

Stefano Fantoni · Nicola Casagli ·
Cosimo Solidoro · Marina Cobal *Editors*

Quantitative Sustainability

Interdisciplinary Research
for Sustainable Development Goals

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Chapter 9

Framing Sustainability



Giovanni Carrosio

Since the promulgation of the 2030 Agenda for Sustainable Development, adopted by the member states of the United Nations in 2015, the concept of sustainability has become pervasive in society. Most social organizations, businesses, institutions, political forces, associations, movements recognize themselves around the idea that sustainability is a goal to be hit. Businesses and public bodies are directing their social and environmental balance sheets, their development programs and plans on the basis of the indications that come from the thematic objectives set by the United Nations. No development strategy could therefore disregard sustainability objectives. Paradoxically, the major limitation of the concept of sustainability lies precisely here. As the French economist [1] claims “a key that opens all doors is a bad key”, so a concept that satisfies everyone, that brings everyone to agreement, risks being a bad concept, a concept incapable of uniquely move to action. Star and Griesemer [2] would say that sustainability is a *boundary object*. Boundary objects, according to these authors, are projects, ideas, maps, texts, concepts “plastic enough to adapt to the needs and constraints of the various parties that use them, but robust enough to maintain a common identity between the different ways of usage. They are loosely structured in common usage and become strongly structured in the use of individual parts. They can be abstract or concrete. They have different meanings in different social worlds, but their structure is common enough to more than one world to make them recognizable, a means of translation” between different social worlds.

The different uses to which the concept of sustainability lends itself, allow us to deduce how large the semantic field of reference is, in which there is a common nucleus such as to ensure that each of us, when he hears sustainability evoked, understands what the boundaries of meaning are within which it is located, but at the same time plastic, malleable enough to ensure that each of us uses sustainability in a specific way, defines its own boundaries, translating it into actions, policies, projects

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that can also be radically different from those proposed by others [3]. There are therefore different social worlds, which assign changing attributes to sustainability.

Sustainability in Frames

The social sciences have tried to explain this plasticity through the theory of frames. Frame refers to the cognitive process of the social construction of meanings [4]. The frame is an interpretative scheme that simplifies and condenses external reality, attributing a particular meaning to objects, events, situations, experiences and actions. Through the frames, individuals codify reality and filter it, bringing it back to a recognized interpretative key. It is within these frames of meaning that everyone signifies the concept of sustainability, linking it to world visions, cultural assumptions, political wills, ideologies that attribute a coherent and specific meaning and move its boundaries within the vast semantic field.

The analytical posture of framing looks at how different subjects construct the concept of sustainability socially, as the process takes place through which single individuals, groups of people and organizations create its shared meaning. In this way, they can describe reality and organize its experience within a frame of meaning that guides individual and collective action. This frame of meaning allows us to arrive at particular definitions on the causes of a problem, on the possible solutions and strategies to be pursued to solve a problem or to reach a desired state. Frames can also be used instrumentally, to unite more people around ways of understanding a concept—in our case sustainability—that benefit specific meanings, values, beliefs, interests rather than others. The alignment around a frame—in the literature it is called the “frame alignment process”—can be a more or less explicit and intentional negotiation process, in which different subjects come to share the meaning to be attributed to sustainability. This process of alignment builds increasingly close relationships between different individual and collective orientations, interests, values and beliefs. It is therefore an active, dynamic, even conflictual process which implies an agency on the part of different subjects, but which leads over time to converge on a single interpretation scheme which facilitates unitary collective action.

We can identify two very general frames within which the boundary object sustainability is filled with meanings. These are two very broad worldviews, within which there may be various specifications, and performatives, capable of influencing the ways in which people think and act on the relationship between man and nature, between society and the environment. These two visions are: anthropocentrism and ecocentrism [5]. Anthropocentrism is the founding vision of Western thought. It is based on the idea that rationality constitutes the basis of morality and that only rational beings, men and women, can be granted a moral status. This vision places man above and outside nature and conceives an interest in protecting the environment only when the relationship between environmental degradation and a reduction in people’s quality of life is evident. In sociological theory, we can include within this way of looking at the society-environment relationship the paradigm of human

