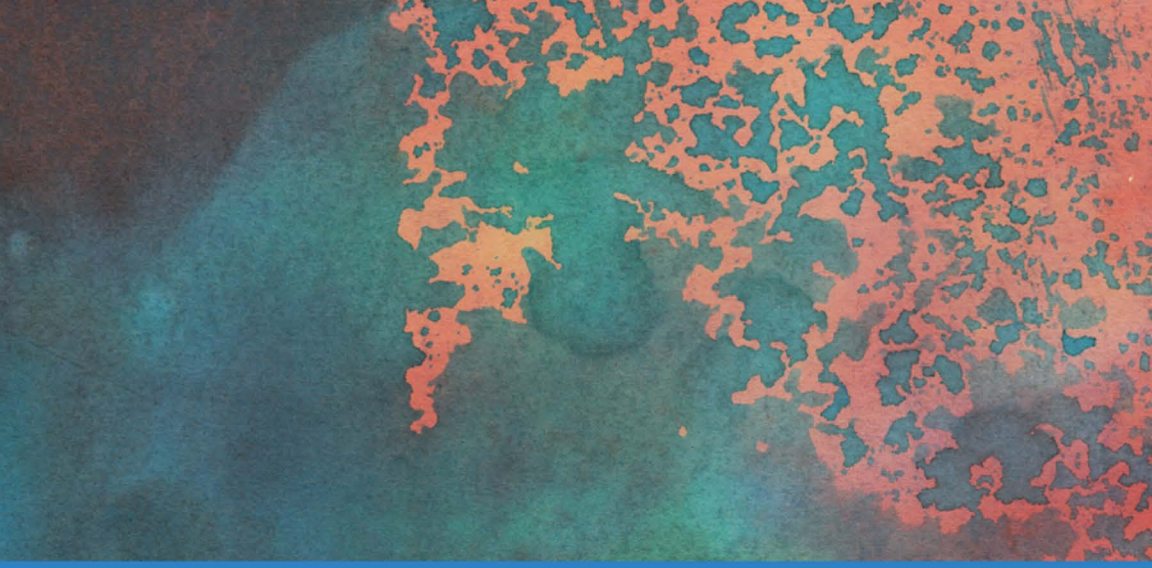
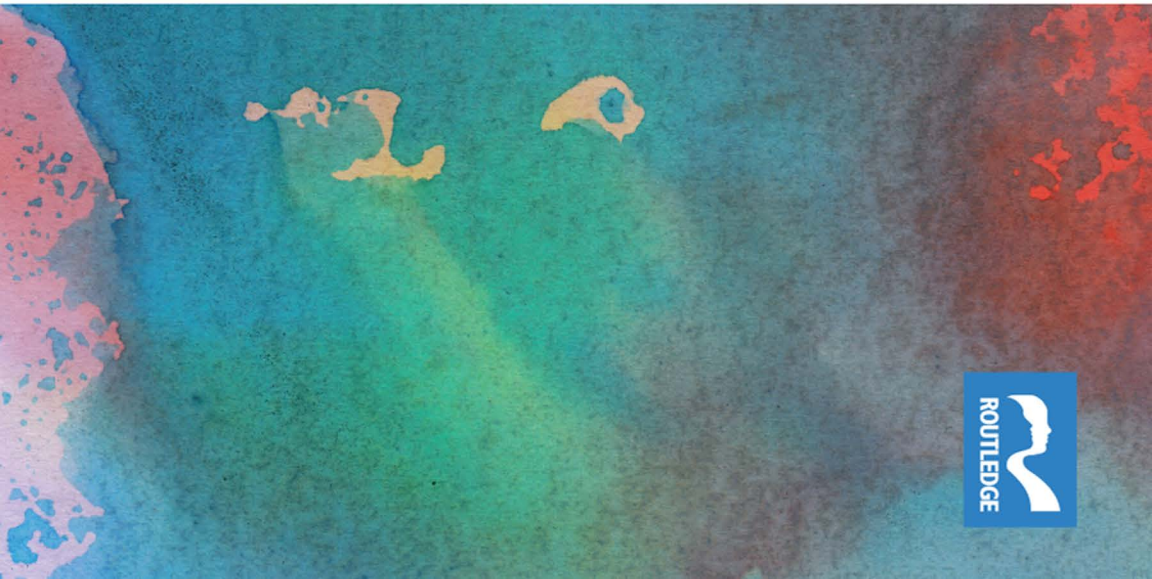


