

Perspective

The Regenerative Lens: A conceptual framework for regenerative social-ecological systems

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SUMMARY

Societies must transform their dynamics to support the flourishing of life. There is increasing interest in regeneration and regenerative practice as a solution, but also limited coherent understanding of what constitutes regenerative systems at social-ecological scales. In this perspective we present a conceptual, cross-disciplinary, and action-oriented regenerative systems framework, the Regenerative Lens, informed by a wide literature review. The framework emphasizes that regenerative systems maintain positive reinforcing cycles of wellbeing within and beyond themselves, especially between humans and wider nature, such that “life begets life.” We identify five key qualities needed in systems to encourage such dynamics: an ecological worldview embodied in human action; mutualism; high diversity; agency for humans and non-humans to act regeneratively; and continuous reflexivity. We apply the Lens to an envisioned future food system to illustrate its utility as a reflexive tool and for stretching ambition. We hope that the conceptual clarity provided here will aid the necessary acceleration of learning and action toward regenerative systems.

INTRODUCTION

Transformations across societies—for better or worse—are inevitable given the scale, pace, and depth of environmental and social change.¹ Some of these deep structural changes will be imposed upon us as impacts of climate and other biophysical change accrue, while other, more desirable transformations may emerge if humanity stewards change toward new social-ecological patterns.¹

In this context, “sustainability” is a commonly stated goal for desired transformations.² Sustainability is typically referred to as finding ways to live today that do not compromise the wellbeing of future generations.² It has been strongly argued, however, that mainstream approaches to sustainability are inadequate. These approaches typically focus on reducing

anthropogenic harm to acceptable levels, such as through improving efficiency (e.g., “net zero” carbon targets), which is deemed too incremental and superficial given that we have already transgressed planetary thresholds.^{3–10} Moreover, sustainability often fails to challenge the underlying drivers of current crises, such as capitalism, commodification, and worldviews where humans are viewed as separate from nature.^{4,6,11–13} New framings and approaches are therefore urgently required to guide more radical transformations.⁴

An alternative approach gaining traction worldwide, encouraging rapid and deep change, is to strive for “regenerative” practice, dynamics, and systems.^{4,5,13–15} Broadly speaking, regenerative social-ecological systems—regions, economies, cities, businesses, communities, and so forth—can be defined as those that maintain positive reinforcing cycles of wellbeing

within and beyond themselves, especially between humans and wider nature.⁴ At its most basic semantic level, something regenerative has a capacity to exist or be created again (deriving from the Latin *regenerare*, “create again”).¹⁶ A regenerative dynamic has also been summarized as “life creates conditions conducive to life,”¹⁷ in which humans are “participating as nature” to support continued co-evolution of the biosphere.⁴

The concept of regenerative systems has long-established philosophical underpinnings, including from Indigenous, Eastern, and Western thought,³ and is still embodied in practice in certain (especially Indigenous) cultures and communities around the world,¹⁸ such as the “good living” approaches of Māori and Quechua peoples.¹⁹ However, regenerative approaches for social-ecological systems are still relatively unfamiliar (or forgotten) in Western societies, and embodying regenerative principles is challenging for newcomers because it requires fundamentally altered ways of thinking, acting, and relating between people and planet. A critical task facing humanity is thus to accelerate learning about transitioning to regenerative systems at a scale, pace, and depth that match those of global crises.

Academic fields drawing on regeneration concepts at social-ecological scales include agriculture, business, economics, and education (Table 1). Regenerative social-ecological systems (which we use interchangeably with “regenerative systems” in this paper) are closely related to other concepts and practices including living systems theory, Gaia theory, ecoliteracy, deep ecology, agroecology, permaculture, biodynamics, biophilia, biomimicry, and holistic management,^{5,13,17} and resonate with many “new economics” approaches aiming to replace the hegemony of neoliberalism, such as eco-feminism.^{8,20,21} Regenerative systems are thus inherently normative and political (particularly in defining human wellbeing) but also built upon fundamental properties of life, as we explore in more detail later on.

The literature often views designing for regenerative systems as a transformational solution to interlinked environmental and social crises, such as climate change and wealth inequality.^{22,38} Regeneration is positioned not only as the antithesis of contemporary societies’ extractive and exploitative activities but also as going well beyond mainstream solutions (e.g., sustainability) in terms of the depth of change advocated, including transformation of worldviews.^{3–13} In particular, regenerative approaches are underpinned by more holistic and mutualistic relations between people and wider nature.^{3,4} Regenerative approaches are also seen to encourage more positive, creative visions and narratives to guide action.^{5,51} This is in contrast to the common societal focus on difficulties of transformation or the threat of dystopian futures, which risks creating a self-fulfilling prophecy and encouraging denial, paralysis, and defeatism.^{3,34,51} Regenerative systems have thus been explored across diverse disciplines as systems that transcend the dynamics of current systems and traditionally advocated solutions.

An increasing number of initiatives and organizations are beginning to put regenerative thinking into practice.¹³ They include: place-based initiatives at local or regional levels, such as towns in the Transition Network or Brazil’s Ecovida network; the “regenerative culture” of care within the global campaign movement Extinction Rebellion⁵²; efforts of more mainstream

organizations exploring what regenerative businesses and economies might look like, such as the World Business Council for Sustainable Development⁵³; whole sectors starting to examine how transformations to regenerative dynamics can be enabled, such as the Regen10 initiative and Regeneration International organization in global food systems; and other new organizations springing up to help cohere or support others to enact regenerative principles, such as the Capital Institute,⁵⁴ Doughnut Economics Action Lab (DEAL), FixOurFood,⁵⁵ Forum for the Future,⁵³ Future Stewards, H3Uni, Positive, Regenerative Communities Network, Regenesi Institute, Regeneration Organization, the Royal Society of Arts,⁵⁶ and many others. Concurrently, regenerative systems are also gaining prominence in accessible non-academic texts spanning fields from business to cultural renewal.^{5,57–60}

Despite the potential for a regenerative framing and approach to overcome many of the challenges facing people and the planet, two important challenges remain. First, the growing body of literature around regenerative systems remains relatively disparate, with few attempts to conceptualize regenerative systems in ways that cut across multiple disciplines and scales to reflect on broader themes. While pluralistic approaches to regenerative systems are not necessarily problematic, a lack of coherence and clarity risks the concept being co-opted for greenwashing^{22,38,61} and then limits understanding about the actions needed to encourage truly regenerative systems. In particular, there is often vagueness in existing explanations of outcomes and dynamics of regenerative systems and how they differ fundamentally from problematic current systems. Conceptual clarity around these aspects is especially important because outcomes of attempts to support transformation will be a reflection of how radical our visions of desired futures are, and therefore how transformative our actions are likely to be.⁶² The focus on dynamics then brings attention to how such outcomes are being realized, and therefore whether or not a system is achieving desired outcomes without also fundamentally changing the underlying nature of the system.¹

Second, although the number of heuristics and tools for designing, identifying, and evaluating regenerative systems is growing, there is a lack of frameworks focused on regenerative systems in a broad sense (e.g., not focused only on the built environment,⁶³ businesses,^{53,64} economies,^{31,54} or development^{65,66}) that remain accessible while being underpinned by a rich global body of knowledge, and whose primary aim is to enhance communication and stimulate conceptual change in order to guide practice toward radically different futures, rather than validation, prediction, or explanation.^{67,68} Addressing these two challenges is necessary if learning is to be accelerated about how to support wider societal transformations to fundamentally new kinds of futures.

In this perspective, therefore, we present a conceptual cross-disciplinary regenerative systems framework, the Regenerative Lens, informed by a wide literature review. The framework emphasizes that regenerative systems maintain positive reinforcing cycles of wellbeing within and beyond themselves, especially between humans and wider nature, such that “life begets life.” We identify five key qualities needed in systems to encourage such dynamics: an ecological worldview embodied in human action; mutualism; high diversity; agency for humans and

Table 1. Regeneration concepts in different fields of study at the scale of social-ecological systems

Field	Regeneration in context	References consulted
Agriculture	Regenerative agriculture, closely related to agroecology, permaculture, and biodynamics, “explicitly focuses on creating reciprocal relationships between ecological, social, cultural, and spiritual components in social-ecological communities to grow all forms of capital while expressing the essence of each person, farm, and place,” ⁷ with particular focus on enhancing soil health. Some definitions of regenerative agriculture focus more on outcomes (e.g., carbon sequestration), while others focus more on practices (which often include zero or low tillage and livestock-arable integration). ²² Some interpretations place more emphasis on the support of human wellbeing (e.g., in farming communities) and political activism aspects (thus aligning more toward agroecology), with regenerative agriculture inseparable from redressing land enclosure and racism ^{23,24}	Gibbons, ⁷ Duncan et al., ¹⁸ Newton et al., ²² Schreefel et al., ²⁵ Lal, ²⁶ Titttonell et al., ²⁷ Carlisle, ²³ Penniman ²⁴
Business	Application of ideas from regenerative design, regenerative development, regenerative sustainability, and stewardship theory to business, such that regenerative businesses adopt a systemic view of the world and their place in it and ensure profits produce rather than reduce socio-environmental wellbeing: they “enhance, and thrive through, the health of social-ecological systems in a co-evolutionary process.” ²⁸ Regenerative or ecocentric entrepreneurship includes treating nature as an enabling partner from which entrepreneurs learn and find creativity ²⁹	Caldera et al., ³⁰ Hahn and Tampe, ²⁸ Vlasov ²⁹
Design	Regenerative design adopts a holistic perspective that is biophilic, biomimetic, participatory, and closely tied to the uniqueness of particular places, aiming for co-evolution between humans and the rest of nature. Applied in architecture and urban planning but in also other areas and design of societies and futures more generally	Camrass, ³ Reed, ⁴ Wahl ⁵
Development	Regenerative development uses a place-based systems thinking approach to actively generate positive, co-evolutionary, ecological, and social outcomes from development, particularly via feedback between them. It recognizes the importance of positive feedback between inner (paradigm) and outer dimensions of sustainability. ⁷ Sometimes seen as similar to, or an application of, regenerative sustainability. “Regenerative community development” builds on regenerative development by focusing on communities as nested and networked building blocks of nature and societies ⁷	Gibbons, ⁷ Caldera et al. ³⁰
Economics	Regenerative economics framings (including regenerative capitalism) emphasize a variety of different principles and practices, including the need to go beyond traditional sustainability approaches, using dynamic systems approaches, resource circularity, understanding wealth holistically, encouraging adaptability and diverse collaboration, and transdisciplinary education and advocacy. ^{7,8} Some have conceptualized regenerative economies as mimicking the structure and dynamics (including self-renewing properties) of natural ecosystems, including: a balance between efficiency and resilience (e.g., from a diversity of organizations and roles) that means strong resource flows can be sustained into the future; high levels of mutualism; and continuous learning ³¹	Gibbons, ⁷ Shannon et al., ⁸ Fath et al., ³¹ Fullerton ³²
Education	Various concepts of regenerative learning, education, and creativity, and education for regenerative futures. Pedagogy for regenerative futures is constantly evolving and embraces connectivity between the human and more-than-human, and ambiguity. Teachers create conditions for the emergence of creativity and mutualism, including transdisciplinarity and finding inspiration from nature, drawing especially on ideas from regenerative design. Students are not just taught about environmental crises but are also given the wisdom and skills to encourage regeneration and flourishing of life. Sustainability education is decolonized and recentered on Indigenous histories, concepts, and wisdom ³³	Armon, ³⁴ Hauk, ³⁵ King, ³⁶ Wooltorton et al. ³³

