Stream 5 – Pushing the Boundaries: Net Positive Buildings (SB13)
CaGBC National Conference and Expo, Vancouver BC, June 4-6, 2013

Regenerative Neighbourhoods – scaling up from net positive buildings

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ABSTRACT: Emerging approaches support regenerative design and development at the building scale. Buildings such as the Centre for Interactive Research on Sustainability at the University of British Columbia (UBC) are attempting to demonstrate that net-zero and even net-positive performance with respect to energy, water and carbon, health, happiness and productivity is technically, financially and institutionally possible. Building-scale applications also demonstrate the limitations of applying regenerative sustainability principles at the building level (e.g., missed opportunities for integration of energy and transport infrastructure, water and wastewater, urban form, community engagement). This paper presents the early findings of the UBC Regenerative Neighbourhoods Project. This includes a scan of the urban sustainability context, a rationale for neighbourhood scale application, and insights on process and potential performance standards.

1 INTRODUCTION

1.1 *Sustainability and the Built Environment*

Predominant sustainability and environmental responses have typically encouraged incremental 'less harm', or possibly 'net zero' solutions. Such efforts are important but inadequate in two ways: they are insufficient because the magnitude of change required to achieve global sustainability demands transformational change that goes beyond net zero to net positive outcomes, and they are demotivating because an invitation to sacrifice, or to minimize harmful human activities, is inherently uninspiring (Gifford and Comeau, 2011).

'Green' building approaches such as LEED illustrate this inadequacy. While they have increased the awareness of green buildings and helped reduce the adverse environmental impacts associated with the construction and operation of buildings, rapid global urbanization and an unprecedented building boom worldwide have contributed to increasing environmental impacts associated with buildings worldwide. This is, in part, because most new (and existing) building stock worldwide is still not being designed to comply with green building standards and, currently, most 'green' building rating systems reward building performance that is based on 'less harm' solutions with respect to energy, emissions, water, indoor environmental quality, and so on. Presently, about 40% of all energy and material resources are used to build and operate buildings globally. Even with the growth in the green building industry, aggregate CO_2 emissions from buildings are projected to grow faster than any other sector through 2030 (UNEP, 2007; 2009).

The insufficiency of the less harm approach can also be explained by looking at the city scale. The world's urban population is expected to increase by more than two billion people in the next 30 years (UNDP, 2012). If current trends continue, this will lead to dramatically increasing demands for urban infrastructure and resources. Fortunately, new approaches to sustainability are emerging.

1.2 *Regenerative Sustainability*

There are a wide range of views on the meaning of 'sustainability' and 'sustainable development'. One view argued for by Robinson (2004) is the view of 'procedural sustainability':
"where sustainability can usefully be thought of as the emergent property of a conversation about desired futures that is informed by some understanding of the ecological, social and economic consequences of different courses of action ... This view acknowledges the inherently normative and political nature of sustainability, the need for integration of different perspectives, and the recognition that sustainability is a process, not an end-state" (Robinson, 2004, p. 381).

Following on this view, 'regenerative sustainability' can be thought of as a net positive approach to sustainability leading to a mutually beneficial co-evolution of socio-cultural ('human') and ecological ('natural') systems. It is explicitly distinguished from a 'less harm' approach. It can be expressed in the form of a question: To what degree can human activities lead to improvement of both ecological integrity and human quality of life as emergent properties?

The aspirations and key principles of regenerative sustainability are emerging from several converging historical threads including architecture and design, community engagement and respect for people and place, systems thinking, sustainability assessment, human well-being assessment and others. Regenerative sustainability embraces such qualities as whole, integrated and closed loop systems; supports the potential for self-organization of living systems; encourages shared responsibility and ownership; and catalyzes the capability for 'net positive' outcomes in human well-being and ecological integrity (Cole 2012; du Plessis 2012; Svec et al. 2012, Reed 2007). While the aspirations and key principles of regenerative sustainability are becoming clearer, the operations and practices as they relate to the built environment are not yet well developed (Cole, 2012).