Routledge Research in Sustainable Urbanism

ECOLOGIES DESIGN

TRANSFORMING ARCHITECTURE, LANDSCAPE, AND URBANISM

Edited by
Maibritt Pedersen Zari, Peter Connolly
and Mark Southcombe



ROUTLEDGE

Contents

5 The paradox of metrics

Setting goals for regenerative design and development

Richard Graves

Introduction

Regenerative design is a transformative approach to architecture that catalyses the relationship between people and other living systems to build social and ecological health. When ecological systems are used to support social needs, complex relationships and interactions can begin to take place. Regenerative design evolved out of a reaction to the mechanistic methodology of green design, which assumes the impacts of a development can be dissected, quantified, and solved.

Green building, architecture, and planning are incremental approaches to "solving" global ecological and social challenges. While green design and the assessment systems that evolved from it (LEED, BREEAM, etc.) have built significant awareness of global environmental challenges, the focus on merely mitigating impacts is myopic. As Cole (2015) points out, "green design is directed at reducing degenerative impacts . . . this is insufficient for an ecologically sustainable future and is an insufficient aspiration to motivate design professionals and their clients".

What is regenerative design and why is it important?

The foundation of regenerative design is built upon the belief that humanity and "nature" are one interconnected system. Regenerative design considers the role of designers as integrators of social, ecological, and technological systems to achieve the potential of a community and to provide a healthy environment for all people and living systems now and in a dynamic future of climate change, social upheaval, and technological disruption. Regenerative design favours a social-ecological view of design, not a mechanistic one (Cole et al., 2013). A social-ecological view of the role of design does not separate design, development, and architecture from an idealised nature, but integrates buildings and neighbourhoods with living systems in time and space. The process involves not only designing systems of resource flows to be self-renewing, but also relates to understanding a new way of social, ecological, and technological systems thinking for design.

A regenerative design process

A number of processes have been developed to guide regenerative design (see for example: Regenesis, 2019; Hes and Du Plessis, 2015; Lyle, 1999). Regenerative design processes acknowledge that the built environment is where social and ecological systems intersect. A successful process analyses the flows of social and ecological systems for context, in order to discover opportunities for future health to "co-evolve". A regenerative social-ecological design process (Figure 5.1) developed by a team of architects and ecologists from the University of Minnesota (Graves et al., 2019), was inspired by theory on complex adaptive systems and resilience. Social-ecological systems, like all complex adaptive systems, are characterised by dynamic and emergent interactions across nested scales of time and place (Gunderson and Holling, 2002; Liu et al., 2007; Levin et al., 2013).

A particular development is part of a bigger system, and is itself made up of multiple interacting subsystems. Resilience is the capacity of a social-ecological system to adapt or transform in the face of change, while continuing to support human well-being (Biggs et al., 2015; Folke et al., 2016). The goal of design is not a fictitious moment of sustainability, but the creation of emerging pathways of systemic resilience providing for social needs, while enhancing the health of all living systems. The process is iterative and has five aspects: place, needs and goals, scenario design, assessment, and implementation. In the assessment phase, different design scenarios are evaluated against the social needs, environmental limits, and social-ecological goals identified for a particular place with community collaboration. Social needs, environmental limits, and social-ecological goals (metrics) are used to evaluate and compare scenarios or potential futures.