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Table 1. Continued

Field	Regeneration in context	References consulted
Food systems	Regenerative food system concepts draw on many other fields such as regenerative agriculture and regenerative design and consider a wide variety of aspects including food production, food waste, entrepreneurship, finance, governance, livelihoods, and technology. Some suggested principles of regenerative food systems include: acknowledging and including diverse forms of knowing and being; taking care of people, animals, and the planet; moving beyond capitalist approaches; commoning the food system; promoting accountable innovations; and long-term planning and rural-urban relations. ³⁷ Relocalizing foodsheds is often a primary goal, and food democracy/sovereignty, shifting consumer worldviews, and elevating Indigenous food systems are also important aspects ⁷	Gibbons, ⁷ Duncan et al., ¹⁸ Anderson and Rivera-Ferre, ³⁸ Loring, ³⁹ Dahlberg ⁴⁰
Governance	“Regenerative governance” modes include holacracies and sociocracies, which mimic the living system characteristics of modularity, subsidiarity, nestedness, and feedback. ⁷ Traditional hierarchical management is replaced by a more self-managing model, with authority distributed across all employees in an overlapping hocracy of roles and domains of work, decisions by mutual consent, and continuous feedback. ⁷ There are many other suggestions of governance models and methods applicable to regenerative (e.g., food) systems, such as cooperatives and commons	Gibbons, ⁷ Duncan et al., ¹⁸ Fath et al., ³¹ Bronson ⁴¹
Nature conservation	Assisted natural regeneration accelerates ecological processes to reach desired restored states for ecosystems (overlaps with regenerative agriculture)	Lohbeck et al. ⁴²
Organizing	Closely related to ideas about regenerative business, regenerative organizing is “the process of sensing and embracing surrounding living ecosystems, aligning organizational knowledge, decision-making, and actions to these systems’ structures and dynamics and acting in conjunction, in a way that allows for ecosystems to regenerate, build resilience and sustain life.” ¹³ Regenerative organizations seek to help local places flourish, and their leadership embraces the ambiguities and paradoxical nature of place-based tensions, thus making them opportunities for reflexivity and creativity rather than merely conflicts ^{28,43}	Muñoz and Branzei, ¹³ Slawinski et al. ⁴³
Sustainability	Regenerative sustainability aims “to address the dysfunctional human-nature relationship by entering into a co-creative partnership with nature to restore and regenerate the global social-ecological system through a set of localized ecological design and engineering practices rooted in the context and its social-ecological narratives.” ⁴⁴ It emphasizes collective constructivist processes of reflection and visioning, with a holistic worldview	Camrass, ³ Gibbons, ⁷ Hes and du Plessis ⁴⁵
Tourism	Regenerative tourism aims to fulfill the potential of local tourism localities, including their environments and communities, to flourish, rather than extracting economic wealth to be distributed elsewhere. It achieves this via a holistic systems approach, weaving Indigenous and Western science knowledge, seeing nature as teacher, encouraging care, collaboration, and continuous reflection, learning and evolution, and fostering the agency of local actors. Tourism systems are regarded as inseparable from nature and obligated to respect Earth’s principles and laws	Bellato et al., ⁴⁶ Dredge ⁴⁷
Urban studies	“Urban regeneration” has many different interpretations, but is often related to the development of a “run-down” urban area to improve socio-economic conditions. ⁴⁸ A neoliberal interpretation focuses on creating financial wealth and individual freedom via market liberalization. ⁴⁹ Ideas about “regenerative cities” include adopting a more holistic, social-ecological perspective of the city in its environment and enhancing the health of cities’ hinterland ecosystems ⁵⁰	de Magalhães, ⁴⁸ Sager, ⁴⁹ Fayed et al. ⁵⁰

non-humans to act regeneratively; and continuous reflexivity. We apply the Lens to an envisioned future food system to illustrate its utility as a reflexive tool and for stretching ambition—and ultimately, we hope, to aid the necessary acceleration of learning and action toward regenerative systems. In the sections that follow, we first describe our methodological approach and assumptions before describing the different aspects of the Regenerative Lens framework and its application. We finish by discussing the Lens in a broader context and suggest some next steps for regenerative systems research.

METHODOLOGICAL APPROACH AND ASSUMPTIONS

Our overall approach to developing the Regenerative Lens was shaped by our motivation to create a reflexive tool,⁶⁹ or an “orienting heuristic” akin to the Three Horizons framework for designing transformative change,⁷⁰ rather than to aim at generating new theory or providing quantitative indicators for evaluating regenerative systems. There is abundant pre-existing theory on aspects of regenerative systems as well as important efforts to develop quantitative (and qualitative) indicator frameworks, including for regenerative economies³¹ and regenerative development.^{65,66} Conceptual constructs such as our Lens may instead have value in improving communication and stimulating conceptual change to guide practice, especially for those entirely unfamiliar with this way of thinking, rather than (or in addition to) validation, prediction, or explanation.^{67,68} The “lens” metaphor is relevant because the framework’s primary intended use is as a figurative lens through which to envision radically different futures, evaluate existing visions, and reflect on one’s action in the world.

With this overall purpose in mind, three key assumptions further informed our approach. First, we considered it valuable to distill insights from diverse disciplines to develop the Lens. Our framing of social-ecological systems is inherently broad and inclusive. Social-ecological systems—themselves “living systems” characterized by the special properties of life⁷¹—are based around humans and wider nature as interdependent interacting entities.⁷² Although regenerative system concepts in other disciplines (e.g., physiology or electrical engineering) may share thermodynamic or living system properties with regenerative social-ecological systems, we focus on more social contexts in this paper. We used an integrative review methodology, which is appropriate for synthesizing disparate information from different fields, to generate new insights and perspectives (but not to comprehensively and systematically review all available literature).⁷³ We reviewed regeneration literature in diverse fields (Table 1) and other literature, using inductive thematic analysis⁷⁴ to identify major themes. We combined literature synthesis with our own conceptual reasoning and some of the authors’ practical experience in facilitating regenerative initiatives (I.F. and B.S.). This integrative method was considered important because there are particular challenges in creating frameworks of concepts of which we have limited experience, and more inter- and transdisciplinary approaches could be vital in helping us to go beyond the limits of our language and current metaphorical ways of understanding things.⁷⁵ Moreover, there is a growing volume of available information about regenerative systems and therefore a concomitant need to consolidate this

information to understand its essence, especially for scholars new to regenerative fields, in a way that increases information accessibility and mitigates information overload.⁷⁶

Second, we considered it valuable to focus on dynamics and outcomes of regenerative systems in our framework. This is not only because we found these aspects typically underdeveloped elsewhere, but because (as we previously highlighted) they are fundamental to encouraging transformatively different futures. A system might produce desired outcomes, but these are likely to be short-lived if they still arise from degenerative dynamics that erode the system’s resilience. If, however, there is a focus on fostering radically different system dynamics with a more beneficial directionality for people and planet, desirable outcomes are likely to be more sustainable in the long term, and the framework could generate more useful insights about how certain practices would more effectively support emergence of regenerative systems.

Third, we aimed for an optimal level of simplicity in designing the framework. In some of the authors’ experience as facilitators, an orienting heuristic with more than about 4–5 distinct elements of the same broad type, such as principles or qualities—even though each element may be rich in underlying detail—is difficult for participants to take in and feel connected to without in-depth exploration. Existing regenerative frameworks often contain relatively large numbers (ca. 8–10) of principles.^{31,32,56} We therefore aimed for a level of simplicity that also preserves important essences of the complexities involved more appropriate to what the human brain has evolved to understand⁷⁷ and does not preclude nuances in particular cases of application.

Overall, the Regenerative Lens resulting from this approach is valuable as an accessible heuristic (while remaining grounded in a rich body of conceptual and empirical literature—indeed, a breadth of synthesis of regenerative ideas hitherto unattempted) that can be used in a wide range of contexts to push ambition, imagination, and transformative intent in envisioning, and therefore action toward, better futures. In the following sections we present the Regenerative Lens framework, which explains the outcomes expected of a regenerative system and the underlying qualities, dynamics, and practices that support emergence of these outcomes.

OUTCOMES OF REGENERATIVE SYSTEMS

Ecological outcome

To be considered regenerative, a system—e.g., a company, city, or bioregion—would maximize the ability of Earth’s biosphere to build, maintain, repair, and reproduce itself, as well as adapt and evolve, such that it retains its integrity over time (Figure 1). This ability might be called the “liveness” of life⁷⁸ and is underpinned by living systems’ distinctive thermodynamic behavior. As “dissipative systems” far from equilibrium and exchanging substantial energy flows with their environment,^{31,79,80} living systems locally overcome the universe’s general tendency toward increasing entropy (roughly speaking, the inaccessibility of a system’s energy for doing useful work) as described by the Second Law of Thermodynamics.^{81,82} Living systems actually decrease local entropy, which often corresponds to an increase in apparent “order.”^{81,82} Life thus avoids “heat death” or “entropic death,” an equilibrium where no further energy flow and change in state

are possible.⁸³ Furthermore, living organisms maintain some structural consistency over time thanks to the information preserved in DNA or RNA, enabling them to regenerate parts or all of themselves following damage, decay, and reproduction.^{84,85} Even an individual organism's death does not preclude regeneration of its structure, assuming it has already passed on its genes.

To maximize lifeness across ecosystems, a general principle is the need for balance between efficiency (equivalent to the removal of entropy-increasing friction⁸⁶) and resilience (interpreted here as the capacity to maintain functioning and adaptability in a changing environment), and the system characteristics producing them (e.g., relating to component size, specialization, and connectivity), as they often trade off against each other.^{31,87} This balance is typically observed in ecosystems under natural selection and results in flows (of, e.g., energy, carbon, nitrogen) being maximized while remaining resilient.^{81,87} Large size and low connectivity (e.g., of species or organisms in food webs) would be expected to typically result in higher efficiency and lower resilience, with small size, high functional specialization, and high connectivity associated with lower efficiency and higher resilience.^{31,87}

The ecological outcome of regenerative systems is thus about maximizing life's inherent capacity to sustain its organization, productivity, and resilience,⁸⁸ which includes a sufficient level of biological diversity and complexity as well as efficiency of resource flows. This contrasts starkly with the present day, in which human activity has reduced both efficiency and resilience of energy flows in ecosystems by eroding wild biomass (especially of the largest animals and plants) and biodiversity, dramatically reducing regenerative potential.^{87,89,90}

Human outcome

A regenerative system would also take a holistic view of human wellbeing in which everyone's full suite of needs is met and ongoing human cultural and intellectual evolution is enabled (Figure 1). Humans have a sophisticated and, some suggest, universal set of needs, as illustrated by many specific frameworks including Maslow's hierarchy,^{30,91,92} eudaimonic wellbeing,⁹³ Sen's capabilities,⁹⁴ human-scale development,⁹⁵ eco-cultural health,⁸⁸ and many others.^{96–98} We have basic material needs, including air, water, food, and shelter, which must be met to avoid death. However, we also have intangible needs, including love, belonging, and meaning, without which we typically enter a negative emotional state.⁹² In Maslow's hierarchy, the highest needs are self-actualization (fulfilling one's potential) and finally self-transcendence.⁹¹ Other holistic health frameworks highlight extensions to more relational, subjective, and emancipatory aspects of wellbeing, including our interactions with other objects, organisms, and patterns (e.g., links between food and culture, socialization, livelihood and identity, and the importance of wider ecological health for human health), and having agency and empowerment to lead meaningful lives.^{88,94,96,97} Emphasis on such higher-order needs alongside basic needs sets regenerative approaches apart from others with narrower accounts of human dignity and personhood.^{30,99}

Similar to the ecological outcome described above, a balance between efficiency and resilience of anthropogenic resource flows (e.g., food, money, and ideas) is also key to meeting human needs and enabling cultural and intellectual evolution.^{31,87} For

example, a balance between large efficient elements (e.g., multinationals) and smaller, less efficient elements (e.g., local contractors) is needed to distribute resources (e.g., finance) in inclusive ways across economies, mimicking other structures found in nature.³¹ However, today's societies exhibit many examples of over-prioritizing resource flow efficiency at the expense of resilience and continued evolution. In this context, resilience includes “transformative resilience” or maintaining the capacity for transformation.⁵ Examples include: our financial systems dominated by a handful of large organizations, whose “brittleness” contributed to the 2008/2009 financial crisis³¹; huge increases in agricultural yield efficiency during the industrial era but a tendency toward monocultures that often have lower resilience in the face of shocks¹⁰⁰; and extreme rates of information flow globally leading to “information overload”⁸⁶ and “ossification of canon” in scientific fields where potentially revolutionary ideas become lost in a huge sea of information.¹⁰¹ Conversely, flow efficiency is insufficient in many cases (e.g., in terms of wealth distribution), contributing to the fact that our societies are increasingly failing to meet even the material needs of billions of people.^{6,39,102} A regenerative system, in contrast, would manage resource flows in ways that balance efficiency and resilience, and thus enable fulfillment of needs and ongoing evolution in human cultures over the long term.

Interdependent outcomes

The desired outcome of regenerative systems is not only ecological and human regeneration but also a mutually reinforcing dynamic between these.⁴ This is an important example of a more general dynamic needed in regenerative systems: the mutual reinforcement between regeneration of a system in question (“internal regeneration”) and regeneration of the wider system it sits within (“external regeneration”) (Figures 1 and 2).

A fully regenerative system would be both internally and externally regenerative (Figures 1 and 2). For a person, internal regeneration might involve supporting one's individual needs while external regeneration could be positively supporting the social and ecological conditions of one's home community, which in turn supports one's internal regeneration. A fully regenerative farm would not only employ practices that advance the farmer's economic needs and regenerate soils and ecosystems on which the farm directly depends but also regenerate wider social and ecological environments, e.g., by boosting pollinator populations and acting as a hub for community interaction, which in turn support the farm. A fully regenerative business would not only focus internally on regenerative outcomes for its employees but also externally for wider society and ecosystems. Moreover, those wider social and ecological environments (e.g., communities, politics, finance systems) must be aligned to the regeneration of the person/farm/business in question, since all systems are internally self-organizing by using external gradients; otherwise, a system risks being “self-sacrificing” and burning out (Figure 2).

