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Theoretical underpinnings of regenerative sustainability

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Over the past half century, a discourse emphasizing environmental constraints and limits has both informed and provided many valuable ways of responding to complex environmental problems and has strongly shaped green building practices and associated environmental assessment methods. This paper delineates the concept of 'regenerative sustainability' – a net-positive approach to sustainability that is rooted in the notion of 'procedural sustainability' and a particular stream of constructivist social theory. The paper contrasts this to the concept of 'regenerative development and design' which, although having many commonalities, is based on different philosophical underpinnings. Since the origins of regenerative sustainability and regenerative design lie primarily in the social and ecological domains respectively, understanding their relationship is of importance in formulating approaches for the successful co-evolution of human and natural systems. The paper describes this relationship between regenerative sustainability and regenerative design, including a discussion of some of the key points of convergence and divergence between them, and concludes with an exploration of the practical implications of the regenerative sustainability concept.

Keywords: design philosophy, net-positive, regenerative design, regenerative sustainability, sustainability, sustainable design

Introduction

The currently predominant sustainability discourse, emphasizing environmental constraints and limits, emerged in response to increasing concern in the second half of the 20th century about the issues of population growth, pollution and non-renewable resource depletion (Boulding, 1966; Carson, 1962; Ehrlich, 1968; Goldsmith & Allen, 1972; Hardin, 1968; Meadows, Meadows, Randers, & Behrens, 1972). Over the past half century, this discourse has both informed and provided many valuable ways of responding to complex environmental problems (*e.g.* du Plessis, 2012) and, over the past 20 years, has strongly shaped green building practices and associated environmental assessment methods. But it has proven to be problematic in at least four key ways. First, its message of scarcity and sacrifice is inherently uninspiring and may be more likely to induce apathy or denial than active engagement and change (Gifford & Comeau, 2011; Sabin, 2013; Shellenberger & Nordhaus, 2004). Shellenberger and Nordhaus (2004), for example, in criticizing environmental messaging

based on presenting environmental bad news suggest that:

[p]erhaps the greatest tragedy of the 1990s is that, in the end, the environmental community had still not come up with an inspiring vision, much less a legislative proposal, that a majority of Americans could get excited about.

(p. 16)

Second, in emphasizing harm reduction and damage limitation, this narrative does not go far enough to counteract dangerous trends and potentially catastrophic consequences of unsustainability. Rather, it has simply prolonged inevitable environmental decline by aiming to make things 'less bad' as opposed to finding ways to rehabilitate and improve unsustainable circumstances (McDonough & Braungart, 2002; Reed, 2007; Waldron & Miller, 2013). The logical goal of a harm-reduction agenda is zero harm, which does not prompt a search for more positive possible outcomes.

Third, in attempting to measure biospheric limits or carrying capacity, this narrative has been mainly environmental in focus and paid much less attention to the social dimensions of sustainability (Summers, Smith, Case, & Linthurst, 2012). Despite the fact that the concept of sustainability and its precursor sustainable development were developed precisely in order to argue for the need to integrate ecological, social and economic dimensions (World Commission on Environment and Development, 1987), the social dimensions of sustainability have received far less attention both in the policy debate and building practice. Finally, ecological limits and scarcity arguments have primarily rested on an unproblematic view of scientific knowledge, and a unidirectional path for knowledge transmission, which rarely recognize the degree to which such understandings are rooted in cultural, political and other processes of knowledge constitution (Wynne et al., 2007).

As mentioned above, the ‘end-game’ of a ‘doing less harm’ approach has logically led to setting net-zero impact as an appropriate goal for building environmental performance. Indeed, such an ambition is increasingly embedded in national energy policies with many countries declaring that all new buildings must conform to performance targets of net-zero energy and/or carbon neutral emission standards by a certain date (Dyrbøl, Thomsen, Albæk, & Danfoss, 2010; Kolokotsa, Rovas, Kosmatopoulos, & Kalaitzakis, 2011). Recently, however, ‘net-positive’ propositions and approaches to building design practice have emerged, in part, in response to the perceived inadequacies of the constraints and limits discourse and in part in the realization of the need to shift the perception that the act of building has negative environmental consequences to one where it adds benefit and value to its context.

