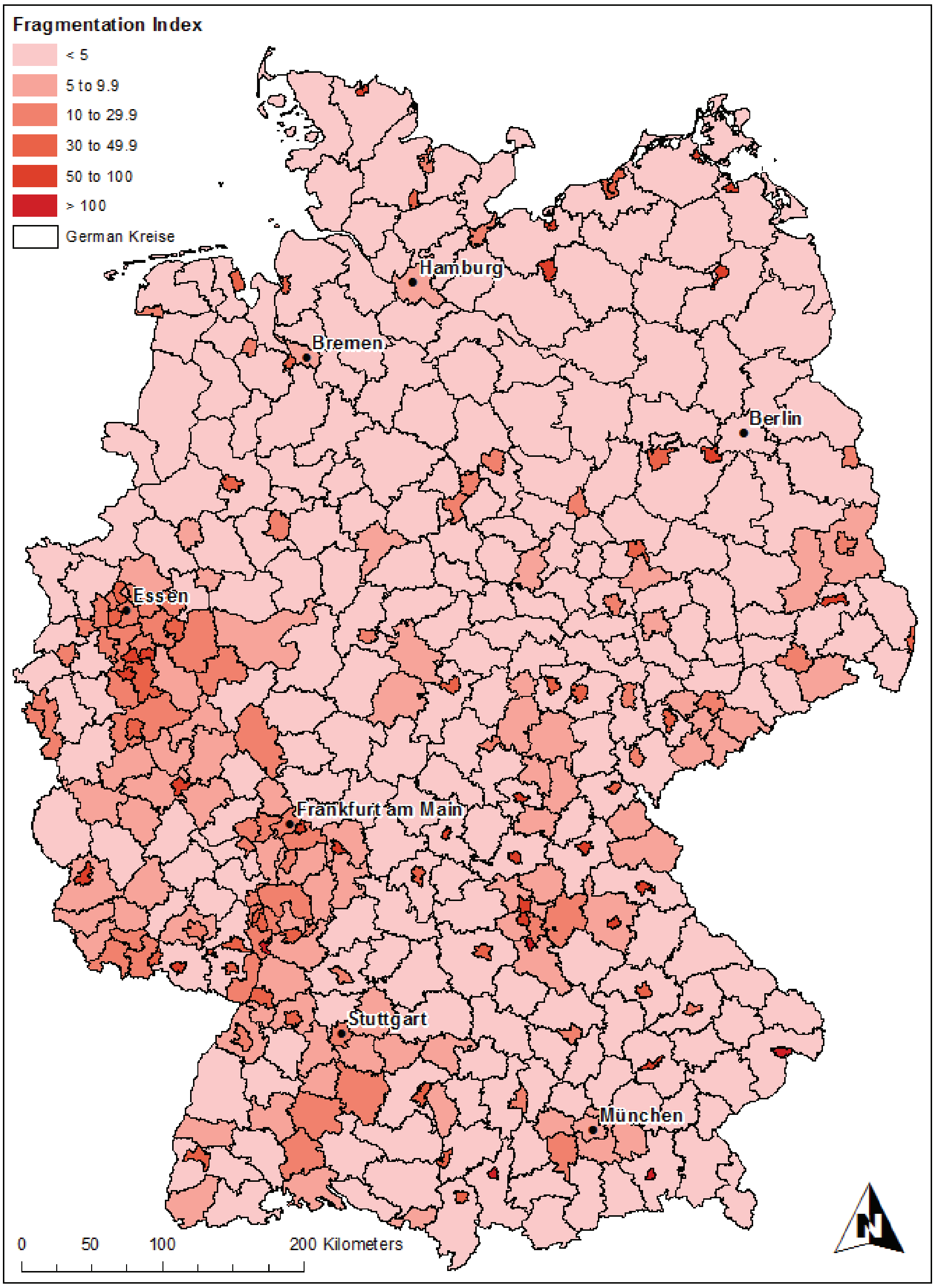


Figure 3. Share of Prime Soil and Top 10% Urban Growth Hotspots in Germany

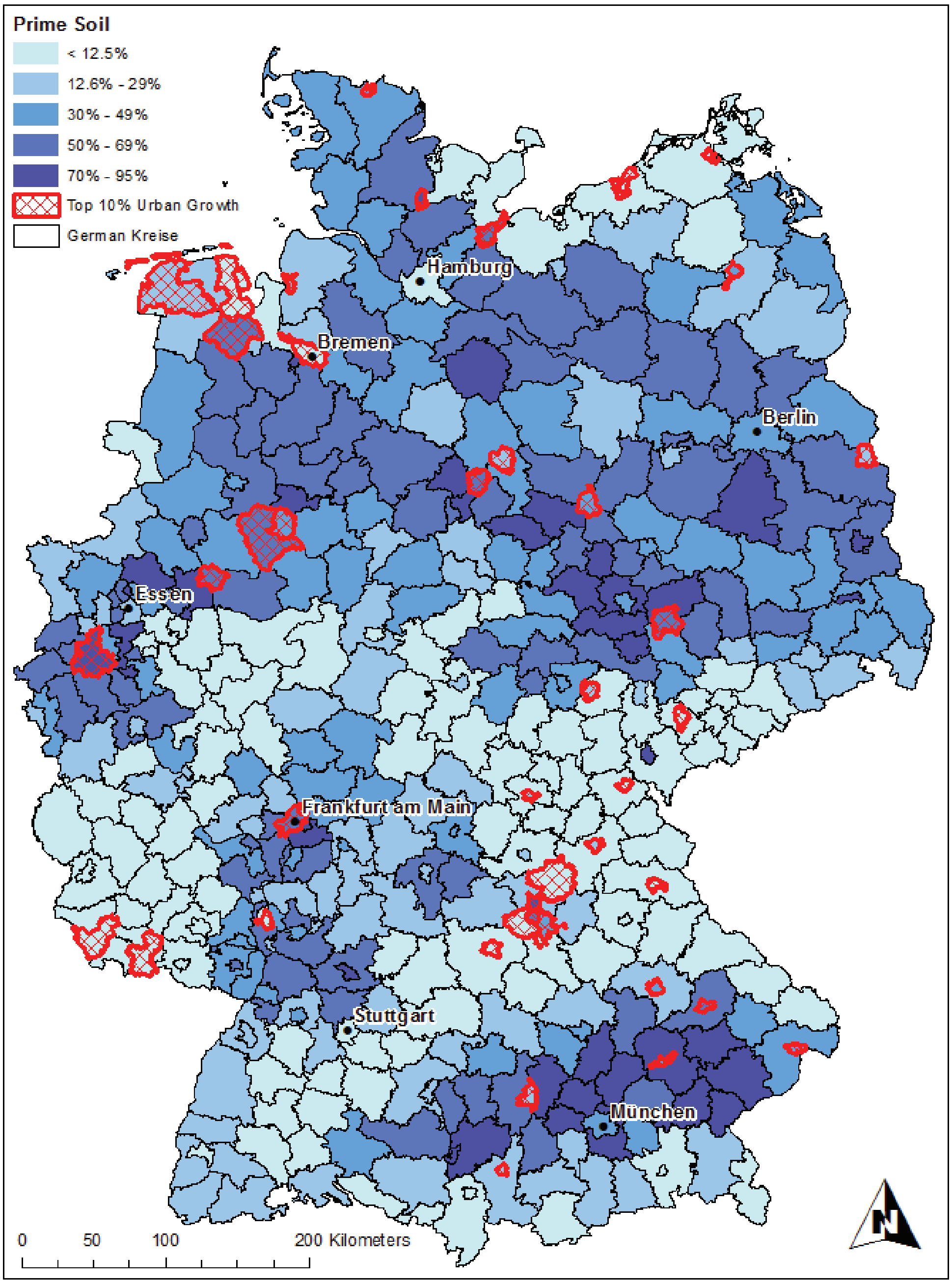


Figure 4. Average Annual Solar