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SWOT Analysis of the Sustainable Development Concept

Analiza SWOT koncepcji rozwoju zrównoważonego

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Abstract
Sustainability, a nebulous but attractive concept, poses an essential question for every activity – if it can continue. The concept of sustainability is broad, and it is also often used interchangeably with the concept of sustainable development (SD). These two concepts are analyzed in their interrelations and in relation to the concepts of the green economy (GE) and green growth (GG). The aim of the work is to define and clarify the strengths, weaknesses, opportunities, and threats to the concept of SD in its interrelation with sustainability. The focus is also on the possibilities of their practical application, with the aim of sustaining or increasing wellbeing and quality of life within ecological limits. The concepts of SD and sustainability are regarded as fundamental notions and as a basic philosophy in relation to which the remaining concepts are analysed. Efforts were also made to clarify the most crucial relations of the transformation discourses to SD. The use of the concepts as a basic philosophy, including the balance of the three pillars of sustainability/SD, are the main strengths identified. Important opportunities arise from exploiting these strengths and moving closer towards the aims of SD, which include quality of life and wellbeing. With the goal of sustaining sources of wellbeing for people, opportunities for crucial practical applications and methods of measurement of SD, including the development of sustainability science, are identified.

Key words: green economy; green growth; human development; sustainability; sustainable development

Streszczenie
Zrównoważony rozwój, mglista, ale atrakcyjna koncepcja, stawia istotne pytanie w przypadku każdej działalności – czy może być kontynuowana. Pojęcie zrównoważoności jest szerokie i często stosowane jest zamiennie z pojęciem zrównoważonego rozwoju (ZR). Te dwie koncepcje analizowane są w ich wzajemnych powiązaniach oraz w odniesieniu do koncepcji zielonej gospodarki i zielonego wzrostu. Celem artykułu jest zdefiniowanie i wyjaśnienie mocnych i słabych stron, szans i zagrożeń koncepcji ZR w jej powiązaniu ze zrównoważonością. Nacisk położony jest także na możliwości ich praktycznego zastosowania, w celu utrzymania lub zwiększenia dobrostanu i jakości życia w granicach wyznaczanych przez środowisko. Pojęcia SD i zrównoważoności uważane są za podstawowe i podstawową filozofię, w odniesieniu do której analizowane są pozostałe koncepcje. Podjęto także próbę wyjaśnienia relacji najważniejszych dla SD dyskursów transformacyjnych. Do głównych zidentyfikowanych mocnych stron należy wykorzystanie tych koncepcji jako podstawowej filozofii, uwzględniającej postulat równowagi trzech filarów zrównoważonego rozwoju/zrównoważoności. Wykorzystanie tych mocnych stron i zbliżenie się do celów zrównoważonego rozwoju, które obejmują jakość życia i dobrostan, stwarza ważne możliwości. Mając na celu utrzymanie źródeł dobrostanu ludzi, identyfikuje się możliwości kluczowych zastosowań praktycznych i metod pomiaru zrównoważonego rozwoju, w tym rozwój nauki o zrównoważoności.

Słowa kluczowe: zielona gospodarka; zielony wzrost; rozwój ludzki; zrównoważoność; zrównoważony rozwój

1. Introduction

Generally, sustainability poses a fundamental question for all human activities – if they can continue. This means that activities such as production, consumption, and related uses of natural, physical, human, or other forms of capital that can be carried out indefinitely can be regarded as sustainable. Sustainable development (SD) has recently been adopted as a growth strategy in the built environment. The SD paradigm emerged to provide a framework by means of which economic growth, social welfare, and the conservation of the environment can be harmonized (Asara et al., 2015). Although such harmonization has proved elusive until very recently, it has been accepted in different areas of human activity. The concept of SD has experienced various developmental phases and the participation of a variety of institutions since its introduction and has undergone different interpretations and critiques over time. In its development, the concept has been adapting to the requirements of a complex global environment, but the underlying principles and goals have remained predominantly unchanged (Klarin, 2018). However, policy goals have been updated, having responded to actual challenges.

An important challenge of the SD/sustainability concepts is to maintain the sources of people's wellbeing. Even more important is to find ways of ensuring that this is compatible with environmental limits and, simultaneously, that social imbalances are minimized. In this work, the approaches and concepts dealing with such issues are analysed. It is emphasised that these are not only theoretical concepts, but their practical applications in general (and how they are put into operation) are crucial for achieving the goals. The aim of the work is to define and clarify the strengths, weaknesses, opportunities, and threats to the concept of SD in its interrelation with sustainability, with the main focus on their practical application. This practical application should be aimed at sustaining or increasing the wellbeing and quality of life of people within ecological limits. For this purpose, the concepts of sustainability, SD, green economy (GE), and green growth (GG) are defined, specified, and distinguished. The growing importance of alternatives to SD is also considered. Practical applications of the concepts and appropriate methods of measuring the multidimensional aspects of SD are suggested.

Several concepts and approaches must be identified first. Primarily, the rationale behind this study lies in a consideration of the concepts of SD and sustainability in relation to SD as a basic philosophy. The mainstream neoclassical environmental economics is considered a basic approach to dealing with environmental issues in economics, and other crucial approaches in economics are also analysed. These are understood as a theoretical foundation for a practical application or more practical concepts. Accordingly, a normative approach is also used in the following section to obtain relevant inputs into the SWOT analysis. The main structure of the paper involves Materials and methods; Results of an in-depth analysis of the concept of sustainable development; Opportunities for the application and measurement of the concept of Sustainable Development; and Conclusions.

2. Materials and methods

The following experimental design was used. After the analysis and synthesis of the knowledge of the history, meaning, and content of the concept of SD and related concepts, a SWOT analysis is carried out. SWOT analysis is the identification and assessment of strengths, weaknesses, opportunities, and threats, and it is intended to yield strategic insights. It is a widely applied tool in the analysis of internal and external environments in order to achieve a systematic approach and support for strategic decision situations (see, e.g., Gürel, 2017). A normative approach in economics is used to critically evaluate the researched phenomena.

2.1. Origin, Brief History, and Recent Approaches to the Concept of Sustainable Development and Related Concepts

The terms *sustainability* and *sustainable* appeared for the first time in *the Oxford English Dictionary* in the second half of the 20th century. The equivalent terms in French (*durabilité* and *durable*), German (*Nachhaltigkeit*, literally meaning *lastingness* and *nachhaltig)*, and Dutch (*duurzaamheid* and *duurzaam*) have been used for centuries (Van Zon, 2002). A detailed analysis of the history of both concepts was presented in Drastichová (2022).

The concepts of sustainability and SD have a very long history in science. As early as 1713, Hans Carl von Carlowitz (head of the Royal Mining Office in the Kingdom of Saxony) referred to *sustainable yield* in the context of sustainable forestry management. He formulated ideas for the sustainable use of forests. He is also considered to be one of the founders of the concept of sustainability (von Carlowitz, 1713; Grober, 2007). Although the origin of the sustainability concept can go back to earlier times, there has never been more rapid growth in production, consumption, and wealth in the history of the world than after the Industrial Revolution. Van Zon (2002) also pointed out the impacts of the demand for raw materials on the environment as a constant issue throughout human history (see more in Drastichová, 2018).

After World War II, there was also rising public awareness of the rapid population growth, resource depletion, and pollution associated with industrial and commercial expansion, which threatened the survival of humans. Since the late 1960s, a great deal of scientific literature on sustainability and SD issues has been published, including alarming scientific information about the damage caused to the natural environment by human activities. The

crucial representative books in relation to the evolution of the SD concept included those of Carson (1962), Ehrlich (1968), Meadows et al. (1972), Goldsmith (1972), and Schumacher (1973), and crucial research articles included those by Hardin (1968) or Molina and Rowland (1974) (among others; see more in Drastichová, 2022). It is, among others, a reaction to the optimistic assumptions of the 1960s that the development problems of the less developed parts of the world could be solved in a short period of time as a result of global economic growth.
By the 1970s, the concepts of progress, growth, and development were being questioned, and in the 1970s, this optimism faded. Economic growth did not show itself to be a proper solution to global problems and inequalities. A paradigmatic shift to the notion of development was required. Then the concept of SD was formed as a compromise between the concepts of development and conservation, which started being understood as interdependent issues. The term sustainability, used in ecology to refer to a state or condition that can be maintained over an indefinite period, was integrated on a more regular basis into development discourses (Du Pisani, 2006). The first oil crisis (1973) indicated the potential consequences of resource shortages. Accordingly, the expectations of unlimited economic growth dwindled when a worldwide recession occurred (1974-1976). Considering the causes of the recession, an awareness of the limits to economic growth appeared, also on the basis of the publication of Meadows et al. (1972) (mentioned above). To sum up, during the 1960s and 1970s, a global understanding of sustainability challenges developed with the emerging environmental movement. The conceptual basis for the current use of the term *sustainable development* was consolidated in the early 1970s. At the beginning of the 1970s, this term was probably conceived by the founder of the International Institute for Environment and Development (IIED), Barbara Ward (Lady Jackson) (Ward and Dubos, 1972).
Since the 1980's, sustainability has become a principle in opposition to unlimited growth (Gowdy, 1994), while environmental degradation and unsustainable use of natural resources have been widely recognized by authorities at an international level. The focus has also shifted from the state of ecosystems to the leadership of society (Baker, 2006), and the new SD paradigm has started being used more widely. In its World Conservation Strategy (IUCN, 1980), the International Union for the Conservation of Nature's (IUCN) argued for conservation as a means to assist development and specifically for the sustainable development and utilization of species, ecosystems, and resources. Allen (1980) defined SD as a development that is likely to achieve lasting satisfaction of human needs and improvement of the quality of human life. Nevertheless, the more universal and most quoted definition was developed in 1987. The General Assembly of the United Nations (UN), in its resolution 38/161 of December 19, 1983, supported the establishment of the World Commission on Environment and Development (WCED) (United Nations, 1983). The WCED submitted a report entitled *Our Common Future*, informally known as the Brundtland Report, to the UN in 1987 (WCED, 1987). In Chapter 2, SD is defined as *development that meets the needs of the present without compromising the ability of future generations to meet their own needs.* The WCED report is a blueprint for the global focus on the concept of SD. Sustainability was accepted as an aim for the use of natural capital and SD as a principle for further development (WCED 1987; United Nations, 1992a,b; Axelsson et al., 2011). This definition of SD also drew from Barbara Ward's landmark book (Ward and Dubos, 1972).
After taking the 1987 WCED report into consideration, the General Assembly of the UN called for the convening of the UN Conference on Environment and Development (UNCED) (known as the Earth Summit, Rio de Janeiro, June 3–14, 1992). The central focus was to find ways of relieving the global environmental system through the introduction of the SD paradigm. One of the main results of the UNCED was Agenda 21, which is a comprehensive plan of action requiring new strategies for investing in the future to achieve overall SD in the 21st century. Nevertheless, in 1998, it was emphasised by the former Secretary-General of the Rio Summit, Maurice Strong, that despite recognition of and commitment to the principles of SD, the crucial changes needed to achieve a transition towards SD have not taken place (Drexhage and Murphy, 2010)

