The Emergence of Sustainability

Fabio Rubio Scarano

Abstract I use Mario Bunge's approach to the interplay between emergence, submergence and convergence to address the emergence of sustainability. In line with this approach, my argument is that sustainability emerges as a novelty out of the convergence between independent lines of inquiry, such as sociology, economics and ecology in the science realm, and out of the tension between environmentalism and development as social movements or ideologies. It is also related to the emergence of a new ethics based on intergenerational justice. The convergence of sustainability as science, as policy and as moral value, in turn, implies submergence or even full disappearance of the old. For instance, out of the modules from which sustainability emerged, namely biological conservation (in science) and environmentalism (its social movement counterpart) are undergoing a crisis that might precede their submergence if not full disappearance. The notion of socio-economic development, one of the modules that contributed to the emergence of sustainability, is also in crisis as alternative views collectively framed as 'postdevelopment' appear. Sustainability, as an emerging new whole, still requires 'glue concepts' (sensu Bunge) to bind together its social, economic and environmental dimensions—this applies equally to sustainability as policy, as moral value and as science. Sustainability emerges as a normative goal (i.e. a desire based on beliefs and values) and as a principle of collective good and, as such, it is a new utopia. Finally, I discuss how the emergence of sustainability furthers the vitality of Lovelock's Gaia hypothesis. Failure or success of sustainability might determine the fate of humankind on the planet.

Introduction

Sustainability emerged as a concept and as a moral value in the Anthropocene (see Crutzen and Stoermer 2000), and particularly in response to the Great Acceleration triggered in the 1950s (Steffen et al. 2015a). Social movements and science embraced this concept, and it became the object of political agreements and decision-making at

F. R. Scarano (✉)
Universidade Federal do Rio de Janeiro, Rio de Janeiro, Brazil
e-mail: fscarano@biologia.ufrj.br

L. H. Wegner and U. Lüttge (eds.), *Emergence and Modularity in Life Sciences*,
https://doi.org/10.1007/978-3-030-06128-9_3

global, national and local levels. The Brundtland Report on Sustainable Development (WCED 1987) was a key milestone in putting sustainability on the global agenda, giving birth to global policy agreements—such as those related to biodiversity, climate change, combat against desertification and, ultimately, the Sustainable Development Goals (SDG)—and triggering the advent of sustainability science (Bettencourt and Kaur 2011).

I use the theoretical framework of Argentinian philosopher Bunge (2003) to address the emergence of sustainability. Although there are many connotations to emergence (Banzhaf 2014), Bunge's approach to the interplay between emergence and submergence, convergence and divergence, seems particularly relevant to address sustainability. It has also been used to address issues as diverse as technology, social sciences, ecology and evolutionary biology (Trosper 2005; De Haan 2006; Kaidesoja 2009). Bunge (2003) extensively focuses on emergence as novelty: it "occurs every time a qualitative new whole appears". This novelty, in turn, often implies submergence or even full disappearance of the old. Emergence calls for convergence between "initially separate approaches and fields". Convergence in this sense is synonym to unification, merger, integration and therefore requires what Bunge calls 'glue' concepts or hypotheses to bind together different components or modules. Conversely, emergence can also take place as a result of divergence or splitting of a whole entity.

In line with Bunge's framework, my argument is that sustainability emerges as a novelty out of independent lines of inquiry, such as sociology, economics and ecology in the science realm, and out of the tension between environmentalism and development as social movements or ideologies. In other words, sustainability emerges from cross-disciplinary collaboration in the science realm and multisectoral dialogue in the policy arena. Meanwhile, out of the modules from which sustainability emerged, namely biological conservation (in science) and environmentalism (its social movement counterpart) are undergoing a crisis that might precede their submergence if not full disappearance. While not the focus of this book, I will also briefly discuss how the development branch that partly promoted the emergence of sustainability is also in crisis. Moreover, I argue that sustainability, as an emerging new whole, still requires a 'glue' to bind together its social, economic and environmental dimensions—this applies equally to sustainability as policy, as moral value and as science. Thus, for now, sustainability emerges as a normative goal (i.e. a desire based on beliefs and values) and as a principle of collective good (Geels 2010). I argue that it is a new utopia, which needs further convergence of its various social, economic and environmental modules to be actually realized. Finally, I will discuss how the emergence of sustainability furthers the vitality of Lovelock's Gaia hypothesis (Lovelock 1979). As society approaches the sustainability utopia, one can even think of a 'deep' sustainability state. Figure 1 shows a schematic representation for the rationale of this chapter.

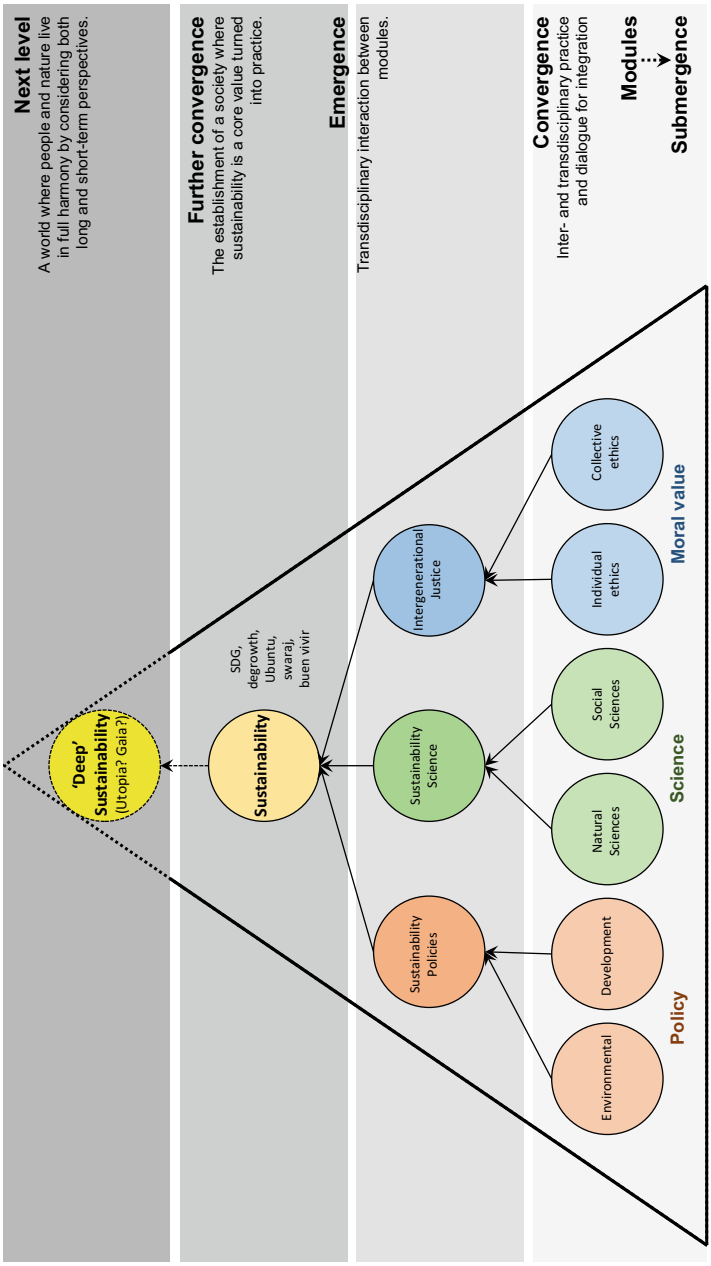

Fig. 1 Schematic representation of the emergence of sustainability. The integration and convergence of distinct modules related to science, policy and moral values, resulted in the emergence of sustainability. These original modules are to some extent experiencing submergence. Sustainability, however, requires further convergence of modules—including principles, values and practices belonging to different worldviews (e.g. African *Ubuntu*, Andean *Buen Vivir* and Asian *Swaraj*, alongside with SDG—Sustainable Development Goals, and *degrowth*)—for becoming a new 'normal'. This new state of things is a new utopia, open in format and definition. The main principle of Lovelock's Gaia hypothesis, of the biosphere in the planet interacting as an indivisible whole, is an example of the need of individually and collectively developing a new mindset to achieve sustainability goals

This chapter is then divided in three main sections: emergence, submergence and convergence. The fourth component of Bunge's framework, divergence, is not dealt with here since clearly, in the case of sustainability, emergence results from convergence and not divergence.