Intensity (short-wave radiation/m^2) with Steep/Saturated Land (non-developable) and Top 10% Urban Growth in Germany

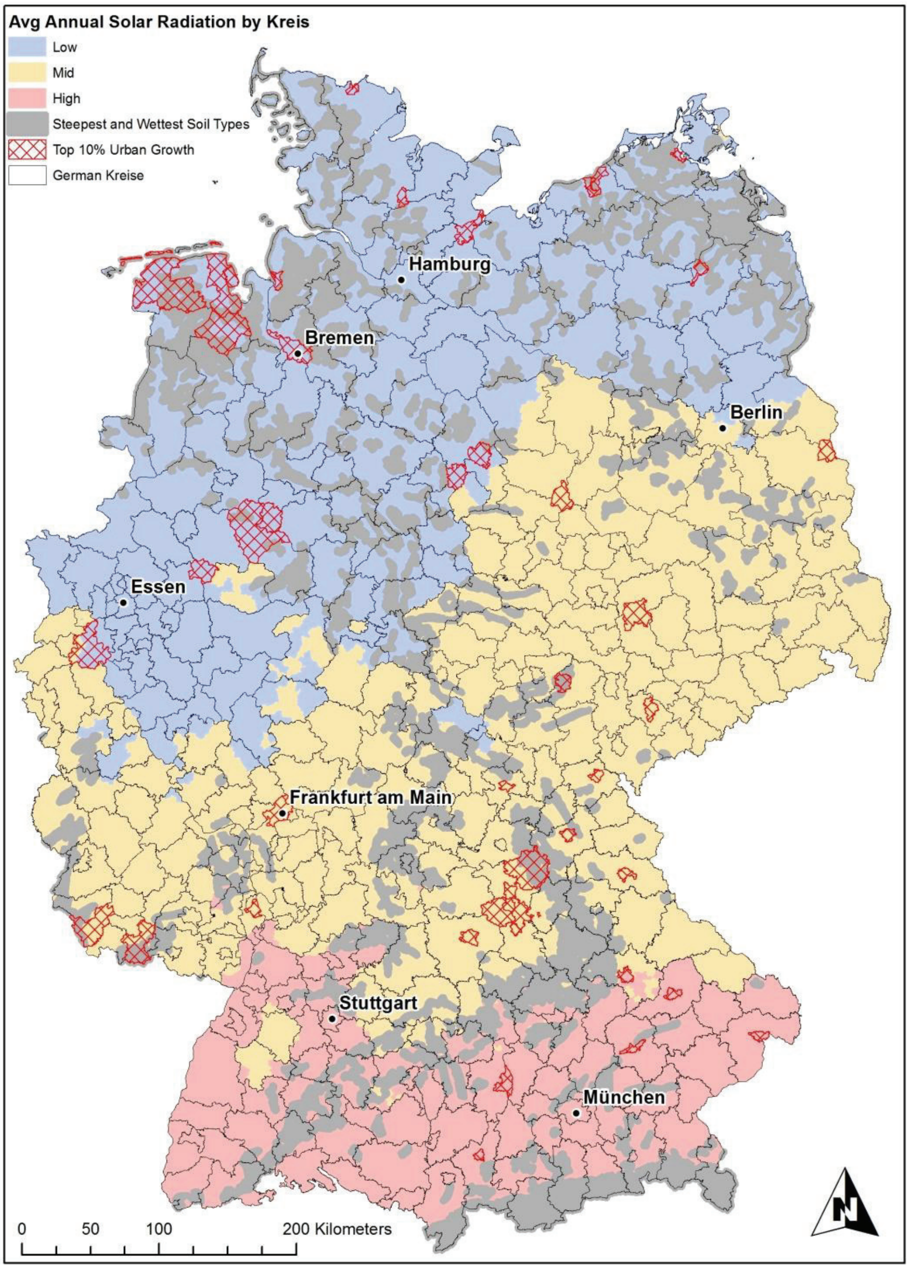
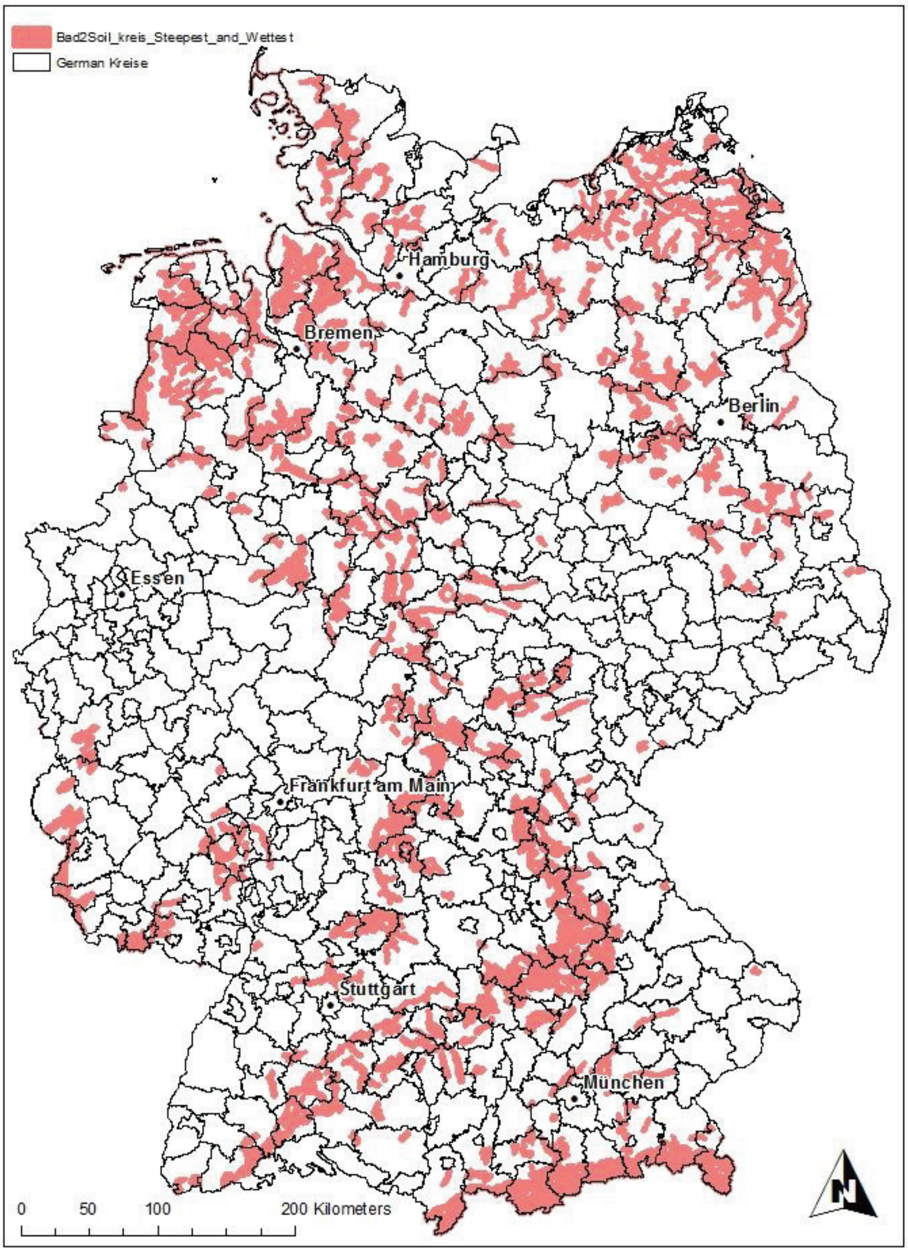


