



Environmental principles for modern sustainable economic frameworks including the circular economy

Piero Morseletto¹

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Abstract

A set of newly defined environmental principles can advance the sustainability performance of economic frameworks such as industrial ecology, cradle-to-cradle, and the circular economy. Currently, the environmental sustainability of these frameworks is mainly derived from the application of efficiency principles such as waste reduction, or closing and narrowing production, and consumption loops. However, these same principles can bring, in some cases, unintended outcomes that are detrimental to the environment. Efficiency principles also fall short of environmental sustainability aspirations, doing little to contribute to addressing the causes of current global environmental crises. This paper examines 7 widely applicable principles aimed at explicit environmental sustainability: doing no harm to nature, minimising environmental damage, restoring/remediating environmental damage, net-positive impact, no net loss, maintaining the health of ecosystems, and continual environmental improvement. These principles could markedly improve efforts to actively pursue sustainability and foster new economic forms that address our current unsustainable trajectories.

Keywords Environmental principles · Industrial ecology and circular economy · Rebound effects · Net positive impact and no net loss · Morality vs greenwashing · Sustainable economy

Economic frameworks¹ such as the performance economy, closed-loop economy, industrial ecology, industrial symbiosis, cradle-to-cradle, and blue economy, have enlivened the debate surrounding sustainability in recent decades. A more recent concept in this group is the circular economy, which integrates several aspects of the aforementioned frameworks (Blomsma and Brennan 2017). All these frameworks are characterised by overlaps and common threads (Bocken et al. 2014), and historically they reflect a mounting interest in reconciling economic practices with social and environmental concerns. Therefore, the frameworks have increasingly attracted the attention of governments, business actors, and academic organisations; for instance, the circular economy is currently high on the agenda of countries

and corporations while being a popular subject in research (Alnajem et al. 2021).

This study focuses on the environmental aspects of sustainability and its related principles within economic frameworks. Principles can be defined as the foundational and guiding ideas that govern actions. They are connected to ethics and culture, and work as reference points of conduct (because of this, principles are sometimes confused with goals or objectives, which are endpoints of actions). Principles are important because they play a descriptive and normative function, that is, they suggest what is right and why this is considered as such (see, e.g. Sandberg 2015).

The above-mentioned frameworks present potential limitations related to environmental sustainability. In fact, although some of those frameworks speak about metabolic processes of waste or preserving, restoring and regenerating natural capital, these concepts still need detail and refinement (see, e.g. Morseletto 2020b). Instead, most of their environmental benefits result from the application of efficiency principles such as waste reduction, synergy among

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✉ Piero Morseletto
piero.morseletto@gmail.com

¹ Faculty of Earth and Life Sciences, Institute for Environmental Studies (IVM), VU University Amsterdam, Amsterdam, De Boelelaan 1111, 1081 HV Amsterdam, The Netherlands

¹ I use here ‘frameworks’ as a unifying term although views, narratives, economic visions or economic models are equally used in the literature.

activities, value retention, and narrowing and closing loops in production/consumption (i.e., using fewer resources and recycling them) (Konietzko et al. 2020; Morseletto 2020a). These principles can produce various favourable outcomes, for example, efficient resource use, reduction of primary materials, prolonging the lifecycle of products, limiting pollution/emissions, and avoiding/re-employing waste. However, environmental benefits may be incidental or not actively sought-after (Dhingra et al. 2014). In different terms, Daly (2002) underlines that frugality (defined as ‘non-wasteful sufficiency’, rather than ‘meager scantiness’) is essential in the pursuit of sustainability; it can engender efficiency, but the reverse is not the case.