Why we need to measure regenerative design

For regenerative design to transform practice, it must demonstrate improvements in the health of people and ecosystems. This success must not only provide good stories and beautiful designs, but must also survive scientific review. Metrics link regenerative design to science, however this interpretation of science could be limited to counting and weighing and therefore arrive at a distorted understanding of performance (Bateson and Catherine, 2008). Fearing such a devolution into a mechanistic framework, regenerative design could simply avoid metrics. However, this would not provide the feedback loops integral to designing and evolving living systems. Scientific assessment can be rooted in the atomistic thinking of Newton, Bacon, and Darwin, which broke down the whole into parts and rendered their interactions into mathematical formulas; this is the predominant scientific thinking that dissects the living world into unrelated parts. Lamarck was a contemporary of Darwin, but rejected atomistic thinking as reductionist in a world that is made of flux and process (Chaney, 2017).

Part of the paradox of advocating for and designing regenerative design metrics is that the complexity of life is difficult to predict and model (Beckage et al., 2011).

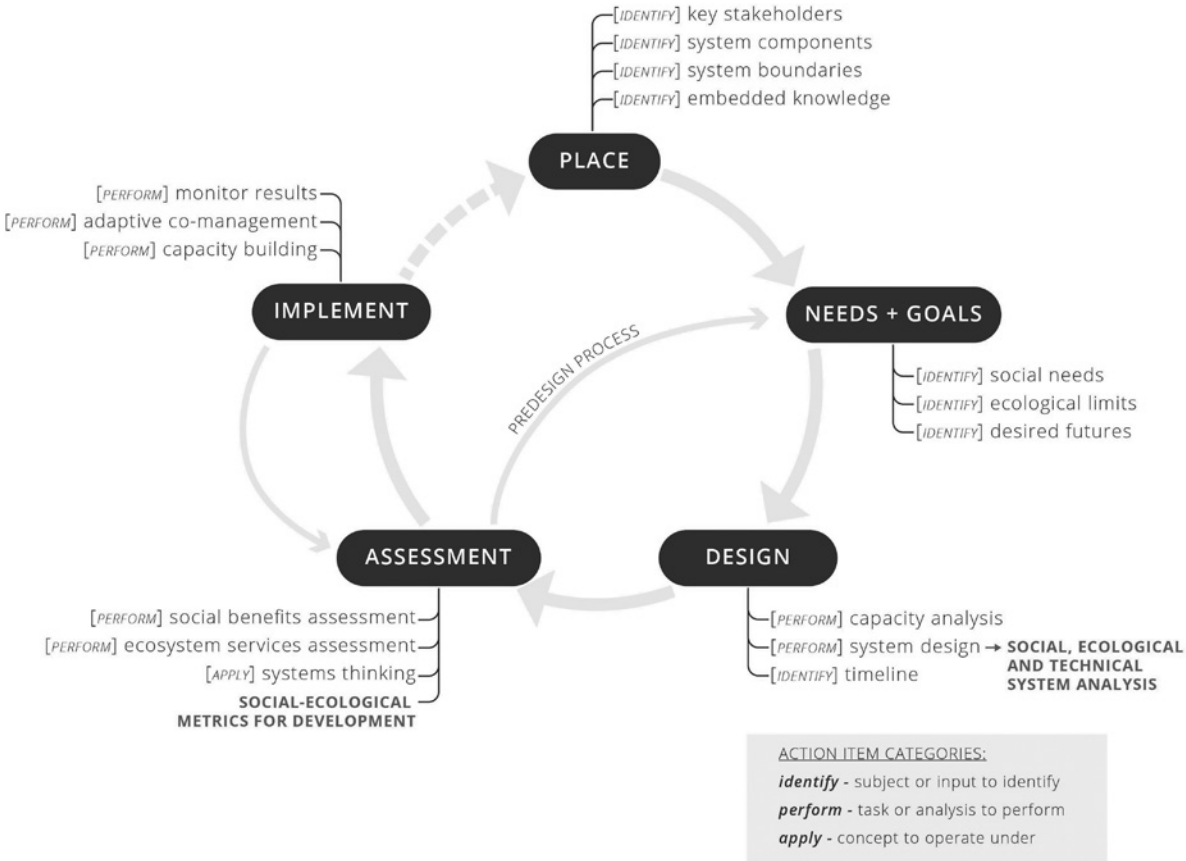


Figure 5.1 A process for regenerative social-ecological design. Graves et al, 2019.