exemptionalism (HEP), which according to [6] accompanied the development of sociology. It considered the human being as endowed with exceptional characteristics that could make him exempt from the laws that regulate the life of living beings on the planet. At the center is man, the ability to manipulate the environment and to progress in the development of techno-science in order to determine one’s limits. The ecocentric vision, on the other hand, starts from the idea of interdependence and holism between man and nature and for this reason calls for a radical rethinking of the ethical assumptions of the man-environment relationship. There is no separation between man and nature and there is no moral superiority of the human species over the others. For ecocentrism, the environmental crisis originates precisely from a vision of man’s superiority over nature, which has morally legitimized a manipulative and destructive attitude on the part of man. The conjunction between ecocentric visions and sociological analysis is found in ontological-realist approaches, where the existence of fundamental, sociophysical and ecological phenomena is postulated, which cannot be measured or experienced directly, but which represent the biophysical basis of the structure of society [7]. At the center is the relationship between man and the material substrate, where the latter determines the limits of action and must be preserved in order to allow society to progress in harmony with nature. These two visions of the world, within which there are different nuances, imply different interpretations of the environmental crisis and therefore different attributions of meaning to the concept of sustainability. We are therefore dealing with two frames, or rather two masterframes, two very broad and inclusive frames from which other frames descend with more specific boundaries of meaning (Table 9.1).

Starting from these two masterframes, different positionings can be identified along the anthropocentrism-ecocentrism continuum. Each of these, through the alignment processes, builds an internally coherent idea of sustainability, with clear boundaries with respect to other ideas of sustainability [8] has distinguished, for example, weak and strong models of sustainability.

Table 9.1 Masterframes of sustainability

Anthropocentrism (human exemptionalism)	Ecocentrism (materialism)
Humans are the managers of the biotic community	Humans are part of the biotic community
The interests of humans define ethical principles	The good of the biotic community defines ethical principles
Humans have priority, but there is a limit beyond which environmental damage cannot be justified	Humans do not have the prerogative of using the environment in ways that counteract the welfare of other species
Environmental problems are viewed in separate ways	Environmental problems are tackled in a systemic logic
The limits are a function of the capacity for technological innovation	The limits are a function of the quantity and quality of the material resources available
Focus on man’s ability to manipulate the environment	Focus on the preservation of the material-ecological substructure

Sustainability Frames: Very Weak, Weak, Strong, Very Strong

Based on Turner, we propose a schematization of the sustainability frames capable of recognizing the main families of ideas that animate the debate today (Table 9.2).

There are underlying characters that distinguish these frames. The element on which there are very different evaluations is the substitutability of natural capital. The idea of substitutability was born with [8], who tried to innovate the definitions of sustainability: he argued that it was important to leave future generations the opportunity to live in a situation of well-being. That is, leaving them a constant quantity of resources (natural capital + artificial capital). But how much physical capital and how much and which natural capital? In what proportions? The availability of natural resources is a central but debated issue. Depending on how we answer the question, we place ourselves in a sustainability frame. Here too we have a continuum of positions, ranging from those who believe that natural capital is perfectly replaceable with artificial capital, to those who believe that no portion of nature can be replaced,

Table 9.2 Frames of sustainability

	Anthropocentrism		Ecocentrism	
	Very weak	Weak	Strong	Very strong
Substitutability	Perfect	Managing of the resources according to their substitutability	Safeguarding resources that are predominantly non-replaceable	Absolute irreplaceability
Causes of unsustainability	The freedom of enterprise is hampered by constraints and rules	Modernization deficit	Capitalistic accumulation	Instrumental rationality
Ethic	Rights and interests of living beings	Intergenerational equity	Collective interests coincide with the preservation of the ecosystem balance	Nature has intrinsic value
How to achieve sustainability	Maximization of GDP and technological innovation	Decoupling growth and use of non-replaceable resources	Redistribution of wealth and collective management of common goods	Reduction of scale and simplification of society
Reference indicator	GDP	Genuine Progress Index	Inclusive development index	Ecological footprint
Ideology	Postnaturalist transhumanism	Sustainable development	Ecosocialism	Degrowth or Deep ecology

those who argue that the next generations should inherit the entire stock of environmental resources present, and those who argue that the important thing is that the next generations are left with an aggregate stock (natural capital + artificial capital) equivalent to today's.

For the latter it is possible to compensate for a lower amount of environment with the increase of roads, machinery, money. Or again, it is possible to replace natural ecosystem functions with artificial ecosystem services, the result of technological innovation. If we think we have to bequeath the totality of natural capital we must preserve for future generations the same stock of pollinating insects that exist now; if, on the other hand, we opt for total replaceability, the decrease in insects due to the massive use of pesticides and global warming is not important, because we are confident that man will be able to design and build technological innovations capable of replacing ecosystem functions of insects (Table 9.3).