1.3 *Regenerative Design and Development*

The term 'regenerative design' was first introduced by John T. Lyle as a design process that takes into account the people and environment in which it is situated to create a project that is in harmony with the local community and ecosystem (Lyle, 1994). Lyle drew from the ideas of permaculture, bioregionalism, and ecological design and applied them to buildings and a small campus.

The Cradle-to-Cradle (C2C) concept applied this thinking to the way we build and design, including applications to industrial processes and product development (McDonough & Braungart, 2002). C2C suggests that products and developments can be designed so that, after their useful lives, they can provide nourishment for something new through technological and biological cycles. Inherent in the C2C concept is the idea of 'net positivity' or 'upcycling.' Today, C2C principles are being applied in a range of contexts, including the built environment (Mulhall & Braungart, 2010).

Some insights about the emerging field of 'regenerative design and development' related to the built environment are provided below. Importantly, they represent not only an intention to restore and regenerate socio-cultural and ecological systems but also a shift in perspective about the role of buildings, and the built environment itself, from being the primary subjects of interest to being seen for their potential to catalyze mutually beneficial co-evolution of human and natural systems in a partnered relationship with place (Cole, 2012). According to Reed (2007), the regenerative process begins by:
"attempting to understand how the systems of life work in each unique place. Our role, as designers and stakeholders is to shift our relationship to one that creates a whole system of mutually beneficial relationships. By doing so, the potential for green design moves us beyond sustaining the environment to one that can regenerate its health – as well as our own" (Reed, 2007, p. 1).

Mang and Reed (2012) differentiate between regenerative *design* and regenerative *development*, suggesting that the former builds the regenerative and self-renewing capabilities of designed and natural systems (i.e., the designed interventions) while the latter creates the conditions necessary for its sustained, positive evolution (i.e., the benefits accrued from regenerative designs). DuPlessis (2012) broadens the narrative, making the case for a 'regenerative sustainability paradigm' that aims to "…restore and regenerate the global social–ecological system through a set of localized ecological design and engineering practices …" (p. 15).

Some early attempts of regenerative design and development frameworks have been suggested, including: the Regenesis Framework (Mang & Reed 2012), the REGEN tool (Svec et al. 2012); the LENSES framework (Plaut et al. 2012) and the Perkins+Will framework (Cole et al. 2012). More information on all of these can be found in the special issue of *Building Research and Information 40(1)*. See Cole (2012) for an overview.

Other frameworks, with potential relevance to regenerative sustainability and neighbourhoods include: the Living Building Challenge 2.1 (International Living Buildings Institute, 2011), the Portland Sustainability Initiative's EcoDistricts framework (PoSI, 2012), Arup's ASPIRE tool (Arup ASPIRE information sheet, n.d.) and Cradle to Cradle Criteria for the Built Environment (Mulhall & Braungart, 2010). All of these frameworks offer some insights about encouraging a shift towards a regenerative approach to design or development, with potential application to the neighbourhood scale. However, most of these approaches – at this stage of their development – remain early efforts with most focused on single building or project design (an exception being the EcoDistricts framework). Furthermore, early thinking on regenerative design and development has been criticized in general as lacking concrete evidence of its efficacy (Cooper 2012), its applicability in an urban context (Clegg 2012), and its applicability at different scales (Tainter 2012).

1.4 Why Neighbourhoods?

To date, regenerative sustainability (including regenerative design and development) has mainly been applied at the building scale. As part of the exploration of scaling up, this paper focuses on informing the potential for net positive neighbourhoods through an understanding of its broader urban context (see Section 3). We expect urban neighbourhoods to be an important context for further exploration of regenerative sustainability because:

- Cities, including their neighbourhoods, have a large influence on global sustainability. They are major centers of human population resource use, waste and emission creation and habitat damage (UN-HABITAT, 2011; UNEP 2007, 2009; Pimm & Raven, 2000) as well as centers of human, social and financial capital with significant potential for creativity and innovation (Glaeser, 2003)
- There is growing empirical evidence and recognition that cities shape themselves 'organically' from the bottom-up through the millions of self-organizing socio-economic and policy-shaping transactions at the building and neighbourhood scales (in addition to top-down 'master plans') (Batty 2008; Batty 2012a; Salat & Bourdic, 2012)
- There are limitations of single-building innovation on overall urban form and function (e.g. doesn't cover connecting infrastructure and services, mobility, public spaces) (Clegg 2012; Tainter 2012) and,
- There is good potential for more meaningful community engagement at the neighbourhood scale than at the metro and building scales. The neighbourhood scale allows smaller, more informed engagement and sense of ownership (compared with the urban, or metro, scale) and more diverse interests to engage in decisions shaping socio-cultural and environmental considerations (compared with the building scale). More meaningful engagement may also offer the potential for enhanced social learning through a reciprocal 'mindset-built form' relationship (i.e. where changing worldviews re-shape neighbourhood built form and neighbourhood built form, in turn, re-shapes worldviews).

This suggests that communities of people engaged in the conceptualization, design, development and on-going life of buildings, neighbourhoods and districts hold considerable potential for contributing to urban sustainability. The premise that urban neighbourhoods are an important context for further exploration is supported by a number of recent efforts focused on sustainability at the neighbourhood scale, including Falk & Carley's (2012) identification of the characteristics of a sustainable urban neighbourhood, The Freiburg Charter for Sustainable Urbanism (2012) 'lessons from Vauban', CABE's (2008) and URBED's (2008) exploration of what makes an 'eco-town' and how the concept has been applied across Europe, and Woodcraft et al.'s (2011) exploration of 'social design' and the creation of thriving communities.

2 RESEARCH PROGRAM

2.1 *UBC Campus as a Living Laboratory*

To respond to the need for better integration of operational and academic sustainability efforts, partnership interests and research, The University of British Columbia (UBC) has developed a formal Campus as a Living Laboratory for Sustainability (CLL) initiative. The intention is to develop interdisciplinary research projects that leverage operational requirements to create substantive partnership opportunities with industry and other community partners, and to leverage teaching, learning and research opportunities for students, faculty and staff. The entire 400-hectare, 400-building campus (containing about 1.5 million square metres of floor-space) is seen as a test-bed in which to demonstrate operational innovations that catalyze the development of new knowledge and new applications, systems and technologies.

Many universities have characteristics similar to UBC that make them uniquely qualified to serve society in this role: (a) they are single decision-makers (and often owner-occupiers) of significant capital stock, consisting of multiple buildings and energy, water and waste systems; (b) they are public institutions, or have a public mandate, that can be more forgiving on pay-backs, and long-sighted on returns; (c) they educate; and (d) they conduct research.

2.2 *The Centre for Interactive Research on Sustainability (CIRS)*

The Centre for Interactive Research on Sustainability (CIRS) is a 5,800m^2 living lab flagship building on The University of British Columbia (UBC) Vancouver campus designed to operate at the frontier of sustainable performance in environmental and human terms, and to serve as a living laboratory of sustainable practice over its lifetime (Robinson et al., 2013). In this sense, CIRS seeks to become an example of building-as-catalyst for the net positive co-evolution of human and natural systems. Embedded in the UBC campus, its ability to fulfill this role will continue to be researched and developed further. CIRS seeks to demonstrate that it is technically, financially and organizationally possible to plan, design, construct and operate buildings that deliver net positive environmental (biophysical) and human well-being benefits to their communities.

CIRS seeks to become net positive in seven ways; 4 environmental (net positive in structural carbon, operational carbon, energy, and water) and 3 human (human health, happiness and productivity). Details of these approaches to net positive performance involving advanced, integrated systems and including a high degree of connectivity to its surroundings can be found at www.cirs.ubc.ca. CIRS is beginning to demonstrate that human and environmental net benefits can spill over from the building into its surroundings. Some observations from CIRS include:

- The sub-system (e.g., building) can only be 'net positive' in relationship to its contribution to the broader system (e.g., its surroundings, or neighbourhood);
- There is a complex, integrated combination of biophysical stocks and flows within and across the building boundary (e.g. heat, power, carbon, water, wastewater, materials);