Complexity science, ecology, and biology have built awareness of the structure of living systems. As John T. Lyle, one of the pioneers of regenerative design, advised: "One of the major conceptual divides that separates us from the designers of the past [is] the awareness of change and uncertainty. For all of the intricacy of our analytical methods, we know that none of them tells us anything for certain. To develop a model is to become aware of its crudity" (Lyle, 1999). Despite the difficulty of prediction, iterative modelling stands as one important method for optimising designs. Measurements from these models are a way to learn about the qualities of the living systems and compare options. Modelling however, dissects complex systems in order to understand them, establishing boundaries in space and time to provide information. Regenerative designers must understand that the bounded modelled system is still part of a larger whole. Despite the challenges of modelling complex living systems and the embedded bias in modern culture toward mechanistic thinking, designers need metrics to compare design scenarios where outcomes can be reviewed and then improved.

Regenerative design requires metrics to be integrated into practice that embody living system thinking. This can seem to be a paradox, but is required of rigorous regenerative design to guide design methodology and compare development scenarios. Regenerative design must skilfully integrate metrics into design to build a more robust practice of developing social and ecological value, while avoiding the simplistic checklist mindset of measuring only that which is quantifiable. Measuring the success and failures of regenerative design provides a feedback loop to guide future practice to move beyond the flaws of the current paradigm of green design metrics, which can be understood to be:

- **Time and space are fixed** and the environmental impact of a building is measured at the end of construction. This limits the ability to acknowledge more complex system values to emerge that take time and have benefits outside of the project boundaries. For example, landscape restorations that have significant regional biodiversity benefits after a decade.
- **Universal measurement**, with the assumption that success can be measured in the same way in every place. Green building programmes generally have a static set of credits or goals that define social and ecological value. However, these systems are intimately connected to the place, culture, and specific situation, therefore goals/metrics should adapt to place.
- **Externalises benefits and impacts**. The popularity of "net zero" energy and water metrics can make a specific building during a particular year seem successful. However, did the design assess the potential to add or degrade value throughout the wider energy and water systems over time?
- **Biases quantification over qualities of systems**. Life cycle assessment is a good example of an assessment system that attempts to quantify a broad range of ecological impacts. However these tend to have significant data gaps in water use, renewable energy, and human toxicity.

(Finkbeiner et al., 2014)

In contrast to this reductive approach to design, regenerative design is holistic and embraces the beauty of complex systems and the uniqueness of their expression in a particular place. Adaptive change depends upon feedback loops; meaning there must be a process of trial and error and a mechanism of comparison. This mechanism of comparison creates the imperative for regenerative metrics. Social-ecological design has specific goals related to benefiting living systems. Some of these goals will always be qualitative, but some aspects can be measured to assess the success or failure of design methods.

How to measure regenerative design

Regenerative design metrics should be methods of "measuring the capacity to enhance vitality, viability and adaptability when looking at the design of a living environment. It is not just about the quantification of increased species, social measures, food production, ecosystem services, etc. It is about the ability for a project to thrive and continue to evolve into the future" (Hes and Du Plessis, 2015). Some of the earliest examples of regenerative design attempted to use ecology as a method of comparison for design scenarios. Lyle quotes the ecologist E. Odum throughout his writings for example (Lyle, 1994, 1999).