2.2. The development in the 2000s and current agenda

In the 2000s, the core milestone related to SD included the Millennium Declaration. It is the document unanimously adopted by the United Nations General Assembly at the UN Millennium Summit in September 2000. It contains a statement of the values, principles, and objectives of the international agenda for the 21st century. The commitments of the world leaders who gathered at the summit include a new global partnership to reduce extreme poverty in its many dimensions and the setting out of a series of time-bound targets (with a deadline of 2015), which have become known as the Millennium Development Goals (MDGs). In the area of the environmental dimension, the Millennium Declaration stated that no efforts must be spared to set back the threat of the planet being irreversibly affected by human activities (United Nations, 2000).
The most recent summits convened by the UN are also crucial in relation to SD. The World Summit on Sustainable Development WSSD (Johannesburg, South Africa, 26 August – 4 September 2002) introduced five themes of particular attention (identified by the Secretary-General Kofi Annan), including water, energy, health, agriculture, and biodiversity. These issues, along with population and poverty, and the relationships among them, were assessed in the Report published before the Summit (United Nations, 2002). The outcome documents more explicitly acknowledged the links between poverty alleviation and environmental protection than the outcome documents of the 1992 UNCED (Azmanova and Pallemaerts, 2006). Although disappointment over the failure to implement the

resolutions of the 1992 UNCED was among the impulses for this summit, it was a significant failure. Governments have awarded transnational corporations a central role in the implementation of SD. The critique also involves putting poverty eradication at the forefront while advancing economic growth as the main strategy for poverty eradication. This leads to the usual recipes for economic growth, such as market liberalisation, direct foreign investment as a major funding mechanism, public-private partnerships, or good national governance to protect property rights, being redefined as SD strategies. On the other hand, counterbalancing environmental and social rules and regulations, or redistributive mechanisms, are missing.

The UN Conference on Sustainable Development in 2012 (UNCSD, Rio+20, Rio de Janeiro, Brazil, June 20–22, 2012) focused on the renewal of political commitments for SD (Stoddart et al., 2012). Two main themes were the main focus of the official discussions: possibilities for building a green economy (GE) to achieve SD and lifting people out of poverty; and possibilities of improving international coordination for SD. Forward-looking decisions on a number of thematic areas were also taken. The areas included decent jobs, energy, sustainable cities, food security and sustainable agriculture, water, oceans, and disaster readiness (United Nations, 2012). The identification of the GE as one of the key themes for the summit represented an opportunity for the definition of a new global economic paradigm. However, there was a risk that previous global agreements on SD (gained with great effort) might be lost when pursuing the new agenda. Innovative guidelines on GE policies include the combination of some of the most important existing principles relating to SD and GE into a coherent guiding tool (Stoddart et al., 2012) (see more in Drastichová, 2018).

In relation to the financial crisis of 2008 and the associated economic crisis, there has been a renewal of interest in the application of the concepts of the green economy (GE) and green growth (GG) by inter- and national authorities, and both concepts have started being widely applied (explained in the following section). GE was designated as one of the main topics of Rio+20, but the final report of this summit did not describe a vision for its further implementation (Bernstein, 2013; Brighton, 2017). The diminished focus on the topic was seen three years later at the UN Sustainable Development Summit, where the GE/GG received minor attention and were not explicitly linked with Sustainable Development Goals (SDGs) in the Post-2015 Development Agenda (Brighton, 2017). The UN Agenda 2030, including the set of SDGs, represents the most recent and comprehensive global political strategy towards the SD path. The agenda and the SDGs reflect experiences with the MDGs, which were in place during 2000–2015. To achieve the ambitious post-2015 development agenda, including all the SDGs, it is necessary to establish a comprehensive, holistic, and transformative approach with respect to the means of implementation. Combining different means of implementation and integrating the economic, social, and environmental dimensions of SD is necessary (United Nations, 2015). While the eight MDGs focused on improving wellbeing in the developing world, the 17 SDGs address all countries and balance the three dimensions of sustainability/SD, i.e., the economic, social, and environmental dimensions (United Nations, 2016). They are also *context-specific*. It means that to achieve the goals, it is necessary to take into account the social, political, and environmental circumstances of particular locales (Oliveira et al. 2019; Weitz et al. 2018; see also Drastichová, 2018, 2022).

3. Results of an in-depth analysis of the concept of sustainable development

For a deeper understanding of the content of the concept of SD, it is necessary to analyse the differences between SD and sustainability in more detail, specifying its supplementary concepts, including the human development approach, GE and GG concepts, and alternatives, particularly that of degrowth. This is the subject matter of this section.

3.1. Sustainability versus sustainable development

Sustainability and SD represent two crucial contemporary discourses at global, international, regional, including the European Union, and national policy levels. These concepts have attracted more interest at these levels due to the challenges and risks faced by human populations in areas such as rural development, environmental conservation, energy, climate change, human wellbeing, etc. (Axelsson et al., 2011). The background to understanding these two concepts (including the differences between them) was briefly outlined in the previous section, dealing with the origin and history of the concept of SD (in more detail in Drastichová (2022).

The idea of sustainability has ancient roots in human societies, related to the need to find ways to use natural resources without depleting them (e.g., Hartig, 1804; Hunter, 1996). Hence, regarding the origin of the term *sustainability* in the sense of the relationship between human beings and ecological systems, it can be understood as deriving from a semantic modification, extension, and transfer of the term *sustained yield*. This has been the doctrine of foresters for two centuries (von Carlowitz, 1713; Grober, 2007). In accordance with that, Axelsson et al. (2011) described sustainability as a policy vision of society with the primary purpose of preventing the depletion of natural resources. Dovers and Handmer (1992) claimed that it was a process of *intentional change and improvement*. More generally, sustainability is a wide and complex research field with several applications in different areas and disciplines (Olawumi et al., 2018) or a process of *intentional change and improvement (*Dovers and Handmer, 1992).

The terms *sustainability* and *sustainable development* are often used interchangeably (especially in public debates) (Norton, 2005), but according to many scholars, including Axelsson et al. (2011), these two terms have different meanings. Some scholars claim that the issue of what sustainability means has become much more complex recently (Kidd, 1992; Lee, 1993; Clark, 2002). The concept of SD is aimed at finding a balance between preserving ecosystems and meeting human needs (Olawumi et al., 2018). These differences and common aspects were analysed in detail in Drastichová (2023). Resulting from the summary of descriptions of the concept of SD and the analysis presented in Drastichová (2023), it is concluded that it is one of the most challenging policy concepts developed in compliance with Turner (1992). A kind of ethical directive is included as a core objective, i.e., to give all people at all times the chance of a dignified life in their respective society (Omann and Spangenberg, 2002).

The different approaches of scholars to the relationships between the concepts of sustainability and SD were analysed in Drastichová (2023). The conclusions are also applied in this work. The first approach is based on the necessity of that development, i.e., the process of change, which is sustainable in order to achieve a desired (required) state of sustainability. Nevertheless, there is no static point that would reflect a final state of sustainability; instead, it is changeable and constantly evolving and developing if the path of SD is pursued. The second approach, also interrelated with the first, is based on several concepts of sustainability defined by particular criteria. Within this approach, SD can be explained in relation to the criteria of very weak, weak, strong, and very strong sustainability concepts, as well as additional sustainability types (described below). In addition to this, the meaning of the term sustainability in relation to SD as a *sustained yield* is also considered.

To expand these conclusions, economists have brought the idea to SD debates that pursuing economic growth and the depletion of environmental resources (i.e., source and sink resources) is tantamount to living off capital rather than income (Victor, 1991). Then, SD is defined as the maximum development that can be achieved without exhausting the capital assets of the nation, which represent its resource base. He also identified four schools of thought on the environment as a capital asset. Those views range across a spectrum from very weak sustainability to very strong sustainability. They include the mainstream neoclassical school, the London school (after Pearce, Barbier, Markandya, and Turner), the post-Keynsian school, and the thermodynamic school (after Boulding, Georgescu-Roegen, Daly, Perrings, and Common). In broader terms, these concepts can be divided into the opposing paradigms of weak and strong sustainability (Hediger, 1999; Neumayer, 1999; Pearce et al., 1994), which are based on different conceptions of capital theory. The particular forms and roles of these assets differ depending on the concept of sustainability that is applied. Hence, the following classification of the concepts of sustainability is derived from the capital base of countries. Widely interpreted, this capital base includes man-made capital (K_m), natural capital (K_n), human capital (K_h), moral (ethical, *Ke)*, and cultural capital (K_c). It is still controversial what types of capital should be preserved for current and future generations (Costanza et al., 2007). Basic and more theoretical differences between two broader concepts of sustainability, i.e., weak and strong sustainability, are displayed in Table 1.

Table 1. Differences between the concepts of weak and strong sustainability (Pelenc et al., 2015)

	Weak Sustainability	*Strong Sustainability*
Key Ideas	K_n and other types of capitals, such as K_m – perfectly substitutable	The substitutability of K_n by other types of capital – severely limited
Consequences	Technological innovation; monetary compensation for environmental degradation	Certain human actions can cause irreversible consequences
Sustainability Issue	The total value of the aggregate stock of capital – at least maintained or increased for future generations	Conserving the irreplaceable stocks of critical K_n for future generations
Key Concept	Optimal allocation of scarce resources	Critical natural capital
Definition of Thresholds / Environmental Norms	Technical/scientific approach for determining thresholds and norms (instrumental rationality)	Scientific knowledge as input for public deliberation (procedural rationality)

Nevertheless, some characteristics of these concepts (in a broader as well as a narrower classification) are in practice less clearly defined and often overlap (a detailed analysis of these concepts was elaborated on by the author (Drastichová (2018, 2023). The weak sustainability concept involves the necessity of maintaining the stock of total capital, including the K_m and K_n, or an economy's generalized productive capacity (Solow, 1986). In narrower terms, there is also *very weak sustainability*, which requires that the generalized production capacity of an economy be maintained intact in order to enable constant consumption per capita over time (Solow, 1974, 1986). This is

also referred to as *Solow sustainability* (Common and Perrings, 1992). In broader terms, *weak sustainability* requires that the welfare potential of the overall capital stock remains intact (Hediger, 1999; Neumayer, 1999; Pearce et al., 1994). On the contrary, from a system perspective, a minimum necessary condition of *strong sustainability* is to maintain the total stock of natural capital constant over time (Daly, 1991). This is a prerequisite for SD. In the more detailed classification, a very strong sustainability perspective is included. It requires a steady-state economic system based on thermodynamic limits and the constraints imposed by them on the overall scale of the macroeconomy. Zero economic growth and zero population growth are required to achieve a zero increase in the scale of the macroeconomy. Nevertheless, advocates of the steady-state paradigm claim that development is not precluded and that social preferences, community-regarding values, and generalized obligations to future generations can all be fully incorporated into the steady-state economy as it evolves. This requires the conservation of moral capital (K_e), on which economic activity eventually depends (Hirsch, 1976; Daly and Cobb, 1989). The analytical descriptions of all concepts of sustainability were presented in Drastichová (2022). The closer we move to stronger sustainability concepts, the closer we also shift to alternative concepts to SD (explained in the following sections).

