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High rugosity cities: The geographic, economic and regulatory pathology of America's most non-concentric urban areas

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ABSTRACT

The guiding theory in urban development largely views non-concentric urban form as undesirable and even pathologic for poor land-use planning, with negative consequences for peri-urban farmland. As a result, the dominant planning discourse calls for concentric urban areas, thereby minimizing the urban interface. Yet, the urban interface is known to be important to housing markets, particularly where farmland amenities are valued. This research argues that increased rugosity, or greater urban interface exposure, is vital to both urban and agricultural markets. Findings from 30 case study counties and spatial multivariate analysis demonstrate that an increased urban interface is associated with large populations, high rates of population growth, high demand in the housing market, and significant historic peri-urban farm holdings involved in direct-marketing. High rugosity urban areas are associated with the sustained vigor of both urban and agricultural land-uses.

1. Introduction

In the design world, the ontological adage 'form follows function' is often elicited. A city with a concentric shape minimizes contact with surrounding lands, and presumably the functionality of the peri-urban interface (PUI). Yet, adjacent farm and natural lands provide a variety of services to urban areas, ranging from ecosystems services like water recharge and pollination to cultural significance through viewsheds (for review, see Brinkley, 2012). Farmland preservation groups are willing to pay an average of $3990 per acre (SD $10,000, median $2830) to preserve these land-use qualities (Brinkley, 2012), particularly at the urban interface. Individual home owners also value peri-urban living. A meta-analysis of over 20 years of farmland amenities studies demonstrates that with few exceptions, housing values increase near farmland (Bergstrom and Ready, 2009). Peri-urban housing developments are in demand from both low-income (Nelson et al., 2010) and high-income (Heimlich and Anderson, 2001) groups with a new focus on farm-to-table residential development (Madaleno and Gurovich, 2004). The urban demand to be proximate to the amenities afforded on the urban periphery creates intense development pressure, which, paradoxically, directly jeopardizes the supply of rural services and viewsheds.

As policy makers consider the long-term impacts of policy on property values, an estimated population increase of 90 million new Americans by 2050, and preservation of natural and cultural amenities, it is necessary to consider how urban form impacts the function of both non-urban and urban lands. The dominant form of development has been ex-urban with the conversion of greenfields (Nelson, 1992). A study by the American Farmland Trust revealed that more than half of farmland lost has been carved into 10 acre lots for low-density urban development (Sorensen et al., 2002). Such low density development is expensive per unit to develop, requiring more infrastructure in roadways, water and sewer systems, and electricity transmission lines. Low-density development also has high maintenance costs due to its spread-out infrastructure. Carruthers and Ulfarsson (2003) find that the per capita cost of most services increases as urban density decreases. Compact, urban form is the hallmark of Smart Growth, put forth by the Ahwahnee Principles (Calthorpe et al., 1991; Corbett and Velasquez, 1994). In support, a study of 100 metropolitan regions in the U.S., Nelson and Sanchez (2005) show that places with urban containment regulations perform better in reducing sprawl than those with natural containment (eg. mountains) or non-containment policies.

But compact form can be concentric or non-concentric (Fig. 1). Batty and Longley (1994) have shown that urban areas tend to grow as fractals. Does a fractal form help urban areas make better use of resources by pairing with non-urban land? Does the length of the urban interface influence population growth or housing stress? How might governance, geography and climate shape urban morphology?

This research is aligned with several emergent theories and practices in green infrastructure planning. Greenspace planning champions the use of green wedges and ecological corridors interwoven with urban areas (Colding, 2011), a popular topic for rapidly growing Asian cities (Jim and Chen, 2003; Li et al., 2005) and in Scandinavian planning (Caspersen et al., 2006). Greenspace can be wildlands, working lands such as ranches or farms, or park space. Baltimore County, Maryland's

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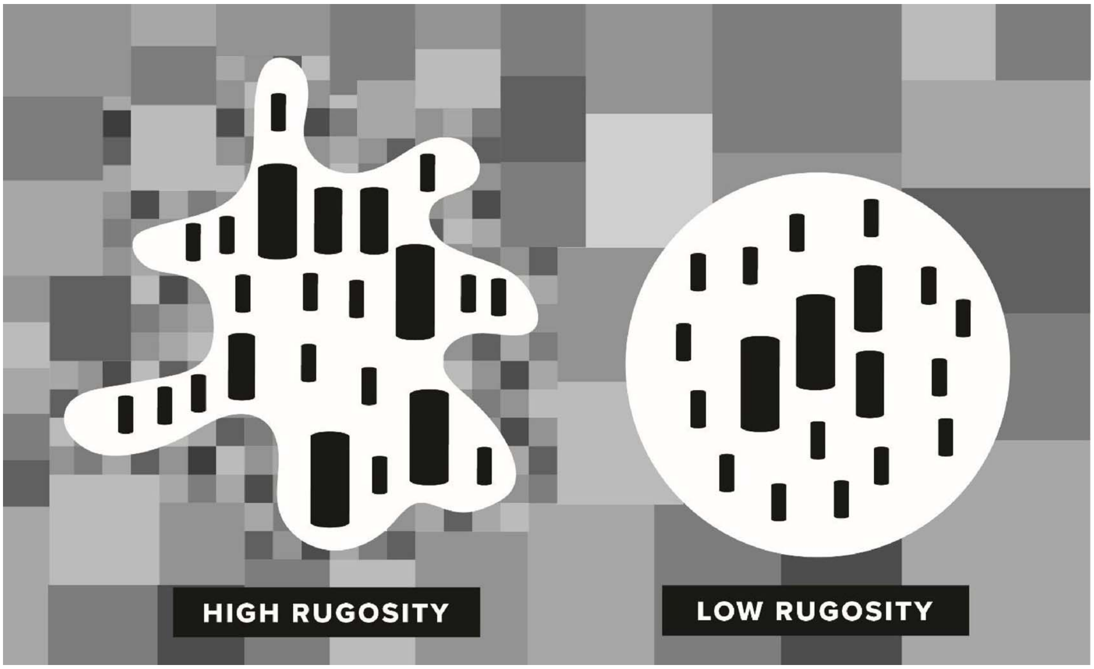

