Growing the Greenbelt: Peri-urban Experiments for Climate Change Resilience

Abstract:

What can landscape designers and planners learn from resilience research to support the transition away from consumption and growth-driven paradigms? As the climate change trajectory is already reaching critical tipping points or thresholds, threatening a regime shift out of the Holocene state (Steffen et al. 2015), this project examines a vision, grounded in resilience theory, that landscape architects and planners can take to design for an uncertain future. Specifically, this paper explores resilience-building configurations of sustainability strategies at the edge between suburban developments, agricultural lands, as well as protected forest patches and riparian corridors, where urban river headwaters, “white belt” and Greenbelt lands intersect. Using a case study approach mixed with knowledge translation from the field of ecological resilience applied to landscape design, this paper explores an alternative vision for contested lands, where growth and conservations policies collide.

Full text:

How do we as landscape architects and spatial designer envision the future resilience of life-sustaining ecosystem services? What can we learn from the field of resilience research and apply to spatial and environmental design, especially in the context of climate change and sea levels rising even faster than the last predictive model indicated (DeConto and Pollard 2016). How can we engage two very different narratives that reveal a deep ambivalence in what we imagine for the future?

In one narrative, while we understand that our broader environmental context has changed and we need to adapt, we are committed to maintaining urban economic growth to become World Class Cities “without all the negative side effects,” specifically, urban inequality, social exclusion, sprawl, and high levels of greenhouse gas emissions (UN Habitat 2018). For instance, the UN Habitat Manifesto for Urban and Territorial Planning (2018) proposes greater efficiency in and effectiveness of urban design and planning, consisting of rapid response, rights-based approaches, development centred on infrastructure, and ensuring alignment with city budgets. What this strategy of improving the efficiency and effectiveness of planning processes fails to reconcile with is the following narrative.

A highlighted statement in the Intergovernmental Panel on Climate Change’s 2014 Synthesis Report states that “anthropogenic greenhouse gas emissions have increased since the pre-industrial era, driven largely by economic and population growth, and are now higher than ever.” Here, the mostly fossil fuel-powered economic and population growth is the key driver of climate change with all its destructive implications for cities—floods, droughts, sea level effects, health, etc. (Homer-Dixon et al. 2015; Lewis
The underlying recognition is that people still ultimately depend on nature to meet essential needs including food, clean air and water, protection from droughts, storms, and flooding, along with recreation and spiritual needs no matter how much technology advances (Biggs, Schlüter, and Schoon 2015, 2–3). This is especially pertinent for cities globally which use between 60 and 80% of the world’s energy and generate as much as 70% of human-induced greenhouse gas emissions (UN Habitat 2016). These two narratives are a simplification illustrating our ambivalence towards and our path dependence\(^1\) on growth and consumption.

As landscape, urban and spatial designers and planners, how we grapple with, think about, and respond to these two competing narratives around growth and ecosystem service provision will be imperative. I argue here that resilience thinking is a useful tool for urban designers and planners when approaching sustainable urban design and making wise trade-offs to accommodate a growing population. Here, resilience principles for ecosystem service provision related to diversity, redundancy, modularity and building of reserves have prominent potential for translation into spatial design guidelines (Biggs, Schlüter, and Schoon 2015). These principles will be explored through examining the edge conditions of the Ontario Greenbelt currently facing increasing development pressures.

**Literature review in Landscape Architecture**

Before introducing resilience thinking for ecosystem services and complex adaptive (or self-regulating) systems as applied to the peripheries of the Ontario Greenbelt (Holling, C. S. 1973a; Holling et al. 2004; Gunderson 2000; B. Walker and Salt 2012), a review of literature found that the resilience approach is rarely explicitly referenced within the field of landscape and urban design. One notable exception is the work of Landscape Architects, Penny Allan and Martin Bryant, in trying to find common ground between disaster recovery and urban design patterns, are proposing socio-ecological resilience and its attributes as a guiding framework for urban design of resilience cities (P. Allan and Bryant 2014; Penny Allan and Bryant 2011; Bryant, Allan, and Kebbell 2017). Conversely, allied disciplines like urban planning, ecology, life sciences and forestry have taken steps to engage with urban design and translate resilience principles and attributes for designers (Wu and Wu 2013; Pickett, Cadenasso, and Grove 2004; Dhar and Khirfan 2017). Lastly, urban planner Nina Marie Lister has written about socio-ecological resilience broadly as a proposed framework for designers (Lister 2015). At the time of this literature review, no research specifically focused on application for spatial design was found to examine the relationship between resilience and spatial attributes.