In summary, the four key concepts of sustainability and the place of SD in relation to them can also be characterized by their different minimum requirements. VWS is defined by constant per capita consumption, WS by non-decreasing social welfare, SS by constant environmental quality, and VSS by a set of stationary-state conditions. By contrast, SD requires compliance with critical levels of natural capital and basic human needs that are not addressed by notional conceptions of either weak or strong sustainability (Hediger, 2006, 2004). Then the position of the concept of SD would be between the concepts of WS and SS. Nevertheless, it goes beyond all these concepts since it also requires the meeting of basic human needs.

Furthermore, several particular types of sustainability form parts of one or several dimensions of SD. These especially include economic, social, environmental, ecological, human, and institutional sustainability. The first four types can mainly be associated with particular dimensions of sustainability and SD, but their interconnections and interdependence must be highly considered. Human and institutional sustainability go beyond all the pillars of SD. These criteria should also be incorporated into the first approach. Human sustainability, wellbeing, and quality of life should be understood as the main aims of SD. In relation to SD, institutional sustainability can be understood as an institutional pillar of SD. It can also encompass interpersonal processes like democracy and participation (institutional mechanisms), distributional and gender equity (institutional orientations), or independent and pluralistic sources of information (organisations) (Spangenberg, 2002).

The environmental sustainability concept is associated with the deep ecology movement. It requires sustenance for every specific component of natural capital and every flow of particular natural resources. Ecological sustainability goes even further towards the protection of natural capital (environmental assets), and it involves maintaining the composition, structure, and processes of an ecological system (Anderson, 2013). Respect for the environment is the main part of both concepts. Taking the natural changes into account, ecological concerns are favoured over economic development. In the goal of intergenerational equity, at least two other forms of sustainability are implicitly included. Human sustainability, in narrower terms, involves the sustenance of the human capital that is needed to maintain levels of health, wealth, production, and welfare (resulting from the previous factors) (Spangenberg, 2002). In broader terms, a human development approach is an approach for advancing human wellbeing that is focused on expanding the richness of human life rather than simply the richness of the economy in which human beings live. It is focused on people and their opportunities and choices. This standpoint and aspects of it are considered in the Human Development Reports (HDR) of the United Nations Development Programme (UNDP), starting in 1990 (UNDP, 2023). The HD approach must be included in every SD strategy and is part of the philosophy and ultimate goal of the SD concept. The ideas of HD and, more precisely, of the Capability Approach (CA) have been gradually introduced to EL economics since the mid-2000's. The contribution of HD can be understood in two main aspects, including development drawn away from a pure economic-based understanding measured in GDP and from a purely state-centered understanding to one where the people become the main agents of development. Such shifts to people-centered approaches included in HD were promoted by the CA (Beling et al., 2018; see more in Drastichová, 2023). Social sustainability is more specific, human-oriented, and focused on personal assets, including education, skills, experience, consumption, income, and employment.

In Drastichová (2023), three major approaches to SD have been derived on the basis of the previous knowledge arising from the adoption of the WCED report (WCED, 1987; see also United Nations et al., 2003). Firstly, the three-pillar approach is based on that view of SD, which refers simultaneously to economic, social, and environmental systems, all of which must be sustainable at the same time, while they are interlinked. Moreover, the fourth institutional dimension is added as the fourth pillar of SD because of its necessity in supporting progress in the previous three pillars and in SD generally (United Nations et al., 2003). This can be specifically related to the first approach to the definition of SD. However, the functioning institutional dimension has a crucial role in achieving SD in general. The three pillars of SD, including environmental, social, and economic sustainability, need to be harmonized to achieve a holistic SD. According to Cusack (2019), the goals of SD, oriented around the *three E's*,

namely, economic growth, environmental protection, and social equity, also correlate with quality of life considerations. Accordingly, the focus on the economic, environmental, and social dimensions of SD must also be extended, or rather, they must be seen to include a human dimension.

Secondly, the ecosystem health approach considers the economic and social systems to be sub-systems of the global environment. The health of ecosystems must be protected, and the capacity of ecosystems must be sustained to respond with resilience to external effects. The third one, the resources/capital approach, regards SD as development that ensures non-declining per capita national wealth by replacing or conserving the stocks of man-made (produced, physical), human, social, and natural capital. It broadens the concept of economic capital by integrating concepts from the physical and social sciences to include measures of, or indicators of, human, social, natural, and environmental capital (Schepelmann et al., 2010). It can be concluded that the previous knowledge was significantly used in the definition of these approaches.

Although each of these approaches reflects a particular view of the concept, they are substantially interrelated. The first approach places the same importance on each of the three pillars, while the second approach also considers that socio-economic systems occur within ecosystems. Although there are many different interpretations by various scholars of what the particular dimensions of sustainability and SD may involve (it also depends on the analytical level of the analysis), achieving a balance between these dimensions is a crucial aspect. Human activities aimed at increasing social wellbeing and quality of life should not exceed the carrying capacity of ecosystems. Hence, while wellbeing and quality of life are increasing, or, in other words, economic, social, and socio-economic variables are improving, the simultaneous impacts on the environment should be minimized. The relevant critical boundaries and thresholds determining the proper functioning of ecosystems and, hence, the survival of human beings must not be surpassed. Nevertheless, Purvis et al. (2019) argued that the emergence of the three-pillar paradigm, with little theoretical foundation, is predominantly a result of the specific origins of sustainability as a concept. A detailed analysis of the possible relationships, including their depictions, is provided in Drastichová (2023), and the relations with depictions of GE are analysed and displayed as well. This three-dimensional description is often presented in the form of three intersecting circles of society, environment, and economy, with sustainability being placed at their intersection. This can be mainly related to the first approach mentioned above. Alternative descriptions include the three nested concentric circles (predominantly associated with the second approach) or literal pillars. The three pillars themselves were explicitly incorporated into the formulation of the SDGs (United Nations, 2012). The third approach defines different kinds of capital assets related to the pillars of the previous two approaches. It also considers the sustainability of the use of different forms of capital (already explained in this section). Wellbeing is an important aim of all these approaches. Ecosystem services (supporting, provisioning, regulating, and cultural), which are the benefits people obtain from ecosystems, are sources of human wellbeing and essential for continuing life on Earth as it is (MEA, 2005).

To sum up the knowledge about sustainability and SD, some conclusions are derived, also on the basis of the analysis of additional scientific works. In compliance with the WCED report (WCED, 1987), SD is future-oriented since it aims to ensure that future generations are at least as well off as current generations in terms of wellbeing (welfare). In economic terms, it is a matter not only of efficiency but also of intergenerational equity. The distribution of rights and assets across generations determines whether the efficient allocation of resources sustains wellbeing across human generations (Howarth and Norgaard, 1990). The relationship between quality of life and SD is unambiguous. Basically, sustainability is a concept that has central importance for the quality of life of present and future generations (Bijl, 2011). Then, sustainability can be understood as a state where the key goals of SD are satisfied, a high quality of life is achieved, and the environment is preserved (Fischer and Adjo 2011). If people are not satisfied with their current quality of life, they cannot be expected to make sacrifices that might be beneficial for future generations. This means that SD strategies must address current wellbeing in addition to that of future generations (Morrill, 2011).

The meanings of both of the concept's origin words, sustainable and development, have generally quite positive meanings. Their combination joins this concept with the essential and near-universal acceptance of sustainability as a substantial value and goal. It should play a great role in diverse social contexts. However, the fundamental principles are not firm; they represent the evolving output of international discussions on the concepts of sustainability and SD. The original emphasis on economic development and environmental protection has been extended to include alternative notions of development, such as human and social development, and alternative views of nature, such as anthropocentric versus ecocentric views. Thus, the concept involves constructive tension between basic principles and the possibility of reinterpretation and adaptation in the face of different social and ecological conditions (Kates et al., 2005). Moreover, special attention should be paid to the institutional aspects of SD.

The concrete challenges of SD are heterogeneous and complex due to the diversity of human societies and natural ecosystems, and the limitations of the definition of the WCED report have gradually become more apparent. Some of them have already been outlined, but the overall evaluation is provided in terms of the results of the SWOT analysis carried out in the analytical part of this work. First, in relation to these limitations, the supplementary and alternative concepts to SD are introduced and critically evaluated.

3.2. The concepts of Green Economy (GE) and Green Growth (GG)

Both Green Economy (GE) and Green Growth (GG) concepts have gained importance in political agendas at the inter- and national scales. International organisations have prepared a number of initiatives in this field, and decision-makers have developed GE/GG policies and action plans and implemented GE/GG in a number of sectors, including energy, transport, and agriculture (see more in Merino-Saum et al., 2020).

Like SD, GE is a multidimensional concept. It focuses on the potential trade-offs and synergies between economic and environmental dimensions without ignoring social aspects. GE definitions can be put into a broader perspective according to their potential as theoretical backgrounds for dealing with the social-ecological challenges posed by the Anthropocene (Merino-Saum et al., 2020). The first mention of the GE concept was in the late 1980s by Pearce et al. (1989). However, apart from its title, the work, usually presented as the conceptual *landmark* in this field, does not refer to the term GE. During the 1990's and early 2000's, the concept of GE almost disappeared from common usage at an international level (Brown et al., 2014) and was rarely addressed in scientific literature. This was, besides other reasons, due to the emergence of SD, which attracted political attention, especially after the UNCED (1992). It was not until 2008 that key international organizations again recognized in the GE concept a possible policy response to the global financial crisis and to the environmental problems that the current socio-economic systems were still encompassing (Bina and La Camera, 2011; Death, 2015). In this particular context, the concept was reused as an operational strategy, enabling both economic recovery and more sustainable growth in the future (Barbier, 2012; Bowen et al., 2009; Georgeson et al., 2017). The GE concept was mainly institutionally supported at the international level by the United Nations Environment Programme (UNEP), which launched the Green Economy Initiative in 2008 and demanded a Global Green New Deal in 2009 (Barbier, 2009). As the UN General Assembly convened the 2012 UN Conference on Sustainable Development (Rio+20) in 2009, it designated the GE as one of its two main focal areas. UNEP defined the GE as *one that results in improved human wellbeing and social equity while significantly reducing environmental risks and ecological scarcities* (UNEP, 2011). GE discourses also represented a way of coping with the decreasing attraction of the SD concept for economic policymaking (Jacobs, 2013). Overall, there are several discourses underpinning the GE concept, such as *econocentric incrementalism, unlimited eco-efficiency,* and *transformative GE*. While the first two of them support transitioning mechanisms as a way to correct failures in existing dominant systems, more *transformative* perspectives on the GE rather advocate modifying the systems themselves.