Lyle identified three types of order in a place: structure of the biological community, the flows of energy and materials, and the patterns of relationships (Lyle, 1999). The process is not linear, but acknowledges that the order exists before the design process begins, and that it will continue to evolve after the design is implemented. Building upon the unique patterns of a place, architecture can embody and catalyse elements of the living systems they inhabit. Designing in this way requires a mind-set and vision that Bateson and Catherine (2008) called "the ecology of mind", an ecology of pattern, information, and ideas embodied in material forms. A building cannot be regenerative in isolation, but it can be the embodiment of regenerative thought and aspire to add value to social and ecological systems. This requires the capacity to process and self-correct the relationship between design and the living world. Creating the adaptive change that is characteristic of living systems is essential for regenerative development.

Lyle integrated ecology into the practice of design and adapted metrics for each project. The measurements were often divided into natural and human processes impacted, and could be quantifiable or qualitative depending on the project. For example, the Aliso Creek Plan for a development near Los Angeles assesses policy scenarios based on a water budget calculation comparing water supply created to water demand. The San Dieguito Lagoon project for an area between Los Angeles and San Diego takes a more qualitative approach analysing the natural and human process impacts as either increased or decreased for a residential complex with an array of factors: organic matter decay, atmospheric pollution, traffic congestion, etc. (Lyle, 1999). A critical insight of his process was that metrics are not only used to assess design proposals to create a plan, but also to monitor the implementation process. This creates a feedback loop for adaptation as natural processes and patterns interact with human development. In living systems,

change is controlled by internal mechanisms and relationships. These relationships are altered for development to serve human needs. This is in line with Cole et al. (2013), who state: "By their nature, regenerative design approaches imply an adaptive stance to building design and operations, which allows the combined human/technical systems of the building process to respond to change over time."

Regenerative design has begun to integrate emerging research in ecology and related fields about the science and policies required to document and measure the flow of ecosystem services supporting human well-being (Pedersen Zari, 2018). The growth in knowledge of ecosystem services has been rapid from early academic work by Daily to the Millennium Ecosystem Assessment of 2005 (MEA, 2005; Daily et al., 2009; Ruckelshaus et al., 2015). The experience of scientists working with ecosystem services has aligned with some of the approaches of regenerative design (Regenesis, 2016). For example, The Natural Capital Project, which was created in 2006, developed the InVEST tool to guide decision-making. While the tool provides a basic template to be used anywhere, their approach needs to co-develop applications with decision makers to ensure inputs are tailored to local needs and outputs are credible and relevant to local stakeholders (Ruckelshaus et al., 2015).

Urban design and planning communities have a growing interest in ecosystem services, particularly in the context of climate change and the potential of nature in cities to mitigate negative climate change impacts through strategies such as ecosystem-based adaptation (Geneletti and Zardo, 2016) and other nature-based solutions (Cohen-Shacham et al., 2016). Significant future work is needed to explore the intersections of regenerative design and ecosystem services in an urban context (Keeler et al., 2019). Pedersen Zari's work creates a foundation for built environment ecosystem service goals and measures and brings rigor to the holistic thinking of regenerative design in terms of relationships with biological ecologies. She mapped and translated ecosystem processes and services into resources for design professionals (Pedersen Zari, 2012, 2015, 2018). Her research determined that buildings can contribute to climate regulation and the purification of air, provide habitat, cycle nutrients, and provide fresh water, fuel and food, and that success can be measured against baseline metrics derived from site specific past or current healthy ecosystems.

The metrics of regenerative design and development also need to connect social needs to ecological restoration and limits more robustly. Ecological conditions and design goals should link with the self-determined social needs of the community and explore the role design can play in providing cultural ecosystem services, which is a category of often intangible ecosystem services that contribute to well-being aspects such as physical and mental health, recreation, spiritual and cultural practices, scenic beauty, social cohesion, and sense of place (Daniel et al., 2012). For regenerative development to emerge from the design phase, the linking of social needs to the biological ecosystem of a place must build relationships of supportive social infrastructure that will persist over time to realise future potential.