**Etymology and definitions**

A brief etymology of resilience is given in Alexander (2013). Tracing the post-industrial etymology of resilience reveals its path through multiple disciplines including mechanical engineering, ecology, and psychology. The oldest and most widely used is the engineering notion of resilience; in the sense of a buffer from failure (Adger 2000). It was first used in 1858 within a description of robustness or resistant properties of steel beams in response to force; an ability to “bounce back” from a force to return to an original functioning state (Alexander 2013). In the 1950s the field of child psychology began using the term resilience to refer to the ability of children to recover from traumatic experiences (Goldstein and

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\(^1\) Path dependency is defined here as the durability or persistence of a decision made based on past conditions that lead to undesirable outcomes and are costly to change, especially given changed current conditions. In Steve Margolis and Stan Liebowit 1995.
Brooks 2005). Within systems ecology, C.S. Holling first introduced the concept of resilience of ecosystems in 1973, as a system’s ability to absorb change/disturbance and still maintain the same relationships between populations or system state variables; a system can have enormous resilience if allowed to cycle through its inherent fluctuations (Holling, C. S. 1973b, 14). In other words, ecological resilience focuses on the boundaries within which fluctuations occur, rather than on equilibrium states. Ecological resilience eventually influenced the social sciences through economists (Batabyal 1998) and geographers (Adger 2000) and in the recent decade has begun the interdisciplinary study of socio-ecological resilience research exemplified through the Resilience Alliance (resalliance.org) and its related journal Ecology and Society.

Within this paper, the definition of resilience will be specifically related to ecosystem services. Resilience here is defined “as the capacity of social-ecological systems to continue providing desired sets of ecosystem services in the face of unexpected shocks as well as ongoing change and development” (Biggs, Schlüter, and Schoon 2015). Note that ecosystem services are considered a type of social-ecological system, where humans as members of the global ecological system are recognized as inherently intertwined and interacting with ecological processes to produce agriculture, raw materials, and recreation among others. These social-ecological systems are complex adaptive systems characterized to have the capacity to self-organize, learn from past experiences, and have unpredictable behaviour (Holling et al. 2004).

Greenbelt case

The Greenbelt around the Greater Golden Horseshoe in southern Ontario is a landscape where the trade-off between ecosystem service provision and population growth is most apparent. Consisting of prime agricultural land and most of the region’s vegetated cover and fauna, the Greenbelt has been evaluated – albeit conservatively—to provide an estimated $2.6 billion in measurable non-market ecosystem services annually (Wilson, Friends of the Greenbelt Foundation, and David Suzuki Foundation 2008). The most recent Growth Plan for the province of Ontario and the Greenbelt Plan were both updated in 2017 (Ontario Ministry of Municipal Affairs) with the former governing the growth of Ontario’s population and economy, while the latter governing the protection of Greenbelt lands through special protections for conservation. The border between Greenbelt land and urban development land is further complicated with “white belt” land where neither Plan has jurisdiction, and where sensitive headwaters of urban river systems are susceptible
to development pressure, pollution, and erosion. The invisible third component of ecosystem services is the amount of pollution and ecosystem pressures that have been offset elsewhere through international trade. Studies presented at the most recent International Panel on Climate Change Scientific Meeting in Edmonton reveal that most cities in Europe and North America do not account for consumption related green house gas (GHG) emissions that have been outsources elsewhere, stacking up GHG emissions that are more than three times higher than previously thought (C40 Cities Climate Leadership Group (C40) 2018, 7). In the Greater Toronto and Hamilton Area, the annual GHG emissions estimated at 47 mega tonnes of equivalent carbon dioxide (MtCO2equ 2015 levels) including consumption GHGs would by C40 methodology increase by a factor of 3 (2015 levels from Lu 2017). Furthermore, as the GTHA’s population is projected to increase by 41% between 2016 and 2041 (Lu 2017), the Ontario Government’s Growth Plan’s pushing development density towards nodes of transit infrastructure does little to address the enormous increase in emissions (Ontario Ministry of Municipal Affairs 2017; Greater Toronto Transportation Authority and Metrolinx 2008). Furthermore, the development encroachment upon the unregulated peri-urban “white-belt” along the Greenbelt’s edge, will add further pressures on ecosystem services at risk.

Due to the increase in existing and consumption-based GHG emissions in the GTHA, it is imperative to examine the peri-urban Greenbelt edge landscapes with its confluence of land uses: farmland, development subdivisions, and conservation areas through the lens of the resilience approach. This confluence of difficult trade-offs could be an opportunity for synthetic fields like landscape and urban design to generate alternate future visions for building resilience of ecosystem services. For, the implications for the Greenbelt is that protection and maintenance of ecosystem service provision capacity is no longer sufficient; we need to design for improving and growing the reserves of ecosystem services. How the resilience principles of functional diversity and redundancy along with modularity in connection might be applied in landscape and urban design is examined below.