Emergence: Three Sustainability Facets in Response to the Planetary Crisis

While concepts such as Anthropocene and planetary boundaries are still being debated (e.g. Malm and Hornborg 2014; Montoya et al. 2017), there is growing scientific consensus that recognizes the magnitude of human impact on Earth and its climate (IPCC 2014). "Anthropocene" is the term originally assigned by Crutzen and Stoermer (2000) to the present human-dominated geological epoch, when the impact of human activities on the Earth System supplemented the Holocene (see also Crutzen 2002). Despite some criticism (e.g. Malm and Hornborg 2014), the term is now broadly used. For some, it starts with the invention of the steam engine by James Watt in 1784, which also coincides with the beginning of growing global carbon dioxide and methane found by analyses of air trapped in polar ice (Crutzen 2002). For others (Steffen et al. 2015a), the beginning of the Anthropocene coincides with the onset of the post-1950 "Great Acceleration", when Earth System indicators show shifts beyond the range of variability of the Holocene, driven by human activities. Arguably, the Great Acceleration has driven humanity beyond a safe operating space, by transgressing planetary boundaries especially as regards climate change and biosphere integrity (Steffen et al. 2015b).

Although concerns with the environment go back to early civilizations, environmentalism as a social movement consolidated in the 1960s (Dauvergne 2009), partly as a resistance to the changes provoked by the Great Acceleration. By the 1970s, environmentalism and conservationism were nearly synonyms, while conservation science was still taking form (Wiens and Hobbs 2015). By then, a lot of the environmentalism was 'ecocentric', nature-focused, and thus defied the notion of the human–nature divide that grants humans greater intrinsic value than all other non-human species (Shoreman-Ouimet and Kopnina 2015). This vision was met with strong opposition from social scientists for various reasons, including the impact of conservation on local peoples and cultures, and connections with the capitalist notion of progress and development (e.g. West and Brockington 2012). Out of this tension, sustainability began to emerge (see timeline on Table 1).

Table 1 Timeline related to the emergence of sustainability as policy, moral value and science

Year	Events
1784	Anthropocene begins
1950s	Great acceleration begins
1960s	Environmentalism consolidates as a social movement
1970s	Early days of conservation science
1972	Stockholm: UN conference on human environment
1979	Lovelock's Gaia hypothesis is published
1987	Brundtland report: sustainable development emerges as a concept
1987	Early days of sustainability science
1988	IPCC is launched
1992	Rio de Janeiro: UN conference on environment and development
1992	Rio de Janeiro: the three UN conventions are created: climate, biodiversity, desertification
1994	World Bank report: sustainability consolidates as a concept
1997	Kyoto protocol is signed
2000	Sustainability science framework begins to consolidate
2000s	Sustainability spreads in governments' manifestos and large corporations' mission statements
2006	Lovelock's "The Revenge of Gaia" published, on more pessimistic tone
2007	IPCC wins Nobel Peace Prize
2012	Rio de Janeiro: UN conference on sustainable development
2015	SDG announced by the united nations
2015	Paris agreement of the UN framework convention on climate change

Acronyms: *UN* United Nations, *IPCC* Intergovernmental Panel on Climate Change, *SDG* sustainable development goals

Sustainability as Policy

By contrasting the topics of three milestone UN Conferences—on Human Environment: 1972; on Environment and Development: 1992; on Sustainable Development: 2012—it becomes clear that sustainable development and sustainability as policy emerged from the convergence between the environmental policy agenda and the

development policy agenda. In 1972, global awareness about environmental risks led to the organization of the United Nations Conference on Human Environment in Stockholm. The conference concluded that environmental issues and development issues should be dealt with jointly. Fifteen years later, in 1987, the Brundtland report was published, coining the term 'sustainable development' defined as "a development that meets the needs of the present without compromising the ability of future generations to meet their own needs" (WCED 1987). Later, Asheim (1994) in a World Bank report defines sustainability as "a requirement of our generation to manage the resource base such that the average quality of life that we ensure ourselves can potentially be shared by all future generations". These documents are evidence of the emergence of sustainability as a concept and as a pathway for policy. It is interesting, however, that despite the political aspiration to converge environmentalism and development expressed in these documents, the diplomatic decision at the (aptly named) UN Conference on Environment and Development (Rio de Janeiro, 1992) was to create three sectoral conventions, namely the UN Framework Convention on Climate Change (UNFCCC), the UN Convention on Biological Diversity (CBD) and the UN Convention to Combat Desertification (UNCCD) (Tolefson and Gilbert 2012). It took twenty years for these conventions to converge and meet again, now under the name UN Conference on Sustainable Development, also in Rio de Janeiro, 2012. On this occasion, heads of states signed a document called "The Future We Want" (see Griggs et al. 2013)—partly a sequel to the Brundtland report also known as "Our Common Future" (WCED 1987).

This process translated into the Sustainable Development Goals (SDG) announced by the UN in 2015. The SDG comprise 17 goals to be achieved globally by 2030. They combine biosphere conservation goals (life on land, life on water, climate action, clean water), with social goals (no poverty, no hunger, good health and well-being, gender equity, clean energy, quality education, sustainable cities, peace and justice), with economic goals (economic growth and decent jobs, sustainable production and consumption, sustainable infrastructure, reduced inequalities), and partnerships between all actors to achieve all goals. Although no clear path has been defined on how to achieve such progress in 15 years, the goals comprise 169 targets and indicators that are expected to guide implementation (Costanza et al. 2016a, b).

I argue that the SDG need a 'glue'—using Bunge's terminology from the start of this chapter—to transform all goals and indicators into the 'indivisible whole' it aspires to be (see also Nilsson et al. 2017). A number of studies reflect on what is needed to deliver these ambitious goals by 2030. Aspects of global and local governance (Biermann et al. 2017; Bowen et al. 2017) and the need to eliminate trade-offs and to promote synergies between goals (Campagnolo and Davide 2017; Nilsson et al. 2017; Pradhan et al. 2017) are among the top concerns. I will come back to that later, when I discuss convergence.

Sustainability as Moral Value

From both Brundtland's (WCED 1987) and Asheim's (1994) definitions above, it can be concluded that the concept of sustainability is inextricably linked with intergenerational justice (Clayton et al. 2016), which by itself is a moral value. Perhaps for this reason, sustainability has become one of the most popular terms used in public and scientific discourse (WCED 1987): it appears in manifestos of governments and of large corporations, in a vast quantity of scientific publications and in various initiatives across civil society (Bettencourt and Kaur 2011). Of course, there is considerable misuse of the term, which has been associated to 'green washing' rethoric (Saha and Darnton 2005; Robinson 2012) and to scepticism of consumers regarding green or sustainable labels (Leonidou and Skarmeas 2017). However, even when the term sustainability is used for illegitimate purposes, it confirms the notion that it became a value: it is a term used to try to convince people about quality or value associated to a given product or action. Thus, this profusion of the concept as value exemplifies how the relationship between societies' present and future needs and rights has gained increased attention (Clayton et al. 2016). Indeed, as early as 1972 (and in parallel to the Stockholm Conference), German philosopher Hans Jonas argued for the need of a new global ethics directed towards future generations—an ethics of the species, since traditional ethics are locally based and present time—an ethics of the individual (Jonas 1979, 2017). The new ethics of responsibility that Jonas proposes is directed towards future generations, people who are not living yet, and who, in present, do not have a voice or a 'lobby', in his words. Thus, I propose that sustainability emerges as a new moral value that combines humanitarian and environmental values related to intergenerational justice.