There are many ways in which social and ecological benefits of a building or site development may be assessed. Communities may develop their own list of relevant

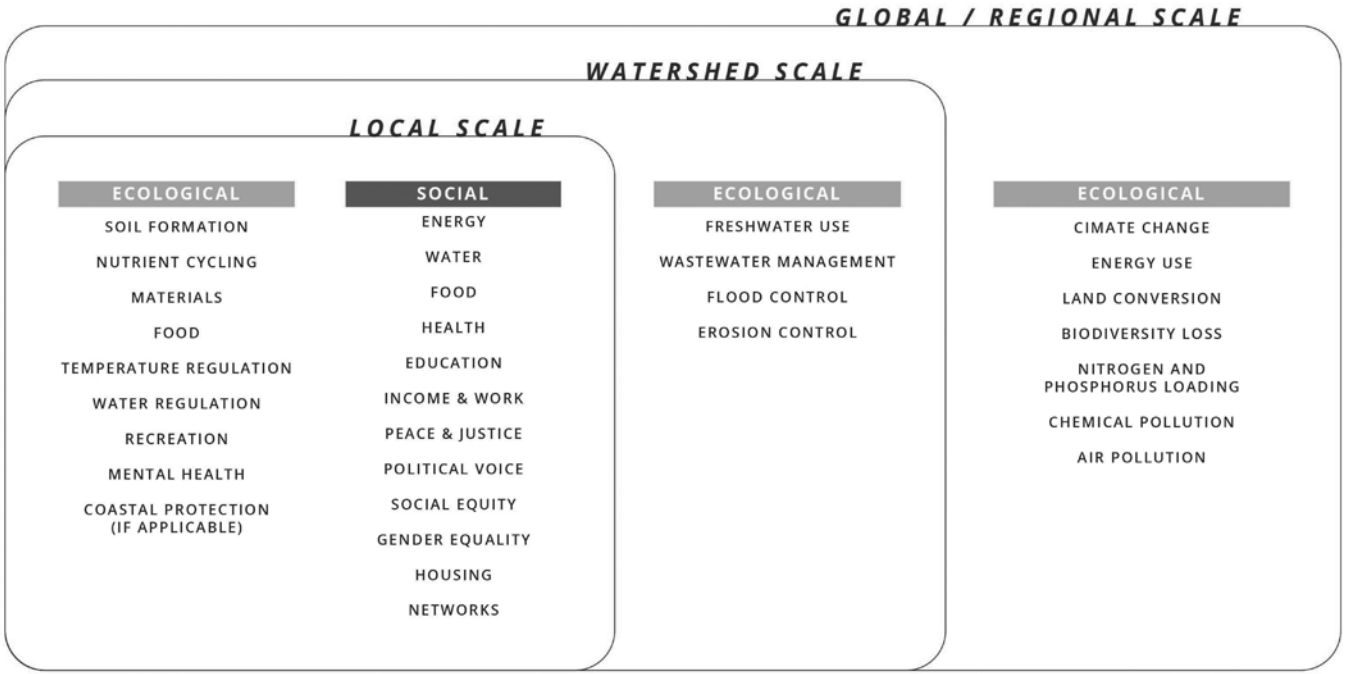


Figure 5.2 Social-ecological metrics for development. Source: Graves et al., 2019.

well-being metrics, specific to their context. On the ecological end of the spectrum of benefits, there exist numerous tools (e.g., Neugarten et al., 2018; Pascual et al., 2017) for assessing ecosystem services, but most rely on the same common elements of identifying ecological structures and processes that produce benefits for people, quantifying those benefits, and assigning various kinds of values to them. The value of an ecosystem service may be expressed in economic terms, but it may also be expressed as a non-monetary contribution to human well-being. The social-ecological approach to design is oriented towards a future vision co-produced by the design team, community, and other stakeholders. This means the provision of benefits by onsite ecological systems is assessed against the social-ecological goals set for the development. Figure 5.2 shows a selection of metrics for a future-oriented social-ecological assessment of development benefits.