- There are biophysical constraints (e.g., space, distance, thermodynamics, etc.) to the building's net positive reach (with respect to flows of energy, water);
- Quantifying 'net positive' is based in part on delineation of building 'system boundary' as part of a lifecycle assessment (LCA);
- The ability to make 'net positive' contributions to the building's surroundings depends, in part, on the unique characteristics of place (e.g. water self-sufficiency in Vancouver may not transfer to more arid climates);
- Social interactions (e.g., the CIRS community of inhabitants) and the communities it engages seem much less limited by these biophysical constraints;
- Early indications are that the influence of the CIRS community in re-framing the sustainability narrative through interactions with its surrounding communities (and supported by tangible building-scale examples), might be one of the more important 'net positive' contributions; and
- Some additional dimensions of 'net positive' are expected at the neighbourhood scale (e.g. transportation, community engagement, food systems, habitat) and warrant a review of the broader urban context) (see Section 3).

2.3 *Regenerative Neighbourhoods Research Project*

In the context of the CLL initiative, UBC is undertaking the Regenerative Neighbourhoods Project (RNP). The purpose of the RNP is to explore and catalyze the emergence of regenerative sustainability at the neighbourhood scale, firstly within the UBC campus and community, and secondly in communities beyond UBC. It has three main tracks: (1) research, (2) application at UBC and, (3), sharing lessons with partners and collaborators outside UBC.

The initial objectives of the Regenerative Neighbourhoods Project are to:

- Understand and explore the concept: What is regenerative sustainability as it applies to the neighbourhood scale? For example, what are the implications of scaling up regenerative sustainability from the building scale (e.g. CIRS)? What are some guidelines for engaging in regenerative sustainability processes?
- Understand assessment: How can regenerative sustainability performance be assessed?
- Understand obstacles/enablers and institutionalize continuous improvement at UBC.

Initial RNP activities include: reviewing relevant literature and best practices; hosting an exploratory summit; testing and refining an evaluative framework ('lens'); institutionalizing continuous improvement at UBC; and working with external partners in the private, public and not-for-profit sectors to test the efficacy of the concept in urban neighbourhoods and support broader knowledge diffusion. This approach is aligned with UBC's sustainability goal to *commit* the entire community to sustainability research, teaching and learning; to *integrate* by embracing interdisciplinary approaches to sustainability; to *demonstrate* by transforming its entire campus into a living laboratory, and; to *inspire* students, faculty, staff, alumni and partners beyond the campus gates.

3 THE URBAN SUSTAINABILITY CONTEXT FOR NEIGHBOURHOODS

The overarching question posed by the Regenerative Neighbourhoods Project is: how can human activity at the neighbourhood scale contribute in a net positive way to the co-evolution of socio-cultural and ecological systems? Neighbourhoods are set within a broader urban context, and as such, there is a reciprocal relationship: the development, on-going life, decline and redevelopment of neighbourhoods influences the patterns and dynamics of urban areas, and the overall urban context can exert considerable socio-economic, cultural, ecological and institutional influence on neighbourhoods. It is this latter context that is explored in this section through an examination of the issues facing cities and the practical and theoretical responses to those challenges.

3.1 *Urban Sustainability Context and Challenges*

Understanding the projected growth of cities and the expected consequences of intertwined current trends can inform urban sustainability approaches. Some biophysical implications of this growth, for example, include increasing habitat destruction, loss of biodiversity (Pimm & Raven, 2000), water shortages and nutrient cycling deficiencies (Kalmykova et al., 2012; Metson *et al.* 2012). Concurrently, cities face aging infrastructure, public sector debt as well as increasingly obsolete and resource-intensive buildings. Global urban infrastructure cost estimates for the next 20 years are $53 trillion, about $2.5 trillion per year (OECD, 2007).