Sustainability as a moral value increasingly implies a moral conduct towards Earth itself. Many argue that the ongoing environmental degradation is a result of the fact that Western philosophy places nature outside the moral community, viewing nature as a collection of objects to be used according to the benefit of property owners (Koons 2008). This has provoked the emergence of ecocentric principles such as environmental ethics (e.g. Barrett and Grizzle 1999) and the so-called Earth Jurisprudence (see Koons 2008). There are now institutions and centres for Earth Jurisprudence in the UK, South Africa, Australia, New Zealand, the USA, among others (Kauffman and Martin 2018). Related trends can also be observed in Latin America. In 2008, Ecuador was the first country to recognize the rights of nature in its constitution (Beling et al. 2018; Kauffman and Martin 2017). In Bolivia, the legislation related to The Rights of Mother Earth appeared shortly after that and has components related to (1) right to life and the diversity of life; (2) right to stabilize concentrations of greenhouse gases in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system, and in sufficient time to allow the components of Mother Earth to adapt naturally to climate change; (3) non-commodification of the environmental functions of Mother Earth; (4) right to support the restoration and regeneration capabilities of all its components that enables the continuity of life cycles; and (5) right to clean air and to live without contamination

(Pacheco 2014). This logic begins to spread. In Brazil, for the first time in history, a river (Rio Doce, in the State of Minas Gerais), represented by an NGO (Associação Pachamama), has entered a lawsuit asking for the recognition of its rights to life and demanding a plan for disaster risk reduction for the local population in the watershed (Scarano et al. 2018). This took place in 2017, two years after the river was impacted by the worst environmental disaster in Brazil's history, with the collapse of a dam and the spill of 40–62 million m^3 of mining tailings in the river (Garcia et al. 2017; Pires et al. 2017).

Nevertheless, the debate around 'weak' (social component predominant) versus 'strong' sustainability (environmental component predominant) is an evidence that sustainability as a moral value remains in dispute, largely because its three dimensions—social, economic and environmental—still did not overcome trade-offs and conflicts (Beckerman 1995; Clayton et al. 2016; Jia et al. 2017). Beckerman (1995) admits that the so-called 'strong' sustainability can be seen as a moral value due to "some intrinsic value in non-sentient forms of natural capital". But he also warns that "democratic societies should be very wary of those who claim, without full explanation, that the activities that they happen to prefer should be elevated to some over-riding moral value to which individuals should willingly sacrifice themselves". As we have seen for sustainability as policy, given all the controversies and competing interests, sustainability as a moral value has emerged, but clearly needs maturing.

Sustainability as Science

Sustainability science (see definitions on Table 2) emerged 30 years ago, following the Brundtland report, and it took some twenty years for a new conceptual and practical whole to consolidate out of the common methodologies designed to connect knowledge and methods from a variety of traditional disciplines (Bettencourt and Kaur 2011). Its emergence as a new and robust research framework is evidenced by the existence of a number of important scientific journals and conferences entirely or partly dedicated to the theme (Clark 2007; Bettencourt and Kaur 2011; Spangenberg 2011). It has been argued that sustainability science is developed in "constructive tension between a descriptive-analytical and a transformational mode" (Wiek et al. 2012), or between 'critical' and 'problem-solving' approaches (Jerneck et al. 2011). The descriptive-analytical mode (critical) seeks understanding of sustainability challenges in coupled human–environment systems, whereas the transformational mode (problem-solving) searches for practical solutions to those problems. To achieve this, sustainability science is highly integrative in nature, comprising integration between theoretical and applied approaches and disciplines (contained in the term interdisciplinarity), integration between research and its application to policy (contained in the term transdisciplinarity), as well as to examine and act in both developed and developing societies (Ascher 2007; Aronson 2011; Bettencourt and Kaur 2011; Brink et al. 2017). The aim to be transformational demands a routine of generating actionable knowledge, and intense dialogue and action outside academia, both incorporating

Table 2 Some definitions of and statements about sustainability science

Definitions	References
"seeks to understand the fundamental character of interactions between nature and society"	Kates et al. (2001)
"transcends the concerns of its foundational disciplines and focuses instead on understanding the complex dynamics that arise from interactions between human and environmental systems"	Clark (2007)
has "its own specific body of knowledge and framework with which to address sustainability issues, even while retaining relationships with other disciplines (…) currently a work in progress, and therefore one may argue that it is still too early to discuss what sustainability science is"	Kajikawa (2008)
"a dynamic and evolving transdisciplinary effort addressing symbiosis between human activity and the environment, providing visions and scenarios indicating transition pathways towards global sustainability while elucidating relevant decisions and agents (…) research providing the necessary insights to make the normative concept of sustainability operational, and the means to plan and implement adequate steps towards this end"	Spangenberg (2011)
"a solution-oriented endeavour" that "must address two additional streams of research questions: first, the normative question of how coupled human–environment systems would function and look like in compliance with a variety of value-laden goals and objectives (…); and, second, the strategic and operational questions that explore which transition pathways are viable for coupled human–environment systems and strategies that find what solutions to sustainability problems could be"	Wiek et al. (2012)
"seeks to address the major challenges facing society while ensuring that human well-being is undiminished and the basic Earth systems continue to operate"	Redman (2014)
"probes interactions between global, social, and human systems, the complex degradation mechanisms of these systems, and the concomitant risks to human well-being"	Saito et al. (2017)

non-scientific knowledge and dealing with different values and political interests (Jahn et al. 2012; Wiek et al. 2012; Popa et al. 2015). In this context, sustainability as policy and as value function as attractors to science, creating a transdisciplinary arena where conventional disciplines meet and feed back into policy and into moral and ethics.

In that sense, transdisciplinarity is more than a research approach well suited to cope with complex issues such as sustainability: it is the very interface between science and society, as proposed by Jahn et al. (2012). In a thorough analysis of the literature on the topic, these authors have shown that transdisciplinarity is still emerging since it remains far from academically established, despite increased popularity (see also Lang et al. 2012). These similarities suggest that sustainability and transdisciplinarity are likely to coevolve. For instance, there is a parallel between

Jahn et al.'s (2012) three types of knowledge framework for transdisciplinarity and our three facets of sustainability: (1) systems knowledge, or the knowledge involved in the understanding of an issue is addressed by sustainability science; (2) orientation knowledge, or the knowledge required for decision-making is addressed by sustainability policy; and (3) transformation knowledge, or the ways and means of practically realizing such decision, is the gap to be filled, but is driven by the imperative of the moral value that sustainability represents. Jahn et al.'s (2012) framework is already being applied to sustainability issues such as ecosystem-based adaptation to climate change and municipal ecosystem services and adaptation planning (Brink et al. 2016, 2017).