Regarding the GG concept, Colby (1989) defined it in the late 1980s as one that *would be based more on increasing the information intensiveness, community consciousness, and experiential quality of economic activity, rather than the material-energy intensiveness*. However, the term was merely used. Similarly to the GE, the GG concept did not draw considerable attention before the 2000s, when the World Bank and the OECD intensively encouraged it at the international level. The OECD published the Green Growth Declaration in 2009 (OECD, 2009) and its Green Growth Strategy Package in 2011. This package included, among other reports, the widely cited *Towards Green Growth*, where GG is defined as a strategy *fostering economic growth and development while ensuring that natural assets continue to provide the resources and environmental services on which our well-being relies* (OECD, 2011). Capasso et al. (2019) summarized views from 113 recent scientific articles related to GG. GG is suggested to be a key element in achieving SD: on the one hand, protecting the environment; on the other hand, allowing economic growth.

Both GE and GG concepts have been criticized by the political authorities (Atkisson, 2013) and many developing countries (Bina, 2013). GE and GG discourses progressively enhanced national policymakers' agendas in the years following the 2008 crisis, and both concepts were widely applied. GE was designated as one of the main topics of Rio+20. However, the summit's final report did not describe a vision for a further implementation of GE (Bernstein, 2013; Brighton, 2017). It has been claimed that this led the concept to a theoretical landscape where it could coexist with other related concepts such as SD, *steady state economy*, or *low-carbon economy* (Georgeson et al., 2017; UNDESA, 2012). A lower interest in the topic was also confirmed three years later at the UN Sustainable Development Summit, where the GE/GG received minor attention and were not explicitly linked with Sustainable Development Goals (SDGs) in the Post-2015 Development Agenda (e.g., Brighton, 2017). Although the GE/GG concepts have lost momentum in recent years, they remain respected at the international level.

There is significant ambiguity related to both concepts, and there is no clear boundary between them or between them and the concept of SD. The common interpretations of the concepts of GE and GG are summarized in the first row of Table 2. Deficiencies in agreement on interpretation result from the innate complexity of GE and GG concepts since both are multidimensional. Conceptual ambiguity can also be a consequence of disagreements in international governance (Brown et al., 2014) or political controversies over practical strategy. It has even been stated that GE and GG *were left deliberately imprecise* as a way to support their acceptance all over the world (Georgeson et al., 2017). Although GE and GG were conceptualized by different organizations, the UNEP and OECD, respectively, they have become barely distinguishable. These organizations have declared that GE/GG are not a mere substitute for SD (OECD, 2011; UNEP, 2011).

Table 2. Features of concepts of GE/GG and their relationships with the concept of SD according to various scholars (author's elaboration)

GE/ GG	*broad* (Bigg, 2011); *umbrella* notions (Loiseau et al., 2016); *vague* (Jänicke, 2012); *disputed* (Faccer et al., 2014); *context dependent* (Richardson, 2013; Death, 2015); encompassing concomitant definitions (Buseth, 2017; Jakob and Edenhofer, 2014; PEP 2012; Speck and Zoboli, 2017).
GE/ GG vs. SD	The GE/GG – a *child of* (Jacobs, 2013), *the intellectual cousin of* (Fiorino, 2014), *a key vehicle for* (ten Brink et al., 2012), *a way to operationalize* (Green Growth Knowledge Platform (GGKP), 2016), *a pathway to* (UNEP, 2011), *a support of* (UNDESA, 2012), *an enabler of* (Georgeson et al., 2017; UNCTAD, 2010) SD; The GE/GG – *narrower in scope* (OECD, 2011); *more focused* (Bowen and Hepburn, 2014; Ferguson, 2015); *practical* (Choi, 2015); or *operational* (Green Growth Knowledge Platform (GGKP), 2016) concepts than SD.

Although the boundaries between the three concepts can be controversial, it can be at least concluded that both the GE and GG concepts are more practical and can be understood as ways of implementing SD and as ways of moving closer to the SD path. Concerning the relationships between the GE and GG concepts, it can be concluded that while GG is focused on the features of economic growth, GE has conceived it as a means rather than an end (Merino-Saum et al., 2020). GE would also encompass a more balanced approach to socio-economic and environmental issues (e.g., Bina and La Camera, 2011). Concerning the analysis and understanding of the concepts of SD and sustainability by the author, the GG concept can be closely related to the operationalisation of the path of SD and moving closer to this path, while the GE concept can involve closer relationships to the dynamic state of sustainability resulting from the path of SD based on GG. Nevertheless, all the concepts can involve various features depending on the analytical level, the stakeholders included, and the stage of development of the analysed unit, among others. Finally, it should be noted that the way in which both the GE and GG were constructed made them attractive for authorities endorsing policies to encourage recovery from the economic crisis. They were supposed to encourage economic growth while being more ecologically friendly and based on better technologies or innovations. This is debatable and depends on many factors, especially the form of application of these concepts in practical strategies and to what extent they can shift economies closer to SD.

3.3. Scientific background: theoretical concepts forming the foundation of more practical and alternative concepts

At this point, the focus shifts towards the relationships between sustainability, SD, GE, and GG on the one hand and alternative, including transformation, concepts on the other. They, among other aspects, represent a response to the deficiencies of the previous concepts. The future of economic growth is one of the crucial questions currently. Challenges, such as declining growth rates in developed countries, ecological limits and related environmental problems, as well as rising socio-economic inequalities, have led to the need to search for alternatives going beyond economic growth. Nevertheless, so far, these debates about sustainability/SD, post-growth, or degrowth have been deficient from a detailed historical perspective. Recently, there has been a focus on the concept of human development (HD), along with several alternative and/or transformation concepts. It can be assumed that the need for an alternative system to capitalism has already been identified. Alternative economics represents current socio-economic theories and practices that may remedy the shortcomings in the current dominant global economic system, which has the form of mainstream capitalism. Kothari et al. (2015) indicated that the GE is not an adequate response to the unsustainability and inequity created by development, which is a western cultural construct, and puts forward alternative socio-environmental futures to, and not of, development. In the context of transformation towards sustainability, including alternative discourses, it becomes desirable to analyse ways in which sustainability science can explicitly and effectively address one of the original causes of global social and environmental degradation, namely, the ideology and practice of economic growth (Asara et al., 2015). It has also been emphasised that inequality, injustice, and unsustainability – already part of many state-dominated systems – have been worsened by the recent phase of capitalism's accelerated expansion (Harvey, 2014).

Beeks (2016) studied fourteen economic systems, including environmental (EN), ecological (EC), circular (CR), green (GN), resilience (RE), complexity (CY), feminist (FE), compassionate (CE), caring (CG), degrowth (DG), steady-state (SE), no-growth (NH), ecosocialism (EM), and anarcho-ecosocialism (AEM) systems. The formation of these systems is related to the misapprehension that a sustainable society can be based on an economy with economic growth, which also has significant effects on environmental services. All these systems have a theoretical basis. Although they are regarded as alternative systems in relation to the system of capitalism in that work, the approach in this work is different to some extent. The first two concepts analysed by Beeks (2016), EN and EC, are the fundamental disciplines for the analysis of all the remaining concepts and systems and, more generally, of the socio-economic-environmental relationships. Moreover, not all of these concepts from the remaining ones represent alternatives to SD, especially CR, GN, and RE economy concepts. Furthermore, GE and its complementary concept, GG, which were analysed in the previous subsection, are also practical concepts that also put the concepts of sustainability and SD into operation. Alternative approaches can involve the concepts of NH, SE, and DG economies, as well as some even more practical alternatives to the concept of DG, reflecting the cultural features of smaller communities. They can involve Buen Vivir from Latin America, Ubuntu from the South (and

other parts) of Africa (human mutuality), and Ecological Swaraj (Radical Ecological Democracy) from India (understood as alternatives to both SD and GE while representing an alternative to growth at a local level). To sum up, there are some groups of concepts related to SD that are based on the scientific disciplines of EN and EC to various extents. Some of them represent practical approaches, such as CR, GN, and RE economy concepts, while several also reflect the political strategies of organizations or countries, i.e., GE, GG, and/or alternative views to them and/or to SD, or to particular aspects of them, such as NH, SE, and DG economy concepts. The remaining concepts, i.e., CY, FE, CE, CG, EM, and AEM systems, are more comprehensive concepts and alternatives to the system of capitalism, while they support quality of life and wellbeing. Hence, this last group includes the concepts that underpin the alternative systems to the prevailing economic system of capitalism.

Hence, two fundamental scientific disciplines were identified. Mainstream neoclassical environmental (EN) economics has become a major subdiscipline of economics since its beginnings in the 1960s. It combines traditional work in the field of welfare economics and the theory of economic growth with more recent views in political economics of choosing policy instruments and the philosophy of SD. The central theses are that environmental problems have their origins in the failure of economic systems to maximize human wellbeing, that environmental quality matters for human wellbeing and for more traditionally oriented economic growth objectives, and that efficient policy can be achieved through incentive design (Pearce, 2002). EC economics (founded at the end of the 1980s) provides a platform for multidisciplinary environmental research by bringing together the core contributing disciplines of economics and ecology (van den Bergh, 2001). Moreover, it also represents a pluralistic approach to environmental research and an alternative approach providing alternative methods that was developed as a response to traditional environmental and resource economics (ERE), which also forms part of mainstream neoclassical economics, along with EN economics. The additional concepts are briefly analysed. The CR economy is described first since it is mostly interconnected with GE/GG concepts and practical strategies. It can also be applied as a practical concept or strategy within these concepts and strategies to achieve goals within the GE (in terms of GG) and the overall goal of SD. It corresponds with the field of biomimicry (mimicking nature) (see, e.g., Geisendorf and Pietrulla (2017). It is a more practical concept to put SD into operation. CR can be defined as a system that is designed to be restorative and regenerative. It means that, as opposed to a linear consumption economy, it favours recycling and reuse of products over disposing of them. This author sees CR as an *alternative growth discourse* instead of an *alternative to growth discourse*. It is associated with eliminating waste, while more value from resources is received through waste reduction. To be more precise, the CR economy should be understood more as a model and strategy than as a theoretical concept, while its practical implications for sustainability and SD are ambiguously defined. The problematic issue is also that the tensions between the ongoing use of natural resources and the physical boundaries of circular flows, such as loss of material properties, are still prevailing (see Sehnem et al., 2022; Kirchherr et al., 2023).