In the particular internal-external case of human regeneration and wider ecological regeneration, humans' active participation with the environment helps ecosystems to regenerate their own health and, therefore, human health^{4,34,88,98} (Figure 1). Ecosystems fulfill a wide array of human needs, including by providing food, materials, carbon sequestration, water purification,

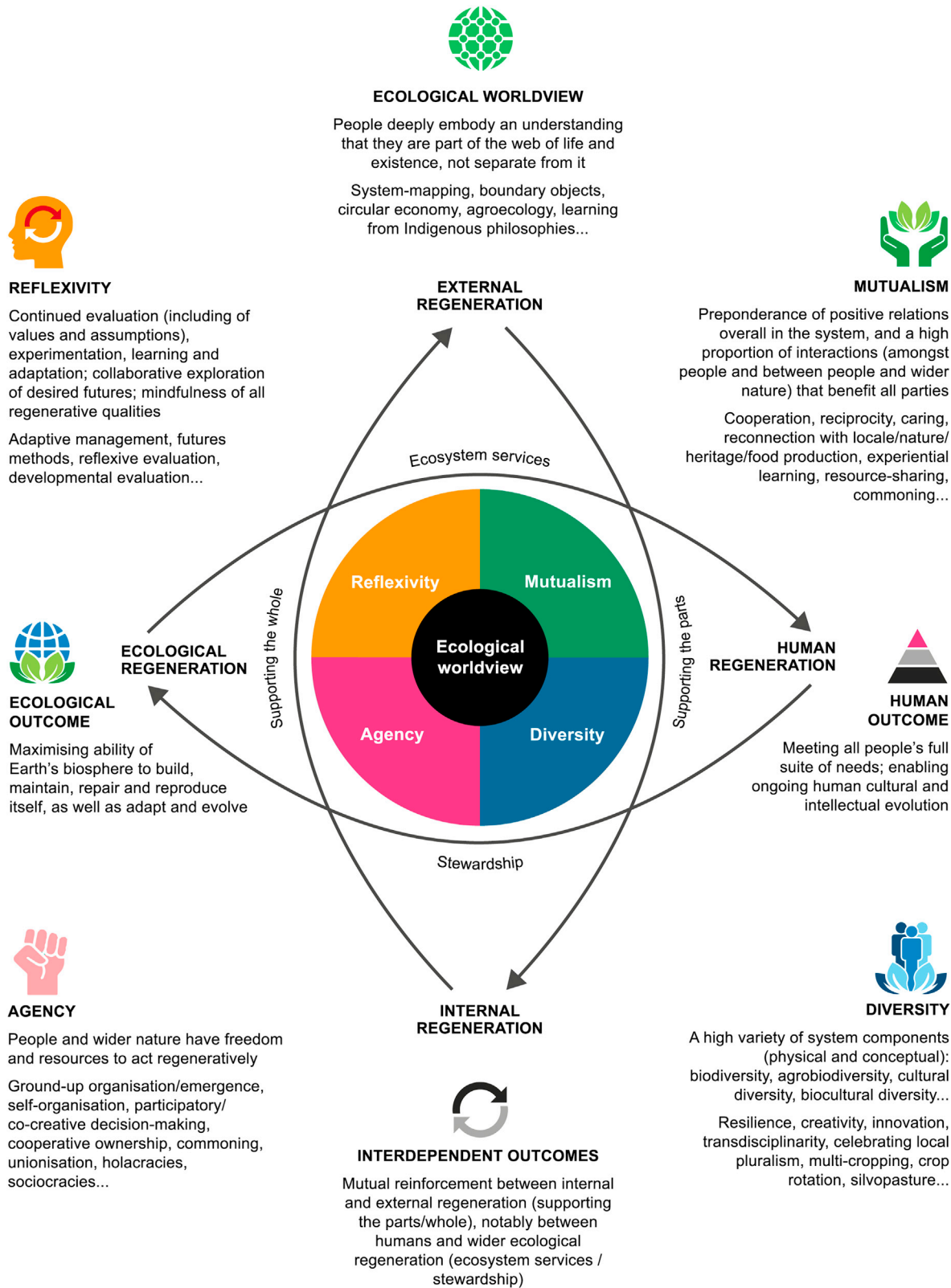


Figure 1. The Regenerative Lens framework

Summary framework of the Regenerative Lens, based on the structure of a human eye. The horizontal and vertical arrowed “outlines” of the eye represent the mutually reinforcing dynamics that characterize the outcomes of regenerative systems, with details given in the text outside the eye to the west, east, and south.

recreation, and spiritual meaning.¹⁰³ The term “ecosystem services” is commonly used to describe this relation¹⁰³; we use the term as a shorthand in our framework (Figure 1), recognizing that although it has received critique, e.g., for encouraging exploitation, anthropocentrism, and commodification, it can also encapsulate other values and ontologies that align more to a regenerative approach.¹⁰⁴ Reciprocally, ecosystems need a degree of human stewardship, as recognized by many Indigenous peoples^{34,98,105,106} (Figure 1). Although a stewardship approach would be humble enough to recognize that ecosystem regeneration is often more effective when unassisted by humans,¹⁰⁷ it also acknowledges that ecosystem health may, at least initially, need help to kick-start positive reinforcing cycles.⁴ As environmental health improves, nature’s integration into human self-identity can be enhanced, further encouraging pro-environmental and pro-social behavior in a virtuous cycle.¹⁰⁸

If a system lacks these dynamics, it risks losing its integrity (Figure 2). This is illustrated by our current extraction and pollution of the environment jeopardizing ecosystem services (e.g., due to biodiversity declines)¹⁰⁹ and driving degenerative reinforcing cycles. These cycles include the reactionary, short-term responses to human-exacerbated crises such as the COVID-19 pandemic that focus on meeting more immediate human needs (important though these are) at the expense of environmental stewardship,¹¹⁰ and environmental degradation reducing humans’ self-identification with nature, which weakens pro-environmental and pro-social behavior.¹⁰⁸ Moreover, much human activity today is externally degenerative and either internally regenerative (“self-centered”), such as polluting businesses that treat their employees well, or internally degenerative (“fully degenerative”), as illustrated by the worsening mental health and mounting human death toll from anthropogenic climate change or the dramatic loss over the last half-century of human cultural (e.g., language) diversity and viability and associated knowledge and practice of maintaining healthy ecosystems, which also threatens the regenerative capacity of wider ecosystems^{111–115} (Figure 2). Fully regenerative futures, meanwhile, would be built around the reciprocal support between internal and external regeneration and, notably, between human and wider ecological regeneration.

FIVE KEY QUALITIES FOR ENABLING REGENERATIVE SYSTEMS

In distilling our knowledge and research on regenerative systems, we identified five key qualities, along with their associated dynamics and practices, which support the achievement of regenerative outcomes (Figure 1).

Ecological worldview

Of foundational importance to enabling regenerative systems is an “ecological worldview,”³ whereby people deeply embody an understanding that they are part of a complex web of existence (including the rest of life) and not separate from it.^{3,38,116,117} This worldview, aligning with much Indigenous

thought globally (such as “good living” philosophies),^{19,34,118} views the world as nested interacting holons (wholes that are also parts) in a holarchy.^{119,120} Without it, approaches and actions are likely to fall back on reductionist and siloed thinking, e.g., as often characterize sustainable development,³ and egocentric notions of humans and human societies separate from nature.⁵ This risks both human and ecological degeneration but also failure to maximize reinforcing regenerative cycles arising from human-ecological relations. Embodying an ecological worldview means that all actions—from production of food, energy, and materials, to financial transactions, to our reproductive decisions (for those with the agency to make such choices)—are performed with awareness of, and in ways that nurture, the positive interdependencies previously described.

An ecological worldview might be encouraged by collaborative efforts to map or otherwise visualize the internal and external system and how they affect each other, with a long-term lens.³⁰ For example, DEAL’s Doughnut Design for Business tool encourages businesses to reflect on how they impact, and are impacted by, the sectors of the “doughnut” that represents the safe and just living space for humanity.¹²¹ Discussions about “boundary objects”—objects that inhabit and foster coherence across multiple intersecting social worlds¹²²—could be similarly beneficial. Furthermore, established economic approaches such as cosmocalism and the circular economy could be useful routes into developing an ecological worldview. Cosmocalism honors local communities as key social units while recognizing their position and role in a global network of sharing resources in a commons, thus transfiguring local-global relations.¹²³ The circular economy, meanwhile, reconceptualizes something traditionally treated as a negative externality (waste) as something that can regenerate production (both internally and externally), contributing to Earth’s cyclical processes of life.^{30,124,125} There are many innovative examples of circular economy practice, from closed-loop vertical farms to “agro-parks” of factories operating in an industrial symbiosis, reusing one company’s waste stream as another’s inputs.¹²⁵ Regenerative agriculture offers examples, such as applying compost and manure rather than synthetic fertilizer and relying on natural pest control rather than pesticides.²⁵ However, circular economy approaches based on economies of scale and commodification may not fundamentally challenge the mindsets and power relations (e.g., relating to human-nature dualism) that regenerative systems aim to transform; smaller-scale, place-based, grassroots agroecological approaches may align more strongly with a regenerative system overall.¹²⁵ Finally, and importantly, there is much to learn from Indigenous philosophies, such as the Quechua people’s “Allin Kawsay” or Maori “Mauri Ora,” in developing more holistic perspectives.³⁰

Understanding the need for an ecological worldview and encouraging it is one thing; it is another to actually embody it so that it becomes a subconscious driver of how we do things. We are a long way from that. Nonetheless, the importance of this shift for enabling regenerative systems cannot be overstated, as the worldview underpins all other qualities.

The pupil and iris include the five key qualities of regenerative systems that support the emergence of regenerative outcomes, with details in the text outside the eye to the north, north-east, south-east, south-west, and north-west. These blocks of text include a brief definition of the quality (first paragraph) and examples of dynamics and practices associated with that quality (second paragraph).

	Internally degenerative	Internally regenerative
Externally regenerative	<p>SELF-SACRIFICING</p> <ul style="list-style-type: none"> • A social enterprise that burns out its employees • A regenerative farm forced to sell its land because its affordably priced produce brings in insufficient revenue • A martyr for a regenerative cause 	<p>FULLY REGENERATIVE</p> <ul style="list-style-type: none"> • A country that becomes carbon-negative through ecosystem restoration and regenerative agriculture • A city that meets the needs of its citizens by restoring its hinterlands • A thriving farm that boosts biodiversity in the wider landscape and acts as a hub for community interaction • A social enterprise that nourishes society and (therefore) its employees
Externally degenerative	<p>FULLY DEGENERATIVE</p> <ul style="list-style-type: none"> • A society that extracts and burns fossil fuels, causing climate change and extreme weather that is increasingly deadly to the society's citizens • A country that starts a war with another country, killing people and crippling the economy on both sides • A predatory company merger or acquisition that reduces the value of both companies and leads to redundancies • A person whose addiction to a harmful drug also damages the person's social relationships 	<p>SELF-CENTERED</p> <ul style="list-style-type: none"> • A country that invests in social infrastructure using profits from activities driving climate change and biodiversity loss • A business that pays and treats its employees well but pollutes the environment • Humanity prioritizing its own reproduction and population growth at the expense of millions of other species' reproduction

Figure 2. Examples of internally/externally regenerative/degenerative systems

Hypothetical examples of social-ecological systems that are internally and/or externally regenerative and/or degenerative.

Mutualism

Mutualism can be a quality of interactions between individual actors as well as an overall network. In the former case, it describes interactions between two or more actors that benefit all parties. In the latter, “network mutualism” describes the preponderance of positive over negative or neutral relations (e.g., exchanges of beneficial resources) in an ecosystem.¹²⁶ As illustrated by healthy natural ecosystems, regenerative systems would need relatively high network mutualism.³¹ This suggests an important role for individual mutualistic interactions, including cooperation (working toward a common goal) and reciprocity (returning favors), to enhance overall network mutualism. That is not to dismiss the importance of apparently non-mutualistic interactions (e.g., parasitism, predation, competition, altruism), as many result in “indirect mutualism”¹²⁶ that promotes overall ecosystem health. Such interactions (e.g., human removal of invasive species, or even human decisions to raise smaller families) might be particularly important in the shorter term as we navigate pathways toward regenerative systems. However, it is clear that societies must overturn the

prevalence of non-mutualistic, internally and externally degenerative dynamics (Figure 2), and place greater emphasis on mutualistic interactions—among humans and between humans and wider nature—if they are to develop regenerative systems. This is because in general, predominantly self-centered or competitive interactions risk external degeneration while self-sacrificing interactions risk internal degeneration (Figure 2).

Mutualism in regenerative systems is as much a shift in our perspective of how organisms interact as it is about how we choose to interact.⁵ It means moving from a narrow view of life founded on individualism and competition, developed from Darwinism and notions of the “selfish gene”⁵ (and which today often characterize the dominant global economic model of neoliberalism^{127,128}), to recognizing the importance of mutualistic relationships in the evolution and flourishing of life on Earth and humans' evolutionary success.³⁴ It also means moving from a blind focus on direct organism interactions to considering how all interactions, including indirect and non-mutualistic ones, contribute to an overall mutualistic and, therefore, regenerative system.^{31,126}

Mutualistic interactions require care for others as well as care to meet one's own needs. Encouraging mutualism therefore means encouraging care. An ideal place to start in inculcating a culture of care is grounding regeneration in local contexts and communities, from which wider responsibility can be developed. Everyone has a local context and typically a special care for it, connecting via cultural narratives—an ever-evolving “story of place” that honors and celebrates habitats, communities, buildings, history, and heritage.^{3,4,46,129,130} Similarly, it could be valuable to reconnect people with the production of their food.^{12,124} For example, local wild food foraging can facilitate people's connectedness to nature, which in turn fosters altruistic motivations.¹³¹ Even exposure to videos of nature can make us more cooperative.¹³² In education, caring and mutualistic relations could be fostered by encouraging understanding of how different cultural values shape both positive and negative human-nature relationships, providing experiential learning in nature, and embedding practical regenerative skills development in curricula.³⁴ Caring can also come simply from an enterprise's collective regenerative mission, increasing feelings of purpose, meaningfulness, and motivation in employees.³⁰ Antitheses of this ethic of care include mental and spatial distancing of workers from their work, and between food production and consumption (which typically accompanies commodification).^{12,124}

Between people, mutualism could also take the form of resource sharing. For instance, food sharing is a form of “social nourishment,” combating loneliness and strengthening social networks and community resilience.^{133,134} Networks of sharing common-pool resources can also powerfully express other regenerative qualities (see below). For example, sharing crop seeds can encourage crop genetic diversity and address dietary deficiencies in key nutrients¹¹ and increase agency by challenging corporate monopoly control of seeds.¹³⁵ Similarly, sharing knowledge about successful (e.g., agricultural) practice could involve use of digital technologies that resist corporate monopolization of data, as exemplified by small-scale networks of regenerative farmers built around commons of data sharing and open-source coding (e.g., sharing environmental farm data, mapping, and co-developing DIY soil sensors).^{41,136} Overall, resource sharing and connecting people with nature and local heritage could encourage mutualistic interactions, which should feature strongly in any regenerative systems' internal-external relations.