However, despite the growing abundance of theoretical and structural studies (e.g. Kumazawa et al. 2009; Jerneck et al. 2011; Miller et al. 2014b) and of empirical studies (e.g. Gruen et al. 2008; Ostrom 2009; Pohl et al. 2017), impact of sustainability research on societal transformations also seems smaller than desired (Van der Leeuw et al. 2012; Wiek et al. 2012; Lang et al. 2017). It still falls short of expectations about integration of its three parts: economic, social and environmental: for instance, by 2012, the economic pillar had the fewest papers published but was the most integrative, while the environmental pillar, on the contrary, had the most articles but drew the least from outside disciplines (Schoolman et al. 2012). Moreover, there is only a handful of higher education programmes fully dedicated to the topic (Wiek et al. 2011).

Submergence: System Dismantling

Bunge (2003) says that the glue that gives rise and holds together a new system often explains the dismantling of another system. In other words, he continues, "emergence explains submergence". The emergence of sustainability provokes (or derives from) a crisis in some of its pillars. In this section, I will discuss submergence and system dismantling by briefly introducing the ongoing crises in conservation science, environmentalism, and of the capitalist notion of progress and development as the driver of the economic–political system.

Crisis of Conservation Science

Colloff et al. (2017) declare that 'normal' conservation science no longer 'works' because the world itself has changed so much, and therefore conservation science should embrace 'postnormal' times—our present times, characterized by chaos, contradiction and complexity (see Funtowicz and Ravetz 1993; Sardar 2010). This crisis of conservation science is also apparent from the debate of 'traditional' versus 'new' conservation science (see Soule 2013; Doak et al. 2014; Kareiva 2014; Miller et al. 2014a). For new conservation scientists, traditional conservation (1) can give rise to

socio-economic issues by emphasizing biodiversity protection without considering human well-being; (2) is based on the myth of pristine nature, which in fact no longer exists; (3) assumes, often wrongly, that nature is inherently fragile and incapable to recover from human interventions; and (4) failed to protect biodiversity, since 13% of the planet's cover is within protected areas and extinction rates continue to be alarmingly high. On the other hand, traditional conservation scientists claim that new conservation science (1) has a week scientific background; (2) has ethical rather than scientific priorities; (3) has economic motivations; and (4) shows no evidence that it can correct eventual flaws of traditional conservation (Doak et al. 2014).

This 'friendly fire' between conservation scientists, in short, seems to be based on accusations that traditional conservation scientists are 'nature-centric', while new conservation scientists are 'anthropocentric' and 'utilitarian'. Colloff et al. (2017) argue that conservation science should move away from the nature-centric versus anthropocentric debate, and instead build on the links and causal relations between nature and human well-being. In their view, redirection of conservation science would involve: (1) building new framings of the links between ecosystems and society; (2) developing new relationships and roles for conservation science; (3) developing new models of how conservation links to society and social change and (4) a search for new approaches to promote conservation outcomes (e.g. addressing conflict resolution, power and intergenerational equity in decision). I argue that if conservation moves in the direction proposed by Colloff et al. (2017), or even in the direction of the somewhat similar proposition of the Intergovernmental Panel on Biodiversity and Ecosystem Services (IPBES; see Díaz et al. 2015; Pascual et al. 2017), it will move closer to sustainability science. Altogether, these new trends and expectations seem to indicate a possible gradual future submergence of conservation science as we know it.

Crisis of Environmentalism and of Development

There are contrasting arguments in the literature that environmentalism is dead (Shellenberg and Nordhaus 2004; Blühdorn 2011), or, conversely, that environmentalism persists (Dauvergne 2009) and that sustainability is a new regime of environmentalism (Bothello and Djelic 2015). All recognize, however, that environmentalism moved from marginal, in its early days, to mainstream, influencing policy, civil society and even science, with the consolidation of conservation science. On the other hand, although mainstreamed in various societal fronts, environmentalism always faces three major obstacles: (1) the disconnect between popular perception and the concept of environment; (2) its incapacity to overcome the broader development culture of consumerism; (3) and the denial discourse (Anderson 2010). These difficulties turned environmentalism into a 'zombie' movement, to use Anderson's (2010) analogy. His argument is that, to thrive, environmentalism needs reframing and alignment with other discourses and identities, "while retaining the utopian stimulus of conventional environmentalism": a more productive framing of environmental practice, or a

'coyote' approach, in his language. Similarly to what I have discussed about conservation science, if environmentalism moves in the direction suggested by Anderson (2010), it will be a lot closer to the sustainability discourse.

Interestingly, although Anderson (2010) argues that consumerism and denial are hurdles that the development culture imposes upon environmentalism, it is also clear that environmentalism has produced some cracks on the wall of the capitalist logic of development. The emergence of sustainability is evidence of that; especially the alternative visions of sustainability that begin to compete/dialogue. Sustainable development is only one of these visions, but other options emerge. Since 'development' led to profound impact on how Asia, Africa, and Latin America came to be seen and treated as underdeveloped since post-World War II, a movement called 'postdevelopment' emerged to question the ability of capitalism to fully and naturally occupy the economy (Escobar 2015). Re-emerging trends in the Global South, such as *buen vivir*, *Ubuntu* and ecological *Swaraj* (or Radical Ecological Democracy), can be seen as postdevelopmental phenomena. More typically in the Global North, another movement emerges, known as '*degrowth*'. These various alternatives are interesting to highlight because they arise from different social and cultural contexts, they either represent a revival of ancient worldviews of indigenous peoples or have emerged from recent social and environmental movements, but essentially they share similar principles (Kothari et al. 2014).

Although no universal definition of *buen vivir* (which means, 'living well') has been attained yet, this vision typical of Andean regions in Bolivia and Ecuador, includes as key elements: (1) harmony with nature; (2) vindication of the principles of marginalized peoples; (3) the State as guarantor of basic needs, social justice and equality; and (4) democracy (Beling et al. 2018). As we have discussed before, this approach has been incorporated to the legislation of Bolivia and Ecuador. Three basic tenets are love of self, of community and of nature. In this respect, it bears great similarity to the African *Ubuntu* (which means 'humanness') metaphysics that connects self, society and nature (Shumba 2011; Ontong and Le Grange 2014). Ubuntu's philosophy has been to some extent incorporated into business and corporate practices in Africa (Khomba et al. 2013). In India, the ecological *Swaraj* (which loosely means self-rule or self-reliance) "is a framework that respects the limits of the Earth and the rights of other species, while pursuing the core values of social justice and equity" (Kothari et al. 2014). These authors explain that this worldview that emerges from practices in the Indian sub-continent places communities and collectives at the centre of decision-making process and governance, which is also similar to *buen vivir* (Beling et al. 2018) and to *Ubuntu* (Shumba 2011).

Degrowth started around 2008 as an activist movement that rejects economic growth as the only alternative. Turned into an academic discipline, it starts from the premise that economic growth cannot be sustained ad infinitum on a resource constraint planet (Kothari et al. 2014). Scientific output on degrowth is largely European, but US and Canada also have a relevant contribution to this vision and it has presence, even as a movement, in countries such as Colombia and Cuba (Weiss and Cattaneo 2017). Escobar (2015) argues that a closer dialogue between postdevelopment and degrowth movements and scholars are much needed, while clearly

demonstrating scepticism with capitalism and sustainable development. Beling et al. (2018), on the other hand, seem more inclusive and suggest that synergies between sustainable development, *buen vivir* and degrowth can compensate for the caveats of each discourse and eventually open pathways towards what they call 'a global new Great Transformation' towards a new state of things. This aimed new state of things—sustainability—can be seen as a new utopia that unlocks new possibilities and alternatives for the future.