This paper explores the notion of ‘regenerative sustainability’ – a net-positive approach to sustainability that departs from dominant sustainability narratives. Over the past decade, Robinson and colleagues (Robinson, 2003, 2004; Robinson et al., 2006; Robinson, Burch, Talwar, O’Shea, & Walsh, 2011; Robinson & Tansey, 2006) have introduced and developed the notion of procedural sustainability and, more recently, explored its implications for operationalizing regenerative sustainability aims, specifically in the design of buildings (Robinson, Cole, Cayuela, & Kingstone, 2013) and neighbourhood development (Waldron, Cayuela, & Miller, 2013). In their search for insights about these implications, they have turned to the regenerative design literature, which sets out a number of core principles and associated approaches for reframing the design of the built environment (e.g. Lyle, 1994; Mang & Reed, 2012; Svec, Berkebile, & Todd, 2012). In doing so, several key differences between the core underpinnings of these regenerative

approaches have emerged and it is these distinctions that are explored in this paper. The significance of understanding the distinctions between these regenerative approaches and, more importantly, their conceptual underpinnings is twofold. First, the notion of ‘regenerative’ is garnering greater interest among key stakeholders associated with the production of buildings and neighbourhood development, and thereby requiring clarity as to its meaning and implications. Second, and perhaps more significantly, the notion of ‘regenerative’ embraces social and ecological systems, and the ways that the interactions of these systems are evidenced in formulating strategic direction in sustainability, is critical. Since the origins of regenerative sustainability and regenerative design lie primarily in the social and ecological domains respectively, understanding their relationship is, it would seem, of equal consequence.

There are multiple understandings of the notion of ‘sustainability’ and how it is positioned within the regenerative design literature. Cole (2012a), for example, has described some different interpretations of the concept in various explanations of the relationship between ‘green’, ‘sustainable’ and ‘regenerative’ approaches to design and assessment. He argues that the terms such as ‘sustainable design’ and ‘sustainable building’ have been widely used interchangeably with ‘green building’ to the extent that the distinctions have become blurred. Other proponents of regenerative design have depicted the notion of sustainable design as an intermediate or ‘neutral’ stage between green and regenerative methods (Pedersen Zari & Jenkin, 2009; Reed, 2007). As Reed (2007) has suggested green design implies the ideal of doing less or no harm, while sustainable design attends to the capacity of human undertakings to sustain the health of social and ecological systems over time. Larrick (1997) and, more recently, Mang and Reed (2012) have taken a broader perspective in that they have situated the concept of sustainability as a dynamic overarching objective to which both green and regenerative approaches to design make complementary and necessary contributions, and both are perceived as essential to the grand process of evolution or sustainability.

The distinctions between green and regenerative approaches to building design are also evidenced in more practical ways. Green design is largely understood in terms of building form and technical systems that support the attainment of higher levels of environmental performance, typically through incremental change. Process aspects of green design primarily relate to those that directly support the evolving design – integrative design, life cycle analysis, commissioning, etc. – and which are largely internal to the design team. By contrast, the regenerative approaches discussed in this paper place considerable emphasis

on the pre-design stage process and engage a broader range of participants within it. Moreover, rather than simply considering design, construction and ongoing management processes as the input of expert knowledge, they can be viewed as ‘educational vehicles for the design team, the client and community stakeholders’ (Mang & Reed, 2015, p. 9). Regenerative approaches are thus fundamentally about rethinking the role of buildings, the types of questions asked during the design process, who is asked and how the discussion is guided. It is with regard to this last point that distinctions between regenerative design and regenerative sustainability practice are most apt and, as such, will be emphasized in the following sections.

‘Regenerative sustainability’ and ‘regenerative development and design’ reflect the different ways in which their proponents have come to grips with the notion of sustainability. While there are many similarities between them, their scientific and philosophical bases are qualitatively different. Much of the regenerative design literature is rooted strongly in the science of ecology (e.g. Lyle, 1994), living systems theory (e.g. Krone, referenced in Mang & Reed, 2012), whole systems thinking (e.g. Reed, 2007) and radical ecogism (e.g. du Plessis, 2012). The ecologically grounded ‘truths’ contained within these fields of thought underpin a set of widely accepted prescriptions for building design strategies and processes. The concept of regenerative sustainability (Robinson et al., 2013; Waldron et al., 2013), on the other hand, rests on the notion of ‘procedural sustainability’, which is rooted in experience in collaborative planning for sustainable community development and, subsequently, a particular stream of constructivist social theory (Robinson, 2004, 2008). Thus, there are important content- and process-related matters to consider when exploring regenerative design scholarship for insights about the practical implications of applying regenerative sustainability at the building and/or neighbourhood scales. For example, while the notion of procedural sustainability discussed in this paper parallels many of the aspects of regenerative development proposed by Mang and Reed, in that both reinforce the primacy of process considerations, regenerative development argues that such primacy precludes predetermined outcomes while regenerative sustainability suggests that it precludes predetermined goals as well.