I argue that efficiency principles are not sufficient for environmental sustainability because, in some cases, they generate greater environmental impacts (e.g. higher emissions, chemical pollution) than simple use-and-disposal (see for instance, Vivanco and van der Voet 2014; Zink and Geyer 2017; Niero et al. 2021; Baumann and Lindkvist 2021). Market distortions, opportunity costs, rebound effects or profit-driven choices can explain why an activity may apply the efficiency principles but be detrimental to the environment (see also Reinhardt 1999; Agrawal et al. 2012; Ekins and Zenghelis 2021; Castro et al. 2022). Furthermore, these principles may have long-term adverse effects when they optimise systems that are inherently unsustainable (e.g. Milne and Gray 2013; Bjørn and Hauschild 2013).

Efficiency principles need to be supplemented by explicit environmental principles to eliminate ambiguities and distortions and contribute to advancing the science and management of sustainability. More importantly, environmental principles are necessary to combat global problems such as climate change, biodiversity loss or habitat degradation, which are occurring at an unprecedented pace, extent, and intensity (UNEP 2019; IPBES 2019; IPCC 2022). While these problems are primarily driven by production/consumption activities, failure to rapidly reduce ecological degradation is provoking irreversible damages or collapse of ecosystems globally (Bergstrom et al. 2021). In this vein, this study aims to identify environmental principles that can divert economic frameworks from this catastrophic trajectory and steer actions towards an effective and coherent pursuit of sustainability.

Some authors have advanced environmental principles for economic frameworks (notably, e.g. Bergen et al. 2001; Muscat et al. 2021). In general, these principles may be too specific (i.e., related to conditions/contexts), too dense (i.e., not nuanced enough or encapsulating multiple principles into one), too blurred (i.e., mixing principles with values, practices or procedures), or insufficiently consider key ecological aspects.

This study takes a different departure point by arguing that principles need to eliminate, reduce, or mitigate

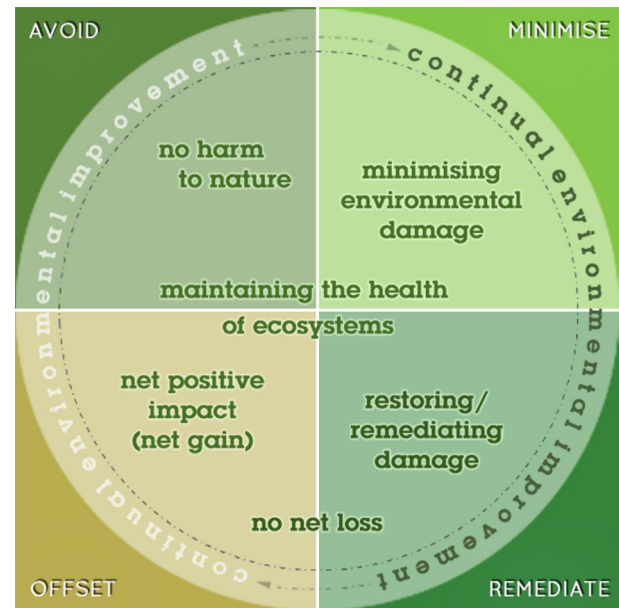


Fig. 1 Avoid, minimise, remediate, and offset steps and the environmental principles

environmental damage (interpreted as including environmental footprint, negative environmental impacts, and alterations to ecosystems). In nature conservation studies, the so-called ‘mitigation hierarchy’ framework is considered as a comprehensive way to address environmental damage in response to increasing land-use pressures and loss of biodiversity in development projects (Arlidge et al. 2018; Bull et al. 2020). It is based on four broad action steps: (1) avoid, (2) minimise, (3) remediate, and (4) offset. Examples are inter alia: avoiding deforestation; limiting chemical fertilisers; removing pollutants; and securing areas to protect species of conservation interest. I use the four steps as a base for determining environmental principles suitable for sustainable economic frameworks (see Fig. 1) and verifying their range of applications.