Since a design is situated within a greater social-ecological system, these metrics are considered at different scales. For example, a vegetable garden producing food (an ecosystem service) contributes to meeting the basic need for food in the community and is a locally confined benefit. Trees and vegetation on the site may sequester and store carbon as they grow, which is an ecosystem service with global benefits. Similarly, the extent to which a development improves water quantity and quality depends on its location within the watershed. Benefits may only accrue to downstream communities.

Conclusion

To achieve its full potential, regenerative design must evolve beyond just the next set of advanced green building strategies. It must develop a mind-set that designs with the beauty of the complexity of life, but also employs the next generation of regenerative design tools and metrics to assess the ability of a design to add to social and ecological health. Regenerative social-ecological design must accept that design and development occur within a milieu of complex systems in space and time. Therefore, things are always changing, and the needs, limits, and goals of the development should constantly be re-evaluated. Regenerative designers should continue to research and share methodologies for creating metrics for gauging and comparing the success of their developments. By navigating the paradox of creating and using regenerative design metrics, innovative measures will evolve to enable more effective integration of the living world and the built.

References

Bateson, G., and M. Catherine. 2008. *Steps to an Ecology of Mind*. Chicago: University of Chicago Press.

Beckage, B., L. J. Gross, and S. Kauffman. 2011. "The Limits to Prediction in Ecological Systems." *Ecosphere*, 2 (11): 125. doi:10.1890/ES11-00211.1.

Biggs, R., M. Schlüter, and M. L. Schoon (eds.) 2015. *Principles for Building Resilience: Sustaining Ecosystem Services in Social-Ecological Systems*. Cambridge: Cambridge University Press.

Chaney, A. 2017. *Runaway: Gregory Bateson, the Double Bind, and the Rise of Ecological Consciousness*. Chapel Hill: The University of North Carolina Press.

Cohen-Shacham, E., G. Walters, C. Janzen, and S. Maginnis. 2016. *Nature Based Solutions to Address Global Societal Challenges*. Glad: IUCN.

Cole, R. 2015. *Understanding Regenerative Design: Challenging the Orthodoxy of Current Green Building Practice*. Available online: www.REMInetwork.org.

Cole, R., A. Oliver, and J. Robinson. 2013. "Regenerative Design, Socio-Ecological Systems and Co-evolution." *Building Research and Information*, 41 (2): 237–247.

Daily, G. C., S. Polasky, J. Goldstein, P. M. Kareiva, H. A. Mooney, L. Pejchar, T. H. Ricketts, J. Salzman, and R. Shallenberger. 2009. "Ecosystem Services in Decision Making: Time to Deliver." *Frontiers in Ecology and the Environment*, 7 (1): 21–28.

Daniel et al. 2012. "Contributions of Cultural Services to the Ecosystem Services Agenda." *PNAS*, 109 (23): 8812–8819.

Finkbeiner, M. et al. 2014. "Challenges in Life Cycle Assessment: An Overview of Current Gaps and Research Needs." In W. Klöpffer (ed.), *Background and Future Prospects in Life Cycle Assessment. LCA Compendium – The Complete World of Life Cycle Assessment*. Dordrecht: Springer.

Folke, C., R. Biggs, A. V. Norström, B. Reyers, and J. Rockström. 2016. "Social-Ecological Resilience and Biosphere-Based Sustainability Science." *Ecology and Society*, 21 (3).

Geneletti, D., and L. Zardo. 2016. "Ecosystem-Based Adaptation in Cities: An Analysis of European Urban Climate Adaptation Plans." *Land Use Policy*, 50: 38–47.

Graves, R., B. Keeler, M. Hamann, E. Kutschke, and C. Nootenboom. 2019. "A Social Ecological Approach to Architecture and Planning." *Journal of Architecture and Construction*, 2 (4): 33–44.