Diversity

Diversity refers here to the variety of system components, both physical and conceptual, quantitative and qualitative, ecological and human. Regenerative systems require high levels of diversity, including biodiversity, agrobiodiversity, cultural diversity, biocultural diversity, the degree of role specialization in society, and diversity of organizations such as businesses.^{11,31,40,35} Diversity makes important contributions to the resilience and other dimensions of regenerative system health.^{31,87,100,137} For instance, biodiversity in wider ecosystems is important for adaptation in the face of environmental perturbations, reducing negative impacts on people^{100,137}; cultural diversity reduces impacts of environmental shocks and stressors on human societies and holds repositories of knowledge (e.g., in language) about

sustaining humans and other life in many different environments^{88,98,138}; and diversity of organizations and currencies in financial systems may increase resilience against shocks such as financial crashes.⁸⁷ Biodiversity may even be autocatalytic, whereby diversification of species creates niches for more species to exist.¹³⁹ Diversity is also important for its direct contributions to human wellbeing (e.g., from experiencing biodiverse surroundings).^{11,140} Particular effort is needed to enhance and protect diversity¹⁴¹ because humanity is already more adept at increasing the efficiency of resource flows,⁸⁶ often at the expense of diversity.

An important manifestation of diversity in human regeneration is creativity, which facilitates cultural and intellectual evolution in a similar way to the genetic mutations that enable biological evolution.^{35,142} To counter global declines in creativity in young people,¹⁴³ exacerbated by education systems that restrict access to creative subjects,¹⁴⁴ creativity would need to be fostered by embracing transdisciplinarity, ambiguity, and awareness of the complexity and regenerative properties of nature (see also “reflexivity” below).³⁵ Creativity and other forms of diversity may be positively reinforcing: for instance, cultural diversity is suggested to play an important role in regenerating our imagination,¹³⁴ further enhancing opportunities for creativity.^{35,129}

Grounding regenerative systems in local stories of place, as described above, is one way in which diversity (e.g., cultural, biological, and biocultural) could be encouraged. This highlights the impossibility of a one-size-fits-all solution for enabling regenerative systems and that regeneration must instead co-evolve with its locale,^{6,46} revitalizing diverse local and Indigenous ways of knowing that include “good living” philosophies and traditional ecological knowledge.^{19,35,38,40,117,145}

Regenerative agriculture features many practices that aim to increase biodiversity, including multi-cropping, crop rotation, and silvopasture.^{25,26} A goal of soil-protecting practices in regenerative agriculture, for example, is to increase diversity of soil fauna and microbiota to improve soil structure.²⁶ On the social side of regenerative agriculture, which includes skill building and encouraging ingenuity and adaptability to new social and economic conditions,¹²⁹ a diversity of agricultural activities can enhance wider regenerative capacity in various ways.¹²⁹ In particular, the diverse social interactions in multi-functional landscapes can lead to synergistic knowledge sharing, innovation, and upskilling.¹²⁹

Agency

We interpret agency as having the freedom and resources to behave in a desired way. It is an important quality in regenerative systems because people and wider nature require agency—the freedom from oppression, and the energy, materials, time, and space—to act regeneratively. For people, this includes having control over their own livelihoods and opportunities to meet their immaterial and material needs, making choices they value while also working toward collective regenerative goals.^{5,31,38,117,136,146} Frameworks such as Sen's capabilities stress the essentiality of this kind of agency for human wellbeing.⁹⁴ This agency has been referred to as “autonomy through interdependence,” in contrast to self-interested autonomy-as-individualism or *homo economicus* that characterizes neoliberalism,¹²⁷ and is closely related to the concept of “food sovereignty” in

food systems whereby local communities control the governance of their own food system (rather than, say, globalized markets and corporations).¹⁸ Although our mainstream economic, political, and other organizational structures may empower people in some ways (e.g., by granting access to all the knowledge and social connection provided by the internet), in other ways they fall far short of the empowerment required in regenerative systems (e.g., by colonizing the land and sea that underpin local and Indigenous livelihoods). Similarly, the enclosure, colonization, privatization, commodification, and technological control of non-human nature that characterize mainstream economies are a far cry from the agency that nature deserves and requires in regenerative systems.^{6,124}

Behind the lack of agency granted by many human societies lies an inaccurate Hobbesian view of people as inherently selfish, violent, and in need of top-down control,¹⁴⁷ and an anthropocentric notion of nature as subordinate to people and in need of taming.^{6,148} That is not to dismiss the importance of top-down policymaking altogether, but enabling agency in regenerative systems requires greater trust in the inherent cooperative tendencies of human communities when given opportunities to self-organize¹⁴⁷ as well as trust in the self-organizing power of ecosystems. The core dynamic associated with agency in regenerative systems is therefore ground-up organization and emergence within supportive policy environments, both in human communities and non-human contexts, as opposed to dependence on more top-down control driven by markets and governments.³¹

Agency in regenerative systems would be reflected in governance structures, including cooperatives, commons, informal collectives of micro-enterprises, unions, holacracies, and sociocracies.^{6,7,31,41,135,136,146} Cooperatives exemplify regenerative modes of exchange whereby value generated is reinvested back into the cooperative, not accumulated by a small number of capital owners.¹⁴⁶ In any case, decision-making should be democratic, with place-based co-creative processes with community stakeholders being commonplace, encouraging discussions about conflicts in views as central to policy processes.^{3,116,149} Enterprises should flatten hierarchies within their organizational structure and ensure inclusive involvement of employees along with senior management in decision-making.³⁰ Holacracies and sociocracies have been suggested as regenerative governance models inspired by living systems for replacing traditional management hierarchies, featuring an overlapping holarchy of roles and domains of work, decisions by mutual consent, and continuous feedback,⁷ although these are still exploratory ideas.

Initiatives focusing on agency in regenerative systems, however, should beware of (possibly unintentional) perpetuation of injustices. For example, a commons in regenerative systems would transcend food banks, community fridges, and school breakfast clubs, where food donors and beneficiaries remain anonymous to each other and the food may be cheap and low in nutritional value.^{6,12} Although such initiatives may have short-term importance, they perpetuate dependency and marginalization without challenging the underlying system that creates such injustices and see food as little more than a political act.⁶ Food justice initiatives, such as farmers' markets, should also avoid becoming elitist and accessible only to richer people.¹² True food sovereignty might instead take the form of community urban farming.^{38,150}

At its heart, agency in regenerative systems is thus a matter of human and non-human justice, including the securing of future intergenerational justice and redress of historical injustice, which is associated especially with the colonialist practices of capitalism.⁶ A system arguably cannot be regenerative if it is not emancipatory and fails to right such injustice (e.g., if it exists on stolen land) or does not enable resource sovereignty. It involves a rebalancing of power dynamics, leveling up hierarchies between groups of people and between people and wider nature.⁶ In this way it is perhaps the regenerative quality most closely tied to ideas about equity and equality. It is key to regenerative systems because regeneration is intimately related to bottom-up, autopoietic forms of organization and network governance without dependence on top-down control, and the importance of freedom for human wellbeing.

Reflexivity

Reflexivity is a deeper form of reflection that continually re-evaluates the values and assumptions underpinning our actions.¹⁵¹ Although it includes continued and iterative experimentation, evaluation, learning, and adaptation^{30,28}—more post hoc, reflective forms of reflexivity—here we consider it to go further, additionally encompassing collaborative exploration of desired regenerative futures³ and also an active, present-moment awareness of the many dimensions of participation in regenerative systems (e.g., ecological worldview, diversity, mutualism, and agency). While being more obviously key to human learning, reflexivity is also a collaborative co-evolutionary quality occurring between humans and wider nature.^{3,28,29} For instance, regenerative entrepreneurs treat nature as an enabling partner from which to reflexively learn, adapt, and find creativity, while regenerative organizations reciprocally enhance the adaptive, evolutionary, and thus regenerative capacity of wider ecosystems.^{30,28,29} The constructivist practice of reflexivity contrasts with the instrumental rationality characterizing many traditional mechanistic approaches to sustainability.^{3,140}

Reflexivity is considered essential to supporting the emergence of regenerative systems for several reasons. Internal and external environments are constantly changing, so frequent reflexive practice is needed for a system to remain viable and to maintain focus, ambition, and motivation.³ This is particularly important today, when major shifts in our values are urgently required. Reflexivity is also key for embodying the regenerative qualities described in this perspective in how we act in the world. Participating in regenerative systems means remaining constantly attuned to and guided by these qualities. An absence of such reflexivity risks over-focusing on limited aspects of regenerative systems or only paying lip service to regenerative qualities.

A long-term regenerative system therefore requires a “learning community”³¹ that embodies deep reflexivity. This requires strong investment in education (notably, education that embraces Indigenous knowledge and encourages creativity and mutualism,^{34,35} as described above) and adaptive management that continually learns from nature and places.^{28,29,43} Regenerative enterprises should remain aware of system feedbacks and recognize that staying viable means continuous engagement with knowledge and innovation.³⁰ Futures thinking and methods, such as collaborative Three Horizons workshops (see [Box 1](#)),⁶²

Box 1. Background to our application of the Regenerative Lens to an envisioned future food system

The future vision to which our Regenerative Lens was applied is taken from a Three Horizons⁶² process run by FixOurFood (a £6 million 5-year research program funded by UK Research and Innovation's Transforming Food Systems Strategic Priority Fund⁵⁵), using surveys and online workshops with researchers and other stakeholders in the Yorkshire food system. FixOurFood aims to understand how to support transformation toward a regenerative food system in Yorkshire.⁵⁵ It focuses on three subsystems—agriculture, schools and early years settings, and food economies—and how they are connected. Three Horizons is a participatory futures practice and framework for convening conversations about transformative change, centered around three horizons of current challenges (the “first horizon”), desired futures (the “third horizon”), and action to support transformation (the “second horizon”).⁶²

Perceived challenges in the current Yorkshire food system include: the system is dominated by a relatively small number of large corporations, limiting agency at local scales to achieve major positive change; conventional farming methods focused on high yields that degrade the local and global environment; insufficient appreciation of food's importance in schools; siloed policy; and high levels of stress for people. The third horizon vision, in contrast, imagines a Yorkshire food system with high local diversity (e.g., of food businesses), agency, and self-sufficiency. The food system's priority is nutritious and sustainable food, with good practice rewarded by government and markets. Food system actors are well connected and engaged, and human and environmental wellbeing are high and increasing. See [Note S1](#) for details of the third horizon vision.

To apply the Regenerative Lens, we convened an online 1.5-h meeting of six FixOurFood researchers to interrogate the third horizon vision (integrated across all three subsystems), with a particular focus on the five key qualities for enabling regenerative systems (ecological worldview, mutualism, diversity, agency, and reflexivity), and asking where and how (1) the vision already aligns to the Lens and (2) alignment to the Lens could be strengthened. Participants were divided into two breakout groups, with each group addressing both questions for a single quality at a time. Responses were recorded in the collaborative online whiteboard Mural (<https://www.mural.co/>).

lend themselves well to such a learning community.³ Reflexivity can also be enhanced by evaluation methods used,³ such as Reflexive Monitoring in Action¹⁵² or Developmental Evaluation.¹⁵³ By making reflexivity a standard practice in our lives, our systems are more likely to maintain agile, co-evolutionary internal-external partnerships that enable adaptation to dynamic conditions, hopeful aspiration toward regenerative futures, and embodiment of regenerative qualities as we participate in regenerative systems.

THE REGENERATIVE LENS AS A WHOLE

When the framework's components are viewed as a whole ([Figure 1](#)), four important additional insights emerge. First, each quality contributes in an essential way to avoiding a system's long-term degeneration. For example, without mutualism and agency there could be no cooperative action in communities toward a common goal of a regenerative future. Similarly, without reflexivity we would struggle to shift worldviews underlying degenerative practice and keep systems viable in constantly changing circumstances. Without an ecological worldview a system is likely to focus on human and internal regeneration, with a continued effect of eroding the wider Earth system's capacity to support people.

Second, the five qualities are mutually reinforcing. For example: epistemic pluralism and creativity could be key to designing responses to system feedbacks, while reflexivity could in turn foster creativity; connecting with nature and locale to foster mutualism could also encourage a more ecological worldview; and mutualistic resource sharing can also enhance agency. Losing any one quality would thus have a disproportionate overall impact.