Income inequality is growing in nearly all OECD countries (OECD, 2011a) with US and Canadian figures among the worst (Goldsmith & Blakely, 2010; Canadian Centre for Policy Alternatives, 2009; OECD, 2011b). At the same time, there is a reduced ability of citizens to articulate and organize requests for good government, a movement away from community life, and increased psychological alienation (Putnam, 2000). For example, in a poll of 3,841 people across Metro Vancouver, preliminary results found that residents considered their community to be a place where neighbourhood relationships are polite, but the connections are not particularly deep and one in four residents found Metro Vancouver to be a lonely place (Wightman, 2012).

Increasing empirical evidence argues strongly that current built form – and urban sprawl in particular – leads to a number of concerning health trends including less physical activity, increased obesity (leading to increased risks of cancer, heart disease, stroke, high blood pressure and depression), increased prevalence of diabetes and cardiovascular disease, increased injuries to pedestrians, less connectivity and social capital, and declines in subjective well-being and psychological health (Flegal et al., 2010; Frumkin et al., 2004). Many of these trends tend to be worse amongst lower income groups (Drewnowski, 2009; Akinbami et al., 2011), and poverty remains a massive issue in cities around the world (OECD, 2011a). In Canada, the urban poverty population is growing at faster rates than non-poor populations and cities are showing increasing spatial concentration of poor families (Canadian Centre for Policy Alternatives, 2009; Gertler, 2009).

Therefore, the urban sustainability context spans a complex, highly interdependent mix of socio-economic, cultural, technological, public health, ecological and institutional considerations. This informs the context for considering regenerative sustainability at the neighbourhood scale: how can neighbourhoods maximize their net positive contribution to improved human well-being and ecological integrity, within this complex and dynamic urban fabric?

3.2 *Sustainable Community Planning*

There has been much written on the ways in which natural and human systems can be better integrated through the design of the built environment. Ian McHarg's *Design with Nature* (1969) and Christopher Alexander's *A Pattern Language* (1977) were early views on the adoption of an 'ecological worldview' in planning and an articulation of how regions should be planned according to natural processes and patterns. Natural patterns and processes can inform regenerative sustainability applied at the neighbourhood scale.

Since Local Agenda 21 emerged from the UN Conference on Environment and Development (Earth Summit) in 1992, a wide range of approaches have emerged for encouraging more sustainable communities. Some approaches (e.g. New Urbanism, Transition Towns) offer overall strategies for improving community sustainability, others focus mainly on improvements to the built environment (e.g., Smart Growth, Transit-Oriented Development) (Duany et al., 2009) and others (e.g., Roseland's Community Capital Tool and STAR Communities Rating System) provide comprehensive sets of indicators, or criteria, for what makes a sustainable community (Roseland 2012; STAR Communities Rating Guide 2012). In the UK, the HQE²R index offers an assessment tool for both the renovation and development of sustainable neighbourhoods (Blum & Grant, 2006).

Some researchers even argue that, in many respects, the unsustainable nature of contemporary cities *is a consequence of* poor planning at the micro or neighborhood scale (Berg & Nycander,

1997; Churchill & Baetz, 1999). Sustainability planning at the neighbourhood scale can help to achieve sustainable urban form at the macro level (Kennedy *et al.*, 2005).

These initiatives provide overviews of issues to be addressed by any urban or neighbourhood sustainability approach and suggest generic, prescriptive – and sometimes 'less bad' – solutions. However, they are not explicitly designed to catalyze 'regenerative sustainability' or neighbourhood-scale 'net positive' solutions and are therefore subject to the limitations of 'less harm' approaches outlined in Section 1.1. Further, these approaches tend to promote 'one size fits all' solutions that are not shaped by the unique potential of each place for mutually beneficial co-evolution of human and natural systems.

3.3 *Complexity Science and Urban Morphology*

Cities can be characterized as entities that are sometimes growing, sometimes declining and continually changing shape and size. Cities can be looked at as a hierarchy of different sub-centers across many scales, from buildings, to neighbourhoods to entire cities. These different 'fractals' or 'systems within systems' tend to show self-similarity of patterns and shapes (Batty 2008; Salat & Bourdic 2012). Further, 'networks of neighbourhoods' connect with each other, and are shaped through transportation networks and flows of people, information, services, materials and energy (Batty, 2008).