Gunderson, L. H., and C. S. Holling. 2002. *Panarchy: Understanding Transformations in Systems of Humans and Nature*. Washington, DC: Island Press.

Hes, D., and C. Du Plessis. 2015. *Designing for Hope: Pathways to Regenerative Sustainability*. New York: Routledge.

Keeler, B., P. Hamel, T. McPhearson, M. Hamann, M. Donahue, K. Meza Prado, K. Arkema, G. Bratman, K. Brauman, J. Finlay, A. Guerry, S. Hobbie, J. Johnson, G. MacDonald, R. McDonald, N. Neverisky, and S. Wood. 2019. "Social-Ecological and Technological Factors Moderate the Value of Urban Nature." *Nature Sustainability,* 2: 29–38.

Levin, S., T. Xepapadeas, A. S. Crépin, J. Norberg, A. De Zeeuw, C. Folke, T. Hughes, K. Arrow, S. Barrett, G. Daily, and P. Ehrlich. 2013. "Social-Ecological Systems as Complex Adaptive Systems: Modelling and Policy Implications." *Environment and Development Economics*, 18 (2): 111–132.

Liu, J., T. Dietz, S. R. Carpenter, M. Alberti, C. Folke, E. Moran, A. N. Pell, P. Deadman, T. Kratz, J. Lubchenco, and E. Ostrom. 2007. "Complexity of Coupled Human and Natural Systems." *Science*, 317 (5844): 1513–1516.

Lyle, J. T. 1994. *Regenerative Design for Sustainable Development*. New York: Wiley.

Lyle, J. T. 1999. *Design for Human Ecosystems: Landscape, Land Use and Natural Resources*. Washington, DC: Island Press.

Millennium Ecosystem Assessment. 2005. *Ecosystems and Human Well-Being: Current State and Trends*. Washington, DC: Island Press.

Neugarten, R. A., P. F. Langhammer, E. Osipova, K. J. Bagstad, N. Bhagabati, S. H. M. Butchart, N. Dudley, V. Elliott, L. R. Gerber, C. Gutierrez Arrellano, K. -Z. Ivanić, M. Kettunen, L. Mandle, J. C. Merriman, M. Mulligan, K. S. -H. Peh, C. Raudsepp-Hearne, D. J. Semmens, S. Stolton, and S. Willcock. 2018. *Tools for Measuring, Modelling, and*

Valuing Ecosystem Services: Guidance for Key Biodiversity Areas, Natural World Heritage Sites, and Protected Areas. Gland, Switzerland: IUCN.

Pascual, U. et al. 2017. "Valuing Nature's Contributions to People: The IPBES Approach." *Current Opinion in Environmental Sustainability*, 26–27: 7–16.

Pedersen Zari, M. 2012. "Ecosystem Services Analysis for the Design of Regenerative Built Environments." *Building Research & Information*, 40 (1): 54–64.

Pedersen Zari, M. 2015. "Ecosystem Services Analysis: Mimicking Ecosystem Services for Regenerative Urban Design." *International Journal of Sustainable Built Environment*, 4: 145–157.

Pedersen Zari, M. 2018. *Regenerative Urban Design and Ecosystem Biomimicry*. New York: Routledge.

Regenesis Group. 2016. *Regenerative Development and Design: A Framework for Evolving Sustainability*. New York: Wiley.

Regenesis Group. 2019. *The Story of Place*. Date accessed August 2019. Available online: https://regenesisgroup.com/services/story-of-place.

Ruckelshaus, M., E. Mckenzie, H. Tallis, A. Guerry, G. Daily, P. Kareiva, S. Polasky, T. Ricketts, N. Bhagabati, S. A. Wood, and J. Bernhardt. 2015. "Notes from the Field: Lessons Learned from Using Ecosystem Service Approaches to Inform Real-world Decisions." *Ecological Economics*, 115: 11–21.