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Sustainable Development and Sustainable Science. Where We Came From, Where We Are Now and Where We Are Heading? Part II: An In-Depth Analysis of the Concept of Sustainable Development

Zrównoważony rozwój i zrównoważona nauka. Skąd przyszliśmy, gdzie jesteśmy i dokąd zmierzamy? Część II: Dogłębna analiza koncepcji zrównoważonego rozwoju

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Abstract

The concept of sustainable development (SD) is broad and moreover, it is often interchangeably used with the more general, but sometimes also more specific, concept of sustainability. The concept of SD is analysed on the basis on its development (analysed in the first part: Drastichová, 2022) and relationships with sustainability and related scientific (theoretical) and practical concepts. The rationale behind this work lies in clarifying the meaning of SD, including the concept of sustainability, and, on the basis of this, identifying the main ways of moving closer towards the aims of SD, including quality of life and wellbeing. The limitations of the concept are identified and summarized, as are the alternatives to SD and sustainability. The rationale behind this work lies not only in the clarifying of the SD concept, but also in the normative evaluation of this concept in relation to the wellbeing and quality of life of the Earth's population for an infinite time period, while maintaining the supply of ecosystem services which the planet provides, taking into account that these resources are not only a source of people's wellbeing, but are essential for people's survival in general. Hence, this work includes an in-depth sophisticated consideration of the SD concept based on its historical development, as well as normative assessments of the concept resulting from this knowledge. Alternative concepts and the possibilities of sustain-ability science are also summarized. A significant effort has been made to identify the relationships of the SD concept with sustainability and to the main related scientific (theoretical) and practical concepts, as well as to the alternative concepts to them. These outcomes were again obtained from a detailed analysis of history and relevant scientific works. Finally, a possible design of the SD concept is outlined on the basis of the analysis and synthesis of the knowledge.

Key words: quality of life, sustainable development, sustainability, sustainability science, wellbeing
JEL Classification: I10, I13, I15, I18, Q01

Słowa kluczowe: jakość życia, rozwój zrównoważony, zrównoważoność, zrównoważona nauka, dobrostan

1. Introduction

Over the course of human development, the human-nature (human-environment) relationships have changed. The capitalist model of production and consumption has caused huge changes in the environment and the scale of its degradation. The reality of relationships between human and ecological systems, as well as between progress, growth and development, and between the development and conservation of nature, predetermined the emergence of the SD concept as a compromise between these concepts and interdependent issues within them. Although they are closely interrelated, there are some distinct features in their use.

The relevant fundamental knowledge for this work is provided in Drastichová (2022), on which this work builds. Sustainability as a nebulous, but attractive concept, poses an essential question for every activity – whether it can continue. The concepts of sustainability and sustainable development (SD) are broad and often used interchangeably, but there are significant differences, although they are interconnected. If an activity is sustainable, it can continue forever, which reflects a general definition of sustainability in relation to the SD concept.
As in the first part, the most famous of WCED (1987), which defined SD as *development that meets the needs of the present without compromising the ability of future generations to meet their own needs,* is considered as fundamental for this work. So are its two key concepts – the concept of needs and that of limitations imposed by the state of technology and social organization on the environment's ability to meet present and future needs. Hence, the concept of SD is composed of two crucial elements, i.e. meeting human needs and respecting the limits imposed by the environment (WCED, 1987). Based on the analysis of history of the SD concept in the first part (Drastichová, 2022), this definition is further analysed and critically evaluated in the following sections.
Similar to the first part (Drastichová, 2022), the rationale behind this study lies in a consideration of the concept of SD as a basic philosophy. Mainstream neoclassical environmental (EN) economics is regarded as the basic scientific (theoretical) approach for dealing with environmental issues in economics. Other crucial approaches in economics, including alternative approaches, i.e. the theoretical foundations for practical applications, are also considered. Beeks (2016) studied fourteen economic systems, including environmental (EN), circular (CR), green (GN), resilience (RE), ecological (EC), complexity (CY), feminist (FE), compassionate (CT), caring (CG), degrowth (DH), steady-state (SE), no-growth (NH), ecosocialism (EM), and anarcho-ecosocialism concepts/systems (AEM). According to him, the formation of these systems is related to the misunderstanding that a sustainable society can be based on an economy with economic growth which also has significant effects on ecosystem services (see more about these services in Drastichová (2022). Nevertheless, the approach applied in this work is different to some extent. Not all of these concepts can be understood as alternatives to sustainability and SD, especially the EN, CR, GN, and RE economy/systems, although they can be provide alternatives to the system of capitalism from several perspectives. Additionally, the EN and EC economics can be understood more as the theoretical foundations to the practical concepts that focus on the relationships and balance between the economic, social, and environmental dimensions of economies. EC economics also provides an alternative to the neoclassical EN economics. Based on this approach, the concepts of sustainability and SD are considered as basic concepts, the concepts of green economy (GE) and green growth (GG) are regarded as more practical concepts, which also operationalize the concepts of sustainability and SD. As alternative approaches, the concepts of SE, NH and DH economies, and a number of even more practical alternatives to the concept of DH, reflecting the cultural features of smaller communities, are considered. The remaining concepts in the list, including CY, FE, CE, CG, EM, and AEM economy/systems are understood as more comprehensive concepts, which significantly support quality of life and wellbeing. They provide not only alternative thinking on the concept of SD, but also alternatives to the concept of capitalism in general.
In this work, the knowledge resulting from the analysis of history and crucial scientific works dealing with SD are summarized (see Drastichová, 2022), further analysed and deeper conclusions derived. The main aim of the work is to clarify the essence and deeper significance of SD based on an analysis of the history of the concept, key scientific works and practical policies, strategies, and actions. Putting the concept into operation is crucial. It should be aimed at sustaining or increasing wellbeing and quality of life within the limits of the planet/ecological limits. Analysis and synthesis of the obtained knowledge are the basic methods applied. Normative approach and critical evaluation are used to derive conclusions and recommendations.
This paper has been divided into the following parts: Introduction (section 1); Results of an in-depth analysis of the concept of sustainable development (section 2); Sustainability science and possible design of the concept of sustainable development (section 3); Conclusions (section 4).