Convergence: Consolidating Sustainability and Moving to the Next Level

As we have discussed earlier, referring to Bunge (2003), for convergence to result in emergence 'glue concepts' are required. Sustainability has emerged, but given the challenges described to consolidation of its three facets (as policy, as moral value and as science) further convergence is needed. Mathematical formula or rationale is a desirable glue in Bunge's approach, but we still seem far from that as regards sustainability. Interestingly, two of the concepts often described as providing such 'glue' are ecosystem-based. Ecosystem services are increasingly used to couple human and natural systems, and conservation science with social sciences (Díaz et al. 2015; Crouzat et al. 2018; Pascual et al. 2017). Ecosystem-based adaptation to climate change and disaster risk are also used as glue concepts and practices to couple ecosystem health and poverty reduction, as an integrated tool to reduce societal vulnerability to climate change and natural disasters (Brink et al. 2016; Kasecker et al. 2018; Scarano 2017). As glue concepts are applied for convergence towards sustainability, one can imagine what a desirable future state would be like (a new utopia), and one can even wonder about how the 'next level' might look like.

Sustainability as Utopia

Funtowicz and Ravetz (1994) pointed out that the main contradiction society lives in the current postnormal times is "(…) the incompatibility between the individual drive for material comfort, convenience and safety, and the ecological consequences of this being achieved even for a significant minority of humanity". It is perhaps no coincidence that the main utopic and dystopic concerns of the twenty-first century have an ecological background, given the mounting evidence of the risk of catastrophes related to climate and land use change (Claeys 2013). Many of the utopias of the twentieth century (e.g. communism, the hippie movement) submerged, while possibly the main concrete current pattern—progress and consumerism—is in steep decline, since it led to the existing ecological crisis. Indeed, the ecological crisis replaced totalitarianism as the main dystopia of our times (Claeys 2013).

The decline of the utopias of the twentieth century has led some to announce the 'death' of utopia (e.g. Gray 2007), or the 'end of the future', as Zygmunt Bauman declared in a conference in Rio de Janeiro, 2014, in reference also to projected futures that were not accomplished (http://epoca.globo.com/ideias/noticia/2014/02/bzygmunt-baumanb-vivemos-o-fim-do-futuro.html). Claeys (2013) says that if utopias are not designed as religion or as a psychological state, but as a 'discourse of voluntary sociability', they can avoid the mistakes that normally define dystopias and, as a consequence, perhaps guide a common future. Similarly, Bregman (2017) says that there are two types of utopia. The one that 'predicts' the future with immutable rules (that he calls 'blueprint' utopia), and the one that unlocks the future (that I call 'open' utopia). The latter, he argues, is the one that inspires new common futures. He also claims that this approach is what inspired Thomas More's 1516 book, 'Utopia' (Logan and Adams 2009), which coined the term.

There are two points discussed previously in this chapter that I would like to address as examples. First, the SDG: with their 17 objectives and 169 targets and indicators, they can be seen as a 'blueprint' utopia. A kind of official 'recipe', which despite tremendous adherence by governments, corporations and science, still receives much criticism for some of its assumptions, especially that of continued economic growth (see Holden et al. 2016; Evans and Musvipwa 2017; Halvorsen 2017; Reid et al. 2017). On the other hand, precisely because of the complexity that their many objectives and targets entail, the SDG can also be perceived as an 'open utopia', applied more as a 'toolbox' than as a 'manual' or a 'roadmap' (see Stafford-Smith et al. 2017; Halvorsen 2017). In fact, the SDG may gradually shift the needle from open utopia to somewhere between open and blueprint utopia, as science furthers the understanding of the interconnections between the goals, and society advances a narrative to describe shifts and policy reforms necessary to achieve the goals (Costanza et al. 2016a, b).

Secondly, alternative approaches to sustainability—such as sustainable development (that the SDG encompass), degrowth, *buen vivir*, *Ubuntu*, ecological *Swaraj*—differ in various aspects, including their visions of the future, but I agree with Escobar (2015) and Beling et al. (2018) that dialogue and synergies between them can compensate for individual caveats and open new pathways towards sustainability. The IPBES is to some extent an effort in this direction (Díaz et al. 2015; Pascual et al. 2017; Scarano et al. 2018). This integrative model, where supposed differences are openly discussed towards finding potential synergies for a common future, I would argue that better fits the 'open utopia' model, which enters into focus as glue concepts appear.

Gaia: The Next Level?

Sustainability is a normative goal (i.e. a desire based on beliefs and values), thus convergence towards sustainability will demand debates about the relative importance of its various social, economic and environmental modules. In parallel, it is also an issue related to collective, common goods, and as such individual actors

have no immediate incentive to address sustainability problems (Geels 2010). These facts create a conundrum, where on the one hand public authorities and civil society are key drivers for a transition to sustainability, while on the other hand individual actors—which largely define action and attitude of public authorities and civil society—may not feel incentivized for changes, for instance, in production and consumption. Clearly then, as suggested by Hans Jonas' ethics of responsibility, and as we have hinted throughout this chapter, transition towards sustainability demands changes in individual mindset towards more collective concerns that include present and future generations of human and non-human beings.

In that sense, reference to Lovelock's Gaia hypothesis (Lovelock 1979) can be particularly relevant. It postulates that Earth is a living system with humanity as part of its large web of life. However, with or without humankind on the planet, the evolution of Gaia will continue (Lovelock 2006; see also Peroff 2008). Nearly forty years of advancement in Gaia's thought and research led to the understanding that organisms (including humankind) and their environment are a coupled system and that they do not evolve separately. Lovelock (2010) even speculates that things might have been different had Darwin considered Gaia (the whole organism rather than only its biological modules) as part of his Theory of Evolution by Natural Selection.

Coupled human–natural systems are central to the agenda of sustainability science and to UN panels such as the IPCC (Intergovernmental Panel on Climate Change) and the IPBES (Díaz et al. 2015; Liu et al. 2015). Research on socio-ecological systems has 'resilience' as an important glue concept (Sterk et al. 2017). Resilience—the capacity of systems (natural and human) to cope with hazardous events responding or reorganizing so that structure, function and identity are maintained, while capacity for adaptation, transformation and learning is also maintained (Field et al. 2014)—is in many ways close to the "Gaian approach of stimulating the Earth to cure itself", highlighted by Lovelock (2010). It is also evident in a number of recent conceptual (e.g. the concept of 'stem species' as 'regenerants of Gaia' in Scarano and Garbin 2013; Lüttge et al. 2013) and applied studies (e.g. natural and spontaneous regeneration of tropical forests after degradation in Rezende et al. 2015; Crouzeilles et al. 2017). Further dialogue between these different approaches and languages (Gaia, resilience, natural regeneration, etc.) to address potentially similar phenomena can possibly promote fertile ground for convergence towards sustainability.

Perhaps, if the sustainability utopia becomes realized one day, society may reach another level, where individuals perceive themselves as important modules of a large web of life—as the Gaia hypothesis proposes and indeed many traditional beliefs suggest.