The paper begins with a description of the roots and key attributes of regenerative development and design. This is followed by an explanation of the conceptual and theoretical background to the concept of regenerative sustainability and its consequences for how approaches to building design and urban planning can be reframed. The paper concludes with a discussion of some key points of convergence and divergence between regenerative sustainability and regenerative

design and identification of the key practical implications of the regenerative approaches.

Regenerative development and design

Regenerative development and design have their roots in an ecological worldview wherein the ‘almost infinite inter-relationships of “ecological systems” are the way living entities, including humans, relate to, interact with and depend upon each other in a particular landscape in order to pursue and sustain healthy lives’ (Mang & Reed, 2015, p. 9) and are approaches that support the co-evolution of human and natural systems in a partnered relationship. It is not the building that is ‘regenerated’ in the same sense as the self-healing and self-organizing attributes of a living system; it is about the ways that the act of building can be a catalyst for positive change within and add value to the unique ‘place’ in which it is situated. In this context, Mang and Reed (2015, p. 8) suggest that adding value to an ecological system means ‘increasing its systemic capability to generate, sustain and evolve increasingly higher orders of vitality and viability for the life of a particular place’. Within regenerative development and design, built projects, stakeholder processes and inhabitation are therefore collectively focused on enhancing life in all its manifestations – human, other species, ecological systems – through an enduring responsibility of stewardship (Cole, 2012a).

Proponents of regenerative design draw on a number of philosophical and theoretical sources, but most prominently are those with ecological underpinnings. For example, Lyle’s (1994) detailed elaboration of what regenerative design is begins with his assertion that the ecosystem concept should govern the relationship between humanity and nature. By extension, an understanding of ‘eco-systematic order’ should underpin the design of human environments. More recently, some essential elements of regenerative design and development have been discussed in practitioners’ explanations of different design and assessment frameworks (e.g. Cole et al., 2012; Mang & Reed, 2012; McDonough & Braungart, 2002; Svec et al., 2012). Others have taken a more explicitly philosophical approach. Reed (2007) and du Plessis (2012), for example, have identified and elaborated on the theoretical foundations of regenerative design. Still others have concentrated on specific principles of regenerative practices. Hoxie, Berkebile, & Todd (2012), for example, has presented an approach to community engagement especially for the purposes of regenerative design. Similarly, Pedersen Zari (2012) has set out a method for analysing ecosystem services in the design of regenerative environments. Svec et al. (2012) have undertaken a helpful literature review that identified the following widely acknowledged basics of regenerative approaches:

- Regenerative practices rest on a perspective that is systems-based, place-based and oriented towards contributing positive outcomes. The systems-based perspective requires a consideration of the interconnections within and between ecological, social and economic systems at various scales. The emphasis on place reflects a desire to incorporate into decision-making a deep understanding of the unique story of a place. Further, a key aim of regenerative approaches is to ensure that projects contribute positive, mutually reinforcing, enduring benefits to human and ecological systems.
- Regenerative practices employ collaborative processes in order to discover the social–ecological stories of a place. Community members may participate over the long-term duration of a project, from conceptualization to ongoing realization. A diverse range of voices may be included, and the aim is to connect individuals with each other, as well as establish a sense of connection to surrounding community systems. The connections that are made during this collaborative process enhance the capacity of a community to sustain them after the practitioner is gone.
- The story of a place is comprised of a diverse range of historic and current, local and regional contextual factors. For example, understanding the story of a place requires information about, among other things, local and regional ecological processes, trends in climate and the social constructs that shape community systems. Regenerative practices, therefore, are essentially interdisciplinary in that they rely on many different sets of information. Moreover, from a regenerative perspective the community and the place are perceived as integral sources of information.