Figure 5. Share of Bad/Unproductive Soil across Germany
Included as part of non-developable land cover classification



II.

II. Model Descriptive Statistics

	Units	Source	Years Observed	Mean	Min.	Max.	West	East
Dependent Variable Urban Growth	Percent	CLC	2000-2006	0.3	-3.1	4.6	0.5	0.08
Independent Variables								
Natural and Forest Land	Percent	CLC	2000	28.37	0	69.3	29.1	26.2
Agricultural Land	Percent	CLC	2000	34.24	0	84.8	29.7	47.1
Prime Soil	Percent	ESDAC	2004	32.64	0	95.2	31.2	35.6
Road and Rail Networks	Percent	ESRI Europe	2004	3.85	0.76	15.8	4.1	3.4
Fragmentation	Patches/ 100 km^2	Metric created from CLC	2000	13.48	0.60	172.7	14.52	10.49
Non-developable Land	Hectares /kreis	ESDAC	2004	7733.9	0.0	80347	5688.2	3553.7
Average Annual Sunshine	Short-wave radiation /m^2	DWD	1981-2006	1458.0	1285	1631.0	1388.0	1469.0
Protected Areas	Percent	CDDA	2004	31.32	0.13	97.21	30	34
Industrial Pollution	Percent	EPER	2004	1.27	0	15.74	1.4	0.6
State Marginal Tax Rate	Percent	G-SOEP	1990-2012	0.509	0.47	0.5376	0.514	0.506
Population Density	Population/km^2	G-SOEP	2000-2006	508.5	40.7	3896.5	565.4	344.5
Per Capita GDP	Share of kreis GDP/person	G-SOEP	2000-2006	23.16	11.5	77.13	25.51	16.53

III. Example GIS process

Spatial Data by Kreis. Nov 2012-Mar 2013, April 2014

General Notes:
Projection ETRS_1989_LAEA_52N_10E
Started with ArcGIS 10 and Excel 2003, ended with ArcGIS10.1 and Excel 2007
All GIS datasets are shapefiles and tables are .dbf converted outside of ArcGIS into Stata 12 .dta format for regression analysis.

Kreise

- Received **kreis_ETRS1.shp**
- Added kreisHA for Hectares and calculated. 439 Kreise.
- Check data by joining SDreduced table (Kreisziffe) from Rose to kreis_ETRS1.shp (GKZ5). Only 22 out of 4829 records in table did not join. They had Kreisziffe of 2 and 11 (Kkz of 2000 and 11000)