The SE economics concept has its origins in the early 1970s. The crucial works include those of Daly (1980; 2009), Jackson (2009), and Georgescu-Roegen (1971, 1993), who dealt with the law of entropy, the second law of thermodynamics (after the transformation, materials become waste with high entropy). The SE approach argues for qualitative rather than quantitative growth and for higher qualitative growth, equating to higher economic growth with greater efficiency (Worstall, 2014). This is also in compliance with the fact that there is a general agreement with the WCED report (WCED, 1987) and SD, which also indicates a willingness to protect the needs of future generations. Other features include community support, a focus on the human community, self-reliance, and the rethinking of the definition of economic value (Daly, Cobb, and Cobb, 1994; Daly, 1997). The existing capitalistic system can be reformed to make it an SE economy, which is the only sustainable economy in the long term. Major researchers and their works in the field of NH economics include Jackson (2012), Daly (2009), and Georgescu-Roegen (1993). The NH economists emphasise that instead of focusing on wealth, we should achieve a higher quality of life, which does not involve excessive material and resource consumption (depletion). More emphasis is also put on wellbeing, which is not focused on wealth accumulation, considering that economies can prosper without growth. It promotes part-time employment with full benefits, such as flexible work hours or job sharing. NH economists also support the SE economy, considering economic growth to be a main contributor to numerous global problems. A number of works support both concepts, regarding them as compatible with each other. However, a distinction outlined above is that an SE economy may have qualitative economic growth without exceeding ecological limits and may therefore achieve a kind of equilibrium. In contrast, an NH economy shows no quantitative economic growth in general, and its advocates propose consumption and population levels below the Earth's carrying capacity so that ecological limits are not surpassed. NH economists regard capitalism in its recent form as excessively focused on accumulation. Therefore, it is necessary to stop dependence upon market forces, laissez-faire idealism, and the related pursuit of profits and economic growth (Trainer, 2011). A sustainable economy can be achieved and prosper without economic growth (Jackson, 2012).

CY economics is based on the assumption that the economy is not necessarily in equilibrium. Economic agents, such as firms or consumers, constantly change their actions and strategies in response to the outcome they mutually create. They do not necessarily encounter well-defined problems or use super-rationality (Arthur, 2014). A CG economy is an economic system that prioritizes the needs of people and the environment, is inspired by the Nordic

nations' policies, captures the benefits of both capitalism and socialism, and is made accessible by imposing higher taxes on the wealthy. In mainstream economics, prosperity is a matter of consumption, income, and wealth. By contrast, CG economics is based on a new way of thinking and conceives of prosperity in terms of deeper sources of durable human wellbeing (Singer and Snower, 2015). RE economics is focused on the resilience of economic systems and ecological systems, considering them inextricably interconnected (Perrings, 1998). This knowledge is essential for understanding how economies need to move towards SD. The concept of RE has its origins in physics and psychology but was mainly applied in ecological science as a descriptive term.

Both EM and AEM approaches advocate ecocentrism as opposed to anthropocentrism, but also simple and communal living, community ownership, the establishment of cooperatives, and the protection of natural systems. The key principles of EM were first developed in the 1880s. Crucial researchers in this field include Smith (2007), O'Connor (1998), and Martínez-Alier (1988). EM is a system of economics that assigns its foundation to Marxism. Ecosocialists claim that capitalism is not compatible with the environment or with a number of social needs, while some aspects of socialism are compatible with both (Löwy, 2005). Two of their many concerns related to neoliberal capitalism include the privatization of basic services and the multiple consequences of globalization (Albo, 2007). AEM rejects Marxist authoritarian socialism and supports libertarianism socialism. The AEM representatives are comprised of anarchists, libertarian socialists, socialists, and liberals. The basic works in this field of study include Reclus (1886) and Bookchin (1978). AEM opposes state or centralized rule in favour of local community control with decision-making at the local level (Biehl and Bookchin, 1998). The field of FT also has some pioneering works, including Waring and Steinem (1988), Nelson (1996), Elson (1995), and Ferber and Nelson (2009). The philosophical background of FT economics originated with ecofeminist principles concerning humankind's tendency to dominate nature. FT economics aims to end discriminatory injustices related to gender, social class, race, age, religion, and others as part of the new economy, as well as hierarchical dualism and the cultural separation embedded in our current economic system. The focus is also on the adequate compensation of traditionally female occupations, such as teaching, nursing, or caregiving. The analysis also focuses on the negative aspects of capitalism

CE economics, an economic system that provides essential improvements to mainstream capitalism, has its origins in 1955 and has a philosophical basis in Buddhism. Therefore, it was named Buddhist economics at that time by E. F. Schumacher (Schumacher, 2011). CE economists have also endeavoured to establish the foundation of a social democracy, emulating the governments of the Nordic nations. They claim that mainstream economics misunderstands the crucial issues due to the oversimplification of complex relationships between society, the environment, and the economy. Hence, it suffers from metaphysical blindness (Schumacher, 2011). CE economics is closer to the philosophy of the SD concept, with a focus on such relationships. It also supports peace through tolerance (Inoue, 1997), the ethical treatment of others, the integration of compassion and spiritual needs, moral value, as well as compassionate, altruistic, empathetic, and holistic approaches to economic analyses (Payutto and Evans, 1994). Other features involve the need for full employment, favouring people over goods, and not using GDP to measure the health of the economy (Schumacher, 2011).

DH thinking is explained as the last conception, since it is of crucial importance for sustainability both as a separate alternative concept to SD and for a number of alternative concepts as well. It has gained influence in the scientific community of EL economics and related fields. Weiss and Cattaneo (2017) reviewed 91 articles focused on DH (period: 2006–2015). It emerged as a paradigm emphasizing the contradiction between sustainability and economic growth, problematizing the SD paradigm and its rebirth in the concept of a GE (Kothari et al. 2015). The concept of *décroissance* (degrowth) was first conceived by André Gorz in a debate organized by Le Nouvel Observateur in Paris in 1972 (Demaria et al. 2013) as a follow-up to the *Limits to Growth* report (Meadows et al. 1972), which encouraged debates about zero growth or degrowth (as indicated in the first section). Gorz employed the term to question the compatibility of the capitalist system with the *degrowth of material production*, and he underscored the importance of reducing consumption and promoting values like frugality, autonomy, and conviviality (Asara et al., 2015). This discourse experienced a strong renewal around the time of the financial crisis of 2008 and the resulting economic crisis. Social movements in Europe used it as a *missile word* to challenge the ecological and social unsustainability of growth-dependent economies and the global economy (Latouche, 2009). It has also been argued that the pathway towards a sustainable future can be found in a democratic and redistributive downscaling of the biophysical size of the global economy (Schneider et al., 2010; D'Alisa et al., 2014; Asara et al., 2015). Kallis et al. (2012) have claimed that economic DH is ecologically desirable and possibly inevitable, although the conditions under which it can become socially sustainable are yet to be investigated. The requirements of global DH instead of SD or *accelerated growth*, although *green* or *inclusive*, which are not clear and unambiguous concepts, have started emerging. Since human activities have already surpassed several planetary boundaries, the need for global DH can become realistic, along with radical redistribution.

Although the GE/GG concepts from the point of view of their applications as strategies have been described in the previous section, the description of Beeks (2016) is added since it brings a broader GN economics perspective. According to this author, GN economists promote sustainability, natural systems, social justice, fairness, environmental needs, and an efficient economy. Hence, all three pillars are included, although in the practical GE/GG

strategies, the economic-environmental dimensions have prevailed. Nevertheless, as a response to such deficiencies, social-inclusive versions have gradually been adopted lately. GN economists support a resource-efficient economy that is low in carbon use while also being socially just (UNEP, 2011). This is the most direct relationship with a practical strategy described in the previous section. In general, in terms of GN economics, low, efficient resource consumption and their low-impact extraction, along with minimal carbon use, are supported. According to some authors, GN economists are politically motivated, supporting democracy, freedom, liberty, solidarity, equality, social justice, and happiness (Kennet and Heinemann, 2006), as well as individual rights, fairness, and the wellbeing of the community (Kahle and Gurel-Atay, 2014). Long-term results over short-term gains are preferred. The crucial works include those of Hahnel (2011), Cato (2009), and Kennet and Heinemann (2006). It is also indicated that GN economics has its origins in 1989, in the work entitled *Blueprint for a Green Economy* (Pearce et al., 1989), which is similar to the practical concept of GE (see the previous section). Some GN economists consider Rachel Carson's Silent Spring to be the first green book (Kennet and Heinemann, 2006), which is a bestseller of great importance to sustainability and SD in general. On the basis of this analysis, a summary of the comparisons of the analysed concepts is provided in the next section, which is followed by the results of the SWOT analysis.

3.4. Summary of the Analysis of the Relationships between Sustainability, SD, and Related/Alternative Concepts: A Background for a SWOT Analysis

Some aspects related to SD or alternative approaches can be summarized. The six systems identified by Beeks (2016), including EN, EC, CR, CY, GN, and RE economic systems, have in common that they place a value on ecological systems, and there is also a general appreciation of the need to accept the complexity of ecological systems, along with the need for interdisciplinary approaches to tackling socioeconomic and socioenvironmental problems. He also argued that the CE economic concept, combined with the approaches of the GN, SE, and EM economic concepts, most comprehensively addresses the issue of economically driven ecosystem threats. GN, EL, and FT economists understand the economy as a component of the larger ecological system. CE, CG, EL, DH, NH, SE, and EM systems are particularly strong at addressing wealth disparity with wealth taxes. CE economists regard global wealth redistribution as a must and as an act of compassion (Mensikov, 1993).

The main concepts related to SD, such as the concept of HD, can be interconnected with the alternative concepts. Some more practical alternatives to the concept of DH have even been formed that better reflect the cultural features of smaller communities. Beling et al. (2018) investigated complementarities among contemporary discourses, including the above-introduced concept of HD (as one of the main concepts related to SD) and the concepts of degrowth and Buen Vivir, challenging conventional notions of (un)sustainable development. HD represents relative transformative strengths in political terms, while DH could serve to reverse unsustainable material-structural features of the contemporary socio-economic system, and Buen Vivir considers cultural variation and is based on a critique of the Euro-Atlantic cultural models. Kothari et al. (2015) dealt with Buen Vivir from Latin America, DH from Europe, and Ecological Swaraj from India. He outlined that there is politics beyond a unilinear future, unsustainable, and unjust, consisting primarily of economic growth.