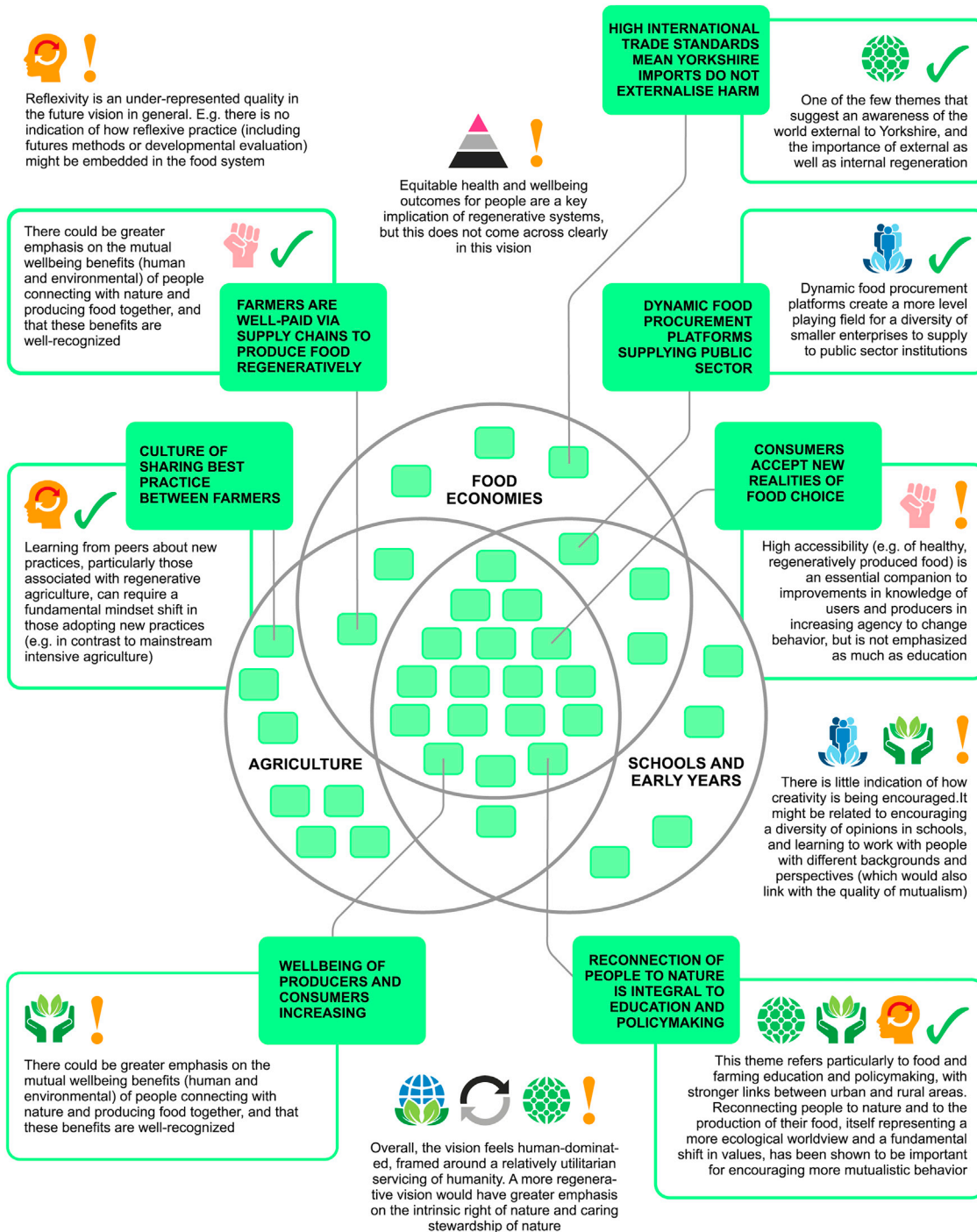
Third, the distinction between reaching and encouraging regenerative systems (i.e., outcome vs. process) is not clear-

cut. This is because a regenerative system's outcomes will never be static⁴³ but rather an ongoing dynamic of mutually reinforcing wellbeing and biological, cultural, and intellectual co-evolution. Regeneration is thus simultaneously a means and an end.³⁶

Finally, the framework uses system distinctions to encourage a conceptual shift but avoids dichotomies. Although the Lens's social-ecological, human-ecological, and internal-external framings do represent dualisms in a framework aiming to break down traditional dualisms, these are fuzzy and flexible boundaries that remain useful as distinctions rather than dichotomies in explaining regenerative concepts.⁷² In each case, the distinction retains the two entities as interactive, interdependent, and mutualistic, which helps to highlight the contrast with our current systems. This is not necessarily incompatible with recognizing indivisible aspects common to all life (whether defined biologically or spiritually). Moreover, the internal-external distinction encourages the user to progressively expand the scope of inquiry to bring increasingly larger systems into view and seek to transform them from degenerative to regenerative, similar to the Scope 1, 2, and 3 approach to cutting carbon emissions.¹⁵⁴ It also distinguishes the framework from common mainstream framings of resilience that focus on how a system can internally sustain itself in relation to external change without addressing the deeper causes of the external change.¹⁵⁵ In this sense our framework is closer to a multi-system model of resilience.¹⁵⁶

APPLYING THE REGENERATIVE LENS

We suggest that the Regenerative Lens could be useful for driving ambition and imagination to create new kinds of futures, maintaining transformational intent in change processes, and reflexively evaluating progress. Here we present an example of using the Lens to evaluate and stretch ambition in an envisioned future, in this case a future Yorkshire food system envisioned by



KEY TO SYMBOLS

Human outcome	Ecological outcome	Interdependent outcomes	Ecological worldview	Mutualism	Diversity	Agency	Reflexivity	Aligns to Regenerative Lens	Alignment to Regenerative Lens could be strengthened

Figure 3. Applying the Regenerative Lens to an envisioned future

Visual summary report from applying the Regenerative Lens to an envisioned future food system. The central Venn diagram represents the whole vision. Each circle represents a subsystem (agriculture, food economies, and schools and early years settings). Each green rectangle is a Post-it note with the title of a theme in

(legend continued on next page)

FixOurFood⁵⁵ through a collaborative Three Horizons⁶² process with 113 food system stakeholders (Box 1 and Figure 3). Humans have considerable imaginative capacity but often struggle to envision genuinely different futures beyond their existing frames of reference.⁷⁵ The Regenerative Lens was therefore used by a group of researchers to stretch the vision. It helped actors to consider where there were existing regenerative qualities and dynamics in the envisioned future and what might need to be modified to give it a stronger basis in regenerative thinking (Box 1 and Figure 3).

There was already considerable inclusion in the envisioned future of regenerative qualities and dynamics. For example, an ecological worldview was suggested in relation to externalities of international trade, diversity was inherent in the theme about dynamic food procurement platforms supplying the public sector (which create a more level playing field for a diversity of smaller enterprises), and several regenerative qualities, including an ecological worldview, mutualism, and reflexivity, were considered to be reflected in the theme “reconnection of people to nature is integral to education and policymaking” (Figure 3). Nonetheless, there were also many opportunities where emphasis on regenerative qualities and dynamics could be strengthened to increase alignment to the Regenerative Lens. For example, the vision as a whole was considered overtly human-dominated, reflecting a utilitarian approach to nature. The vision also lacked clarity on: how creativity would be encouraged; the mutual wellbeing benefits of people connecting with nature and producing food together; equitable health and wellbeing outcomes; and how reflexive practice would be embedded in food system activity (Figure 3). Without greater consideration of these issues, the envisioned future then had less potential to support ambitious transformative action.

Participants gave positive feedback on the application exercise, notably how it helped them to reflect on their vision and consider more deeply interconnections between its different components. Thus, while developing a more structured, reproducible method for applying the Lens was outside the scope of this perspective, the framework did have significant value for the participants involved. Currently we are therefore learning how to apply the Lens more regularly, continuously, and collaboratively in futures-oriented work and in supporting transformational, reflexive forms of evaluation. Ultimately, a more ambitious vision based on regenerative principles makes actors more likely to engage in practices that give rise to regenerative dynamics.

DISCUSSION AND NEXT STEPS

Regenerative systems are a significant departure from dominant approaches focused on reducing harm to acceptable levels. Yet, so far, there has been little synthesis of the many disparate ideas about regenerative systems, limited clarity around regenerative outcomes and dynamics, and a lack of simple but powerful orienting heuristics for encouraging regenerative systems in diverse contexts. Our framework emphasizes that to be regener-

ative, a system—e.g., a person, family, community, or organization—cannot be regenerative on its own but only as part of a regenerative “ensemble” of interdependent social-ecological systems that are mutually supporting each other. To foster these dynamics and therefore the wellbeing and continued evolution of human societies and wider nature, a regenerative system would need the individual and mutually reinforcing contributions of five essential qualities: an embodied ecological worldview, mutualistic interactions, high diversity, agency, and reflexivity.

Our work confirms the ideas in various other regenerative frameworks.^{31,53,54,56,63–66} The particular value of the Regenerative Lens, however, is in the focus of its purpose as an orienting tool for encouraging reflexivity and ambition in futures processes in diverse contexts, along with its relatively broad, interdisciplinary approach. The framework’s structure is also in itself apparently a new way of conceptualizing regenerative systems, notably its emphasis on the dynamics of regenerative systems, with other aspects of the framework then situated within this foundation. These other aspects focus on regenerative qualities that explain deeper motivations for applying certain practices and why they are essential for supporting wider regenerative dynamics. With this said, we do not view our framework as static: in line with the need for reflexivity, the framework will inevitably evolve as we learn more about supporting change toward regenerative futures.

By applying an integrative review methodology, we do not intend to suggest that complete agreement exists across all researchers and initiatives on the definition of a regenerative system. Nor should there be, as locally (e.g., bioregionally) defined regeneration, avoiding blanket interventions, is a key principle of regenerative systems. Our engagement with the literature is in any case non-comprehensive and omits much practical or embodied knowledge that is less readily accessible. Nonetheless, some frequently arising themes become evident when exploring transformative interpretations of regenerative systems, as we summarize in our framework; as Table 1 illustrates, there is much overlap between different regenerative fields. There are two main areas where we have purposefully avoided certain interpretations of regenerative systems: neoliberal interpretations (e.g., of urban regeneration) and apolitical interpretations (e.g., of regenerative agriculture), which have both been criticized.^{27,72,157} Instead, we recognize that regenerative systems are inextricably normative and political as well as founded on the fundamental properties of life. In particular, the quality of agency in our framework emphasizes the importance of redressing injustices against people and wider nature (including those associated with neoliberalism).

Many important questions remain, especially regarding how regeneration can be enabled or embodied within thinking and action. When our framework has been raised with colleagues, some have questioned whether a system might need to be degenerative (externally or internally) before it can be regenerative in the longer term; whether regeneration in one aspect of a system might mean degeneration in another; and whether the

the vision. Some themes are thus associated with a particular subsystem, or cross-cutting (in spaces between overlapping subsystems). Analysis of only a subset of the themes is included in this figure—these themes are magnified to show their titles, and lines connect them to their corresponding position in the Venn diagram. For the other theme titles and detailed text underpinning each theme, see Note S1. Some of the analysis refers to a particular theme (text adjacent to the enlarged green Post-it notes), and some refers to the vision as a whole (text unassociated with enlarged green Post-it notes).

practices we advocate are ambitious enough, given that they are typically small-scale and yet we require global-scale regenerative systems. Yet these questions, while valid, may not be the most useful questions to ask, because they are underpinned by assumptions—in this case, of scarcity and the need for economies of scale—that regenerative systems purposefully challenge. We should certainly heed potential negative side effects of regenerative action and consider the role of non-mutualistic interactions in a wider mutualistic system, but there is also a need to shift emphasis from problems to potential and creatively developing new approaches. Moreover, we should honor regeneration's distinctive and transformative approaches to geographic scales of action, power relations, governance structures, and change pathways. For instance, economies of scale may provide more efficient resource flows but fail to embody other (e.g., social justice or diversity) aspects of regenerative systems. We think that more important questions might include the following. (1) Where is there greatest synergy between the different regenerative qualities? (2) What can we learn from regeneration success stories about how regenerative systems can be enabled? (3) What forms of networks and collaboration facilitate the spread of regenerative practice from grassroots origins while preserving pluralism? (4) And ultimately, how can we encourage virtuous reinforcing feedback between human and wider ecological wellbeing?

While the need for regenerative systems has never been more urgent, we are a long way from embodying regenerative dynamics in how we think, act, govern, or do business. This perspective, however, has attempted to clarify how regenerative systems could look and behave and has shown how a Regenerative Lens can guide ambitions for new kinds of futures. Nonetheless, regeneration is a radical shift from mainstream thought and action. Even as increasingly deadly extreme weather events drive home the reality of our environmental crises, narratives of reducing harm to sustainable levels (e.g., net zero carbon) dominate, perpetuating the notion that we can continue to improve current societal patterns rather than acknowledging that deeper transformations are required. On the other hand, a focus on growing regenerative systems that reinforce human and planetary wellbeing provides a much more transformative and hopeful message for reaching a radically different future.

SUPPLEMENTAL INFORMATION

Supplemental information can be found online at <https://doi.org/10.1016/j.oneear.2023.06.006>.

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AUTHOR CONTRIBUTIONS

Conceptualization, S.J.B. (lead), I.F., B.S., and E.S.O. (supporting); methodology, S.J.B. (lead), I.F., and B.S. (supporting); formal analysis, S.J.B.; investigation (integrative literature review), S.J.B.; investigation (applying the Regener-

ative Lens), S.J.B. (lead), I.F., B.S., E.S.O., B.D., and R.L. (supporting); investigation (Three Horizons process), S.J.B., I.F. (co-leads), B.S., E.S.O., B.D., P.B., K.D., M.B., R.L., S.B., M.C., E.C., L.C., N.N., C.Y., A.C., B.F., A.F., G.G., A.J., I.K., A.K., B.M., and M.S. (supporting); writing – original draft, S.J.B. (lead) and I.F. (introduction only); writing – review & editing, S.J.B. (lead), I.F., B.S., E.S.O., B.D., P.B., K.D., M.B., R.L., E.C., L.C., N.N., C.Y., and S.M. (supporting); visualization, S.J.B.; supervision, S.J.B., I.F., and B.S. (equal); project administration, S.J.B. (lead) and I.F. (supporting); funding acquisition, I.F., B.D., P.B., K.D., M.B., S.B., M.C., and L.C. (equal).