Avoid refers to not implementing actions that cause environmental damage. The principle that can be associated with this step is ‘**doing no harm to nature**’. This principle is preventive, meaning that it prevents damage from occurring; it is also a safeguard as some impacts (in particular related to biodiversity) cannot be reversed and might be considered unacceptable (Bull et al. 2020). Except for a small number of cases, such as in international law and arbitral practice, the no-harm principle is rarely mentioned in the environmental field (Gupta and Schmeier 2020). However, the application of this principle helps avoid destructive or damaging practices to the environment in any context including economic activities. For example, residues from the forest industry are returned in a form/quantity that nature can assimilate

without harming the ecosystem integrity (Korhonen et al. 2001).

Although the no-harm principle should continuously be exercised, it is not always possible to avoid damaging nature when undertaking economic activities. Producing and consuming goods/services implies extractive, transformational and distributional activities that cause unavoidable negative environmental impacts, for example, emissions or waste and consumption of resources. Furthermore, the economy is so dependent on fossil fuels that it is currently impossible to halt the multiple ecological consequences related to these sources. However, if no-harm cannot be adopted in absolute terms within the current economic systems, governments or organisations can apply it to specific projects with the prospect that it becomes an increasingly adopted principle. No harm to nature recalls the principle of ‘*primum non nocere*’ (first, do no harm), a core principle of medicine and bioethics. In these terms, it should be considered an overarching precept or inspirational principle in sustainable economic frameworks. As such, other principles need to supplement it.

‘**Minimising environmental damage**’ can be understood from ‘minimise’ in the mitigation hierarchy. This expression is broadly used in the environmental field even if it is not commonly considered as a principle. Nonetheless, the minimisation principle can provide practical guidance on sustainability in the economic and governance domain. This aspect implies reducing damages as much as possible while eliminating unintended negative consequences on natural systems in relation to all production/consumption practices starting from those causing greenhouse gas emissions, land-use change, and chemical pollution (UNEP 2019; Wilting et al. 2017; Wang et al. 2020). Minimisation requires actors to constantly seek to reduce impacts at the scales and locations where they occur (Griffiths et al. 2019), ideally in every phase of economic activities. For instance, in aluminium recycling, every operation from scrap collection to recycled ingot can be the object of damage minimisation (Luthin et al. 2021). Similarly, the cultivation of algae in wastewater can provide bioremediation services (e.g. removal of excess nutrients, metals) in addition to its use as a biomass resource (Lawton et al. 2017).

The no-harm and minimisation principles can have significant implications for sustainable economic frameworks. First, they can be used as selection criteria: activities that lead to worse environmental impacts should be considered unsustainable and be rejected or at least limited as much as possible. As such, these principles are useful to detect unsustainable practices or misleading statements associated with green policies. Furthermore, avoiding and minimising environmental damage can consolidate a culture of environmental protection and respect. However, these principles come at the cost of renouncing as much as possible damaging practices, which implies rethinking the way we make

and use goods (Schumacher 1973; Latouche 2010; Jackson 2009; Alexander 2012).

In the mitigation hierarchy, avoid and minimise relate to abstaining and refraining, while remediate and offset require positive action to amend environmental damage. Offset is considered as a residual category that aims to tackle impacts—not captured by the first three steps—that are offset elsewhere (Arlidge et al. 2018). However, for the identification of principles, remediate and offset can be treated together because they both deal with remediation whether this is direct (i.e., occurring where damage resides) or indirect (i.e., occurring elsewhere, as a form of compensation). A related principle is **restoring/remediating environmental damage**. The restoring and remediating terms are similar and often used interchangeably. A narrow interpretation of restoring refers to returning to a state similar to that before the damage occurred. Remediation initially referred to removing pollution or contaminants, and over time has evolved to include solutions such as rewilding, recreating habitats, and re-establishing depleted resources (Arlidge et al. 2018). Here, I use restoration/remediation to indicate permanent actions aimed at repairing damage produced, that is restoring—if possible—the composition, structure, and functioning of an ecosystem considering its historic trajectory (Palmer et al. 2016). An example of restoration/remediation in sustainable economic frameworks can be represented by recycling agricultural by-products for soil improvement and restoration practices. Agro-waste applications can improve soil characteristics (e.g. pH, tilth, cation exchange capacity and microbial activity) while enhancing its structure (i.e., making it more porous and permeable to air and water) (see Singh et al. 2021). Nonetheless, the no-harm and minimising damage principles should be kept in mind: even biological materials do not necessarily biodegrade safely into an ecosystem to feed environmental processes. Due to the complexity of ecosystems, restoration/remediation requires substantive knowledge of ecological functions and dynamics of an ecosystem (prior to the specified damage as well as the desired state of a restored ecosystem) (see, e.g. Morsetto 2020b). This is why sustainable economic frameworks must involve experts of different scientific disciplines, in particular, the life sciences, to articulate and apply the restoring/remediating environmental damage principle.