**Functional diversity**

Functional diversity within ecosystem service provision emphasizes the distribution of diverse system components rather than simply their diversity in numbers (Brian Walker, Kinzig, and Langridge 1999). The existing diversity of land use in the peri-urban fringes of the Greenbelt make it a suitable landscape to experiment with and incubate various sustainable design strategies, hoping at least some of which will be a winning strategy to meet uncertain futures. For, if there is diversity and redundancy within a group of system components that have a similar function, it can increase resilience and provide options for responding to disturbance and to surprise (Kotschy et al. 2015).

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2 Based on conversations with local non-governmental organizations Environmental Defense, who have organized a coalition of Civil Society actors around Greenbelt conservation in the past decade.

3 The Toronto and Region Conservation Authority is currently looking into this area through their update of the Terrestrial Natural Heritage System Strategy.
In the same way that a stock portfolio is diversified to reduce risk, functional diversity uses the same principle to increase resilience of ecosystem services to unpredictable climate change disturbances. In the example of the Greenbelt, this principle could be applied at several scales. At the site scale, a farmer might change focus from short term gain to long term sustainability, namely from methods like monocropping to tree intercropping, an approach to planting trees and crops together in such a way that a diversity of plant functions is paired together to increase sustainable yields and ecosystem service provision (Hawken 2017). At the landscape scale, different modules or lots of farming techniques ranging from tree intercropping to silvopasture can diversify non-depleting methods of food production, carbon sequestration, and water filtration. When facing the uncertainty of climate change and its related disturbances, known and unknow, a large pool of strategies and approaches to ensure food production, for example, is more likely to provide options for adaptation. Note here that this approach is likely more costly as efficiency is decreased when functional diversity and redundancy is increased (Brian Walker, Kinzig, and Langridge 1999). Though, if the consumption-related GHG emissions are considered, this initial cost is minimal viewed in a seven generations time horizon.

Modular connectivity

A second resilience principle useful in the spatial design of Greenbelt periphery landscapes is modularity of connectivity. Increasing modular or compartmentalized system connectivity of heterogeneous system components (i.e. lakes, which are functionally organized as independent clusters that are very loosely connected to each other) can buffer the spread of disturbance and adjust more gradually to disturbances (Scheffer et al. 2012).

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Connectivity is defined here as the architecture and strength of the interactions between resources, species or actors within a system (Dakos et al. 2015). In an increasingly interconnected world with rapid transmission speeds carrying materials and information, the risks are much higher for cascading crisis, or multiple, simultaneous, and interacting stresses at a global scale (Homer-Dixon et al. 2015; Beddington 2009). For example, the interlinking of financial instability and large swings in oil and food pricing (indicating that these resources are under extreme pressure), population growth, and climate change characterized the 2008 financial and food crisis (Homer-Dixon et al. 2015). At the scale of the Greenbelt edge, the varied land uses in this area – agriculture, residential sub-divisions, protected forest patches, and headwater creeks and rivulets – could be ideal for experimentation and learning in terms of novel or ancient agricultural practises intermixed with ecosystem service generating building methods. This potential for experimentation to prepare for uncertainty can benefit from variable modularity of use, or the ability to determine the level of compartmentalization a certain land use is from the next plot or patch. For example, the plots of land that are experimenting with living buildings that filter rainwater to potable standards (Hawken 2017), are by design as closed-loop systems, incidentally cut off from municipal water systems or groundwater wells to prevent spread of contamination. In the case of no-till and crop-rotation agriculture (Friedrich, Derpsch, and Kassam 2012), might also act as a relatively contained learning and experimentation parcel that could be loosely connected to share/spread to other plots when the timing and method is appropriate. By ensuring that modules of parcels are loosely connected to each other, it would enable the region to experiment with and incubate spatial design strategies to enhance ecosystem service provision, ready for seeding to other areas of the GTHA.

Conclusion

If we become more cognizant of our path dependency on economic and population growth and its consequent destruction of the ecosystem services fundamental to our well-being, our mindset might be better framed to envision and design an alternative future for our cities and landscape. A suitable starting point could be at the fringes of the Ontario Greenbelt, where growth and conservations policies collide, neither moving us closer to a more resilience sustainable future. In these difficult collision points we might find opportunities for integrating old and new ways to live with and build ecosystem services, rather than, at best, conserve and, at worst, deplete them. Socio-ecological resilience thinking can help...
guide landscape and urban designers in framing ecosystem service enhancing experiments safely in modular compartments, with the goal of generating a diversity of solutions to face the uncertainties of climate change.
Bibliography