Concluding Remarks: The Ticking Clock

Postnormal times are a transition period between one old 'normal' and a new 'normal' (Sardar and Sweeney 2016). In this paper, I argue that sustainability is the new 'normal' society is largely aiming for. However, perhaps the greatest challenge of our current postnormal times is that there are clear deadlines for society to effectively

bring transition to an end and definitely move into a sustainability normal. The SDG and the Paris Agreement of the Climate Convention envisage a sustainable future by 2030 (although they are not precise about how to get there). In parallel, under a "business-as-usual" scenario, climate change models indicate a global mean temperature increase of >2 °C in 2050 compared with pre-industrial times, and consequent dramatic changes in life as we know it (IPCC 2013; Rogelj et al. 2016). Thus, 2030 and 2050 are crucial deadlines and potential tipping points. In other words, society has some twelve years to perform its transition to sustainability, so as to deliver on the moral value of intergenerational justice and avoid a warmer future with dramatic consequences to future generations. Given the shortage of time for such profound changes, one can be inclined to imagine that ruptural transformation (i.e. a sharp break with existing institutions, structures, mindsets) will be required, whereas symbiotic transformation (i.e. through broader social participation in decision-making processes) and interstitial transformation (i.e. that takes places in specific niches, often marginal to mainstream) would just not meet the supposed deadlines. However, Wright's (2010) recommendation for combining all three approaches to turn utopias real is likely also very applicable to the case of sustainability. There is as much need for rupture with sectoral policies and thinking, and also with individualistic mindset, as there is for a greater symbiosis between different actors to share decision-making responsibilities, and for new sustainability models and examples at local scale to inspire change at larger scales.

Souza and Lüttge (2015) remind us that "menace and hope are currently deeply attached to sustainability", and therefore failure or success of sustainability might determine the fate of humankind on the planet. Thus, the clock is ticking: from emergence, to convergence, to new normal, humanity will need to move fast with transformations to make sure it continues to be part of Gaia.

Acknowledgements I dearly thank Ebba Brink for critically reading the manuscript, for sharing her reflections about emergence and convergence, about transdisciplinarity, and for our constructive discussions about sustainability science—all which helped give final shape to this paper. I also thank Aliny Pires for artwork in Fig. 1, for her inspiring capacity to transform ideas in images and for critically reading the manuscript. My warmest thanks also to Prof. Ulrich Lüttge for two decades of partnership, for his insightful coaching all these years and, more recently, for critically reading this manuscript and introducing me to the philosophy of Hans Jonas. My studies on sustainability are supported by the Brazilian Platform on Biodiversity and Ecosystem Services (BPBES), funded by CNPq Grant Number 405593/2015-5.

References

Anderson J (2010) From 'zombies' to 'coyotes': environmentalism where we are. Environ Politics 19:973–991

Aronson J (2011) Sustainability science demands that we define our terms across diverse disciplines. Landscape Ecol 26:457–460

Ascher W (2007) Policy sciences contributions to analysis to promote sustainability. Sustain Sci 2:141–149

Asheim GB (1994) Sustainability: ethical foundations and economic properties. World Bank Policy Research Working Paper 1302
Banzhaf W (2014) Genetic programming and emergence. Genet Program Evolvable Mach 15:63–73
Barrett CB, Grizzle R (1999) A holistic approach to sustainability based on pluralism stewardship. Environ Ethics 21(1):23–42
Beckerman W (1995) How would you like you 'sustainability', Sir? Weak or strong? A reply to my critics. Environ Values 4(2):169–179
Beling AE, Vanhulst J, Demaria F, Rabi V, Carballo AE, Pelenc J (2018) Discursive synergies for a 'great transformation' towards sustainability: pragmatic contributions to a necessary dialogue between human development, degrowth, and buen vivir. Ecol Econ 144:304–313
Bettencourt LMA, Kaur J (2011) Evolution and structure of sustainability science. Proc Natl Acad Sci 108:19540–19545
Biermann F, Kanie N, Kim RE (2017) Global governance by goal-setting: the novel approach of the UN sustainable development goals. Curr Opin Environ Sustain 26–27:28–31
Blühdorn I (2011) The politics of unsustainability: COP15, post-ecologism, and the ecological paradox. Organ Environ 24:34–53
Bothello J, Djelic M-L (2015) Transnational path generation: the institutionalization patterns of modern environmentalism. In: Academy of management proceedings. https://doi.org/10.5465/ambpp.2015.13168abstract
Bowen KJ, Cradock-Henry NA, Koch F, Patterson J, Häyhä T, Vogt J, Barbi F (2017) Implementing the "Sustainable Development Goals": towards addressing three key governance challenges—-collective action, trade-offs, and accountability. Curr Opin Environ Sustain 26–27:90–96
Bregman R (2017) Utopia for realists: how can we build the ideal world, 1st ebook edition. Little, Brown and Company, New York
Brink E, Aalders T, Ádám D, Feller R, Henselek Y, Hoffmann A, Ibe K, Matthey-Doret A, Meyer M, Negrut NL, Rau A-L, Riewerts B, von Schuckmann L, Törnros S, von Wehrden H, Abson DJ, Wamsler C (2016) Cascades of green: a review of ecosystem-based adaptation in urban areas. Glob Environ Change 36:111–123
Brink E, Wamsler C, Adolfsson M, Axelsson M, Beery T, Björn H, Bramryd T, Ekelund N, Jephson T, Narvelo W, Ness B, Jönsson KI, Palo T, Sjeldrup M, Stålhammar S, Thiere G (2017) On the road to 'research municipalities': analysing transdisciplinarity in municipal ecosystem services and adaptation planning. Sustain Sci 13:765–784
Bunge M (2003) Emergence and convergence: qualitative novelty and the unity of knowledge. University of Toronto Press, Toronto
Campagnolo L, Davide M (2017) Can the Paris deal boost SDGs achievement? An assessment of climate mitigation co-benefits or side-effects on poverty and inequality. Working Paper 048.2017. Fondazione Enrico Mattei, Venice
Claeys G (2013) Utopia: A História de uma Ideia. Translation by Pedro Barros. Edições SESC, São Paulo
Clark (2007) Sustainability science: a room of its own. Proc Natl Acad Sci 104:1737–1738
Clayton S, Kals E, Feygina I (2016) Justice and environmental sustainability. In: Sabbagh C, Schmitt M (eds) Handbook of social justice theory and research. Springer, New York, pp 369–386
Colloff MJ, Lavorel S, Van Kerkhoff LE et al (2017) Transforming conservation science and practice for a post-normal world. Conserv Biol 31:1008–1017
Costanza R, Daly L, Fioramonti L, Giovannini E, Kubiszewski I, Mortensen LF, Pickett KE, Ragnarsdottir KV, De Vogli R, Wilkinson R (2016a) Modelling and measuring sustainable wellbeing in connection with the UN sustainable development goals. Ecol Econ 130:350–355
Costanza R, Fioramonti L, Kubiszewski I (2016b) The UN sustainable development goals and the dynamics of well-being. Front Ecol Environ 14:59
Crouzat E, Arpin I, Brunet L, Colloff MJ, Turkelboom F, Lavorel S (2018) Researchers must be aware of their roles at the interface of ecosystem services science and policy. Ambio 47:97–105

Crouzeilles R, Ferreira MS, Chazdon RL, Lindenmayer DB, Sansevero JBB, Monteiro L, Iribarrem A, Latawiec AE, Strassburg BBN (2017) Ecological restoration success is higher for natural regeneration than for active restoration in tropical forests. Sci Adv 3:e1701345

Crutzen PJ (2002) Geology of mankind. Nature 415:23

Crutzen PJ, Stoermer EF (2000) The "Anthropocene". IGBP Glob Chang Newsl 41:17–18

Dauvergne P (2009) Historical dictionary of environmentalism. Scarecrow Press, Plymouth, UK

De Haan J (2006) How emergence arises. Ecol Complex 3:293–301

Díaz S, Demissew S, Carabias J, Joly C, Lonsdale M, Ash N, Larigauderie A, Adhikari JA, Arico A, Báldi A et al (2015) The IPBES conceptual framework: connecting nature and people. Curr Opin Environ Sustain 14:1–16

Doak DF, Bakker VJ, Goldstein BE, Hale B (2014) What is the future of conservation? Trends Ecol Evol 29:77–81