Very weak sustainability is based on perfect substitutability between different forms of capital. Very strong sustainability, on the contrary, postulates the impossibility of replacing different forms of capital. The middle positions, on the other hand, argue that there is no such thing as perfect substitutability, that certain stocks of natural capital cannot be replaced by man-made capital, and that some ecosystem functions and services are essential for human survival as services of life support. Substitutability is assessed according to a rational cost–benefit criterion. From this perspective, for example, the cementing of agricultural land can be accepted, if one is able to develop forms of hydroponic agriculture (a method of cultivation outside the soil. The plant is irrigated with a nutrient solution made up of water and compounds chemicals necessary to provide all the essential elements for normal mineral nutrition).

From the positioning with respect to the substitutability of natural capital, a series of ideas on sustainability derive, inherent to the causes of the environmental crisis, to possible solutions, to the relationship between man and nature, to the indicators that can measure sustainability. These are internally coherent systems of thought, which tend to manifest themselves as *ideologies of sustainability*.

The Very Weak Sustainability

The very weak idea of sustainability foresees the perfect and infinite substitutability between natural capital and artificial capital. His techno-centric tension leads to prefer technological objects to nature. They are in fact programmable and controllable, while the laws of nature and the functioning of ecosystems make man live in uncertainty and force him within limits. Hoping for the progressive replacement of nature with artifacts, the issue of sustainability is declined as the construction of policy and market conditions to ensure that the process of technological innovation is fast enough to deal with any environmental problems that may arise as unintended consequences development wishes. For this to be possible, it is necessary to push on the growth of the Gross Domestic Product (GDP) and on the concentration of wealth

Table 9.3 Natural capital (bees) and artificial capital (pollinator drones)

Natural capital	Artificial capital
 A black and white photograph of a natural bee on a flower. The bee is positioned on the center of a flower, with its head and thorax visible. The background is dark, making the bee and the light-colored petals stand out.	 A black and white photograph of a robotic pollinator drone. The drone is a small, insect-like robot with a segmented body, two long antennae, and four legs. It is shown from a top-down perspective against a light background.

in the large urban agglomerations, where research centers and technological companies are concentrated. Thanks to the spatial concentration of investments and the accumulation of knowledge, continuous solutions can be developed. In this frame, urbanization and concentration are tools for the artificialization of society, which generate an environment in the image and likeness of man and therefore recognizable and controllable. It is also through the market and the freedom of enterprise that it is possible to create systems favorable to innovation. At the heart of very weak sustainability is therefore the idea that nature, non-sentient beings, have no rights and have no value in themselves. Nature has an exclusively instrumental value with respect to satisfying human needs. This also applies to future generations: the rights and interests of contemporaries prevail. This frame is structured on a faith-based attitude towards technology and man's ability to continually find solutions to the problems he faces. It is so permeated by an attitude of faith that he hopes that one day humanity will be able to completely free itself from nature and manage every aspect of life on earth in a controlled way. We can include in this frame those who believe that in the future the climate can be controlled and managed through technological systems based on geoengineering [9]. In its most extreme version, there are those who believe that the resources available to man are infinite, because the universe is infinite: if one day the earth is inhospitable to man, we will still have found a way to migrate to other livable planets [10]. The ideology that supports this frame is postnaturalist transhumanism, a movement that supports the use of scientific and technological discoveries to increase man's physical and cognitive abilities, in view of a posthuman and postnatural transformation, where artificial intelligence and genetic and robotic technologies will be able to manage socio-technical systems and the progressive transformation of the natural environment into a technological one [11].

The Weak Sustainability

Weak sustainability postulates a partial substitutability between natural and artificial capital. There are ecosystem functions that must be protected, because today we do not have the technological capacity to deal with their possible impoverishment. Sustainability is built starting from a careful management of natural resources, evaluating the costs and benefits of actions and projects that can cause environmental damage. In general, the negative externalities of growth are recognized, which produce a decline in the quality of life and feedback on the efficiency of economic and production processes. We must therefore be careful not to deplete resources that we are unable to replace, also to guarantee option rights for future generations and continuity of levels of well-being. It is a vision still entirely within the market economy, convinced of the possibility of making capitalism ecological, by decoupling growth and resource consumption, thanks to technological innovation and the circularity of production processes. The problem is therefore not growth, but the quality of growth. It is not the existence of a limit to development, but the ability to continuously shift it