Although DH economists have some fundamental disagreements with SE economists concerning the sustainability of qualitative growth (Kerschner, 2010; Trainer, 2011), they share certain similarities. They focus on a higher quality of life without enormous consumption, and they advocate wellbeing as opposed to an irresponsible lifestyle, which does not increase happiness. Moreover, the NH economy can be understood as a SE economy (Beeks, 2016). CR, DH, and SE economies share a number of important principles and goals besides the existing differences. These frameworks share the aim of allowing human society to operate within the ecological limits of the planet, contrary to growth-oriented models. However, while the theoretical frameworks of DH and SE have been highly developed, this is not the case for the CR economy, which is predominantly focused on eco-efficiency (the economic-environmental relationship). Hence, the CR economy can also be based on the philosophy of EN economics, SD, and growth economies in general.

Finally, both EM and AEM approaches advocate ecocentrism as opposed to anthropocentrism and a system that is exploitative towards people, but also simple and communal living, community ownership, the establishment of cooperatives, and the protection of natural systems. They also support democratic control and the empowerment of the working class, as well as the establishment of self-sufficient rural communities. Similarly to the CE economic system, neoliberal globalization institutions are understood as detrimental to the environment and society, e.g., by providing poor working conditions. Both systems identify the symptoms of societal breakdown, such as poverty, wealth disparity, and environmental destruction. They also support a higher quality of life. Moreover, the anarcho-eco-socialists reject any form of centralized government, and in that sense, they are against the recommendations of both EM and CE economic approaches. The ideas of the CR, EM, and AEM systems are seriously considered crucial for the future economic system by Beeks (2016). It must be added that sustainability and SD should remain the basic philosophy. The practical concepts can have some form of combination of GE and GN, applying the concepts of the CR economy and decoupling with appropriate alternative concepts. Abandoning economic growth may require a considerable period of time; thus, at the minimum, social-inclusive alternatives of

GE/GN economy concepts should be applied, incorporating a focus on wellbeing and happiness instead of merely economic growth and material consumption. With this in mind, a SWOT analysis is carried out in the next section .

3.5. Results of the SWOT analysis

A SWOT analysis was carried out, drawing on an in-depth analysis of the concept of SD and related and alternative concepts, including their origins, history, meanings, content, and practical use in policies and activities. It is especially focused on the concept of SD and, in general, sustainability, but a number of the identified components can be related to several of the analysed concepts. The differences are emphasised and discussed in more depth. The results of the SWOT analysis displayed in Table 3 are derived from studies and analyses of works by a number of authors dealing with SD and related or alternative concepts. The rationale behind the crucial bullets included in Table 3 is included in the following text.

Table 3. Results of the SWOT analysis (author's elaboration)

Strengths	**Weaknesses**
Use of the concepts of sustainability/SD as a basic philosophy; Keystone: achieving balance between the pillars; Goals: wellbeing, quality of life, meeting the needs of both present and future generations, respecting the limits of the environment; Flexibility: the choice between the concepts of sustainability (in some boundaries), between SD and alternative concepts, and the practical application in order to achieve the goals from the previous bullet (a dynamic state of sustainability).	No clear and fixed meaning of the concepts and related flexibility of their use resulting from multidimensionality, heterogeneity, complexity of the concepts: – unclarity, ambiguity related to the dimensions / pillars of sustainability/SD; – prioritizing one or some pillars of SD; – greenwashing of socially / environmentally harmful activities; – political determination of the meaning / content of the concepts and their goals; SD as an oxymoron.
Opportunities	**Threats**
The development of sustainability science; Achieving goals is based on identifying the meaning of concepts, strengths, and weaknesses; Exploiting synergistic effects; Scientific underpinnings of the relationship between socio-economic and environmental systems: Respecting ecological limits – a question of survival itself; Space for ecological economics and transdisciplinary sciences in genera; Space for the development of scientifically substantiated (sub)concepts and alternative concepts; Measurement of multidimensional aspects: development of suitable scientific methods; Strengthening the institutional dimension.	Resulting from the weaknesses and multidimensionality of concepts: Negative perception, interpretation of concepts, rejection, and failure of the concepts; Replacement of one concept by another, forming new concepts without scientific reasoning, associated ambiguity, and failure of all related concepts; SD, GE, and GG as *buzzwords*; Developing countries: imitation of the development models of developed countries; Misuse of concepts for the interests of concrete stakeholders.

Since the WCED first defined SD, a large number of scholars have submitted their own definitions. Nevertheless, the concept still does not have a clear or fixed meaning. Thus, SD has also been referred to as an oxymoron, i.e., it is fundamentally contradictory. An additional problem related to the concept is the possibility of redefining or reapplying this term by whomever to fit their own purposes. Then, it can become meaningless in practice, or moreover, it can be used to mask or greenwash socially and/or environmentally damaging activities.

The term *greenwashing* was originally coined by environmentalist Jay Westerveld in a 1986 critical essay in which he indicated that the hotel industry falsely promoted the reuse of towels as part of a broader environmental strategy. In fact, the act was designed as a cost-saving measure (Orange and Cohen 2010). Greenwashing generally includes the dissemination of false or deceptive information regarding an organization's environmental strategies, goals, motivations, and actions (Becker-Olsen and Potucek, 2013). It not only affects an organization's profitability, but it also results in ethical harm. It may result from a misunderstanding or exploitation of the deficiencies of the concept of SD (or GE/GG) to organizations' own benefit and can be regarded as a misuse of these concepts, shifting economies away from the path of SD.

It is true that the SD concept gains much of its significance because of its very ambiguity. However, not only the comprehensiveness but also the universality of the SD definition enable various stakeholders to use this term with flexibility, and their initiatives could be incorrectly referred to as SD initiatives. Some individuals, groups, countries, regions, or others, in the effort to achieve their goals and meet their needs at the expense of others, could misuse the concept. However, this is not the essence of SD. Moving closer to SD requires the participation of various stakeholders and the harmonization of perspectives. Thus, it involves the harmonization of different and often opposing values and goals towards a new synthesis and subsequent coordination of mutual action to achieve multiple values simultaneously and even synergistically. Achieving an agreement on sustainability values, principles, goals, targets, and actions is often a difficult task, as different stakeholder values can be affected in different

ways or even criticized. That is, the individual stakeholders can regard the process as threatening to their own values. Following that, they can either reject the process entirely to focus on their own goals or criticize it ideologically without searching for compromises. However, the relevant critique is a crucial part of the proper evolution of the SD concept. It is important because this concept should represent various local to global efforts in order to create and enact a positive vision of a world in which basic human needs are met without damaging or irreversibly degrading the natural systems and ecosystem services that these systems provide and on which humanity depends (Kates et al., 2005).

Nevertheless, the particular challenges of SD are heterogeneous and complex due to the diversity of human societies and natural ecosystems. The adjustability of the SD concept supports its openness, dynamics, and adaptability to such various conditions across space and time. Similarly, it allows participants at different levels, from local to global, within and across sectors, and in various institutions of governance, business, and civil society, to redefine and reinterpret its meaning to fit their own situation. Thus, the concept has been adapted to address very different challenges. At the most aggregated levels, the focus is on the macroeconomic or overall sustainability of national economies, including aspects of international and global sustainability. This means that SD must be achieved globally, and one country must not harm other countries, or, in other words, restrain their attempts to achieve the SD path. At the lower analytical level, i.e., within the countries, it can (among others) range from the planning of sustainable regions, cities, and municipalities through organizations, companies, or livelihoods to individuals. Thus, at the lowest possible level, every individual needs to behave according to the relevant SD principles. The effort to achieve SD must also take place in the relevant industries affecting sustainability and SD. All the industries using natural resources or creating pollution that also affects human health and wellbeing generally must be concerned. That is also the focus of the Rio Declaration's Principle 4, according to which, *in order to achieve sustainable development, environmental protection shall constitute an integral part of the development process and cannot be considered in isolation from it* (United Nations, 1992b). The particular industrial sectors – energy, transport, agriculture, fishing, and the tourism sector – and particular activities in these and other sectors need to be managed in order to be sustainable.

Despite continuing discussions about the meaning of the SD concept, a few common principles have often been emphasized. The first one is a commitment to equality and fairness, in which priority should be given to improving the conditions of the poorest in the world and considering the rights of future generations. The second is a long-term view emphasizing the precautionary principle according to Principle 15 of the Rio Declaration, i.e., w*here there are threats of serious or irreversible damage, a lack of full scientific certainty shall not be used as a reason for postponing cost-effective measures to prevent environmental degradation* (United Nations, 1992b). Thirdly, SD embodies understanding, integration (as explained in the previous paragraph), and acting on the complex interconnections that exist between the environment, economy, and society. This does not imply pursuing one issue at the expense of another, but recognizing the interdependence of these three SD pillars (Drexhage and Murphy, 2010) and also taking into account the role of the institutional pillar.

There is no scientific background for the pillars of sustainability, i.e., no single origin of the three-pillar concept exists (Purvis et al., 2019). The political biases of the concept of SD, to which sustainability science is inextricably linked (Kates et al., 2001), raised concerns about the solidity of its scientific basis, which have remained unclear (Komiyama and Takeuchi, 2006). For the DH concept, the weakness of SD as a genuinely transformative concept directly stems from its falsely consensual nature (Hornborg 2009). The DH concepts pointed out the ideological role of capitalist growth (Purdey 2010) and encouraged discussion about the relations between the economy, society, and sustainability, including their cognitive, material, and political interactions. In terms of the concept, the existing contradictions between economic growth, the environment, and social wellbeing are further emphasized. Hence, it has supported a multi-scalar transformation towards smaller and localized economies that redistribute wealth. In doing so, the DH concept aims to repoliticize the debates on the science and practice of sustainability.

It has been suggested that sustainability scientists have conceived a *thin sustainability* concept, i.e., meeting human needs, both currently and in the future, without degrading the planet's life support systems. Such a definition limits a deeper discussion over a *thick sustainability* (Miller, 2013). By providing a thicker meaning of sustainability, DH repoliticizes the debate in such a way that if a sustainable and just future for present and future generations is to be guaranteed, why should economies grow? Finally, through a detailed analysis of weaknesses, several more specific issues, shown in a more general list in Table 4, can be identified. This knowledge is also associated with the weaknesses of both the GE/GG/SD approach identified by Kothari et al. (2015), and it is completed with the author's own evaluation.