- **EPER**
- European Pollutant Emission Register (EPER). Downloaded spreadsheets for Facility, Pollutant and Emission 2004 data from public domain EPER site.
- Created **EPERFacilityGerman2004pts** by joining spreadsheets and reducing to just Germany.
- Included all points because all have impact in different and perhaps important ways depending on the landscape.
- Created point shapefile from Lat/Long coordinates in the spreadsheet. Created 2 polygon shapefiles by buffering 1km (arbitrary distance) with and without the dissolve option in order to get footprint area (no overlapping polygons) and overlap area (multiple buffer polygons on top of each other for points close to each other). Spatial extent or share of a spatial unit (like Kreis) is obtained with the dissolve buffer polygons (EPER2004buf1km_diss). Measures of intensity can be obtained with the overlap buffer polygons (EPER2004buf1km_overlap) because one hectare of ground might be counted multiple times or by a simple count variable (number of EPER points per spatial unit). For Kreise analysis used only the dissolved.
- Intersected **EPER2004buf1km_diss.shp** and kreis_ETRS1 to create **eper_kreis.shp** . Added and calculated EPER_HA hectares.
- Create and save a .dbf table of acres summed up for each kreis (summarize on GKZ5 field, sum of EPER_HA), naming the table **EPERsum.dbf**
  3/15/2013
- Joined EPERFacilityGerman2004pts to NACE.xls and selected “NACE.Text” LIKE ‘%**metal**%’ OR ‘%**paper**%’ OR ‘%**petroleum**%’ OR ‘%**chemical**%’ OR ‘%rubber%’ OR ‘%sewage%’ OR
  ‘%pulp%’ OR ‘%**iron**%’ OR ‘%steel%’ OR ‘%**disposal**%’ OR ‘%**treatment**%’ OR ‘%processing%’ (Note that this query captured or there were none in Germany: ‘%mining%’, ‘%nuclear%’, ‘%quarrying%’ , ‘%tanning%’ too)
- Exported as EPERSelect.shp and buffered 1km with dissolve to create **EPERSelectBuf1kmDiss.shp**
- Intersect with kreis_ETRS1 to create **EPERSelect_kreis.shp**
- Add EPERSelHA and calculate hectares.

CLC Landcover

- Download Corine Land-Cover (CLC) from EEA . The Corine (Coordinate Information on the Environment) group provides seamless vector polygon shapefiles for 2000 and 2006. The polygons were created by reclassifying, smoothing and manually improving the original 100m pixel satellite (Landsat 7 Enhanced Thematic Mapper) raster data. Each land-cover type (code) is a separate shapefile.
- Three groups of CLC codes were used.
  "Urban" consists of codes:
  111-Continuous urban fabric
  112-Discontinuous urban fabric
  121- Industrial or commercial units
  122-Road and rail networks and associated land
  123-Port areas
  124-Airports
  131-Mineral extraction sties
  132-Dump sites
  133-Construction sites
  Only 111 and 112 are extensive and the rest are included simply for completeness. Satellite imagery is not suitable for capturing smaller extents (e.g. airports) or dominantly linear features (e.g. roads).
  "Agriculture" consists of codes:
  211- Non-irrigated arable land
  212- Permanently irrigated land
  There was no 212 in Germany.
  "Natural" consists of codes:
  311- Broad-leaved forest
  312- Coniferous forest
  313- Mixed forest
  321- Natural grasslands
  322- Moors and heathland
  324- Transitional woodland-shrub
  411-Inland marshes
  412- Peat bogs
  This group was dominated by the forest codes (311, 312, 313).
- 331-Beaches-dunes-sands, 421-Salt marshes, 422-Salines and 423-Intertidal flats covered too little area within kreise and were not combined to create "Coast".
- Union the 2006 urban code shapefiles then clip to clipbox (Germany plus) to create urban06. Union the 2000 urban code shapefiles and clip to create urban00. Likewise create agri06, agri00, natural06 and forest00 (already created in 2011) plus other00 made up the natural 2000 category.
- Add HA field to each, e.g. urban06HA, natural06HA, agri00HA, etc. and calculate hectares.
- Union all the CLC above to create clc06clc00urbanagrinatural.shp. Combine all the CLC codes for 2000 into one field (CLC00code) and same for CLC06code.
- Intersect clc06clc00urbanagrinatural and kreis_ETRS1 to create **clc06clc00_kreis.shp** and recalculate all the HA fields, making sure only records with appropriate type are selected, e.g. first select agri00HA not null (i.e. polygons with agri00) then calc agri00HA hectares.
- Create and save a .dbf table of acres summed up for each kreis for each cover group and year (summarize on GKZ5 field, sum of urban06HA; repeat for urban00HA, agri06HA, etc.). Tables named:

urban06sum.dbf, agri00sum.dbf, agri06sum.dbf, natur00sum.dbf, SumUrban00_HA.dbf, SumNatur06_HA.dbf

Soil

- From European Soil Data Centre (ESDAC), Joint Research Centre (JRC) European Soil Portal, downloaded full vector (version 4 beta) 1:1,000,000 scale **sgdbe4_0.shp** and clipped to Germany plus box to create **sgbe4_0clip.shp**
- Soil Typological (NOT topological) Units (STU) are grouped into Soil Mapping Units (SMU) with dominant STU attribute for linking to the ptrdb and sgdbe tables of attributes.
- Joined both tables to sgdbe4_0clip.shp.
  For "Bad Soil" selected:
  AGLIM1 = 3 (most important limitation for agriculture is presence of stones
  OR AGLIM1 = 4 (most important limitation for agriculture is lithic- hard rock within 50cm)
  OR WR = 3 (wet within 80cm for over 6 months, but not wet within 40cm for over 11 months)
  OR WR = 4 (wet within 40cm for over 11 months)
  OR TEXT-EROD = 4 (textural factor of soil erodibility unfavourable)
  OR TEXT-EROD = 5 (textural factor of soil erodibility very unfavourable)
  Exported selected polygons as **BadSoil.shp** and added BadSoilHA and calculated hectares.
  For "Good Soil" selected:
  AGLIM1 = 1 (no limitation to agricultural use)
  AND SLOPE-DOM = 1 (level, dominant slope ranging from 0 to 8%)
  Exported selected polygons as **GoodSoil.shp** and added GoodSoilHA and calculated hectares.
- Created and save a .dbf table of acres summed up for each kreis (summarize on GKZ5 field, sum of BadSoilHA), naming table **SumBadSoil.dbf.** Likewise for GoodSoil.
- **Note** that same polygons can and often were selected with both Good and Bad criteria. Bad soil criteria selected almost all polygons since used "OR". Good soil much more restrictive (both criteria had to be met, not just one), but still selected more than expected polygons. Should probably try different criteria, and just the actual physical soil characteristics, not an aggregated interpretation like AGLIM.

