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Evaluation of planning policy for protecting green infrastructure from loss and degradation due to residential encroachment

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ABSTRACT

Studies indicate substantial degradation and loss of urban green infrastructure area following adjacent residential development. A content analysis of Ontario's most authoritative policy documents was performed to determine whether they had policy goals, objectives and tools for protecting designated green infrastructure from the negative impacts of residential encroachment. Results indicate few policy goals, or measurable objectives. Furthermore, few policy tools sought to limit residential encroachment within green infrastructure following point of development. Existing local government policy tools were narrowly focused on establishing boundary structures and education programs among adjacent residents, without specifying impacts of concern. Policies requiring the monitoring of impacts and tools for their mitigation were missing. Long-term protection policy goals, measurable policy objectives, and effective policy tools are required to limit the anticipated negative impacts associated with residential encroachment following development. Where impacts are uncertain, monitoring policies are required to test and improve policy effectiveness. Furthermore, adaptive management policies are required to protect essential ecosystem services from unanticipated long term impacts, such as those arriving with climate change.

1. Introduction

Green infrastructure is defined by Tzoulas et al. (2007) as "all natural, semi-natural and artificial networks of multifunctional ecological systems within, around and between urban areas, at all spatial scales." These systems provide ecological, social and economic services essential to healthy functioning urban ecosystems. For example, they provide habitat and movement corridors in support of local and regional native biodiversity (e.g., Cornelis and Hermy, 2004), particularly in the context of climate change (Pettersson and Keskitalo, 2013). They cleanse and cool the air in support of human thermal comfort and health (Brown, 2010). They sequester carbon to slow climate change (e.g., Nowak and Crane, 2002); and provide storm water recharge and cleansing services (e.g., Zhang et al., 2012). They are also highly valued for their recreational facilities, and their aesthetic attributes (e.g., Florgard and Forsberg, 2006). For many communities they provide important economic goods and services, such as fish and wildlife products, lumber and support for tourism (e.g., Deng et al., 2010; Konijnendijk et al., 2006). Of increasing recognition is their key role in protecting urban communities from tidal rise, storm surges and flooding associated with climate change (Kubal et al., 2009), and from geological hazards, such as liquefaction associated with earthquakes (Olshansky, 2001).

The Millennium ecosystem assessment (2005) anticipates increased degradation of green infrastructure over the next decades as human populations continue to grow, particularly in and around cities. Studies demonstrate negative impacts of residential development within and adjacent to both rural (e.g., Revilla et al., 2001; Hansen and DeFries, 2007) and urban (e.g., McWilliam et al., 2009, 2010, 2011; Stenhouse, 2004; Matlack, 1993; Sharpe et al., 1986; Moran, 1984; Bagnall, 1979) green infrastructure networks. These impacts are commonly referred to as residential encroachment and occur at multiple spatial scales.

Negative impacts increase with housing density and proximity to forested green infrastructure systems (McWilliam et al., 2009, 2010, 2011; Matlack, 1993; Friesen et al., 1995; Parks and Harcourt, 2002; Hansen et al., 2005). The number and proximity of houses

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adjacent to rural ecological networks is increasing within many landscapes (e.g., Wade and Theobald, 2009; Hansen and DeFries, 2007; Radeloff et al., 2010). It is also increasing within and adjacent to urban green infrastructure with the current implementation of planning policies that seek to increase housing density and intensification within suburban communities (Kenney, 2003; Nowak et al., 2001).

Within rural landscapes, studies demonstrate coarser scaled impacts with a loss of native biodiversity with increased housing density, in proximity of, but not necessarily abutting, ecological networks (Heller and Zavaleta, 2009; Friesen et al., 1995; Odell and Knight, 2001; Parks and Harcourt, 2002). Residential developments replace productive land uses within buffer zones, and are less supportive to adjacent core and corridor ecosystem services. They tend to increase fragmentation within these networks, reducing the area of, and connectivity between, core, buffer and corridor components (Hansen and DeFries, 2007; Revilla et al., 2001).

At finer spatial scales, increased density and proximity of housing alters abiotic and biotic flows into and out of green infrastructure patches and corridors relative to those occurring prior to adjacent housing development. These impacts are particularly prevalent in urban areas where there are no buffer zones between housing land uses and green infrastructure, and where buffer zones are reduced in width to narrow strips. For example, subdivision construction adjacent to forested green infrastructure commonly alters and degrades surface and groundwater regimes relative to those present under adjacent rural land uses. This often results in a change in the quantity, and rate of flow, of water available to the forest following storm events, increasing the occurrence of drought, flooding and soil erosion, and the degradation of aquatic and semi-aquatic wildlife habitats (Beck, 2005; Donohue et al., 2005; Kominková et al., 2005). Increased density and proximity of housing to green infrastructure also increases the amount of incoming nutrients, pesticides and other pollutants (Brander et al., 2004). Pollutants associated with residential land uses include nitrates found in fertilizers (Exner et al., 1991; Cook et al., 2012), fecal coliform and streptococci (Young and Thackston, 1999; U.S. Environmental Protection Agency, 1995)