A further principle related to remediation and offset in the mitigation hierarchy is **no net loss**, which can be defined as balancing environmental impacts with mitigation, restoration or compensation efforts to ensure that no overall environmental loss results. No net loss is important for sustainable economic frameworks because it establishes that environmental losses should be counterbalanced by equivalent gains. For example, loss in soil fertility can be compensated by an equal gain from biofertilizers from by-products

of food production and consumption (Diacono et al. 2019). Similarly, pollutant emissions from recycling activities can be compensated by nature-based solutions (see, e.g. Schaubroeck 2018).

Where the gain exceeds the loss, the terms net-positive impact or net gain are used. **Net-positive** can, therefore, be considered a further principle for sustainable environmental frameworks. The point behind this principle is that the consequence of an activity or the remedy to a damage can have positive environmental impacts. No net loss and net-positive are sometimes included in the nature-positive concept, and are frequently quoted in economic and business affairs; however, they are defined vaguely and pursued poorly (Curran et al. 2014; Rainey et al. 2015; Bjørn and Hauschild 2013; Morseletto 2020b). In addition, the indiscriminate and unqualified use of the terms in the current sustainability debate causes confusion and ambiguity (Maron et al. 2018).

Therefore, the no net loss and net-positive principles need to be applied carefully to meet the urgent need for the active rehabilitation of natural systems. Related actions require clear metrics, baselines, reference scenarios, and associated objectives (Curran et al. 2014; Rainey et al. 2015; Bull et al. 2020). Furthermore, improving ecological functions is complex; ecosystems have sophisticated structures, and our knowledge of them is still incomplete, as is our understanding of rapid anthropogenic change. This is demonstrated by the various unintended negative consequences that nature-positive initiatives can have (e.g. Holl and Brancalion 2020); in this case, such initiatives would contrast with the principles of no harm. Therefore, they should be renounced, although this aspect should not discourage action but rather give further impulse to gathering further knowledge for restoring ecosystems effectively and improving their functions.

The principles so far mentioned can be complemented by another principle, that is, ‘**maintaining the health of ecosystems**,’ advanced by Daly (1991). The ecosystem’s health (also named ecological integrity, biological integrity, or ecosystem condition) means that an ecosystem is stable, provides ecological services, and maintains its structure and function over time (see Scow et al. 2019). In my view, this principle is required because it is not sufficient to avoid harm or amend damage. Sustainable economic frameworks need to keep a long-term vision on nature conservation, and maintaining the ecosystem health is a helpful principle toward this ambition. Like ‘no harm’, even this principle can be considered an overarching one because maintaining ecosystems’ health is a requisite to sustain existing environmental conditions.

The last principle that can guide sustainable economic frameworks to reduce environmental damage is ‘**continual environmental improvement**’. This principle can be defined as an attempt to constantly reduce the negative



Fig. 2 The 7 principles

consequences of economic activity and improve the condition of the environment. Continual improvement recalls management practices such as those that gained recognition as ‘Kaizen’ (see Kessler 2013), which aims for continual small improvements for major business benefits. The principle of ‘continual environmental improvement’ refers to efforts that aim to improve the effectiveness of environmental actions. In this vein, this principle reflects an attitude that galvanises all other principles because there is no end to making practice better.