4/7/2014

- Created another version of "Bad Soil" to represent "Undevelopable" land. Selected SLOPE_DOM = 4 OR SLOPE_SEC = 4 OR WR = 4. Looked reasonable with steep land in the south and wet land in the north. Exported as **Bad2Soil.shp**.
  Intersected with kreis_ETRS1 to create **Bad2Soil_kreis.shp**.
  Added field **Bad2SoilHA** and calculated hectares.
  Created and saved a .dbf table of acres summed up for each kreis (summarize on GKZ5 field, sum of Bad2SoilHA), naming table **SumBad2Soil.dbf**

NOTE: GIS manipulation work conducted with help from **Pamela Keller,** GIS lead in Bureau of Land Management, Oregon. November 2012-April 2014.

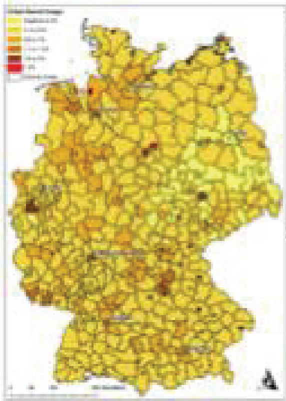
IV. Summary Poster

Urban growth in the fragmented landscape: estimating the relationship between landscape pattern and urban land use change in Germany, 2000-2006

Rose Keller; *Bremen International Graduate School of Social Sciences - University of Bremen and Jacobs University*

Background

- The expansion of urban land into natural landscapes has resulted in loss of ecosystem services and traditional livelihoods throughout Europe.
- Exurban growth 'pull factors': greater access to natural land, proximity to agricultural and habitat reserves, and landscape fragmentation.
- Draw on environmental amenity theory and directly implicate level of landscape fragmentation as a 'tipping the scale' predictor of urban conversion.
- Employed GIS to overlay land cover, pollution and prime soils data; calculated shares and fragmentation metric.



Urban growth in Germany 2000-2006

Research question and methods

- To what extent does landscape pattern drive urban growth?
  - Does this effect differ in former East vs. West Germany?
- Combining kreis- level socioeconomic data with satellite imagery and other geospatial data, used OLS and geographically weighted regression to investigate the conversion to urban land in Germany over a 6 year period.
  - Following amenity and LUCC literature: calculated predictor variables at 2000 levels and categorized them under broad themes of vital ecosystem services/ landscape composition, landscape configuration, and land use/human influence.
  - Results are a function of change in urban land from 2000 to 2006, conditional on their neighboring 6 kreise: *ΔUrban2000-2006= ρWy+β1WNaturalLand2000+ …βnWXn*

Results

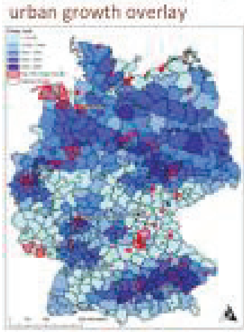
- Overall urban land grew by six percent across Germany from 2000-2006.
- Increased share of natural land, protected areas, prevalence of road and rail networks *and* landscape fragmentation correspond with higher urban growth over study period.
  - Partly explains why growth is more common in areas with larger shares of fragmented land rich in natural resources.
- The effect of industrial pollution is negative: increase in industrial pollution is associated with 18 % less urban land; suggesting prevalence of waste sites hinders exurban development.

Key results from OLS and Spatial Models

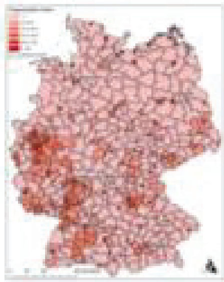
	Model 1 OLS	*Model 2 Expanded model*	*Model 3 Spatial Regressive Model*	*Model 4 Expanded spatial model*
Natural and Forest Land	-.0043 * (.0024)	-.0040 * (.0024)	-.0043 ** (.0024)	-.0039 * (.0023)
Agricultural Land	.0028 (.0024)	.0034 * (.002)	.0024 (.0020)	.0031 * (.0020)
Prime Soil	-.0022 * (.0011)	-.0061 *** (.0019)	-.0020 ** (.0012)	-.0057 *** (.0019)
Fragmentation	.000050 *** (.00001)	.000051 *** (.00001)	.000048 *** (.00001)	.000044 *** (.000014)
Protected Areas	.0023 * (.0013)	.0091 *** (.0030)	.0024 ** (.0013)	.0090 *** (.0029)
Industrial Pollution	-.0390 ** (.0148)	-.1831 ** (.0656)	-.0385 ** (.0146)	-.1817 ** (.0641)
State Tax Level	-.0860 * (.0430)	-.0950 * (.0432)	-.0817 ** (.0424)	-.0912 * (.0424)
West	.0039 *** (.0007)	.0065 *** (.0021)	.0037 *** (.0007)	.0064 *** (.0020)
West Road/Rail Networks		-.0746 * (.0333)		-.0748 * (.0326)
West Prime Soil		.0052 ** (.0022)		.0047 ** (.0022)
West Industrial Pollution		.1563 ** (.0675)		.1554 ** (.0661)
West Protected Areas		-.0077** (.0032)		-.0090*** (.0029)
N = 439	R_{sq}= .17	R_{sq}= .21		

*p = .1, ** p= .01, *** p= .001

Level of prime soil with top 10% urban growth overlay



Level of landscape fragmentation



Three Points for Planning Policy

1. Fragmented areas that contain a large amount of protected and natural resource rich land are attractive to developers and increase urban growth potential,
2. Polluted areas and kreis with high state tax display a negative influence on urban growth because they are cost intensive for developers, and unattractive for new industry or homebuyers, and,
3. Areas with a large extent of prime soil may limit urban growth, but due to a weaker relationship in west vs. east and that the top 10% urban this trend should not be overstated.

- In Germany, protected areas cover 28.5 % of the country's land surface. The overall aim of protected areas in Germany is to maintain functioning of the ecosystem for the sustained usability of natural assets- but these are also attractive areas for new development!

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Appendix C
The competing legacies of environment and industry on West Hayden Island: The political ecology of natural amenities and scale

I. Interview Guide

West Hayden Island Interview Topics (January 10, 2014)
Rose Keller
University of Bremen Geography; Portland State College of Urban Affairs

I want to understand, from your point of view, how development and projects unfold in differing contexts, specifically in the case of West Hayden Island.