DECLARATION OF INTERESTS

The authors declare no competing interests.

REFERENCES

1. Fazey, I., and Leicester, G. (2022). Archetypes of system transition and transformation: Six lessons for stewarding change. *Energy Res. Soc. Sci.* 97, 102646. <https://doi.org/10.1016/j.erss.2022.102646>.
2. Kuhlman, T., and Farrington, J. (2010). What is Sustainability? *Sustainability* 2, 3436–3448. <https://doi.org/10.3390/su2113436>.
3. Camrass, K. (2020). Regenerative futures. *Foresight* 22, 401–415. <https://doi.org/10.1108/FS-08-2019-0079>.
4. Reed, B. (2007). Shifting from 'sustainability' to regeneration. *Build. Res. Inf.* 35, 674–680. <https://doi.org/10.1080/09613210701475753>.
5. Wahl, D.C. (2016). *Designing Regenerative Cultures (Triarchy Press)*.
6. Ferrando, T. (2020). Commons and commoning to build ecologically reparatory food systems. In *Routledge Handbook of Sustainable and Regenerative Food Systems*, J. Duncan, M. Carolan, and J.S.C. Wiskerke, eds. (Routledge), pp. 262–276. <https://doi.org/10.4324/9780429466823-19>.
7. Gibbons, L.V. (2020). Regenerative—The New Sustainable? *Sustainability* 12, 5483. <https://doi.org/10.3390/su12135483>.
8. Shannon, G., Issa, R., Wood, C., and Kelman, I. (2022). Regenerative economics for planetary health: A scoping review. *Int. Health Trends Perspect.* 2, 81–105. <https://doi.org/10.32920/ihhp.v2i3.1704>.
9. East, M. (2020). The transition from sustainable to regenerative development. *Ecocycles* 6, 106–109. <https://doi.org/10.19040/ecocycles.v6i1.168>.
10. Haberl, H., Fischer-Kowalski, M., Krausmann, F., Martinez-Alier, J., and Winiwarter, V. (2011). A socio-metabolic transition towards sustainability? Challenges for another Great Transformation. *Sustain. Dev.* 19, 1–14. <https://doi.org/10.1002/sd.410>.
11. Natividad, P., Ferrufino, M.C.O., de Scurrah, M.M., and Sherwood, S. (2020). Enabling more regenerative agriculture, food, and nutrition in the Andes : The relational bio-power of "seeds". In *Routledge Handbook of Sustainable and Regenerative Food Systems*, J. Duncan, M. Carolan, and J.S.C. Wiskerke, eds. (Routledge), pp. 304–317. <https://doi.org/10.4324/9780429466823-22>.
12. Ioris, A.A.R. (2020). Controversies around food security : Something difficult to swallow. In *Routledge Handbook of Sustainable and Regenerative Food Systems*, J. Duncan, M. Carolan, and J.S.C. Wiskerke, eds. (Routledge), pp. 420–435. <https://doi.org/10.4324/9780429466823-30>.
13. Muñoz, P., and Branzi, O. (2021). Regenerative Organizations: Introduction to the Special Issue. *Organ. Environ.* 34, 507–516. <https://doi.org/10.1177/10860266211055740>.
14. Egmoose, J., Jacobsen, S.G., Hauggaard-Nielsen, H., and Hulgård, L. (2021). The regenerative turn: on the re-emergence of reciprocity embedded in living ecologies. *Globalizations* 18, 1271–1276. <https://doi.org/10.1080/14747731.2021.1911508>.
15. Girardet, H. (2020). People and Nature in an Urban World. *One Earth* 2, 135–137. <https://doi.org/10.1016/j.oneear.2020.02.005>.
16. Rhodes, C.J. (2017). The imperative for regenerative agriculture. *Sci. Prog.* 100, 80–129. <https://doi.org/10.3184/003685017X14876775256165>.
17. Benyus, J.M. (2002). *Biomimicry: Innovation Inspired by Nature*, 2nd ed. (Mariner Books).
18. J. Duncan, M. Carolan, and J.S.C. Wiskerke, eds. (2020). *Routledge Handbook of Sustainable and Regenerative Food Systems*, 1st Edition (Routledge). <https://doi.org/10.4324/9780429466823>.
19. Huambachano, M. (2020). Indigenous good living philosophies and regenerative food systems in Aotearoa New Zealand and Peru. In *Routledge Handbook of Sustainable and Regenerative Food Systems*, J. Duncan, M. Carolan, and J.S.C. Wiskerke, eds. (Routledge), pp. 38–49. <https://doi.org/10.4324/9780429466823-4>.

20. Riedy, C. (2020). Discourse coalitions for sustainability transformations: common ground and conflict beyond neoliberalism. *Curr. Opin. Environ. Sustain.* 45, 100–112. <https://doi.org/10.1016/j.cosust.2020.09.014>.
21. Ruder, S.-L., and Sanniti, S. (2019). Transcending the Learned Ignorance of Predatory Ontologies: A Research Agenda for an Ecofeminist-Informed Ecological Economics. *Sustainability* 11, 1479. <https://doi.org/10.3390/su11051479>.
22. Newton, P., Civita, N., Frankel-Goldwater, L., Bartel, K., and Johns, C. (2020). What Is Regenerative Agriculture? A Review of Scholar and Practitioner Definitions Based on Processes and Outcomes. *Front. Sustain. Food Syst.* 4. <https://doi.org/10.3389/fsufs.2020.577723>.
23. Carlisle, L. (2022). *Healing Grounds: Climate, Justice, and the Deep Roots of Regenerative Farming* (Island Press).
24. Penniman, L. (2018). *Farming while Black: Soul Fire Farm's Practical Guide to Liberation on the Land* (Chelsea Green Publishing).
25. Schreefel, L., Schulte, R.P.O., de Boer, I.J.M., Schrijver, A.P., and van Zanten, H.H.E. (2020). Regenerative agriculture – the soil is the base. *Glob. Food Sec.* 26, 100404. <https://doi.org/10.1016/j.gfs.2020.100404>.
26. Lal, R. (2020). Regenerative agriculture for food and climate. *J. Soil Water Conserv.* 75, 123A–124A. <https://doi.org/10.2489/jswc.2020.0620A>.
27. Titttonell, P., El Mujitar, V., Felix, G., Kebede, Y., Laborda, L., Luján Soto, R., and de Vente, J. (2022). Regenerative agriculture—agroecology without politics? *Front. Sustain. Food Syst.* 6. <https://doi.org/10.3389/fsufs.2022.844261>.
28. Hahn, T., and Tampe, M. (2021). Strategies for regenerative business. *Strateg. Organ.* 19, 456–477. <https://doi.org/10.1177/1476127020979228>.
29. Vlasov, M. (2021). In Transition Toward the Ecocentric Entrepreneurship Nexus: How Nature Helps Entrepreneurs Make Ventures More Regenerative Over Time. *Organ. Environ.* 34, 559–580. <https://doi.org/10.1177/1086026619831448>.
30. Caldera, S., Hayes, S., Dawes, L., and Desha, C. (2022). Moving Beyond Business as Usual Toward Regenerative Business Practice in Small and Medium-Sized Enterprises. *Front. Sustain.* 3. <https://doi.org/10.3389/frsus.2022.799359>.
31. Fath, B.D., Fiscus, D.A., Goerner, S.J., Berea, A., and Ulanowicz, R.E. (2019). Measuring regenerative economics: 10 principles and measures undergirding systemic economic health. *Glob. Transit.* 1, 15–27. <https://doi.org/10.1016/j.glt.2019.02.002>.
32. Fullerton, J. (2015). *Regenerative Capitalism: How Universal Principles and Patterns Will Shape Our New Economy* (Capital Institute).
33. Wooltorton, S., Guenther, J., Poelina, A., Blaise, M., Collard, L., and White, P. (2022). Learning regenerative cultures: Indigenous nations in higher education renewal in Australia. *Asia Pac. Educ. Rev.* 23, 639–651. <https://doi.org/10.1007/s12564-022-09789-y>.
34. Armon, C. (2021). Regenerative Collaboration in Higher Education: A Framework for Surpassing Sustainability and Attaining Regeneration. *Philosophies* 6, 82. <https://doi.org/10.3390/philosophies6040082>.
35. Hauk, M. (2014). Complex Regenerative Creativity. In *A Critique of Creativity and Complexity: Deconstructing Clichés*, D. Ambrose, B. Sriraman, and K.M. Pierce, eds. (SensePublishers), pp. 97–121. https://doi.org/10.1007/978-94-6209-773-5_7.
36. King, J. (2021). Shades of Becoming Toward Regenerative Futures: Revelatory Purposes and Process in Sustainability Education and Public Pedagogy. *J. Public Pedagog.* 39–56. <https://doi.org/10.15209/jpp.1244>.
37. Duncan, J., Carolan, M., and Wiskerke, J.S.C. (2020). Regenerating food systems: A social-ecological approach. In *Routledge Handbook of Sustainable and Regenerative Food Systems*, J. Duncan, M. Carolan, and J.S.C. Wiskerke, eds. (Routledge), pp. 1–11. <https://doi.org/10.4324/9780429466823-1>.
38. Anderson, M.D., and Rivera-Ferre, M. (2021). Food system narratives to end hunger: extractive versus regenerative. *Curr. Opin. Environ. Sustain.* 49, 18–25. <https://doi.org/10.1016/j.cosust.2020.12.002>.
39. Loring, P.A. (2022). Regenerative food systems and the conservation of change. *Agric. Hum. Val.* 39, 701–713. <https://doi.org/10.1007/s10460-021-10282-2>.
40. Dahlberg, K.A. (1994). A transition from agriculture to regenerative food systems. *Futures* 26, 170–179. [https://doi.org/10.1016/0016-3287\(94\)90106-6](https://doi.org/10.1016/0016-3287(94)90106-6).
41. Bronson, K. (2020). A digital “revolution” in agriculture? : Critically viewing digital innovations through a regenerative food systems lens. In *Routledge Handbook of Sustainable and Regenerative Food Systems*, J. Duncan, M. Carolan, and J.S.C. Wiskerke, eds. (Routledge), pp. 336–349. <https://doi.org/10.4324/9780429466823-24>.
42. Lohbeck, M., Rother, D.C., and Jakovac, C.C. (2021). Editorial: Enhancing Natural Regeneration to Restore Landscapes. *Front. For. Glob. Change* 4. <https://doi.org/10.3389/ffgc.2021.735457>.
43. Slawinski, N., Winsor, B., Mazutis, D., Schouten, J.W., and Smith, W.K. (2021). Managing the Paradoxes of Place to Foster Regeneration. *Organ. Environ.* 34, 595–618. <https://doi.org/10.1177/1086026619837131>.
44. du Plessis, C. (2012). Towards a regenerative paradigm for the built environment. *Build. Res. Inf.* 40, 7–22. <https://doi.org/10.1080/09613218.2012.628548>.
45. Hes, D., and du Plessis, C. (2014). *Designing for Hope: Pathways to Regenerative Sustainability*, 1st ed. (Routledge).
46. Bellato, L., Frantzeskaki, N., and Nygaard, C.A. (2022). Regenerative tourism: a conceptual framework leveraging theory and practice. *Tour. Geogr.* 25, 1026–1046. <https://doi.org/10.1080/14616688.2022.2044376>.
47. Dredge, D. (2022). Regenerative tourism: transforming mindsets, systems and practices. *J. Tour. Futures* 8, 269–281. <https://doi.org/10.1108/JTF-01-2022-0015>.
48. de Magalhães, C. (2015). Urban Regeneration. In *International Encyclopedia of the Social & Behavioral Sciences*, Second Edition, J.D. Wright, ed. (Elsevier), pp. 919–925. <https://doi.org/10.1016/B978-0-08-097086-8.74031-1>.
49. Sager, T. (2015). Is neoliberalism hegemonic? *Plan. Theory* 14, 268–295.
50. Fayed, L., Elshater, A., and Rashed, R. (2020). Aspects of Regenerative Cities. In *Architecture and Urbanism: A Smart Outlook*, S. Kamel, H. Sabry, G.F. Hassan, M. Refat, A. Elshater, A.S. Abd Elrahman, D.K. Hassan, and R. Rashed, eds. (Springer), pp. 303–319. https://doi.org/10.1007/978-3-030-52584-2_22.
51. Mann, S., Bates, O., Forsyth, G., and Osborne, P. (2018). Regenerative computing: de-limiting hope. In *Proceedings of the 2018 Workshop on Computing within Limits LIMITS '18* (Association for Computing Machinery), pp. 1–10. <https://doi.org/10.1145/3232617.3232618>.
52. Westwell, E., and Bunting, J. (2020). The regenerative culture of Extinction Rebellion: self-care, people care, planet care. *Environ. Polit.* 29, 546–551. <https://doi.org/10.1080/09644016.2020.1747136>.
53. *Forum for the Future* (2021). *A Compass for Just and Regenerative Business* (WBCSD).
54. Capital Institute (2017). *8 Principles of a Regenerative Economy* (Capital Institute). <https://capitalinstitute.org/8-principles-regenerative-economy/>.
55. Doherty, B., Bryant, M., Denby, K., Fazey, I., Bridle, S., Hawkes, C., Cain, M., Banwart, S., Collins, L., Pickett, K., et al. (2022). Transformations to regenerative food systems—An outline of the FixOurFood project. *Nutr. Bull.* 47, 106–114. <https://doi.org/10.1111/nbu.12536>.
56. Warden, J. (2021). *Regenerative Futures: From Sustaining to Thriving Together* (Royal Society of Arts).
57. Sanford, C. (2017). *The Regenerative Business: Redesign Work, Cultivate Human Potential, Achieve Extraordinary Outcomes*, 1st ed. (Nicholas Brealey Publishing).
58. Sanford, C. (2020). *The Regenerative Life: Transform Any Organization, Our Society, and Your Destiny* (Nicholas Brealey Publishing).
59. Hutchins, G., and Storm, L. (2019). *Regenerative Leadership: The DNA of Life-Affirming 21st Century Organizations* (Wordzworth Publishing).
60. Hawken, P. (2021). *Regeneration: Ending the Climate Crisis in One Generation* (Penguin).
61. Cusworth, G., Lorimer, J., Brice, J., and Garnett, T. (2022). Green re-branding: Regenerative agriculture, future-pasts, and the naturalisation of livestock. *Trans. Inst. Br. Geogr.* 47, 1009–1027. <https://doi.org/10.1111/tran.12555>.
62. Sharpe, B., Hodgson, A., Leicester, G., Lyon, A., and Fazey, I. (2016). Three horizons: a pathways practice for transformation. *Ecol. Soc.* 21, 47. <https://doi.org/10.5751/ES-08388-210247>.
63. Mang, P., and Reed, B. (2012). Designing from place: a regenerative framework and methodology. *Build. Res. Inf.* 40, 23–38. <https://doi.org/10.1080/09613218.2012.621341>.
64. Vasconcellos, S., de Fraguier, N., Barat, L., Barat, M., and Rostan, S. (2021). In *The Positive Handbook for Regenerative Business A practical guide with a compass to empower changemaker companies to unleash positive impact*, M. Brown, ed. (Positive).
65. Gibbons, L.V. (2020). Moving Beyond Sustainability: A Regenerative Community Development Framework for Co-creating Thriving Living Systems and Its Application. *J. Sustain. Dev.* 13, 20. <https://doi.org/10.5539/jsd.v13n2p20>.
66. Gibbons, L.V., Pearthree, G., Cloutier, S.A., and Ehlenz, M.M. (2020). The development, application, and refinement of a Regenerative