Like all principles, the ones described in this study (summarised in Fig. 2) ask for both rigour and pragmatism besides their function to give direction and assure coherence in economic and environmental praxis. Different solutions adopted in sustainable economic frameworks (e.g. reuse, recycle, remanufacture, cannibalisation of a product) can have various opportunity costs vis-à-vis impacts or different levels of feasibility and preferability. In this context, principles can be applied differently or even bend according to circumstances.

As seen, no harm to nature and maintaining the health of ecosystems work as overarching principles, together they act as a kind of *grundnorm* that operates as a foundational norm; nonetheless, their strict application may not always be possible, and their intensity can vary. In general, environmental damage needs to be minimised in the first place; damage needs to be restored, possibly with no net loss or even some gain. The continual environmental improvement principle aims to keep all the principles aligned to establish and enforce pro-nature culture. Generally, principles are straightforward in their abstract form, but they can be

adapted when checked against reality. This feature makes principles different from procedures, which are specific and codified methods for performing a certain task. Different situations can demand one or more principles, or a partial application of a few principles. Indeed, limits on the knowledge of the impacts of an activity can affect the delivery of actions based on those principles. Furthermore, the application of principles requires defining boundary lines, which can be social, cultural, policy or context-specific; for instance, setting the level of acceptable/unacceptable damage, or the amount of sufficient/adequate action. Environmental principles—again, like all principles—can always be undermined or partially applied. Nonetheless, principles are not invalidated by poor application. The intervention to reduce environmental impacts demands, *inter alia*, leadership, clear objectives, adequate funding, robust project management, and transparent monitoring systems.

The 7 principles considered here complement efficiency principles and aim to establish a strong sustainability ethos that supports more informed decisions in the economy while favouring the diffusion of environmentally benign practices. Concurrently, the 7 principles can also be interpreted as criteria, or constraints, that can be applied to any economic framework. In these terms, principles provide practical guidance and offer a broad and holistic perspective on nature that transcends the limits of frameworks based solely on economic performance. Put more simply, environmental sustainability cannot be reached by neglecting environmental principles.

Future research may refine further these environmental principles or inspire or complement codes of conduct and policies of corporations, governments and organisations. For example, the United Nations Guiding Principles on Business and Human Rights, the International Organization for Standardization's 'ISO 26000:2010 Guidance on social responsibility' or 'ISO/WD 59004 Circular economy—Framework and principles for implementation'.² The 7 principles may be used to define thresholds of what is acceptable vis-à-vis environmental change or contribute to relaunching a process such as the one initiated by The Bellagio Sustainability Assessment and Measurement Principles (Jesinghaus 2014). After all, sustainability can be attained through a plurality of principles, and also visions and methodologies. A debate on principles is always relevant to verify if claims and intentions about sustainability are aligned with actions. In this view, principles remain one of the linchpins to reconnect reality with morality, and morality with sustainability (see Norgaard 1985, 2021). Sustainability requires continuous effort for its realisation and principles are necessary to steer this endeavour.

² Currently under development: <https://www.business-humanrights.org/en/big-issues/un-guiding-principles-on-business-human-rights/>, <https://www.iso.org/obp/ui/#iso:std:26000:ed-1:v1:en>, <https://www.iso.org/standard/80648.html>.

Humanity is walking a narrow corridor. On the one side, induced environmental change provokes severe impacts and the trespassing of several ecological thresholds at the local and global scales (Vanham et al. 2019). On the other side, the economy has difficulties moving away from schemes that pollute and consume resources; instead, sustainable solutions are not applied extensively. The adoption of the 7 principles can enlarge the wiggle room for sustainability by significantly reducing environmental damage. At the same time, they can increase the range and magnitude of sustainability within economic frameworks. In this sense, the 7 principles of environmental sustainability can help to navigate the future through the multifaceted challenges of meeting basic human needs without compromising ecosystem functioning.

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Declarations

Conflict of interest No conflict of interests.

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