- How do you define your role as a planning leader in the long-term development of the region?

Body of Interview

- How do you feel about the value of WHI?
- Did environmental legacy of the city play a key role in the annexation process? In the zoning?
- Is WHI a particularly contentious area to annex and zone? Why?

- WHI was designated by Metro in 2005 as a Moderate Habitat Conservation Area, based on the high value of development potential and high value of natural resources. What groups or agencies determine zoning? Are there some groups more influential than others in terms of these determinations? .

- As stated in the recommended Island Project draft? WHI's "[site] characteristics… render them especially suitable for industrial use"(PSC Recommended Draft, 7) Are these landscape characteristics unique to the Island?
- Is there a template of landscape characteristics that deem a site especially suitable for industry, or do recommended plans for an area vary widely according to each individual case?
- What are the standards of evaluation and analysis that environmental managers use vs. those industrial analysts use?
- Do you feel respected as an industrial planner/environmental planner?
- "How was the development of a grain terminal on WHI justified by the Port, the City?"
- In your opinion, was this process more or less political than other plans in the metro?
- In your opinion, were there folks who were underrepresented at meetings?"
- Can you walk me through a typical meeting of the PAC, Port and City?
- How has the urban growth boundary factored into the issues surrounding WHI?
- If yes, how?
- If not, why not?

- In what ways did land use goals 5 and 9 factor in to the annexation process? How do you perceive goal 5's importance in relation to goal 9 in the region?

- What do you perceive the future of WHI is?

- ***Questions of interest if time in the interview.***
- Does development have intrinsic value in our society?
- Does the environment have intrinsic value in our society?

- Do you use material from academia, such as, ecological patch diversity metrics, land use change models, sociological research from human geographical or other social sciences when conducting your evaluations of projects in the region?

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II. Example of Interview Consent Letter

Presented to all participants before start of interview.

Letter of Intent: Rose Keller, Toulan School of Urban Studies and Planning
Re: Urban Geography Research
2/13/2014 Interview

Research Goal: The purpose of this research is to capture some underlying contextual elements that contribute to urban land use change. The researcher has selected West Hayden Island as a case study of how land use is determined and predicted to change in a contemporary context. To this end, the researcher will interview key expert planners, conservationists, and scientists who represent city, state, federal, and non-governmental constituents. The researcher's aim is to understand urban land use change, conservation and management of resources from these experts' perspectives. Ms. Keller's final chapter in her dissertation will highlight the Oregon experience of land use planning, following land use change chapters regarding the experience of Germany in the last decade.

Rights: The participant has the right to withdraw or change comments during and after the interview has taken place. The participant can contact Ms. Keller at any time with these adjustments, up until a paper from this research is submitted for publication (in other words, it would not be possible to change already published material, IF the resultant paper is accepted for publication). The participant will see and can comment on the final paper before it is submitted to peer-reviewed journal, with a minimum of two weeks' time to review, comment and approve all quoted material Ms. Keller has used from the interview. The participant has the right to remain anonymous in name, with the understanding that the paper will explicitly state quoted material from **known organizations and departments** with key planners, conservationists, and policy makers who were either directly or indirectly involved with the areas of West Hayden Island and North Portland.

Benefits: The participant will contribute their knowledge, experience, and perspective to a wider effort to understand urban land use change on a global scale, by participating in an international mixed-methods research project.

Sponsorship: The researcher has no official sponsorship and no funding for this project apart from her study stipend from the Bremen International Graduate School of Social Sciences. This project is her own and will remain so, granting no third party rights to its material, apart from the rights she must waive upon submission to a peer-reviewed journal.

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III. Hayden Island Code Frame, Overview.

(code consecutive numbers within main categories– e.g. interview 5, category 2, code 3 = 5/2.3)

(1) Reasons for West Hayden Island (WHI) development
- 1.1: Natural amenity of open space and large lot size
- 1.2: Not polluted: brownfields have high start up costs
- 1.3: Not polluted: no liability
- 1.4: Location and landscape perfectly suited for development of grain port
- 1.5: Location and landscape vital to remain a link in wider ecological network
- 1.6: Fulfills goal 9 requirements
- 1.7: Within UGB, surrounded by industrial land
- 1.8: Residual reasons concerning WHI development

(2) Planning process among local, regional and state scales
- 2.1: The subjugation of environment to business
- 2.2: Port expected environmental exemption
- 2.3: Planning WHI was 'too big to fail'
- 2.4: Political agenda of Mayor & City Council
- 2.5: Past conflicts among stakeholders
- 2.7: Need for public ownership of natural land
- 2.8: Residual tensions among scales in planning process

(3) Statewide planning goals
- 3.1: Goal 9 influence in planning-how calculated
- 3.2: Goal 5 influence in planning-how calculated
- 3.3: Degree of involvement in planning to fulfill goals
- 3.4: Interplay of goals 5 & 9 in WHI plan
- 3.5: Residual statewide planning goals influence

(4) Tensions in planning process
- 4.1: Clash of Portland ideals
- 4.2: Economic vs. Environmental equity
- 4.3: 'Enviros vs. Econs'
- 4.4: Environment in dollar value aids in economic comparisons
- 4.5: Sprawl mentality
- 4.6: UGB role envisioned
- 4.7: Inherent issue of 'chicken and egg'
- 4.8: Need for public ownership of natural land
- 4.9: Residual tensions in planning

(5) Future of WHI
- 5.1: WHI not developed: used instead as mitigation project
- 5.2: WHI will be developed in future as port
- 5.3: Consequences of development of WHI
- 5.4: Residual ideals of WHI future

IV. Urban Growth Boundary Influence in Value of Natural Amenities of West Hayden Island

Contrary to popular perception, UGBs are not static or unchanging, but rather planning tools intended to change, expand, to accommodate particular needs (Walker and Hurley 2011). What is different about Oregon, is the UGB is strictly regulated by the LCDC, to which local jurisdictions must "demonstrate that needs cannot reasonably be accommodated on land already inside the UGB, prior to expanding the boundary," (Walker and Hurley 2011: 35). Local governments typically seek to include more land inside UGBs than LCDC believes is justified based on demographic and economic trends. In most cases, LCDC forced local governments to reduce the amount of land contained within UGBs. It forces land use to be "out of pure market control[26]."