While city planning approaches have often emphasized a top-down master planning approach, empirical studies show that as much as being influenced by top-down planning, cities tend to grow organically "from the bottom up as products of millions of individual and group decisions…" (Batty 2012a, p. S9). From Batty (2012a):

"In short, cities are more like biological than mechanical systems and the rise of the sciences of complexity which has changed the direction of systems theory from top down to bottom up is one that treats such systems as open, based more on the product of evolutionary processes than one of grand design. During the last half century, the image of a city as a 'machine' has been replaced by that of 'organism' but the origins of these ideas remain firmly embedded in past developments." (Batty 2012a, p. S9).

Another key difference between buildings and neighbourhoods is the relative lack -- at the neighbourhood scale -- of discrete 'pre' and 'post' occupancy assessment opportunities:

"New growth or absolute decay tends to be a relatively small proportion of the total change. Cities are continually in flux as people and their activities respond incessantly to changed circumstances that involve shifts in movement patterns, locations, the use of buildings and in social preferences" (Batty 2012b, p.54).

Regenerative sustainability strategies for neighbourhoods will, therefore, need to find key leverage points within this continuous flux, recognizing that while major events or discrete projects may take place in neighbourhoods (e.g. a (re)construction project, a new factory or public facility) cities, and the neighbourhoods within them, are constantly changing. A key part of this will be skills development, productivity and economic development as it will also play an important role in how cities shape themselves and grow (Glaeser, 2003). Therefore, an understanding of current and emerging economic models, with relevance to urban and neighbourhood settings, including their underlying assumptions, is likely to be an important practical consideration for regenerative sustainability principles applied at the neighbourhood scale.

3.4 *Urban Metabolism*

Whether explicitly or implicitly, regenerative sustainability invariably evokes an analogy with, or direct application of, ecological and biological sciences. Some researchers and practitioners point to the inability of existing planning theory to integrate the complex spatial, temporal and biophysical relationships present in cities, and have conceptualized the built environment as being a social-ecological system, where multiple-related metabolisms interact at different (physical and temporal)

scales (Moffatt & Kohler, 2008). They argue that ecological models provide a useful basis for such an approach that integrates time scales and allows for an assessment of important factors related to resilience such as adaptive capacity.

With origins in 'industrial ecology', considerable applied research is also being undertaken in the area of 'urban metabolism' and 'neighbourhood metabolism.' Urban metabolism is the study of the stocks and flows of energy and materials in cities and their relationship with urban infrastructure (Kennedy et al., 2007; Wolman 1965). Proponents suggest an expanded and more widely integrated agenda in the field, and posit that "practical solutions to the development of sustainable cities can be achieved through studying urban metabolism, urban ecology, city carbon and water footprints, the dynamics of city growth, and the interdependency between social actors, institutions, and bio-physical system flows" (Kennedy et al., 2012, p. 778). These recent perspectives represent a thread that is likely to be informative for regenerative sustainability at the neighbourhood scale.

4 SUMMARY: EMERGING CHARACTERISTICS OF REGENERATIVE SUSTAINABILITY AT THE NEIGHBOURHOOD SCALE

4.1 *Overview*

This paper started by articulating regenerative sustainability concepts including key aspirations, principles and frameworks mainly for the building or site scale, followed by a review of an actual application at the building scale (CIRS). The scale of analysis was then expanded to the neighbourhood and urban scale, including a scan of predominant urban sustainability approaches, urban morphology and metabolism to identify further insights relevant to neighbourhoods regarding both p*rocess* and *performance.* This section summarizes early insights as well as some propositions and emerging questions for further research.

4.2 *Process*

Applying regenerative sustainability principles at the neighbourhood scale means engaging *with,* as a part of, the mutually beneficial co-evolution of living systems and the technological support systems. Since neighbourhoods are dynamic and constantly changing, it also means engaging with neighbourhoods at key intervention points (e.g. major development projects, policies and bylaws, etc.) and with the on-going life of the neighbourhoods, including their constituents, relationships and surroundings (e.g. catalyzing the on-going capability for regeneration).