- Development Evaluation Tool and indicators. *Ecol. Indicat.* **108**, 105698. <https://doi.org/10.1016/j.ecolind.2019.105698>.
67. Fazey, I. (2010). Resilience and higher order thinking. *Ecol. Soc.* **15**, 9. <https://doi.org/10.5751/ES-03434-150309>.
68. Joseph, R. (2020). Toward a Pragmatic Understanding of Rawls' Social Justice Theory in Social Work: A Critical Evaluation. *J. Hum. Rights Soc. Work* **5**, 147–156. <https://doi.org/10.1007/s41134-020-00127-z>.
69. Olmos-Vega, F.M., Stalmeijer, R.E., Varpio, L., and Kahlke, R. (2022). A practical guide to reflexivity in qualitative research: AMEE Guide No. 149. *Med. Teach.* **45**, 241–251. <https://doi.org/10.1080/0142159X.2022.2057287>.
70. Schaal, T., Mitchell, M., Scheele, B.C., Ryan, P., and Hanspach, J. (2023). Using the three horizons approach to explore pathways towards positive futures for agricultural landscapes with rich biodiversity. *Sustain. Sci.* **18**, 1271–1289. <https://doi.org/10.1007/s11625-022-01275-z>.
71. Miller, J.G. (1978). *Living Systems* (McGraw Hill Higher Education).
72. Boulangeat, I., Allain, S., Crouzat, E., Girard, S., Granjou, C., Poirier, C., Ruault, J.F., Paillet, Y., and Arpin, I. (2022). From Human-Nature Dualism Towards More Integration in Socio-ecosystems Studies. In *Human-Nature Interactions: Exploring Nature's Values Across Landscapes*, I. Misiune, D. Depellegrin, and L. Egarter Vigl, eds. (Springer International Publishing), pp. 37–49. https://doi.org/10.1007/978-3-031-01980-7_4.
73. Snyder, H. (2019). Literature review as a research methodology: An overview and guidelines. *J. Bus. Res.* **104**, 333–339. <https://doi.org/10.1016/j.jbusres.2019.07.039>.
74. Braun, V., and Clarke, V. (2006). Using thematic analysis in psychology. *Qual. Res. Psychol.* **3**, 77–101. <https://doi.org/10.1191/1478088706qp063oa>.
75. Slaughter, R.A. (1998). Futures beyond dystopia. *Futures* **30**, 993–1002. [https://doi.org/10.1016/S0016-3287\(98\)00101-3](https://doi.org/10.1016/S0016-3287(98)00101-3).
76. Hampton, S.E., and Parker, J.N. (2011). Collaboration and Productivity in Scientific Synthesis. *Bioscience* **61**, 900–910. <https://doi.org/10.1525/bio.2011.61.11.9>.
77. Lakoff, G., and Johnson, M. (1999). *Philosophy in the Flesh: The Embodied Mind and its Challenge to Western Thought* (Basic Books).
78. Malaterre, C., and Chartier, J.-F. (2021). Beyond categorical definitions of life: a data-driven approach to assessing liveness. *Synthese* **198**, 4543–4572. <https://doi.org/10.1007/s11229-019-02356-w>.
79. Prigogine, I., and Stengers, I. (1984). *Order Out of Chaos: Man's New Dialogue with Nature* (Flamingo).
80. Downs, T.J., and Ambrose, R.F. (2001). Syntropic ecotoxicology: A heuristic model for understanding the vulnerability of ecological systems to stress. *Ecosyst. Health* **7**, 266–283. <https://doi.org/10.1046/j.1526-0992.2001.01038.x>.
81. Schreiber, A., and Gimbel, S. (2010). Evolution and the Second Law of Thermodynamics: Effectively Communicating to Non-technicians. *Evol. Educ. Outreach* **3**, 99–106. <https://doi.org/10.1007/s12052-009-0195-3>.
82. Gómez-Márquez, J. (2021). What is life? *Mol. Biol. Rep.* **48**, 6223–6230. <https://doi.org/10.1007/s11033-021-06594-5>.
83. Denbigh, K.G. (1955). *The Principles of Chemical Equilibrium with Applications to Chemistry and Chemical Engineering* (Cambridge University Press).
84. Peterson, J. (2012). Understanding the Thermodynamics of Biological Order. *Am. Biol. Teach.* **74**, 22–24. <https://doi.org/10.1525/abt.2012.74.1.6>.
85. Minh-Thai, T.N., Samarasinghe, S., and Levin, M. (2021). A Comprehensive Conceptual and Computational Dynamics Framework for Autonomous Regeneration Systems. *Artif. Life* **27**, 80–104. https://doi.org/10.1162/artl_a_00343.
86. Heylighen, F. (2004). Complexity and Information Overload in Society: why increasing efficiency leads to decreasing control. *Bull. Med. Lib. Assoc.* **87**, 2.
87. Ulanowicz, R.E., Goerner, S.J., Lietaer, B., and Gomez, R. (2009). Quantifying sustainability: Resilience, efficiency and the return of information theory. *Ecol. Complex.* **6**, 27–36. <https://doi.org/10.1016/j.ecocom.2008.10.005>.
88. Rapport, D.J., and Maffi, L. (2011). Eco-cultural health, global health, and sustainability. *Ecol. Res.* **26**, 1039–1049. <https://doi.org/10.1007/s11284-010-0703-5>.
89. Rockström, J., Steffen, W., Noone, K., Persson, A., Chapin, F.S., 3rd, Lambin, E.F., Lenton, T.M., Scheffer, M., Folke, C., Schellnhuber, H.J., et al. (2009). A safe operating space for humanity. *Nature* **461**, 472–475. <https://doi.org/10.1038/461472a>.
90. Enquist, B.J., Abraham, A.J., Harfoot, M.B.J., Malhi, Y., and Doughty, C.E. (2020). The megabiota are disproportionately important for biosphere functioning. *Nat. Commun.* **11**, 699. <https://doi.org/10.1038/s41467-020-14369-y>.
91. Danesh, H.B. (2011). Human needs theory, conflict, and peace. *Encycl. Peace Psychol.* <https://doi.org/10.1002/9780470672532.wbep127>.
92. Hodgson, A. (2019). Foresight and the Seven Dimensions of Experience. *World Futures* **75**, 113–134. <https://doi.org/10.1080/02604027.2018.1562832>.
93. Ryff, C.D., Boylan, J.M., and Kirsch, J.A. (2021). Eudaimonic and Hedonic Well-Being. In *Measuring Well-Being: Interdisciplinary Perspectives from the Social Sciences and the Humanities*, M.T. Lee, L.D. Kubzansky, and T.J. VanderWeele, eds. (Oxford University Press), pp. 92–135. <https://doi.org/10.1093/oso/9780197512531.003.0005>.
94. Frediani, A.A. (2010). Sen's Capability Approach as a framework to the practice of development. *Dev. Pract.* **20**, 173–187.
95. Max-Neef, M., Elizalde, A., and Hopenhayn, M. (1989). Human scale development: An option for the future. *Dev. Dialog.* **1**, 7–80.
96. Breslow, S.J., Sojka, B., Barnea, R., Basurto, X., Carothers, C., Charnley, S., Coulthard, S., Dolšák, N., Donatuto, J., García-Quijano, C., et al. (2016). Conceptualizing and operationalizing human wellbeing for ecosystem assessment and management. *Environ. Sci. Pol.* **66**, 250–259. <https://doi.org/10.1016/j.envsci.2016.06.023>.
97. Britton, E., and Coulthard, S. (2013). Assessing the social wellbeing of Northern Ireland's fishing society using a three-dimensional approach. *Mar. Pol.* **37**, 28–36. <https://doi.org/10.1016/j.marpol.2012.04.011>.
98. Loring, P.A., Hinzman, M.S., and Neufeld, H. (2017). Can people be sentinels of sustainability? Identifying the linkages among ecosystem health and human well-being. *Facets* **1**, 148–162. <https://doi.org/10.1139/facets-2016-0022>.
99. Stock, P.V., and Szrot, L. (2020). Justice. In *Routledge Handbook of Sustainable and Regenerative Food Systems*, J. Duncan, M. Carolan, and J.S.C. Wiskerke, eds. (Routledge), pp. 98–112. <https://doi.org/10.4324/9780429466823-8>.
100. Shroff, R., and Cortés, C.R. (2020). The Biodiversity Paradigm: Building Resilience for Human and Environmental Health. *Development* **63**, 172–180. <https://doi.org/10.1057/s41301-020-00260-2>.
101. Chu, J.S.G., and Evans, J.A. (2021). Slowed canonical progress in large fields of science. *Proc. Natl. Acad. Sci. USA* **118**. e2021636118. <https://doi.org/10.1073/pnas.2021636118>.
102. FAO; IFAD; UNICEF; WFP; WHO (2021). *The State of Food Security and Nutrition in the World 2021: Transforming Food Systems for Food Security, Improved Nutrition and Affordable Healthy Diets for All* (Food and Agriculture Organization of the United Nations).
103. IPBES (2019). In Global assessment report on biodiversity and ecosystem services of the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services, E.S. Brondizio, J. Settele, S. Diaz, and H.T. Ngo, eds. (IPBES secretariat). <https://doi.org/10.5281/zenodo.6417333>.
104. Schröter, M., van der Zanden, E.H., van Oudenhoven, A.P., Remme, R.P., Serna-Chavez, H.M., de Groot, R.S., and Opdam, P. (2014). Ecosystem Services as a Contested Concept: a Synthesis of Critique and Counter-Arguments. *Conserv. Lett.* **7**, 514–523. <https://doi.org/10.1111/conl.12091>.
105. Chapin, F.S., III, Power, M.E., Pickett, S.T.A., Freitag, A., Reynolds, J.A., Jackson, R.B., Lodge, D.M., Duke, C., Collins, S.L., Power, A.G., and Bartuska, A. (2011). Earth Stewardship: science for action to sustain the human-earth system. *Ecosphere* **2**, art89. <https://doi.org/10.1890/es11-00166.1>.
106. Bennett, N.J., Whitty, T.S., Finkbeiner, E., Pittman, J., Bassett, H., Gelcich, S., and Allison, E.H. (2018). Environmental Stewardship: A Conceptual Review and Analytical Framework. *Environ. Manage.* **61**, 597–614. <https://doi.org/10.1007/s00267-017-0993-2>.
107. Couzeilles, R., Ferreira, M.S., Chazdon, R.L., Lindenmayer, D.B., Sansevero, J.B.B., Monteiro, L., Iribarrem, A., Latawiec, A.E., and Strassburg, B.B.N. (2017). Ecological restoration success is higher for natural regeneration than for active restoration in tropical forests. *Sci. Adv.* **3**, e1701345. <https://doi.org/10.1126/sciadv.1701345>.
108. Oliver, T.H., Doherty, B., Dornelles, A., Gilbert, N., Greenwell, M.P., Harrison, L.J., Jones, I.M., Lewis, A.C., Moller, S.J., Pilleay, V.J., et al. (2022). A safe and just operating space for human identity: a systems perspective. *Lancet Planet. Health* **6**, e919–e927. [https://doi.org/10.1016/S2542-5196\(22\)00217-0](https://doi.org/10.1016/S2542-5196(22)00217-0).
109. Isbell, F., Gonzalez, A., Loreau, M., Cowles, J., Diaz, S., Hector, A., Mace, G.M., Wardle, D.A., O'Connor, M.I., Duffy, J.E., et al. (2017). Linking the influence and dependence of people on biodiversity across scales. *Nature* **546**, 65–72. <https://doi.org/10.1038/nature22899>.