However, land use decisions outside of market control to a greater or lesser extent does not make the process any less subjective. This is why it is valuable to people involved in planning to understand the different interpretations of the UGB role and function in land use change. Largely, it is the interpretation of Metro that matters in determining where and how much the UGB is expanded. One reason the WHI plan was so contested was the local jurisdiction (Portland) wanted to the Port to *implement* the large environmental mitigation plan, because they saw the role of the UGB and the decisions concerning the land inside of it differently than Metro and the Port. The local and regional scale saw the boundary to be more porous, and less deterministic of the open greenfields inside, so as to justify natural land taking precedence over the difficult task of meeting goal 9 needs in a land locked city:

Table 3. **Perceptions of UGB**

Scale	Function of WHI inside UGB	Function of UGB	UGB value in planning	Supporting quotes
Local	Natural area preserves health of ecosystem and human community	Primary function is limit sprawl into resource and scenic lands, but does not allow urban 'island' ecologies to link to larger landscape.	Excellent tool: Needs work to ensure better infill: use of vacant land and brownfields, while allowing more flexibility on the UGB fringes if it allows larger natural areas inside urban cores.	we're lucky to have some big patches of habitat left in the city, like WHI, and we should look to preserve and join those to the larger landscape (1) land is tight in the city of Portland, it really is. Luckily, we've been able to acquire a bit of land but still these aren't large enough parcels for restoration (2) …this is the largest greenfield inside the UGB, largest patch of lowland cottonwood forest, there's nothing comparable to it inside the UGB or outside (8)
Regional	Industrial zones are needed, but WHI makes sense as a mitigation bank/green space for future development projects	Primary function is force purposive planning of where is best to allow urban growth. Limits encroachment on agricultural and forest land.	Good tool: Needs reconceptualization and updating to fit contemporary urban needs, a little out-dated.	the UGB is designed for ever expanding growth. It makes the expansion intentional, so not a willy-nilly leap frogging development follows, but it still has a strong ideology of ever expanding growth of cities. It comes down to how you feel about how that line is! (3) I think the fact that it is already in the UGB was a big factor in motivating the WHI plan. Also, the zoning around it provides some motivation for the Port (4)

[26] Bureau of Planning and Sustainability. January 23, 2014, Interview 5.

				I don't know if this function is really well defined, but I do know that, at least at some level, urbanization of land inside the UGB is expected (5)
State	Necessary as industrial marine port to support state economy, grain growers in other parts of the state and greater region. Necessary to maintain Portland's competitive edge as transit hub in Pacific NW.	Primary function is to keep valuable resource lands functional and outside urban cores while maintaining the vitality and economy of urban centers.	Necessary planning tool, but economy and the market needs to be there to back it up.	there is still a strong ethic of protecting resources from within, but you have to get the 'yes' on urbanization somewhere. Also, the land in other states does not have the same resource value the land here does. So the dynamics are different between here and California, for example. The theory behind the line is it protects encroachment of urban into those valuable areas (6) here the hiways, rivers, rails, come together so this is the primary hub of oregon, and that's what makes this prime industrial land, it's unique chacter, the infrastructure is already in place. Keeping industrial lands is vital to keeping the middle class, and Portland's primary role in the state economy (7)