Recognizing the complexity of the urban fabric and unique qualities of each neighbourhood, an effective co-evolutionary process will also be unique to each neighbourhood. Therefore, pre-determining 'the' process for engagement, or planning, is not recommended. Notwithstanding this, generic project processes may be useful as a 'point of departure' for planning a specific intervention or project, for example, EcoDistricts' five phases (e.g. district organization, district assessment, project feasibility, project development, district monitoring (PoSI, 2012) or Plaut et. al's phases of a project's life cycle: discovery/conception, design/gestation, implement/birth, operate/life, decay/death and the beginning of a new cycle (Plaut et al., 2012). Other emergent, co-creative processes have been developed and applied (e.g. see Mang and Reed 2012, Hoxie et al, 2012). Further explorations of emergent, co-creative processes are warranted. For example, an exploration of Roger's diffusion of innovation theory (Rogers, 1962) may be informative in this context.

Based on this review of emerging regenerative and neighbourhood-scale sustainability theory and practice, the following process principles are proposed for further consideration and development:

Place-based Narrative. Sets an overarching net positive, motivational frame and connects with the unique story of place, or 'essence' of the neighbourhood and its surroundings. Recent related research as well as initial experience with the Regenerative Neighbourhood Project suggests that simply 'changing the story' from a sacrificial frame to a motivational frame can increase engage-

ment in aspects of sustainability (Gifford and Comeau, 2011). Research and early applications also suggest that this guideline takes on more importance with scaling up as neighbourhoods can be more influenced by people and place than individual buildings.

Highly Participatory, Relevant and Resonant. Genuinely engages diverse people and place, and develops resonance with the unique expressed values, goals and needs. It utilizes dialogue and integrative multi-stakeholder processes to co-create integrated systems solutions (analogous to an integrative design process at the building level, but engaging the more diverse range of stakeholders that exist at the neighbourhood scale).

Potential-seeking. Aims for the unique 'net positive' potential of people and place, in part through provocative, inspiring questions and goal-setting. Creates clarity of meaning and purpose associated with the key aspirations and principles of regenerative sustainability at the neighbourhood scale (see Section 4.3).

Capability enabling. Relies not only on one-time restoration (e.g. a building that net sequesters carbon in its structure), but also on catalyzing the on-going 'capability' of self-organizing socio-cultural (including economic) and ecological systems towards net positive outcomes. This is analogous to a 'net positive social capital' directed towards the potential for net positive co-evolution of human and natural systems. The distinction is also significant in that it shifts the perspective from seeing the primary role of the built environment as one of product, to one of catalyst for co-evolution and net positive human and environmental outcomes.

Adaptive and Transformational. Processes for engaging with neighbourhoods will become more connected to the dynamic urban systems within which they reside, adapting to their unique context and transforming themselves (and their surroundings). For example, different infrastructure systems will need to respond to this co-evolution by optimizing at different scales (McGregor et. al, 2013) and be supported by further analysis, testing and adaptation.

Further practice and research is needed to test the appropriateness and efficacy of each of these suggested principles in the context of neighbourhoods. Other questions include, for example, what impact can 'changing the story' to a motivating 'net positive' aspirations and specific goals for neighbourhoods? How can these process principles enhance community engagement and project design processes? What are the barriers preventing regenerative sustainability aspirations and principles from taking root? Which systems optimize at which scales?

4.3 *Performance Assessment*

Regenerative sustainability performance assessment at the neighbourhood scale is still at the nascent stage. Early ideas support (a) an overall systems approach that integrates all biophysical, socio-cultural, technological, institutional aspects and identifies relationships between these aspects (e.g. in a 'story of place') (e.g. Cole 2012; Mang & Reed 2012; Hoxie et al. 2012) and (b) qualitative and, where possible, quantitative indicators as well as net positive targets. Given the systems-based approach inherent in regenerative sustainability, the emphasis is on the former. Overemphasis on metrics can result in fragmented and sub-optimal systems solutions.