110. Sandbrook, C., Gómez-Baggethun, E., and Adams, W.M. (2022). Biodiversity conservation in a post-COVID-19 economy. *Oryx* 56, 277–283. <https://doi.org/10.1017/S0030605320001039>.
111. Parncutt, R. (2019). The Human Cost of Anthropogenic Global Warming: Semi-Quantitative Prediction and the 1,000-Tonne Rule. *Front. Psychol.* 10, 2323. <https://doi.org/10.3389/fpsyg.2019.02323>.
112. Bressler, R.D. (2021). The mortality cost of carbon. *Nat. Commun.* 12, 4467. <https://doi.org/10.1038/s41467-021-24487-w>.
113. Vicedo-Cabrera, A.M., Scovronick, N., Sera, F., Royé, D., Schneider, R., Tobias, A., Astrom, C., Guo, Y., Honda, Y., Hondula, D.M., et al. (2021). The burden of heat-related mortality attributable to recent human-induced climate change. *Nat. Clim. Chang.* 11, 492–500. <https://doi.org/10.1038/s41558-021-01058-x>.
114. Rao, M., and Powell, R.A. (2021). The Climate Crisis and the Rise of Eco-Anxiety (BMJ Opinion). <https://blogs.bmj.com/bmj/2021/10/06/the-climate-crisis-and-the-rise-of-eco-anxiety/>.
115. Hickman, C., Marks, E., Pihkala, P., Clayton, S., Lewandowski, R.E., Mayall, E.E., Wray, B., Mellor, C., and van Susteren, L. (2021). Climate anxiety in children and young people and their beliefs about government responses to climate change: a global survey. *Lancet Planet. Health* 5, e863–e873. [https://doi.org/10.1016/S2542-5196\(21\)00278-3](https://doi.org/10.1016/S2542-5196(21)00278-3).
116. Mehmood, A., Marsden, T., Taherzadeh, A., Axinte, L.F., and Rebelo, C. (2020). Transformative roles of people and places: learning, experiencing, and regenerative action through social innovation. *Sustain. Sci.* 15, 455–466. <https://doi.org/10.1007/s11625-019-00740-6>.
117. Chesnais, A. (2020). Beyond culturally-significant practices : Decolonizing ontologies for regenerative food-systems. In *Routledge Handbook of Sustainable and Regenerative Food Systems*, J. Duncan, M. Carolan, and J.S.C. Wiskerke, eds. (Routledge), pp. 50–64. <https://doi.org/10.4324/9780429466823-5>.
118. Hart, M.A. (2010). *Indigenous Worldviews, Knowledge, and Research: The Development of an Indigenous Research Paradigm*. *JISD* 7.
119. Benne, B., and Mang, P. (2015). Working regeneratively across scales—insights from nature applied to the built environment. *J. Clean. Prod.* 109, 42–52. <https://doi.org/10.1016/j.jclepro.2015.02.037>.
120. Koestler, A. (1967). *The Ghost in the Machine* (Macmillan).
121. Sahan, E., Ruiz, C.S., Raworth, K., van Winden, W., and van den Buuse, D. (2022). What Doughnut Economics Means for Business: Creating Enterprises that Are Regenerative and Distributive by Design (Doughnut Economics Action Lab).
122. Star, S.L., and Griesemer, J.R. (1989). Institutional Ecology, “Translations” and Boundary Objects: Amateurs and Professionals in Berkeley’s Museum of Vertebrate Zoology, 1907–39. *Soc. Stud. Sci.* 19, 387–420.
123. Schismenos, A., Niaros, V., and Lemos, L. (2020). Cosmolocalism: Understanding the Transitional Dynamics Towards Post-Capitalism. *tripleC* 18, 670–684. <https://doi.org/10.31269/triplec.v18i2.1188>.
124. Soma, T. (2020). Cradle to cradle: The role of food waste in a regenerative food system. In *Routledge Handbook of Sustainable and Regenerative Food Systems*, J. Duncan, M. Carolan, and J.S.C. Wiskerke, eds. (Routledge), pp. 406–419. <https://doi.org/10.4324/9780429466823-29>.
125. Pascucci, S. (2020). Circular food economies. In *Routledge Handbook of Sustainable and Regenerative Food Systems*, J. Duncan, M. Carolan, and J.S.C. Wiskerke, eds. (Routledge), pp. 318–335. <https://doi.org/10.4324/9780429466823-23>.
126. Fath, B.D. (2007). Network mutualism: Positive community-level relations in ecosystems. *Ecol. Modell.* 208, 56–67. <https://doi.org/10.1016/j.ecolmodel.2007.04.021>.
127. Carolan, M. (2020). Citizen entrepreneurship : The making, and remaking, of local food entrepreneurs. In *Routledge Handbook of Sustainable and Regenerative Food Systems*, J. Duncan, M. Carolan, and J.S.C. Wiskerke, eds. (Routledge), pp. 232–247. <https://doi.org/10.4324/9780429466823-17>.
128. Fernández-Herrera, A., and Martínez-Rodríguez, F.M. (2016). Deconstructing the neoliberal “Entrepreneurial Self”: A critical perspective derived from a global “biophilic consciousness”. *Pol. Futures Educ.* 14, 314–326. <https://doi.org/10.1177/1478210316631709>.
129. Morse, C., Morgan, C., and Trubek, A. (2020). Planning regenerative working landscapes. In *Routledge Handbook of Sustainable and Regenerative Food Systems*, J. Duncan, M. Carolan, and J.S.C. Wiskerke, eds. (Routledge), pp. 376–387. <https://doi.org/10.4324/9780429466823-27>.
130. Hassan, G.F., Rashed, R., and Mohsen EL Nagar, S. (2021). Regenerative urban heritage model: Scoping review of paradigms’ progression. *Ain Shams Eng. J.* 101652. <https://doi.org/10.1016/j.asej.2021.101652>.
131. Grivins, M. (2020). Forging by foraging : The role of wild products in shaping new relations with nature. In *Routledge Handbook of Sustainable and Regenerative Food Systems*, J. Duncan, M. Carolan, and J.S.C. Wiskerke, eds. (Routledge), pp. 277–288. <https://doi.org/10.4324/9780429466823-20>.
132. Zelenski, J.M., Dopko, R.L., and Capaldi, C.A. (2015). Cooperation is in our nature: Nature exposure may promote cooperative and environmentally sustainable behavior. *J. Environ. Psychol.* 42, 24–31. <https://doi.org/10.1016/j.jenvp.2015.01.005>.
133. Davies, A. (2020). Food sharing. In *Routledge Handbook of Sustainable and Regenerative Food Systems*, J. Duncan, M. Carolan, and J.S.C. Wiskerke, eds. (Routledge), pp. 204–217. <https://doi.org/10.4324/9780429466823-15>.
134. Wegerif, M. (2020). The symbiotic food system. In *Routledge Handbook of Sustainable and Regenerative Food Systems*, J. Duncan, M. Carolan, and J.S.C. Wiskerke, eds. (Routledge), pp. 188–203. <https://doi.org/10.4324/9780429466823-14>.
135. Patnaik, A., and Jongerden, J. (2020). Social processes of sharing and collecting seeds as regenerative agricultural practices. In *Routledge Handbook of Sustainable and Regenerative Food Systems*, J. Duncan, M. Carolan, and J.S.C. Wiskerke, eds. (Routledge), pp. 289–303. <https://doi.org/10.4324/9780429466823-21>.
136. del Milagro Nuñez-Solis, M., Rosin, C., and Ratna, N. (2020). Coffee micro-mills in Costa Rica : A non-cooperative path to regenerative agriculture? In *Routledge Handbook of Sustainable and Regenerative Food Systems*, J. Duncan, M. Carolan, and J.S.C. Wiskerke, eds. (Routledge), pp. 248–261. <https://doi.org/10.4324/9780429466823-18>.
137. Oliver, T.H., Heard, M.S., Isaac, N.J.B., Roy, D.B., Procter, D., Eigenbrod, F., Freckleton, R., Hector, A., Orme, C.D.L., Petchey, O.L., et al. (2015). Biodiversity and Resilience of Ecosystem Functions. *Trends Ecol. Evol.* 30, 673–684. <https://doi.org/10.1016/j.tree.2015.08.009>.
138. Hegmon, M., Peebles, M.A., Kinzig, A.P., Kulow, S., Meegan, C.M., and Nelson, M.C. (2008). Social transformation and its human costs in the prehispanic U.s. southwest. *Am. Anthropol.* 110, 313–324. <https://doi.org/10.1111/j.1548-1433.2008.00041.x>.
139. Gatti, R.C., Hordijk, W., and Kauffman, S. (2017). Biodiversity is autocatalytic. *Ecol. Modell.* 346, 70–76. <https://doi.org/10.1016/j.ecolmodel.2016.12.003>.
140. Giusti, M., and Samuelsson, K. (2020). The regenerative compatibility: A synergy between healthy ecosystems, environmental attitudes, and restorative experiences. *PLoS One* 15, e0227311. <https://doi.org/10.1371/journal.pone.0227311>.
141. Eriksen, T.H. (2021). The Loss of Diversity in the Anthropocene Biological and Cultural Dimensions. *Front. Polit. Sci.* 3. <https://doi.org/10.3389/fpos.2021.743610>.
142. Cardoso, G.C., and Atwell, J.W. (2011). Directional cultural change by modification and replacement of memes. *Evolution* 65, 295–300. <https://doi.org/10.1111/j.1558-5646.2010.01102.x>.
143. Kim, K.H. (2011). The Creativity Crisis: The Decrease in Creative Thinking Scores on the Torrance Tests of Creative Thinking. *Creat. Res. J.* 23, 285–295. <https://doi.org/10.1080/10400419.2011.627805>.
144. Neelands, J., Belfiore, E., Firth, C., Harty, N., Perrin, L., Brock, S., Holdaway, D., and Woddis, J. (2015). *Enriching Britain: Culture, Creativity and Growth (The 2015 Report by the Warwick Commission on the Future of Cultural Value)* (The University of Warwick).
145. Dwiartama, A. (2020). Indigenous livelihood. In *Routledge Handbook of Sustainable and Regenerative Food Systems*, J. Duncan, M. Carolan, and J.S.C. Wiskerke, eds. (Routledge), pp. 26–37. <https://doi.org/10.4324/9780429466823-7>.
146. Sbicca, J. (2020). Labor regeneration : Work, technology, and resistance. In *Routledge Handbook of Sustainable and Regenerative Food Systems*, J. Duncan, M. Carolan, and J.S.C. Wiskerke, eds. (Routledge), pp. 113–125. <https://doi.org/10.4324/9780429466823-9>.
147. Bregman, R. (2020). *Humankind: A Hopeful History, Circa edition* (Bloomsbury Publishing).
148. Bruce, D. (2008). How sustainable are we? Facing the environmental impact of modern society. *EMBO Rep.* 9 (Suppl 1), S37–S40. <https://doi.org/10.1038/embor.2008.106>.
149. Deijl, L., and Duncan, J. (2020). Co-creative governance of agroecology. In *Routledge Handbook of Sustainable and Regenerative Food Systems*, J. Duncan, M. Carolan, and J.S.C. Wiskerke, eds. (Routledge), pp. 84–97. <https://doi.org/10.4324/9780429466823-7>.
150. Woods, M. (2020). Rural–urban linkages. In *Routledge Handbook of Sustainable and Regenerative Food Systems*, J. Duncan, M. Carolan, and J.S.C. Wiskerke, eds. (Routledge), pp. 363–375. <https://doi.org/10.4324/9780429466823-26>.
151. Chinn, D. (2007). Reflection and reflexivity. *Clin. Psychol. Forum* 7, 13–16.

152. Klaassen, P., Verwoerd, L., Kupper, F., and Regeer, B. (2021). Reflexive monitoring in action as a methodology for learning and enacting Responsible Research and Innovation. In *Assessment of Responsible Innovation: Methods and Practices*, E. Yaghmaei and I. van de Poel, eds. (Routledge), pp. 222–243.
153. Patton, M.Q. (2010). *Developmental Evaluation: Applying Complexity Concepts to Enhance Innovation and Use*, 1st ed. (Guilford Press).
154. Teske, S., and Nagrath, K. (2022). Global sector-specific Scope 1, 2, and 3 analyses for setting net-zero targets: agriculture, forestry, and processing harvested products. *SN Appl. Sci.* 4, 221. <https://doi.org/10.1007/s42452-022-05111-y>.
155. Leichenko, R., McDermott, M., and Bezborodko, E. (2015). Barriers, Limits and Limitations to Resilience. *J. Extr. Even.* 02, 1550002. <https://doi.org/10.1142/S2345737615500025>.
156. Liu, J.J.W., Reed, M., and Fung, K.P. (2020). Advancements to the Multi-System Model of Resilience: updates from empirical evidence. *Heliyon* 6, e04831. <https://doi.org/10.1016/j.heliyon.2020.e04831>.
157. Lovering, J. (2007). The Relationship Between Urban Regeneration and Neoliberalism: Two Presumptuous Theories and a Research Agenda. *Int. Plan. Stud.* 12, 343–366. <https://doi.org/10.1080/13563470701745504>.