Escobar A (2015) Degrowth, post development, and transitions: a preliminary conversation. Sustain Sci 10:451–462

Evans H-C, Musvipwa R (2017) The sustainable development goals, the paris agreement and the addis agenda: neo-liberalism, unequal development and the rise of a new imperialism. In: Halvorsen T, Ibsen H, Evans H-C, Penderis S (eds) Knowledge for justice: critical perspectives from southern African-nordic research partnerships. African Minds and Sanord, Cape Town, pp 37–56

Field CB, Barros VR, Mach KJ et al (2014) Technical summary. In: Field CB et al (eds) Climate change 2014: impacts, adaptation, and vulnerability. Part A: Global and sectoral aspects. Contribution of working group II to the fifth assessment report of the intergovernmental panel on climate change. Cambridge University Press, Cambridge, pp 35–94

Funtowicz SO, Ravetz JR (1993) Science for the post-normal age. Futures 25:739–755

Funtowicz SO, Ravetz JR (1994) Emergent complex systems. Futures 26:568–582

Garcia LC, Ribeiro DB, de Oliveira Roque F, Ochoa-Quintero JM, Laurance WF (2017) Brazil's worst mining disaster: corporations must be compelled to pay the actual environmental costs. Ecol Appl 27:5–9

Geels FW (2010) Ontologies, socio-technical transitions (to sustainability), and the multi-level perspective. Res Policy 39:495–510

Gray J (2007) Black mass: apocalyptic religion and the death of Utopia. Penguin Books, London

Griggs D, Stafford-Smith M, Gaffney O et al (2013) Sustainable development goals for people and planet. Nature 495:305–307

Gruen RL, Elliott JH, Nolan ML, Lawton PD, Parkhill A, McLaren CJ, Lavis JN (2008) Sustainability science: an integrated approach for health-programme planning. Lancet 372:1579–1589

Holden E, Linnerud K, Banister D (2016) The imperatives of sustainable development. Sustain Dev. https://doi.org/10.1002/sd.1647

Holvorsen T (2017) The sustainable development goals, knowledge production and the global struggle over values. In: Halvorsen T, Ibsen H, Evans H-C, Penderis S (eds) Knowledge for justice: critical perspectives from Southern African-nordic research partnerships. African Minds and Sanord, Cape Town, pp 13–36

IPCC (2013) Climate change 2013: the physical science basis. Contribution of working group I to the fifth assessment report of the intergovernmental panel on climate change. Cambridge University Press, Cambridge

IPCC (2014) Climate change 2014: impacts, adaptation, and vulnerability. Part A: Global and sectoral aspects. Contribution of working group II to the fifth assessment report of the intergovernmental panel on climate change. Cambridge University Press, Cambridge

Jahn T, Bergmann M, Keil F (2012) Transdisciplinarity: between mainstreaming and marginalization. Ecol Econ 79:1–10

Jerneck A, Olsson L, Ness B, Anderberg S, Baier M, Clark E, Hickler T, Hornborg A, Kronsell A, Lövbrand E, Persson J (2011) Structuring sustainability science. Sustain Sci 6:69–82

Jia F, Soucie K, Alisat S, Curtin D, Pratt M (2017) Are environmental issues moral issues? Moral identity in relation to protecting the natural world. J Environ Psychol 52:104–113

Jonas H (1979) Das Prinzip Verantwortung. Versuch einer Ethik für die technologische Zivilisation, Insel Verlag, Frankfurt
Jonas H (2017) Tecnologia e responsabilidade: reflexões sobre as novas tarefas da ética. In: Jonas H (ed) Ensaios Filosóficos: Da Crença Antiga ao Homem Tecnológico (Portuguese translation by Lopes WES). Editora Paulus, São Paulo, Brazil, pp 23–49
Kaidesoja T (2009) Bhaskar and Bunge on social emergence. J Theory Soc Behav 39(2):300–322
Kajikawa Y (2008) Research core and framework of sustainability science. Sustain Sci 3:215–239
Kareiva P (2014) New conservation: setting the record straight and finding common ground. Conserv Biol 28:634–636
Kasecker TP, Ramos-Neto MB, Silva JMC, Scarano FR (2018) Ecosystem-based adaptation to climate change: defining hotspot municipalities for policy design and implementation in Brazil. Mitig Adapt Strateg Glob Change 23:981–993
Kates RW, Clark WC, Corell R, Hall JM, Jaeger CC, Lowe I, McCarthy JJ, Schellnhuber HJ, Bolin B, Dickson NM, Faucheux S, Gallopin GC, Grübler A, Huntley B, Jäger J, Jodha NS, Kasperson RE, Mabogunje A, Matson P, Mooney H, Moore B III, O'Riordan T, Svedin U (2001) Sustainability science. Science 292:641–642
Kauffman CM, Martin PL (2017) Can rights of nature make development more sustainable? Why some Ecuadorian lawsuits succeed and others fail. World Dev 92:130–142
Khomba JK, Bakuwa RC, Kangaude-Ulaya EC (2013) Shaping business ethics and corporate governance: an inclusive African Ubuntu philosophy. Glob J Manag Bus Res A 13(5). https://globaljournals.org/GJMBR_Volume13/4-Shaping-Business-Ethics-and.pdf
Koons JE (2008) Earth jurisprudence: the moral value of nature. Pace Environ Law Rev 25(2):263–339
Kothari A, DeMaria F, Acosta A (2014) Buen vivir, degrowth and ecological swaraj: alternatives to sustainable development and the green economy. Development 57(3–4):362–375
Kumazawa T, Saito O, Kozaki K, Matsui T, Mizoguchi R (2009) Toward knowledge structuring of sustainability science based on ontology engineering. Sustain Sci 4:99–116
Lang DJ, Wiek A, Bergmann M, Stauffacher M, Martens P, Moll P, Swilling M, Thomas CJ (2012) Transdisciplinary research in sustainability science: practice, principles, and challenges. Sustain Sci 7(Supplement 1):25–43
Lang DJ, Wiek A, von Wehrden H (2017) Bridging divides in sustainability science. Sustain Sci 12:875–879
Leonidou CN, Skarmeas D (2017) Gray shades of green: causes and consequences of green skepticism. J Bus Ethics 144(2):401–415
Liu J, Mooney H, Hull V, Davis SJ, Gaskell J, Hertel T, Lubchenco J, Seto KC, Gleick P, Kremen C, Li S (2015) Systems integration for global sustainability. Science 347. https://doi.org/10.1126/science.1258832
Logan GM, Adams RM (2009) Utopia: Thomas More (Portuguese translation by Camargo JL, Cipolla MB), 3rd edn. WMF Martins Fontes, São Paulo, Brazil
Lovelock J (1979) Gaia. A new look at life on earth. Oxford University Press, Oxford
Lovelock J (2006) The revenge of Gaia. Penguin Books, London
Lovelock J (2010) Our sustainable retreat. In: Crist E, Rinker HB (eds) Gaia in turmoil: climate change, biodepletion, and earth ethics in an age of crisis. MIT Press, Cambridge, pp 21–24
Lüttge U, Garbin ML, Scarano FR (2013) Evo–Devo–Eco and ecological stem species: potential repair systems in the planetary biosphere crisis. Prog Bot 74:191–212
Malm A, Hornborg A (2014) The geology of mankind? A critique of the anthropocene narrative. Anthropocene Rev 1:62–69
Miller B, Soulé ME, Terborgh J (2014a) 'New conservation' or surrender to development? Anim Conserv 17:509–515
Miller TR, Wiek A, Sarewitz D, Robinson J, Olsson L, Kriebel D, Loorbach D (2014b) The future of sustainability science: a solutions-oriented research agenda. Sustain Sci 9:239–246
Montoya JM, Donohue I, Pimm SL (2017) Planetary boundaries for biodiversity: implausible science, pernicious policies. Trends Ecol Evol. https://doi.org/10.1016/j.tree.2017.10.004