Similarly, du Plessis (2012) has identified the following ‘philosophical departure points’ on which regenerative approaches are based:

- human systems are an integral part of ecosystems
- human activities should contribute positively to ecosystem function and evolution
- human endeavours should be informed by context-specific aspirations
- ongoing participatory and reflective processes are needed in the design and development of regenerative places

Mang and Reed (2012) make a critically important distinction between regenerative ‘design’ and regenerative ‘development’ – a distinction which, as will become evident below, becomes important in identifying

parallels with regenerative sustainability. While regenerative design builds the regenerative, self-renewing capacities of designed and natural systems (the designed interventions), regenerative development creates the conditions necessary for its sustained, positive evolution. Regenerative development and design, they suggest, ‘does not end with the delivery of the final drawings and approvals, or even with construction of a project’ (p. 34) but design responsibilities include: ‘putting in place, during the design and development process, which is required to ensure that the ongoing regenerative capacity of the project, and the people who inhabit and manage it, is sustained through time’ (p. 34). This form of active and reflective stewardship builds the capacities of people to design, create, operate and evolve regenerative socio-ecological systems in their place.

Procedural and regenerative sustainability

The roots of prevalent sustainability narratives, at least in the Western world, lie in a literature about environmental limits that emerged in the late 20th century from the increasing evidence that scale and the types of human activity are producing impacts that are both dispersed and close to or exceeding global limits of production and assimilation. Notwithstanding the importance of social and economic needs and constraints, the health of the biosphere is considered from this point of view to be the limiting factor for sustainability. Continued degradation of the biosphere through over-exploitation and abuse diminishes not only its ability to produce essential resources but also its ability to recover from such abuses. A prerequisite for sustainability is therefore seen as the maintenance of the functional integrity of the ecosphere so that it can remain resilient to human induced stresses and remain biologically productive (Rees, 1991). The question of unabated growth in the ‘throughput’ of energy and material to satisfy human demand is considered critical. As Rees (1999, p. 208) argues, ‘empirical evidence suggests that resource consumption already exceeds the productive capacity of critical biophysical systems on every continent’. He further suggests that ‘waste production already breaches the assimilative capacity of many ecosystems at every scale’. Moffat (2014) draws on Rees (2009) and suggests that:

[a]lthough it is often expressed in utopian terms, sustainability is actually based upon a single slow-moving disaster scenario where humanity runs out of critical physical resources or overshoots the ecological carrying capacity. Learning to live within limits is the solution.

(p. 202)

Since the publication of its First Assessment Report in 1990, the Intergovernmental Panel on Climate Change

(IPCC) has offered compelling evidence of the consequences for climate change resulting from unabated global warming. Their conclusions have been variously cast in terms of alarm, pessimism and a depressing possible future – notions that, although characterizing and conveying clear warning and risk, regrettably have had little effect in engaging the public (Moser & Dilling, 2007). History, by contrast, suggests that offering a positive vision that strikes accord with human values may be more effective in creating change than presentation of alarming facts alone. Shellenberger and Nordhaus (2004), for example, emphasize that effective leadership during troubled times involves ‘inspiring hope against fear, love against injustice, and power against powerlessness’ and offering a ‘positive, transformative vision’ that creates the ‘cognitive space for assumptions to be challenged and new ideas to surface’ (p. 31). Implicit here is the potency of approaches that offer positive direction and encourage collective action to solve environmental problems.

The ‘limits’ argument continues to be influential today (e.g. Burger et al., 2012; Rockström et al., 2009), but in the intervening decades a series of critiques of the premises underlying such an approach have been articulated. Of particular importance for this paper have been arguments about the model of scientific knowledge and the social role of science that have found expression in fields such as the sociology of scientific knowledge, and science and technology studies. Such concepts as Mode 2 science (Gibbons et al., 1994; Gibbons, 2000), or post-normal science (Funtowicz & Ravetz, 1993); and interactive social research (Robinson & Tansey, 2006; Shove & Rip, 2000) began to articulate a concept of the role and nature of science that suggests that our understandings of the world are necessarily socially mediated, and constructed in terms of deeply held values and theoretical presuppositions. When combined with emerging forms of scenario analysis (Wack, 1985a, 1985b), this gave rise to modes of analysis of complex interdisciplinary sustainability problems that were characterized by high levels of uncertainty and engagement with citizens and stakeholders (Salter, Robinson, & Wiek, 2011). These approaches acknowledged the importance of alternative forms of knowledge and processes of ‘extended peer review’ in recognition of the importance of questions of intentionality and volition with respect to the future of complex socio-ecological systems (Swart, Raskin, & Robinson, 2004). One strand of this work was focused on the development of participatory backcasting techniques to explore sustainable futures at the regional level (Robinson, 2003; Robinson & Tansey, 2006; Robinson et al., 2011). This work in turn gave rise to a rethinking of conventional approaches to sustainability based on limits discourses and unproblematic concepts of the role and status of scientific knowledge, and to agreement with

recent suggestions that sustainability can be seen as an essentially contested concept (Connelly, 2007; Ehrenfeld, 2008, 2009; Jacobs, 2006). That is, like other such concepts, such as truth, beauty and justice, sustainability cannot be defined scientifically or in absolute terms but finds different expression in different times and places. In turn this leads to the view that sustainability can usefully be thought of in procedural terms 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 (Robinson, 2003, 2004; Robinson & Tansey, 2006). This approach acknowledges the inherently normative and political nature of sustainability, the need for examination and integration of different perspectives, and the recognition that sustainability is a process, not an end-state, based on provisional understandings and decisions about the nature of the world:

It must be constructed through an essentially social process whereby scientific and other “expert” information is combined with the values, preferences and beliefs of affected communities, to give rise to an emergent, “co-produced” understanding of possibilities and preferred outcomes.

(Robinson, 2004, p. 381)

Procedural sustainability argues that our common cultural desire to separate culture from nature, and fact from value, are themselves implicated in the sustainability crisis itself, in that they give rise to a mechanistic approach to understanding nature that underlies much human exploitation and domination (Berman, 1984; Leiss, 1972). Sustainability then involves creating processes of discussion and negotiation in order to address the inherently normative and ethical question of how we should live, and what choices we want to make, given the best available scientific knowledge.

Procedural sustainability sets up a kind of discursive playing field in which the societal discussion about what kind of world we want to live in can take place. In that context, returning to the concerns expressed above about the conventional ‘limits and constraints’ cultural storyline about sustainability: it is not engaging, it does not go far enough, it is often primarily focused on environmental considerations, and it adopts an uncritical approach to role and meaning of scientific understanding. This suggests the desirability of a different substantive narrative about sustainability, one that is much more engaging, that goes beyond harm reduction and damage limitation, and one that broadens beyond the environmental dimensions of sustainability and a narrowly realist view of science and technology. It is in this context that the concept of regenerative sustainability emerges (see the discussion in Miller, 2013).

The notion of regenerative sustainability is used by du Plessis (2012) in framing a regenerative paradigm that is explicitly designed ‘to engage with a living world through its emphasis on a co-creative partnership with nature based on strategies of adaptation, resilience and regeneration’ (p. 7). She describes three key ways that this view changes how sustainability is understood in three fundamental ways:

- moving towards a developmental model that aligns human development efforts with the creative efforts of nature, *e.g.* following a development approach based on how nature works, not on how humans would like the world to work
- accepting reality that the world as an ever-changing, impermanent and inherently unpredictable set of processes
- the notion that humans and nature are one autopoietic system where members of the species *Homo sapiens* participate in the production, transformation and evolution of the ecosystem in which they find themselves. (p. 15)

The use of the term ‘regenerative sustainability’ in this paper, while sharing some aspects of du Plessis’s position, places emphases on the procedural approach. As with du Plessis’s characterization, it goes far beyond harm reduction approaches and is based on the view that human activity does not necessarily have to be minimized because it is inherently harmful, but can instead contribute directly to both environmental and human well-being (*i.e.* net-positive outcomes). In keeping with a procedural approach, it is not rooted in any claims about absolute or necessary truth, but in an empirical process of societal discussion and negotiation, in which both goals and outcomes must emerge from that process.

Of course, environmental, economic and social limits and constraints of various kinds clearly exist at various temporal and spatial scales, and not all negotiated choices create win–win situations; as a result, some trade-offs are inevitable in particular circumstances. However, the regenerative sustainability approach as advocated here suggests that it is worthwhile looking first for ways in which net-positive activities can be undertaken. That is, the challenge is to identify what approaches to the design of buildings and urban systems can be regenerative and create positive human and environmental outcomes, rather than simply reduce the negative ones.

As with regenerative development and design, key questions that remain are where regenerative sustainability is possible and how it might be operationalized in various contexts: Are there some generic content and process components of a procedurally based

understanding of regenerative sustainability? At which temporal and spatial scales are net-positive outcomes possible in specific circumstances? And perhaps most important in the immediate term, how can net-positive outcomes be conceived and measured? This last question raises critical issues of scale, hierarchy and measurement. Virtually all of our measurement techniques are designed to show the extent of reducing the environmental impact of buildings and, implicitly, progress towards a net-zero condition. Regenerative sustainability requires different and complementary approaches to discussing ‘success’ than those currently deployed in such green building performance assessment:

- It is not currently obvious, either conceptually or in practice, how to conceive and measure net-positive outcomes in a number of critical of social, cultural or ecological performance areas.
- Given the evolving human and ecological processes, the full merits of a regenerative project cannot be predicted with any precision at the outset and, indeed, will not be known until after a considerable time. The explicit acceptance of uncertainty clearly represents a significant departure from describing green performance.
- The measure of success in regenerative design can perhaps only be represented in terms of the capacity invested in a building at the outset and stakeholder input that endow it with an ability to support this future co-evolution of human and natural systems. However, determining if and to what extent a capability has been invested in a project will be based on the collective experience of the design team, continued stakeholder engagement and, what Reed (2007) emphasizes, ‘conscious processes of learning and participation through action, reflection and dialogue’ (p. 678), rather than evaluating the achievement of specific, easily quantifiable features or measures.

Contrasting regenerative sustainability with regenerative design

The core components of regenerative development and design highlighted above (in the section entitled ‘Regenerative design and development’) illuminate some potentially useful content and process requirements for regenerative sustainability at the building and neighbourhood scales:

- The concept of regenerative sustainability and the core precepts of regenerative design are well matched in that both represent a departure from predominant sustainability discourses (du Plessis, 2012). In turning away from these discourses, both carry the positive message of considering

the practice of building, as well as human activities more generally, as things that have the potential to give back more than they receive.

- Both regenerative design and regenerative sustainability embrace the notion of adding value to place and aspire to deliver enduring, net-positive benefits to social, economic and ecological systems, while considering these systems and benefits in an integrated way. Regenerative development and design can thus rest more comfortably beside regenerative sustainability because it fulfils a key specification of the procedural basis of regenerative sustainability, *i.e.* the principles and aspirations of regenerative design have emerged from a conversation about desired futures informed by some understanding of the social, economic and ecological consequences of different courses of action.

Regenerative design and regenerative sustainability are, however, strange bedfellows due to some fundamental differences:

- In their efforts to delineate the core precepts of regenerative design, regenerative design scholars have embraced the science of ecology, whole systems thinking, and the political ideology of ecologism. There is general agreement among regenerative design scholars that the respective tenets of these fields of thought constitute a much needed shift in mindset, from the dominant Cartesian–Newtonian mechanistic worldview of the mid-17th century to an ecologically grounded, holistic way of thinking and practice (Cole, 2012b; du Plessis, 2012; Mang & Reed, 2012; Reed, 2007). For regenerative design practitioners, the science of ecology has illuminated essential lessons about the structures and processes of ecological systems. These lessons have been critical to their understanding of how to design the built environment in such a way to restore and maximize ecosystem well-being (Graham, 2003; Lyle, 1994; McDonough & Braungart, 2002; Pedersen Zari, 2012). Whole systems thinking represents a mental model or way of thinking about the complex interconnections within and between socioeconomic, built and ecological systems at different scales (Mang & Reed, 2012; Reed, 2007). As Reed (2007) has explained, whole systems thinking is integral to regenerative design practice, which is essentially about engaging and focusing on the evolution of whole systems:

Regeneration of the health of the humans and local earth systems is an interactive process – each supports the other in a mutually beneficial way. This awareness or consciousness

of vital and viable interrelationship is the beginning of a whole system healing process. (p. 5)

- The political ideology of ecologism (Dobson, 2000) has armed regenerative design scholars with a worldview that aligns human activities with the ‘creative efforts of nature’ (du Plessis, 2012). As a political ideology among other political ideologies (*e.g.* liberalism, conservatism, etc.) ecologism rests on some perceived fundamental ‘truths’ about the human condition and how the world works. These truths have been derived from developments in 20th-century physics, the science of ecology and the philosophy of ‘deep ecology’ (Dobson, 2000, pp. 36–61); and they underpin ecologism’s prescriptions for a sustainable society (Dobson, 2000, pp. 62–111).

Thus, in rejecting the mechanistic worldview, regenerative design scholars have sought to establish another worldview based on an ecologically grounded ontology. However, in doing this, they have essentially replaced one set of prescriptions or goals for how we ought to live with another. As a result, in embracing the science of ecology as the foundational thread that weaves through these prescriptions, regenerative design scholars have not fully departed from Enlightenment tenets of instrumental rationality. Rather, the precepts of regenerative design are rooted in a particular set of ‘truths’ about the world. In contrast, as discussed above, the notion of regenerative sustainability is rooted in an understanding of reality (including such concepts as ‘truth’, ‘sustainability’, ‘regenerative’, and so on) as contested and socially constructed. From this procedural standpoint, the basic elements of regenerative design are perceived to be emergent properties of these social processes. Advocates of regenerative sustainability, then, would acknowledge and accommodate the precepts or prescriptions of regenerative design, but they would not pledge allegiance to them in the sense that they would not perceive them to be absolute truths or the only ones that might emerge and prove to be useful. In other words, while regenerative design scholars would assert that there is a ‘right’ way to go about designing net-positive environments, regenerative sustainability scholars would assert that there might be many ways to go about it.