over time thanks to technological innovation: produce and consume more, reducing the energy intensity of production and its secondary effects. For this reason, the reference indicator of this sustainability model is the Genuine Progress Indicator (GPI), which measures economic growth by subtracting all its secondary effects from the accounts. It is through the tools of the market economy that it is believed that the ecological transition can be accelerated to achieve a sustainable structure: incentives, regulatory systems, investment in technological innovation, supply and demand mechanisms based on the economy of agreements, together with bans and forms of environmental protection for endangered species and ecosystems. By the economy of agreements we mean the systems of exchange of goods that enhance the reputation of products and of those who produce, for example through environmental certifications. According to this approach, certification should generate preferences that lead to competition between companies to position themselves on green markets. The mechanism should make companies transition towards more sustainable production models. In the frame of weak sustainability, in assessing the value of the environment, one looks not only at the material instrumental dimension, but also at the immaterial instrumental dimension, linked to people's perceptions regarding the environment, healthiness, the beauty of nature, to walk in an environment rich in natural resources. However, the instrumentality and centrality of the human condition remains in the face of the need or otherwise to protect the environment. The most important European environmental policies are based on these principles, which respond to the dictates of ecological modernization: a mix of regulations and incentives to change the behavior of businesses and households, so that they increasingly adopt sustainable technologies and virtuous lifestyles. The idea of sustainable development promulgated by the main international organizations, starting with the Sustainable Development Goals, has many overlaps with this sustainability frame.

The Strong Sustainability

Looking at sustainability from a strong perspective means assuming the limit of natural resources and their reproducibility as a perspective within which to build social well-being. The perspective shifts from anthropocentrism to weak ecocentrism, not so much because it is believed that there is no ontological distinction between man and nature, but because the materiality of the environmental crisis is placed at the centre, as the result of the overcoming by the capitalist system of the limits of production and reproduction of natural resources. These positions on sustainability are therefore critical not only of the development model, but of the underlying principles that guide capitalist economies: in particular, the principle of capitalist accumulation, which leads to a continuous growth of the process of transformation of nature into commodities and the its pervasive expansion in space.

Natural resources are mainly non-replaceable: to use them sustainably it is necessary to change production relationships and de-commodify nature, which must be managed as a common good.

Among these ideas of sustainability there is space for eco-Marxist theories linked to political ecology. Unlike traditional Marxism, they innovate on the point of trust in progress and technology: historical Marxism is imbued with positivism and anthropocentrism, while eco-Marxism recognizes the limits of the laws of ecosystems, within which human experience it can progress, moving from a quantitative view to a qualitative view of development [12]. This vision of sustainability is attentive to the distributive aspects of wealth and critical of the new forms of green economy induced by environmental policies, which it considers as functional and instrumental in generating a new cycle of capitalist accumulation based on sustainability, as a discourse of legitimation of the dominant system. In its qualitative meaning of development, the inclusive development index finds space as an indicator of sustainability. In its formulation, in addition to GDP, it takes into consideration inclusion, intergenerational equity, sustainable management of natural resources and the expectation of a healthy life. This index includes criteria of social and environmental justice, even if the measurement of economic growth is not completely abandoned. Among the varied positions that refer to strong sustainability, we find the strand of environmental justice [13], which focuses on the social and territorial distribution of environmental bads and goods as an outcome of projects and policies for sustainability. In this case, there is a strong focus on social sustainability and on the possibility that environmental policies can be a vehicle for promoting social justice.

The Very Strong Sustainability

The very strong conception of sustainability focuses on the concept of limit and postulates the incompatibility between the paradigm of growth and the finiteness of environmental resources. There can be no sustainability within an economic system oriented towards the growing consumption of resources. The assumption of the limit to growth, which today appears radical among the ideas on sustainability, was for several years a concept at the center of mainstream thought on the environmental crisis, which gave shape to the famous 1972 report on the limits to growth drawn up by MIT for the Club of Rome. There was the idea that states should regulate capitalist economies by planning the balance between the economy, demography and finiteness of environmental resources and it was proposed to overcome the growth paradigm towards the achievement of a stationary state (Daly, 1974). In more recent years, the criticism of growth comes from approaches that take positions antagonistic towards the dominant economic and political system. To name a few: the political ecology of André [14], the deep ecology of Arne [15], the degrowth of Serge [1].

These thinkers are not united only by the critique of capitalism and growth, but by the questioning of instrumental rationality, as a myth resulting from the Enlightenment “thought in continuous progress” [16]. It is in man’s desire to dominate

nature and to free himself from its constraints that the environmental crisis originates. Sustainability, then, must be pursued by re-incorporating human communities into the functioning logic of ecosystems, through appropriate technological development, which does not produce artificialisation, but sets the co-evolution link between society and the environment back in motion. To do this it is necessary to reduce the scale of technologies and reduce social complexity, and at the same time to recognize the entitlement of nature to rights. The comparatist legal school, which investigates the affirmation of environmental protection in national constitutions, has produced an interest in the subjective rights of nature, in an attempt to subjectivize natural elements from a juridical point of view, in order to make them interacting allies to empower human actors in the struggle for sustainability. In this regard, [17] speaks of ontological struggles, as they are based on a denaturalization of Western dualisms in favor of indigenous perspectives according to which all living beings always exist in relation and never as objects or individuals.