Threats to the sustainability and SD concepts result from their weaknesses. There is a danger that the theoretical concepts and their practical counterparts will replace one with the other since all are multidimensional, cover many aspects, and their precise definitions (or at least some of their aspects and features) are missing. They can be used in distorted forms, depending on the organisations operationalising them or the stakeholders involved, who are pursuing their own interests. This can even lead to misuse of the concepts and greenwashing. Hence, the goals of people's quality of life and wellbeing, while respecting environmental limits, should represent the crucial strengths of the sustainability and SD concepts, regardless of the related or alternative concepts applied. The opportunities

should be mainly the advancement of methodology in all crucial aspects, involving the measurement of environmental limits, quality of life, and wellbeing, but above all, their interconnections and developing appropriate methods that are able to evaluate all crucial aspects together, including their interconnections, as well as allowing for assessments of crucial particular aspects. Hence, a significant challenge and opportunity are represented by the development of sustainability science and the transdisciplinary research within it. A similarly crucial challenge and opportunity is the application of its results in practical action, strategies, and policies at all levels, involving different stakeholders and interests, to achieve global sustainability while increasing the quality of life and wellbeing of people.

Table 4. The summary of weaknesses of the sustainability SD, GE, and GG concepts (Kothari et al., 2015 and author's elaboration)

1. Deficiencies in the analysis of the historical and structural origins of unsustainability and related issues;
2. An inadequate focus on direct democratic governance;
3. An inability to recognize the biophysical limits of economic activities: although green and inclusive, accelerated growth is still predominantly required;
4. Irresponsible corporate behaviour towards environmental services and continued faith in market mechanisms as a major element of the GE;
5. The major focus of the concepts of SD (GE/GG) on science and technology without sufficient promotion of democratic, community-based research and development (R&D);
6. The crucial links between culture, sustainability, and equity are not yet being adequately resolved;
7. The continuation of consumerism: although there is a significant focus on sustainable production and consumption, which forms the basis of the concept of decoupling, there is no explicit focus on the necessity of reducing the current consumption of developed countries. Concepts of decoupling economic activity from environmental harm and the rebound effect (including the Jevons paradox) play a significant role here (analysed in depth in the next section);
8. Deficiencies in forming global relations based on localization: relatively self-reliant communities should be created, which can encourage both sustainability/SD and gradual degrowth. The evidence has shown that, in contrast, the GE approach has continued to promote large-scale global trade in green products, which would be more competitive;
9. Deficiencies in supporting a better architecture for global governance, which would also prioritize human rights and environmental agreements.

To sum up, there are many opportunities for the advancement of the methodology of the measurement of sustainability, regardless of which of the concepts or their combinations are applied, and for their practical application. The concept of sustainability and respecting environmental limits should be used as the basic philosophy. Pursuing the quality of life and wellbeing of people should be a primary goal, and to achieve this goal, appropriate selection of the forms of sustainability and SD concepts in combination with related and alternative concepts should be considered, but only on the condition that environmental limits are respected.

As regards the opportunities identified, there is a place for science-based (sub)concepts, which can help move humanity closer towards the path of SD, as well as for science-based alternative concepts. Some of these alternative concepts may be appropriate for small communities only. However, the flexibility involved in the concept of SD is reflected here, and it is necessary to bear in mind that the whole world can consist of small, sustainable communities. Although still not completely accepted (and there is a long way to go before it is), the concept of DH has the potential to become a more universal philosophy, which can move us closer towards sustainability or even a particular version of SD (although there are contradictions in their theoretical bases). However, DH is not the opposite of GDP growth or negative growth, which is an oxymoron. DH is not focused on achieving less of the same. It involves changing humanity's social organisation to produce and consume to a smaller extent. It involves a critique of the ideology of economic growth. It is also a hypothesis for novelty, encompassing the ecological demands of a lower level of metabolism, a reduction in throughput, and lower material and energy use (see, e.g., Nesterova, 2020).

4. Opportunities for the application and measurement of the concept of sustainable development

Based on the results of the SWOT analysis, two kinds of crucial opportunities for the concepts of sustainability and SD are further analysed. Firstly, it is necessary to apply the concept in practice in such a way as to continue increasing, or at least sustaining, the wellbeing and quality of life of people for an infinite period of time. Improvements and advancements in the methodological area are required and necessary for progress in the first area as well. These areas are analysed in more detail in the following two subsections.

Table 5. Opportunities for the application of the sustainability/SD concepts in practice and their measurement (author's elaboration)

Opportunities for practical application	Opportunities for methodology
• Use of the sustainability/SD concepts as a basic philosophy; based on the initial conditions – the flexibility of choice between the concepts of sustainability (in some boundaries) and a space for related or alternative concepts; • The concepts of: planetary boundaries; decoupling economic growth from environmental harm; circular economy/bioeconomy; • Application of appropriate discount rates.	• Use of composite indicators in combination with indicator frameworks; • Multivariate Data Analysis Techniques: Principal Component Analysis (PCA), Parallel Factor Analysis (PARAFAC), Cluster Analysis, and Biclustering Techniques; • Multivariate Regression Analysis: Partial Least Squares (PLS) regression, Lasso regression; • Compositional Data Analysis.

4.1. Opportunities for practical application

From a scientific point of view and most generally, the practical application and operationalization of the concept of SD can be found in the form of the decoupling of economic activity from environmental harm. The concepts of GE/GG, CR economy, or bioeconomy (see more on European Commission, 2023) are more comprehensive, and they can apply the concept of decoupling (in various forms). The environmental dimension of SD is of crucial importance for sustaining wellbeing, but, even more importantly, not exceeding the assimilation capacity of ecosystems is also essential for the survival of humanity. The concept of planetary boundaries scientifically reflects the limits of ecosystems and hence the boundaries for the environmental dimension. It is a condition for the survival of humanity and, therefore, a condition of SD.

The application of appropriate discount rates for discounting future environmental costs and benefits is also of significant importance with regard to putting the concept of SD into operation, in particular, in relation to the issue of intergenerational equity. Future generations cannot defend their own interests, while current generations tend to discount the future in their trade-offs. The degree of concern, as expressed by the rate of time discount attached to the wellbeing and welfare of future generations, which is ethically required of the current generation, is a highly controversial issue and requires a detailed analysis. The discount rate converts future costs and benefits into their present values. However, its selection is not straightforward. Although there is no consensus on a particular social discount rate for environmental benefits, most of the justifiable rates are in the range of 1–8%, and a number of economists support even lower rates, i.e., in the range of 2–3% (Anderson, 2013). If the rights and interests of future generations had the same weighting as those of current populations, DR would equal zero. This should be considered at least for some projects that are of great interest for sustaining wellbeing or where there is a danger of surpassing the assimilation capacity of ecosystems, taking the concept of planetary boundaries into account, with possible irreversible effects on ecosystems.

The concept of planetary boundaries can be critical for the sustainability and survival of humanity. Although there have been many years of efforts to implement sustainability and SD policies, the human ecological footprint (Wackernagel and Rees, 1996) has surpassed the carrying capacity of the planet (Rockström et al., 2009). More advanced concepts for the measurement of the relationships between the demand and supply of ecosystem services have also been developed. The expression of biophysical limits is dissatisfactory in terms of the definition of SD in the WCED report (WCED, 1987). It also neglects the importance of social justice and equity. However, SD should be understood as a dynamic process enabling all people to become aware of their potential and to improve their quality of life while the planet's life-support systems are protected and enhanced. It means that SD is not only about managing the environment more effectively and efficiently while people continue to do their business as usual. On the contrary, it is a social, economic, and environmental challenge with the objective of optimizing people's wellbeing (Hinterberger et al., 2009; Porritt, 2005). Many scholars have pointed out the need for a paradigm integrating the continuing development of human societies and the maintenance of planetary systems in a resilient way. The planetary boundaries framework is a reflection of such a paradigm by providing a science-based analysis of the risk that human activities will destabilize the Earth system at the planetary scale. According to Rockström et al. (2009), anthropogenic pressures on the Earth System, i.e., the exponential growth of human activities, have reached a scale where abrupt global environmental change can no longer be excluded. Their approach to global sustainability involves the definition of planetary boundaries within which humanity can operate safely. Surpassing planetary boundaries can have catastrophic effects since exceeding given thresholds will cause nonlinear, abrupt environmental changes even in planetary-scale systems. The nine planetary boundaries identified in Rockström et al. (2009) include the global biogeochemical cycles of nitrogen, phosphorus, carbon, and water; the major physical circulation systems of the planet, including the climate, stratosphere, and ocean systems; the biophysical features of Earth, which affect the resilience of its self-regulatory capacity, involving marine and terrestrial biodiversity and land systems; and two crucial aspects connected with anthropogenic global change, which include aerosol loading and chemical pollution. They quantified control variables for seven of these boundaries. For the remaining two planetary boundaries, i.e., chemical pollution and atmospheric aerosol loading, the authors have not yet been able to construct quantitative boundary levels.

Rockström et al. (2009) computed that humanity has already overshot three planetary boundaries, i.e., climate change, rate of biodiversity loss, and changes to the global nitrogen cycle. That is of great importance for the construction of the SD indicators. Planetary boundaries are interlinked and interdependent, i.e., overshooting some of them may both shift the status of other boundaries and trigger their overshooting as well. The social impacts of overshooting will be a function of the social-ecological resilience of the relevant population. The concept of planetary boundaries lays the groundwork for shifting the approach to governance and management, a shift from the sectoral analyses of limits to growth focused on minimizing negative externalities, towards the assessment of the safe space for human development. Since the calculated boundaries are approximate estimates while large uncertainties exist, the enhancement of knowledge is required. Although this knowledge can predominantly be part of the natural sciences, such as ecology, biology, physics, chemistry, or meteorology, the interconnections with the human and social sciences are inevitable. All these aspects should be researched as interdependent within sustainability science.
Table 6 displays both the quantification of the planetary boundaries by Rockström et al. (2009) in the first column and the author's additional knowledge and data related to these issues based on the relevant and most recent available sources.

Table 6. Quantifications of the seven planetary boundaries (Rockström et al., 2009 and Author's elaboration)

1. *Climate Change:* CO_2 concentration in the atmosphere *<350 parts per million (ppm)* and/or a maximum change of *+1 W/m*$^{-2}$ in radiative forcing;	January 2021: *415.52 ppm*; January 2020: *413.61 ppm;* 2020 (mean): *414.24 ppm* Global Monitoring Laboratory (2021) (Last updated: February 10, 2021).
2. *Ocean Acidification:* mean surface seawater saturation state with respect to aragonite ≥ *80%* of pre-industrial levels;	Global mean ocean surface acidity: a global pH value: 2000 = *8,087;* 2019 = *8.055* (Eurostat, 2021). *The predicted pH decrease is approximately 0.3 units during the 21st century* (Science on a Sphere, 2021).
3. *Stratospheric Ozone: <5%* reduction in O_3 concentration from pre-industrial level of *290 Dobson Units (DU);*	The average O_3 concentration is roughly *300 DU.* The ozone forecast – on a daily basis on CAMS (2021).
4. *Biogeochemical Nitrogen* (N) Cycle: limit industrial and agricultural fixation of N_2 to *35 teragram of* N *per year* (*Tg* N *yr−1*) and Phosphorus (P) Cycle: annual P inflow to oceans not to exceed *10* times the natural background weathering of P;	Vitousek et al. (2013): Pre-industrial N fixation = *58 (range of 40–100) Tg N fixed yr−1;* adding conservative assumptions for geological N reduced the best estimate to *44 Tg N yr−1.* The net input of dissolved P from land to the oceans *is 4–6 Tg P/y* (a doubling of prehuman input fluxes). Eutrophication in coastal areas enhances biological production in the whole ocean (Filippelli, 2008).
5. *Global Freshwater Use*: *<4000 km*^{3} per year of consumptive use of runoff resources;	*2014 = 3985.6816 km*^{3} (Global Change Data Lab, 2021).
6. *Land System Change*: *<15%* of the ice-free land surface is under cropland;	*Worldwide, 2.7% of semi-natural vegetated land* was lost to other land cover types from 1992; 1992-2015: natural and semi-natural land – converted to cropland *(81%);* to artificial surfaces *(5%);* to water *(5%);* to bare land *(8%)* (OECD, 2018).
7. The rate of *Biological Diversity Loss: an* annual rate of *<10* extinctions per million species (E/MSY).	2018: global LPI = *69* (WWF and ZSL, 2022); The values of E/MSY for various taxonomic groups, summarized in Lamkin et al. (2016), significantly surpass the quantified boundary levels.