Within the regenerative design literature, shifting the prevailing paradigm – the set of beliefs and assumptions that constitute a particular ‘world view’ – is central. Little discussion, however, is offered as to how, or what circumstances will create this societal-wide shift or over what time frame it could happen. The notion of regenerative sustainability at this stage in its development remains a proposition but, given

its strong procedural roots, this overarching frame would itself be emergent rather than predefined.

Plaut, Dunbar, Wackerman, & Hodgins, (2012) characterize the emerging set of regenerative design tools as being ‘process-based’ and primarily directed at guiding design as distinct from the green building rating tools which are primarily concerned with evaluating buildings as ‘products’. Moreover, whereas these product-based tools keep individual environmental performance requirements discrete, the graphic organization of the emerging regenerative design tools expands the issues to include social, cultural, economic and ecological systems and processes but also emphasizes the relationship between them. In short, they accept the built environment as a complex socio-ecological system and attempt to offer guidance to designers and other stakeholders in situating projects within it.

In sum, while regenerative design and development and regenerative sustainability share many core assumptions – notably a focus on the design and implementation of projects with net-positive goals – they also differ in ways having mostly to do with the role and status of scientific understanding, and thus the degree to which certain ecologically derived goals can be specified in advance. The similarities suggest strong opportunities for fruitful exchange and overlap in the practical implications of these approaches. It remains

to be seen whether underlying philosophical differences will lead to problems in the future.

Discussion and conclusions

This paper has presented the notion that regenerative development and design, and regenerative sustainability represent different but potentially complementary approaches to sustainability at the building and neighbourhood level. Despite their ontological and epistemological differences, many of the aspirations and principles of regenerative design seem quite compatible with the procedural basis of regenerative sustainability, at least at the level of existing practice. Perhaps most importantly, both suggest a reorientation of focus from reducing harm and damage to creating net-positive outcomes in both environmental and human terms at the building (Robinson et al., 2013) and neighbourhood scale (Waldron et al., 2013). Figure 1 shows the commonalities and distinctions between regenerative development and design and regenerative sustainability.

Given the recent genesis of both concepts (especially regenerative sustainability), any thoughts about potential inconsistencies in the future remain somewhat speculative. But it seems possible to suggest that differences might emerge over the question of how ecological principles should be interpreted and used in

Regenerative Development and Design	Regenerative Sustainability
Offer net positive contributions & add value	
Roots: <ul style="list-style-type: none"> • Science of ecology • Living systems theory • Whole systems thinking • Set of ‘truths’ about the world 	Roots: <ul style="list-style-type: none"> • Participatory integrated assessment/backcasting • Science studies/Science & Technology Studies • Procedural sustainability • Reality as contested & socially constructed
Emphasis: <ul style="list-style-type: none"> • Coevolution of human & natural systems • Build natural & social capital • Sustainability dictated by ecological constraint 	Emphasis: <ul style="list-style-type: none"> • Collective decision-making about desirable futures • Sustainability informed by ecological, social & economic consequences of different courses of action
Process: <ul style="list-style-type: none"> • Primacy of process over predetermined outcomes • Collaborative processes in order to discover social-ecological stories of place 	Process: <ul style="list-style-type: none"> • Primacy of process over predetermined goals • Collaborative processes in order to seek ways in which net positive activities can be undertaken

Figure 1 Commonalities and distinctions between ‘regenerative development and design’ and ‘regenerative sustainability’

regenerative building or community decisions. Are such principles statements of how the world works that must be adhered to in order to avoid ecologically unsustainable outcomes, or are they provisional interpretations, reflecting historically contingent human values and assumptions, and of no greater fundamental importance than other principles about human systems functioning and desired outcomes? What is the role of expert knowledge in making such decisions, and how should that be balanced against forms of lay understanding and knowledge? Perhaps most pointedly, what if the participatory processes of negotiation of meaning that lie at the heart of procedural approaches to sustainability lead to outcomes that violate ecological sustainability principles? Is sustainability ultimately a matter of decision or of science? It seems possible that the interplay between attempts of implement regenerative sustainability approaches on the one hand, and approaches based on regenerative design and development on the other, may help us to confront such questions.