Studies indicate that increased recreation activities arriving with adjacent residential land uses can also negatively affect adjacent green infrastructure. Impacts associated with increased proximity to residential areas include increased litter, trampling and damage to soils and vegetation, fire rings, trail erosion and widening, increased dispersal of exotic vegetation, disturbance to wildlife (Matlack, 1993), and reduced aesthetic and recreational experiences (Lynn and Brown, 2003). Impacts occur up to 70 m into forest edges where there are at least 10 houses located within 100 m of forest borders, and increase with road and trail access (Matlack, 1993).

Negative impacts associated forest patches and corridors with directly abutting housing have been demonstrated within many countries (McWilliam et al., 2009, 2010, 2011; Matlack, 1993; Moran, 1984; Sharpe et al., 1986; Stenhouse, 2004; Bagnall, 1979). Impacts extend more than 50 m from forest borders (McWilliam et al., 2009) and cover 26–50% of the forest floor within the first 20 m (McWilliam et al., 2011). Where forest fragments are small in area or narrow (e.g., less than 100 m wide), impacts can negatively affect the entire area of green infrastructure (McWilliam et al., 2009, 2010, 2011). Activities causing impacts include waste disposal, the creation of unauthorized forest pathways, fire pits and tree forts; and the replacement of forest with yard structures such as lawns, patios and swimming pools (McWilliam et al., 2010, 2011). Many of these activities remove and damage soils and vegetation (Florgard, 2000; Seidling, 1999); facilitate the spread of invasive exotic plants (McWilliam et al., 2009, 2010, 2011); disturb native wildlife (Sauvajot et al., 1998); and, degrade aesthetic and recreational experiences (Lynn and Brown, 2003). They may also reduce storage, and filtering capacity of soils and vegetation, particularly within riparian buffer zones (U.S. Environmental Protection Agency, 1995).

Many governments have policies that seek to protect designated green infrastructure from the negative impacts of development. For example, in Ontario, Canada, governments have developed policies to identify, leave undeveloped and/or control the development of essential provincially significant green infrastructure and their adjacent land uses. Policies do not allow development within and adjacent to significant green infrastructure, such as wetlands, unless developers demonstrate no negative impact to their features and functions (Section 2.1, Ontario Ministry of Municipal Affairs and Housing (OMMAH), 2006). These policies are contained in the 2005 provincial policy statement (2006), one of the most authoritative environmental policy documents in Ontario. This indicates the high importance attributed to protecting green infrastructure for the long term. Regional and local governments are required to develop policies to implement these provincial policies in addition to ensuring the protection of other regionally and locally significant green infrastructure within their jurisdictions (e.g., Regional Municipality of Halton, 2004; Town of Oakville, 2004).

Studies measuring degradation and loss of forested green infrastructure within southern Ontario municipalities suggest local and regional policies for implementing the Section 2.1 policies of the 2005 Provincial policy statement (2006) may be missing or inadequate. A previous study of local municipal policies within Southern Ontario municipalities based on interviews with Ontario municipal planners, landscape architects, bylaw officers and forest managers, found an awareness of only a few explicit municipal policy or practice goals, objectives, tools, and bylaws for protecting green infrastructure from impacts associated with residential encroachment following development (McWilliam et al., 2012). In addition they identified many barriers to their implementation (McWilliam et al., 2013), including a lack of awareness and priority placed on addressing this issue. Local level policies are often driven by those within more authoritative policy documents, such as official and secondary plans in Ontario. This lack of awareness and priority placed on addressing long term impacts, such as residential encroachment, may indicate a policy gap within these more authoritative policy documents.

Taking six Southern Ontario municipal and their regional governments as a case study, the goal of this paper is to determine whether Ontario's most authoritative environmental policy documents have policy goals, objectives and tools for protecting their green infrastructure against the long term impacts of residential encroachment following development. Recommendations for long term protection policies are provided.

2. Methodology

2.1. Study area

Southern Ontario, Canada was chosen as a case study because successive Ontario provincial policy statements have indicated a desire to protect their essential green infrastructure in both rural and urban landscapes for the long term. For example, Section 2.1.1 in the provincial policy statement (PPS) (OMMAH, 2006, Pol. 2.1.1) states, "Natural features and areas shall be protected for the long term." Ontario's Regional governments are required to generate regional official plan policies that implement the policies dictated in the PPS in addition to their own environmental policies; and local governments are required to implement both provincial and regional policies in their municipal official plans. They are also encouraged to establish and implement their own local