There is, however, a discourse attempting to identify some measurable indicators and 'net positive' targets that are widely applicable and flexible enough to allow unique, integrated systems solutions, and help facilitate comparisons and learning across networks of neighbourhoods. An initial synthesis follows, based on the frameworks outlined above and the experience with CIRS (with examples of suggested shifts in emphasis associated with scaling up to neighbourhoods in brackets):

Biophysical/environmental: Energy, carbon and climate (e.g. emphasis on urban form/spatial pattern, transportation systems, mixed use and energy sharing, district energy systems); water (e.g. emphasis on stormwater management, regeneration of aquatic ecosystems; optimized scale for wastewater treatment); materials management (e.g. neighbourhood re-use and up-cycling opportunities), food & nutrients (e.g. emphasis on urban food systems and nutrient cycling (e.g. phosphorous); biodiversity (e.g. emphasis on habitat regeneration and a wider range of species) and air quality (e.g. indoor *and* outdoor air quality). Applying regenerative sustainability at the neighbourhood

scale should also offer cost savings through elimination, downsizing, or delaying of redundant municipal infrastructure due to building and building-to-building solutions.

Human/Social: happiness (e.g. emphasis on inter-personal connections in private and public spaces); physical and mental health (e.g. emphasis on spatial patterns, active transportation, connectivity and community-building amongst diverse stakeholders); learning, education, arts and beauty (e.g. public art, art-based place-making); housing (e.g. accessible and affordable housing for all); diversity and social justice (e.g. emphasis on decreasing economic, institutional and behavioural barriers, attention to non-motorized public spaces); safety (e.g. attention to safety in public and private, indoor and outdoor spaces) and transportation (e.g. neighbourhood connectivity with sustainable urban transportation systems).

In line with the discussion, the following characteristics are suggested for an assessment tool:

- Whole systems: assesses integrated systems (including socio-economic, ecological/biophysical, technological, institutional) as opposed to only system-by-system; sector-by-sector; or department-by-department;
- Participatory/Diverse Stakeholders: engages diverse stakeholders in co-creating objectives, interactive feedback and evaluation;
- Embraces Ambitious Goals: able to track progress towards 'net-positive' goals including qualitative and, where possible, quantitative indicators;
- Comprehensive: addresses a representative wide range of interdependent human/social and environmental systems and including the capability for on-going regeneration;
- Generic enough to track progress over time and facilitate comparisons and learning between neighbourhoods, yet flexible enough to be tailored to the unique places; and
- Simple, elegant and intuitive (so the 'essence' of neighbourhood and regenerative sustainability is not obscured).

Further critique, development and testing of assessment tools represent a challenging and important field. How can performance assessment tools make use of already-developed sustainability assessment frameworks and tools? How can an assessment framework(s) be embedded within an appropriate regenerative sustainability process?

4 CONCLUSION

The exploration of regenerative, 'net positive' sustainability at the building scale has yielded some encouraging results (e.g., CIRS on UBC Campus) but has also uncovered some of its limitations. Early findings suggest that the neighbourhood scale is an appropriate scale, or 'niche,' within the broader urban fabric to further explore and apply regenerative sustainability principles.

This paper has expanded the range of interconnected issues involved by considering neighbourhoods in their dynamic urban context. Suggestions have been provided to inform process and performance considerations for engaging in regenerative sustainability at the neighbourhood scale.

Recognizing that millions of socio-economic transactions inevitably shape urban neighbourhoods, applying regenerative sustainability at the neighbourhood scale will require engaging a diverse citizenry in integrated, participatory and placed-based processes. In addition to exciting new opportunities for design professionals, successfully applying regenerative sustainability at the neighbourhood scale should engage a diverse array of expertise and interests (e.g. citizens, local, regional and senior governments, land developers, public health officials as well as finance, local business and civil society representatives). Exploring the potential and practicalities of new institutional, socio-economic and technological models should be considered.

With UBC's Regenerative Neighbourhoods Project, we envision a rich applied research space that builds on, synthesizes and advances these and related emerging ideas.

Acknowledgements

The authors would like to thank the Bullitt Foundation and the Kresge Foundation for their kind support of this research.

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