As an initial contribution to this emerging conversation, the authors offer the following thoughts about some possible practical implications of the regenerative sustainability approach, as it applies to the design and operation of buildings and the development of neighbourhoods.

As suggested above, a defining characteristic of the regenerative sustainability approach is a procedural view of sustainability, which suggests that the meaning of sustainability cannot be stated in absolute terms, but must be discussed, and negotiated, for particular times and places. In these discussions, scientific and other knowledge about natural and human systems and processes play an essential role as inputs to normative, ethical and political decisions about what kind of future we want to create. In the context of buildings and neighbourhoods, this suggests the need for more consistent and effective ways of incorporating processes of stakeholder engagement. At the building scale, this means incorporating new participants (*e.g.* building inhabitants, operators, commissioning agents) in the increasingly popular integrated design process (IDP), and extending it through the whole building lifecycle (pre-design, design, construction, commissioning and operations) (Fedoruk, 2013). At the neighbourhood scale, this means using participatory planning processes to engage citizens and private public and non-governmental organization (NGO) sector stakeholders in exploring desired future neighbourhoods, and connecting these to urban planning and policy processes (Sheppard et al., 2011). Two key goals of these processes are as follows:

- To create buildings and neighbourhoods that might be said to exhibit forms of interactive adaptability (Cole, Robinson, Brown, & O'Shea, 2008;

Chiu, Lowe, Raslan, Altamirano-Medina, & Wingfield, 2014), whereby the building or neighbourhood co-evolves in accordance with the changing aspirations and values of its inhabitants, which themselves reflect the biophysical and social conditions of the building or neighbourhood, and the evolving policy context.

- To enhance human and environmental well-being through processes of reflection, feedback and dialogue. Emerging work in the field of behavioural sustainability suggests that simple awareness of the sustainability aspirations and goals of buildings can significantly affect the behaviour of inhabitants of the building (Wu, DiGiacomo, & Kingstone, 2013). Developments in controls, sensing and monitoring technology offer the potential for creating new kinds of 'conversations' between inhabitants, operators and the buildings and neighbourhoods in which they live and work. The literature on social practice (Reckwitz, 2002; Shove, Pantzar, & Watson, 2012) offers a powerful starting point to develop processes of engagement in which the regenerative context of the exchange and the design features of the infrastructure may help to signal, and reinforce, sustainability meanings, and reinforce more sustainable practices.

These suggestions raise important questions about the locus of power and agency throughout the building lifecycle and development of neighbourhoods. They might require, for example, changes in the relative roles of design professionals, operators, inhabitants, planners, policy-makers, and others. At a building scale, for example, it has become clear that moving in this direction requires rethinking the contractual arrangements among design consultants and commissioning agents, as well as the processes that govern the operation of building management systems, and the inhabitants' interaction with each other, with building managers, and, critically, with the building itself (Fedoruk, 2013).

Shifting the responsibility to creating buildings and neighbourhoods that offer net-positive benefits, requires discussions regarding what is actually meant by net-positive – both theoretically and practically – and its implications for measurements, metrics and management. While the search for greater clarity in the definition of net-positive contributions and performance are emerging (for example, see the special issue of *Building Research & Information*, 'Net-Zero and Net-Positive Design', 2015, volume 43(1)), measuring successful outcomes is less well understood. While the reductive approaches in green building assessment method have provided explicit requirements and measures of what would constitute successful performance, regenerative approaches are

systems-based, characterized by inherently unpredictable emergent properties and thereby embrace levels of complexity not easily accommodated in practice. Indeed, rather than emphasizing performance outcomes, the emphasis is clearly shifting to process outcomes.

Many of the regenerative sustainability approaches suggested here are compatible, to a large degree, with a regenerative design perspective. The differences between these two approaches may appear to be small and nuanced compared to their differences with current building and neighbourhood scale planning, design and operational practices. Yet the questions raised above may point to some possible areas of friction. In particular, whether sustainability ultimately is a matter of decision or of science would appear to be worthy of a more detailed examination. Such an exploration is beyond the ambit of this paper, but the authors would point out that taking a procedural approach to sustainability seriously suggests that science provides a crucial input to sustainability decision-making, but that the ultimate decision as to what is understood by a sustainable society is a matter of negotiation and choice.

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