V. Political Agenda Matrix

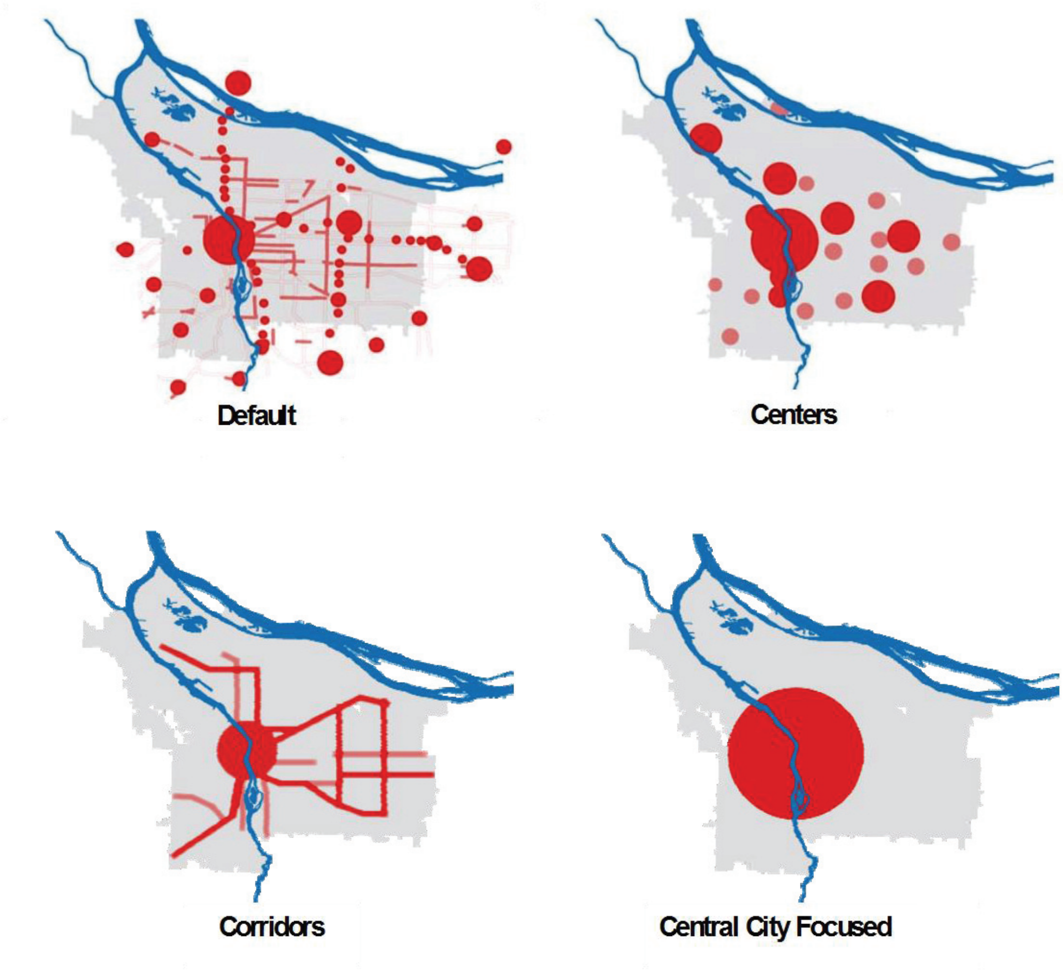
Theme	Local	Regional	State	Description
2.3: Planning WHI was 'too big to fail'	…this is a case of process more important, more profitable, than outcome…I think we have this tendency to think these billion dollar projects are inevitabilities, people stake their whole careers on these projects, huge amounts of money at stake, reputations at stake, and though I attribute no malice at all to this, I think people fear that these things are so big the idea of *not* going through with them is terrifying (1.13) ...I mean, I had the chief econ guy in planning saying, 'look, I'm going for the win here, my bias is to do this. We don't know what the economic projection is like, we don't know the next big thing, but we think we will just eventually need this, someone's gonna want it, we need to be ready (1.19)	…the whole island is high value, but the HCA is programmatic, it reflects the intention of economic development, which is how it was designated "moderate" by Metro, not "high'' (3.12) With WHI it was already in the UGB and it was slated for development. The discussion of rural or urban reserves never came up. It was slated for development long before Metro came through with these sort of regional environmental standards (TITLE 13). It's sort like, it got set aside, and we've been playing catch up with understanding the natural resource value upon that island. Now it's like we're pulling back from what its original intent in the UGB was (4.17)	…but if you have an example of a big project that has a lot at stake , a huge planning process, and a lot of conflicting interests going forward, and a mitigation proposal that is untenable for a major landowner, I see council negotiate solutions at that stage, and ultimately they come up with a result that both sides could live with, at least what developers would find, doable...so I was a little surprised that it didn't move forward (5.9)	Refers to the many stakeholders from natural resources side, Port side and City, inovlved in WHI Plan.. This theme relates the fact that many people's careers were staked on this process.
2.4: Political agenda of Mayor/City Council	I think, what people have lost sight of is, the port of Portland, didn't initiate this process. Sam Adams did. The last mayor, it was his legacy. So a lot of it was it was purely political. The mayor wanted a legacy project, he wanted to be able to say he brokered the deal that did the environment and the development together (8.31) We demanded also a health impact analysis, which was also critical to this. The city bocked. They suggested we do it after the annexation. One of the planning commissoers said: eh, what would be the point of doing this anaylsis after the annexation, wouldn't this be needed to judge the annexaction process, not retroactively validate it? And the commission stood up to Staff. The city staff were not supportive of the commission, they were enablers of the port …I think we have good politicians in this city, pretty left-wingy folks, and generally they want to support our economy, I can understand that. But it was interesting to watch them absolutely struggle with the facts here.… (1.28)	…there was never a question of should WHI be developed, that was already decided, but how it should be developed (4.11) …I think Hales said, 'I'm not going to mess with what PSC put forward, and yes, we really *do* mean, mitigate for everything' (3.47)	…the Port obviously had some discussion with Council members, I guess they were reading that they didn't feel like that was a likely success for them, in this case. Looking at the political side, there was enough support for PSC report that they saw they couldn't bend the case. I don't know if the Port was pushing, or they were being led into this process, I don't have an answer for that but I'm sure that was a dynamic in this process. That would explain the Port's withdrawal at this time, the timings just not right. (5.13) …on the one hand you have the Port seeking land to develop eventually into a grain terminal hosting valuable industry jobs, family wage jobs as we like to say, and the other of setting aside a site for natural resources. The question was, usually is, what is the right balance? For the port, the 'right balance' wasn't enough. For the planning commission it was, and the City Council tacitly affirmed it by not changing it (6.21)	Refers to how WHI process was driven politically. This code is specific to the references to the Mayor's (Adams or Hales) direct involvement in the process.

VI. Overall Code Matrix (example segment)

Code agreement (example from segment): 24(code agrees)/ 35 (total) = .685

Coding Unit Number	First Code	Second Code	Final Code
1.1	4.1	4.3	4.3
1.2	4.2	4.1	4.1
1.3	1.1	1.1	1.1
1.4	1.5	1.5	1.5
1.5	2.1	2.1	2.1
1.6	4.2	4.2	4.2
1.7	5.1	5.1	5.1
1.8	5.1	5.1	5.1
1.9	4.3	4.3	4.3
…	…	…	…
2.1	5.2	5.2	5.2
2.2	4.3	4.1	4.1
2.3	4.5	4.5	4.5
2.4	3.4	3.4	3.4
2.5	1.1	1.1	1.1
2.6	1.3	2.2	2.2
2.7	3.4	3.1	3.1
2.8	2.2	2.4	2.4
2.9	4.4	4.4	4.4
…	…	…	…
8.1	1.5	1.5	1.5
8.2	4.1	4.3	4.3
8.3	4.4	4.4	4.4
8.4	1.5	1.5	1.5
8.5	4.2	4.2	4.2
8.6	4.3	4.3	4.3
8.7	3.3	3.3	3.3
8.8	4.2	4.2	4.2
8.9	1.5	1.5	1.5
8.10	4.1	4.1	4.1
8.11	3.1	3.1	3.1
8.12	3.3	3.2	3.2
8.13	3.6	3.3	3.3
8.14	1.7	1.5	1.5
8.15	4.1	4.3	4.3
8.16	4.2	4.2	4.2
8.17	4.1	4.1	4.1

VII. Growth Scenarios for Portland Metro



Adapted from: BPS Growth Scenario Report 2013

1) The default option is based on existing development patterns in the region, continued growth of this mix of sprawling corridors and centers is predicted.

2) The centers option is a proposed strategy to concentrate future business/industrial centers in areas that are a mix of current development centers, and creating intensive centers away from major riparian areas. West Hayden Island can be seen in this scenario as a light red dot on the Columbia River.

3) The corridors option is similar to centers, but has a stronger central city district and linearly concentrated commercial/industry along major road arteries.

4) The central city option concentrates all new development in a wide radius from city center, creating a highly dense urban core. This strategy concentrates the most growth away from natural land surrounding the rivers. There is continued debate among planning stakeholders regarding a scenario least impacting the watershed.

VIII. Thank you