Nilsson M, Griggs D, Visbeck M (2017) Map the interactions between sustainable development goals. Nature 534:320–322
Ontong K, Le Grange L (2014) The role of place-based education in developing sustainability as a frame of mind. South Afr J Environ Educ 30:27–38
Ostrom E (2009) A general framework for analyzing sustainability of social-ecological systems. Science 325:419–422
Pacheco D (2014) Living-well in harmony and balance with Mother Earth: a proposal for establishing a new global relationship between human beings and Mother Earth. Universidad de la Cordillera, La Paz. Available at http://www.ucordillera.edu.bo/descarga/livingwell.pdf
Pascual U, Balvanera P, Díaz S, Pataki G, Roth E et al (2017) Valuing nature's contributions to people: the IPBES approach. Curr Opin Environ Sustain 26:7–16
Peroff NC (2008) Complexity theory, Lovelock's Gaia and tribal peoples. Soc Evol Hist 7(2):26–39
Pires APF, Rezende CL, Assad ED, Loyola R, Scarano FR (2017) Forest restoration can increase the Rio Doce watershed resilience. Perspect Ecol Conserv 15:187–193
Pohl C, Krütli P, Stauffacher M (2017) Ten reflective steps for rendering research societally relevant. Gaia 26:43–51
Popa F, Guillermin M, Dedeurwaerdere T (2015) A pragmatist approach to transdisciplinarity in sustainability research: from complex systems theory to reflexive science. Futures 65:45–56
Pradhan P, Costa L, Rybski D, Lucht W, Kropp JP (2017) A systematic study of sustainable development goal (SDG) interactions. Earth's Future 5. https://doi.org/10.1002/2017ef000632
Redman CL (2014) Should sustainability and resilience be combined or remain distinct pursuits? Ecol Soc 19(2):37. https://doi.org/10.5751/es-06390-190237
Reid AJ, Brooks JL, Dolgov L, Laurich B, Sullivan BG, Szekeres P, Wood SLR, Bennett JR, Cooke SJ (2017) Post-2015 sustainable development goals still neglecting their environmental roots in the anthropocene. Environ Sci Policy 77:179–184
Rezende CL, Uezu A, Scarano FR, Araujo DSD (2015) Atlantic forest spontaneous regeneration at landscape scale. Biodivers Conserv 24:2255–2272
Robinson JG (2012) Common and conflicting interests in the engagements between conservation organizations and corporations. Conserv Biol 26(6):967–977
Rogelj J, den Elzen M, Höhne N, Fransen T, Fekete H, Winkler H, Schaeffer R, Sha F, Riahi K, Meinshausen M (2016) Paris agreement climate proposals need a boost to keep warming well below 2 °C. Nature 534:631–639
Saha M, Darnton G (2005) Green companies or green con-panies: are companies really green, or are they pretending to be? Bus Soc Rev 110(2):117–157
Saito O, Managi S, Kanie N, Kauffman J, Takeuchi K (2017) Sustainability science and implementing the sustainable development goals. Sustain Sci 12:907–910
Sardar Z (2010) Welcome to postnormal times. Futures 42:435–444
Sardar Z, Sweeney JA (2016) The three tomorrows of postnormal times. Futures 75:1–13
Scarano FR (2017) Ecosystem-based adaptation to climate change: concept, scalability and a role for conservation science. Perspect Ecol Conserv 15:65–73
Scarano FR, Garbin ML (2013) Stem species: plant species that function as regenerating cells of Gaia. Nova Acta Leopoldina NF 114:317–324
Scarano FR, Garcia K, Diaz-de-Leon A, Queiroz HL, Rodríguez Osuna V, Silvestri LC, Díaz CF, Pérez-Maqueo O, Rosales M, Salabarria DM, Zanetti EA, Farinaci JS (2018) Options for governance and decision-making across scales and sectors. In: Rice J, Seixas CS, Zaccagnini ME, Bedoya-Gaitán M, Valderrama N (eds), IPBES 2018: the IPBES regional assessment report on biodiversity and ecosystem services for the Americas. Secretariat of the intergovernmental science-policy platform on biodiversity and ecosystem services, Bonn, Germany, pp 644–744
Schoolman ED, Guest JS, Bush KF, Bell AR (2012) How interdisciplinary is sustainability research? Analyzing the structure of an emerging scientific field. Sustain Sci 7:67–80
Shellenberger M, Nordhaus T (2004) The death of environmentalism: global warming politics in a post-environmental world. http://www.grist.org/article/doe-reprint/

Shoreman-Ouimet E, Kopnina H (2015) Reconciling ecological and social justice to promote biodiversity conservation. Biol Conserv 184:320–326
Shumba O (2011) Commons thinking, ecological intelligence and the ethical and moral framework of Ubuntu: an imperative for sustainable development. J Media Commun Stud 3(3):84–96
Soulé ME (2013) The new conservation. Conserv Biol 27:895–897
Souza GM, Lüttge U (2015) Stability as a phenomenon emergent from plasticity–complexity–diversity in eco-physiology. In: Lüttge U, Beyschlag W (eds) Progress in botany, vol 76. Springer, Switzerland, pp 211–238
Spangenberg JH (2011) Sustainability science: a review, an analysis and some empirical lessons. Environ Conserv 38(3):275–287
Stafford-Smith M, Griggs D, Gaffney O, Ullah F, Reyers B, Kanie N, Stigson B, Shrivastava P, Leach M, O'Connell D (2017) Integration: the key to implementing the sustainable development goals. Sustain Sci 12:911–919
Steffen W, Broadgate W, Deutsch L, Gaffney O, Ludwig C (2015a) The trajectory of the anthropocene: the great acceleration. Anthropocene Rev 2:81–98
Steffen W, Richardson K, Röckstrom J et al (2015b) Planetary boundaries: guiding human development on a changing planet. Science 347. https://doi.org/10.1126/science.1259855
Sterk M, van de Leemput IA, Peeters ETHM (2017) How to conceptualize and operationalize resilience in socio-ecological systems? Curr Opin Environ Sustain 28:108–113
Tolefson J, Gilbert N (2012) Rio report card. Nature 486:20–23
Trosper RL (2005) Emergence unites ecology and society. Ecol Soc 10(1):14. http://www.ecologyandsociety.org/vol10/iss1/art14/
Van der Leeuw S, Wiek A, Harlow J, Buizer J (2012) How much time do we have? Urgency and rethoric in sustainability science. Sustain Sci 7(Supplement 1):115–120
WCED—World Commission on Environment and Development (1987) Our common future. Oxford University Press, Oxford
Weiss M, Cattaneo C (2017) Degrowth—taking stock and reviewing an emerging academic paradigm. Ecol Econ 137:220–230
West P, Brockington D (2012) Introduction: capitalism and the environment. Environ Soc Adv Res 3(1):1–3
Wiek A, Withycombe L, Redman CL (2011) Key competencies in sustainability: a reference framework for academic program development. Sustain Sci 6:203–218
Wiek A, Ness B, Schweizer-Ries P, Brand FS, Farioli F (2012) From complex systems analysis to transformational change: a comparative appraisal of sustainability science projects. Sustain Sci 7(Supplement 1):5–24
Wiens JA, Hobbs RJ (2015) Integrating conservation and restoration in a changing world. Bioscience 65:302–312
Wright EO (2010) Envisioning real Utopias. Verso, London