As indicated above, Table 6 is completed with the results of the author's analysis of particular planetary boundaries and important aspects related to them. The global data are included. The recent available data, additional indicators, or related works of other authors are assigned to each of the seven boundaries. In relation to sustainability in its considered meaning, it must be emphasised that biodiversity underpins human life. It is the source of a number of ecosystem services that humans depend on, while the basic life-supporting functions also have high priority (as do others, e.g., provisioning, regulating, or cultural services) (see Millennium Ecosystem Assessment, 2005). It provides services critical for wellbeing and human health as a part of it (e.g., the drugs discovered from plant sources). Reversing trends in biodiversity losses and restoring degraded ecosystems is therefore an essential element of the SD path (OECD, 2019). The Living Planet Index (LPI), which shows the average rate of change in animal population sizes (birds, mammals, fish, reptiles, and amphibians), declined by 69% between 1970 and 2018 (WWF and ZSL, 2022). Ocean acidification is an often overlooked consequence of humankind's release of carbon dioxide (CO2) emissions into the atmosphere from fossil fuel burning. Excess CO2 enters the ocean and reacts with water to form carbonic acid, which decreases ocean pH (describing the acid and base properties of a solution) and lowers carbonate ion concentrations. The predicted pH decrease during the 21st century (see Table 3) would probably be higher than at any time in the last 300 million years. The ocean's surface has an average pH of around 8.1, which is slightly basic. Although the pH of the open ocean is relatively stable in both time and space, the uptake of CO2 by the ocean has caused measurable changes in seawater (Science on a Sphere, 2021).

It is challenging both to determine and to meet the thresholds of SD due to many reasons related to the relationships between human and ecological systems, such as limitations imposed by socio-economic systems, technological advancements, or the ability of the ecosystem to adapt to degradation from human activities. Therefore, it is unrealistic to have a single SD goal or strategy for every country or region. Each country (or a lower spatial unit) needs to develop its SD goals and policies, taking into account a global objective of SD as a basic principle and philosophy. Hence, the cooperation and coordination of strategies and actions at different analytical levels is necessary in order to create synergic effects and move closer towards the path of SD.

To sum up, planetary boundaries define the extent and limits of human activities so that certain significant human-caused environmental changes on a global scale are avoided (Rockström et al., 2009). Specifying boundaries, thresholds, and the assimilative capacity of environmental systems is a crucial issue related to SD since it affects not only the environmental pillar but also the development of economic and social systems (two additional pillars of SD), as well as the resulting wellbeing of people. This research area is demanding in terms of time, quality data, and scientific knowledge, but vital in order to achieve SD/sustainability. The scientific underpinnings of the planetary boundary framework have been further strengthened (Steffen et al., 2015), and this work should continue within the framework of relevant scientific disciplines and sustainability science in light of their interdependence and interconnections.

4.2. Opportunities for methodology

Taking the main features of the concept of SD into account, including multidimensionality, complexity, interdependence between dimensions and variables, different interests of stakeholders, etc., several advanced methods have already been identified as appropriate for the analysis of crucial aspects of SD, or SD as a whole. Multivariate data analysis techniques can be especially useful for that kind of analysis.

PCA is a mathematical procedure and a dimension-reduction tool that is applied to reduce a large set of variables to a small set that still contains most of the information. PCA transforms a number of (possibly) correlated variables into a smaller number of uncorrelated variables named principal components (see, e.g., Johnson and Wichern, (2007). This methodology has already been applied by the author in the analysis of SDGs (Drastichová and Filzmoser, 2019). PARAFAC simultaneously fits multiple two-way arrays of a three-way array in terms of a common set of factors with differing relative weights in each slice (Harshman and Lundy, 1994). PARAFAC is applied in the recent author's studies, since they are especially focused on the analysis of the countries. This method allows for the modelling of the country effect and the time effect separately. Thus, it will be possible to identify the main structure in the time trend, the main structure in the country's behaviour, as well as deviations from these main trends.

Partial Least Squares (PLS) regression, where the relationship between explanatory variables and responses is modelled by fewer components (Varmuza and Filzmoser, 2009), The number of components to be used is a tuning parameter, and its choice is based on a cross-validated error measure, such as the mean squared error (MSE). A second approach is Lasso regression (Tibshirani, 1996), where a penalized LS problem is considered with an L1 norm penalty on the regression coefficients. This has the advantage that, depending on the tuning parameter, some regression coefficients will be shrunken to zero, and thus the corresponding variables can be considered irrelevant for explaining the response. Thus, this corresponds to a variable selection, and the resulting model should also achieve better predictive power. The combination of PCA, PLS, and Lasso regression was applied by Drastichová and Filzmoser (2021) to identify crucial factors affecting quality of life in relation to SD.

Compositional data analysis involves the analysis of compositional data, which are data that measure parts of a whole, such as percentages, i.e., proportions. This is often the case for issues related to the concept of SD. Compositional explanatory variables should not be directly used in a linear regression model because any inference statistic can become misleading. An approach based on the pivot coordinates has already been applied by the author for the analysis of relationships between the relationship between health outcomes and health expenditure in the EU countries, the United Kingdom, Iceland, and Norway (Drastichová and Filzmoser, 2020). Biclustering techniques can also have a crucial place in this research, as they involve clustering rows and columns of a data matrix simultaneously (Padilha and Campello, 2017). Therefore, the next focus of the author is the application of this methodology to discover if countries tend to move closer towards SD and/or some of the related or alternative concepts (analysed above). In contrast to classical clustering algorithms, biclustering simultaneously partitions the rows and columns of a data matrix according to some similarity measure.

More generally, an appropriate combination of indicator frameworks and composite indicators to measure crucial aspects of SD should be applied in each initiative or policy framework. As a crucial example, the most recent SD agenda should be mentioned. The 17 UN's SDGs have 169 specific targets, which are often measured by several indicators. Dasgupta et al. (2022) noticed that missing from the list is an indicator that can be used to judge whether the policies that countries follow to meet the targets support SD. They provided an account of the concept of inclusive wealth report findings. This report monitors inclusive wealth. Since in this framework, economic progress is measured by growth in inclusive wealth, conceptualised by three categories of assets (man-made capital, human capital, and natural capital), it is in compliance with the concept of SD. My recommendation is that the

indicator(s) reflecting a shift towards additional concepts, including the alternative concepts, should also be added. This is also my current research area of interest, starting with the application of the method of biclustering in order to examine how the analysed countries move closer towards SD/sustainability and simultaneously towards the application of the CR, CE, DH, and GE/GG concepts.

5. Conclusions

The concept of sustainability is broad, and it is also often used interchangeably with the concept of SD. These two concepts were also analyzed in relation to the concepts of the GE and GG and also to additional, including alternative concepts. A number of alternatives, including transformation discourses, have been developed over time as a reaction to the deficiencies of the SD concept. The aim of the work was to define and clarify the strengths, weaknesses, opportunities, and threats to the concept of SD, with the main focus on the possibility of its practical application, which should aim to sustain or increase wellbeing and quality of life within ecological limits. The concept of SD is taken as a fundamental concept and as a basic philosophy in relation to which the remaining concepts are analysed.

Efforts were also made to clarify the relations of the most crucial alternative, including transformation, discourses to SD. The use of the concepts of sustainability and SD as a basic philosophy, including the balance of the three pillars of sustainability in general, are the main strengths identified. Crucial opportunities include exploiting these strengths and moving closer towards the aims of SD, which should include the quality of life and wellbeing of people. With the goal of sustaining sources of wellbeing for people, opportunities for crucial practical applications and methods of measurement of the concept of SD are identified. The relationships with the other concepts were summarized.

Ecological economics can provide a platform for a transformation towards a new socio-economic model respecting the environment, with a focus on biophysical planetary boundaries, and improving wellbeing and quality of life while challenging current forms of economic growth and taking the above-mentioned concepts into account. It should provide the inevitable knowledge required for the newly forming emerging science dealing with sustainability and SD, namely sustainability science. Regardless of which concepts and practical strategies are chosen to achieve sustainability, the main aim of wellbeing and quality of life within ecological limits, or more particularly, within planetary boundaries, should be pursued. The future socio-economic-environmental system could have a form of compassionate economy. The discussion about an acceptable form of degrowth is also a significant challenge for the future. The gradual formation of an institutional background, including policies for sustainable degrowth, is inevitable.

It is not obvious whether the concepts of SD, GE, and GG will continue to have an important place in international and national policy agendas or will progressively disappear due to the criticism they have received or will receive, or if these terms will become buzzwords and/or conceptual terms. Alternatives (including the transformation concepts) tend to focus on human sustainability to a greater extent, but it is not clear that this extent is higher than that of the concept of SD based on the WCED report (WCED, 1987), in which the focus on human needs is significant. Compassionate economics and the appropriate features of all the analysed concepts, in combination with the application of philosophy and the basic principles of degrowth (in particular), represent an economic system that could provide essential improvements to mainstream capitalism. Lower growth rates mean lower material consumption, decreasing environmental impacts, and reduced use of natural resources. This could help return human activities to a space within the safe limits of global ecosystems. Hence, a high level of wellbeing and quality of life within planetary boundaries should be the main focus of the socio-economic-environmental systems applied in the future.

My recommendation is that the indicator(s) reflecting a shift towards additional concepts (including alternative concepts) should also be added. This is also my current research area of interest, starting with the application of the method of biclustering in order to examine how the analysed countries move closer towards SD/sustainability and, simultaneously, towards the application of the CR, CE, DH, and GE/GG concepts.

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