Fig. 1. Rugosity Visualization. Higher rugosity (left) and minimum rugosity (right) for the same urban area (shown in white with areas of greater density depicted as larger cylinders) as compared to the non-urban area (shown in grayscale). Higher urban rugosity can be achieved by maximizing the urban interface through implementation of greenbelts, green wedges, and wildlife habitat corridors. Higher densities on the urban interface are associated with smaller agricultural plot sizes and greater diversity of production. Image created by Nicole Martin of the Center for Regional Change.

1940s radial design incorporates six green wedges (Sanders and Rabuck, 1946; De Oliveira, 2017, p. 98) that have been further protected by the 1967 Urban Rural Demarcation Line, zoning, and agricultural easement purchases. Baltimore County's 2020 Master Plan boasts that its greenway system, adopted in the 2010, "enhances the social and cultural life of the neighborhood and improves quality of stormwater runoff" (Baltimore Master Plan 2020, p. 32). More broadly, Green wedges present short- and long-term preventative health features as they reduce the urban heat island effect (Forman, 2014, p. 134) and improve water quality through stormwater management and recharge (Gill et al., 2007). Lynch (2016) assesses green infrastructure plans at the county and state-level, finding the connectivity, landscape quality and large blocks of greenspace are important to functionality. Urban ecologist Richard Forman (2014) has championed the notion of "lobes and coves," interleaving urban and natural habitats to create biodiversity hotspots for wildlife. Concentric urban form would prevent the interleaving of such greenspaces, and potentially limit the beneficial urban health impacts.

This research proposes the measurement of 'rugosity' to describe the urban interface for two reasons. First, theories and empiric data on urban form are limited as scholars struggle to precisely define and measure the PUI. The urban periphery can be bordered by high or low-density housing developments, natural lands, forest, and coastline. I argue that adopting the concept of rugosity and an empiric definition of the urban interface, allows simple correlations between the pathologies of health and disease. Rugosity is a measurement used in ecology (Shumway et al., 2007) and medical sciences (Samsel and Seneff, 2013) to approximate complex topographies. For example, metabolism in the gut is enhanced by the rugose surface provided by microvilli. By increasing the structural complexity and lengthening the metabolic interface, the microvilli provide habitat niches for a complex mix of flora which also aide in digestion. Measuring the rugosity of the gut provides a clinical diagnostic for health or disease associated with resilience (immunity) and growth (Samsel and Seneff, 2013). Rugosity measurements need not be precise. They offer estimates. In the same manner, the morphology of the urban interface may offer an indicator for the biodiversity of peri-urban land-uses and associated flows of economic and social capital necessary for a city to thrive and grow. To bridge the understanding of shared urban and non-urban metabolisms, "rugosity" invokes this concept of a metabolic membrane.

Second, the term rugosity exposes an initial presupposition about the functionality of the urban interface, namely that a non-concentric city is currently considered pathological for poor land-use planning when it may, in fact, indicate a healthy urban metabolism with numerous niches for other synergistic land-uses. Pathology is a medical term referring to the study of symptoms and related structural and functional changes produced by them. For example, though 'tennis elbow' can be considered a sign of disease, it can also signify a high-performing system that needs extra intervention and care to maintain such high performance. This research hypothesizes that urban areas with high rugosity will have a greater interchange across urban and non-urban lands. Landscapes are mixtures of natural and social phenomena. Such exchange may be crucial for urban metabolism, expressed as the dispersion of the urban heat island effect (Forman, 2014, p. 134) or as retaining high land values in both urban and non-urban lands (Brueckner, 2001). In so doing, this research posits that the urban edge may be as important to urban metabolism and growth as recent notions of scale (Bettencourt and West, 2010; West, 2017).

At the root of this research is a fundamental questioning of concentric urban growth practices. Countering over 200-years of urban theory, this research considers the urban interface as an important metabolic barrier to be maximized. Urban planning is often informed by Central Place Theories (CPT, Openshaw and Veneris, 2003) and concentric growth models (Von Thunen, 1826), which focus on the highest land values clustering in city centers as opposed to the theoretically undesirable urban periphery. Perhaps as a result of the perceived undesirability of the peri-urban zone, many planners call for concentric and low-density peri-urban development. For example, Ebenezer Howard organized his 1898 Garden City as a series of concentric urban developments. Similarly, current urban design theory and practice calls for low-density fringe development as popularized by the Duany transect models (Duany and Talen, 2002) and widely adopted in county plans (see County Plan for Lancaster and plans designed by Duany Plater-Zyberk & Company). CPT plays out practically in planning, with