To measure sustainability, one must take into account the encumbrance of human activities on the planet. The reference indicator is therefore the ecological footprint, which is used to monitor the use of the ecological resources available on our planet by individuals, cities and nations up to all of humanity, depending on the level of aggregation at which it is calculated.

Humanity, therefore, must drastically reduce the consumption of resources, seeking forms of wish fulfillment that go in the direction of conviviality, frugality, gift economies.

In Summary: The Distinctive Elements of the Sustainability Frames

To summarize, we can identify the following distinctive elements of the different sustainability frames, organized in continuum within which the different positions find space:

- exemptionalism and human rights—ecosystem relationships and the intrinsic value of nature;
- science and technology as a solution—science and technology as a problem;
- artificialisation of ecosystem services—conservation of ecosystem services;
- unlimited development—the limits of development;
- capitalism and the market as a solution—capitalism and the market as a problem;
- centrality of the present generation—centrality of future generations;
- presence of many solvable environmental problems—presence of a systemic environmental crisis.

The four visions that we have schematized, and many nuances that we have left out, sometimes collide and other times coexist side by side in our society. They often hybridize and mix up. The policies, with respect to the quadripartition and the

synthesis continuums, are contradictory. If we analyze the individual environmental and sustainability policies, we can place each one in different frames. From geoengineering policies on carbon dioxide capture in the subsoil, through the creation of biodiversity conservation areas, to the promotion of lifestyles aimed at reducing consumption. However, this variety must not mislead: most of them, invoking sustainable development, certainly fall within the context of weak sustainability [18].

References

1. S. Latouche, *Farewell to Growth*. Cambridge, UK: Polity (2009)
2. S.L. Star, J.R. Griesemer, Institutional ecology, translations' and boundary objects: amateurs and professionals in Berkeley's Museum of Vertebrate Zoology, 1907–39. *Soc. Stud. Sci.* **19**(3), 387–420 (1989)
3. D. Mebratu, Sustainability and sustainable development: historical and conceptual review. *Environ. Impact Assess. Rev.* **18**(6), 493–520 (1998)
4. D. Snow, R. Benford, Master frames and cycles of protest, in A.D. Morris e C. McClurg Mueller (a cura di), *Frontiers in Social Movement Theory*, New Haven, CT, Yale University, pp. 133–155 (1992)
5. T. Riordan, Research policy and review 6. Future directions for environmental policy. *Environ. Planning A* **17**(11), 1431–1446 (1985)
6. W. Catton, A. Dunlap, A new ecological paradigm for post-exuberant sociology, in *American Behavioral Scientist*, 1 (1980)
7. P. Giuntarelli, Paradigmi e modelli della sociologia dell'ambiente, in A. Agostoni, P. Giuntarelli, R. Veraldi (eds.), *Sociologia dello spazio, dell'ambiente e del territorio*, Franco Angeli (2007)
8. R.K. Turner, *Sustainable Environmental Economics and Management: Principles and Practice*. Belhaven Press (1993).
9. O. Morton, *Il pianeta nuovo. Come la tecnologia trasformerà il mondo*, Il Saggiatore (2017)
10. C.S. Cockell, *Interplanetary Liberty: Building Free Societies in the Cosmos*. Oxford University Press (2022)
11. M. Arias-Maldonado, Rethinking sustainability in the anthropocene. *Environ. Politics* **22**(3), 428–446 (2013)
12. A. Gorz, *écologie et liberté*. éditions galilée, Paris (1977)
13. J. Martinez-Alier, El ecologismo de los pobres. Conflictos ambientales y lenguajes de valoración, Editorial Icaria (2004)
14. A. Gorz, *Critique of economic reason*. Verso books (2011)
15. A. Naess, *Ecology, community and lifestyle: outline of an ecosophy* (Cambridge University Press, 1990)
16. T.W. Adorno, M. Horkheimer, *Dialectic of Enlightenment* (Herder and Herder. Original work published, New York, 1947)
17. A. Escobar, Sustaining the pluriverse: the political ontology of territorial struggles in Latin America. In *The Anthropology of Sustainability*, pp. 237–256. Palgrave Macmillan, New York (2017)
18. L. Pellizzoni, Sociologia dell'ambiente: un profilo genealogico', *Sociologia Urbana e Rurale*, 115 (2018)

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