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

For a deeper understanding of the content of the SD concept, the differences between the concepts of SD and sustainability need to be analysed in more detail. The related basic and more practical concepts, and alternative scientific concepts need to be analysed and correctly understood.

2.1. Sustainability versus sustainable development; related concepts; alternative concepts

The fundamental science in the field of economics on which sustainability science could be based can be represented by environmental economics and the fundamental alternative (transdisciplinary) science especially by ecological economics (EC) and subsequently by other concepts, which can be understood as parts of (or to some extent based on/resulting from) the previous two. However, some of them have already developed to such a high level of comprehensiveness that they can be understood as more or less separate concepts. They include circular (CR), green (GN), degrowth (DH), non-growth (NH), steady state (SE), and resilience (RE) economics. They also have

their practical counterparts, which can also be understood as strategies in policies which are comparable or alternatives to the concepts of SD or sustainability or their alternatives. A number of them have already developed to a high level of comprehensiveness, i.e., use at global, international, national levels (and subsequent application at lower levels) has been achieved. This has occurred especially with the concepts of the GE and GG; the CR might also be included, although it can be understood as part of the GE. CR corresponds with the field of biomimicry (Church, 2014; Pauli, 2010), which represents eliminating waste, mimicking nature, internalizing externalities (as is seen in natural processes), and emulating a closed loop cycle. A circular economy, as opposed to a linear consumption economy, is one that is regenerative and that recycles and reuses products rather than disposing of them. NH and SE economies maybe more specific; nevertheless, there are several definitions of these concepts. NH economists support the SE economy, considering economic growth to be a main contributor to numerous global problems. A number of works support both SE and NH economies, regarding them as compatible with each other; however, a distinction is that an SE economy may experience qualitative 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 (Trainer, 2011). NH economists consider capitalism in its present form to be too focused on accumulation. Therefore, it is necessary to stop reliance on market forces, laissez-faire idealism, and the related pursuit of profits and economic growth (Trainer, 2011). Jackson (2012) claimed that a sustainable economy can be achieved and prosper without economic growth.

From the practical alternative concepts, that of DH has been gaining ground. However, there are still significant obstacles to putting it into operation fully. As lower-level alternatives to DH or other concepts, several practical concepts at regional or local levels have evolved, especially in the developing countries, better responding to their needs. They include Buen Vivir, or Ecological Swaraj, which represent genuine alternatives to both SD and the GE. Although in Beeks (2016), the fourteen scientific socio-economic-environmental models are defined together as the alternative systems to capitalism, here a deeper classification was adopted, while some of them are understood as basic scientific socio-economic-environmental concepts, especially the EN economics, which can be understood as a fundamental science for the so-called sustainability science. The concepts indicated above, including CR, GN, DH, NH, SE, RE economics, are partly based on it, and partially on the EL economics, which can be understood as an alternative to EE economics, but these eight models can be based on both of them, while also including alternative ideas and having some relations to SD/sustainability concepts.

CT, CG, CY, EM, AEM and FT economics, which are the remaining concepts (systems) analysed in Beeks (2016), can be understood in a more complex way, while the previous models can affect and determine particular aspects of their philosophy. These models also involve more complex social aspects, and as more complex models they can represent the alternatives to the current system of capitalism, which is increasingly understood as destructive to natural and social systems (Martínez-Alier et al., 2010). Finally, there are supplementary concepts, especially those involving human development approaches, and different sustainability types, which can significantly determine and define the approach to SD and sustainability in general. Moreover, there are many more fundamental concepts involved in the SD concept and its practical counterparts, especially GE, GG and CR, which must work with them in order to move closer towards SD and sustainability. These especially include the concept of decoupling economic activity from environmental harm (further: *decoupling*). The concept of decoupling implies breaking the link between environmental *bads*, which represent environmental pressures, including the use of natural resources and the emission of pollutants/generation of waste, and economic *goods*, referred to as driving forces, which are economic activities, often expressed in terms of GDP at the macroeconomic level. Hence, all ecosystem services can be included. Absolute decoupling, including an absolute decline in resource (ecosystem service) use over time while the economy grows, has not been taking place (Fritz and Koch, 2016; O'Neill et al., 2018), and it does not have to change in the future (Jackson, 2017). There are several key factors responsible for this development. The crucial one is the *rebound effect*, which is an umbrella term for a variety of mechanisms that reduce the potential energy savings from improved energy efficiency. It results in any reduction in the market costs of relevant resources caused by improvements in efficiency being translated into an increase in aggregate throughput, rather than a decrease (Sorrell, 2009). Since the seminal work of S. Jevons (*The Coal Question*) (Jevons, 1866), the issue of the rebound effect has repeatedly been a subject of energy policy debates, challenging the consensus that improved energy efficiency will reduce energy use (carbon emissions) and mitigate resource depletion. Energy efficiency is often considered to be essential for harmonizing economic growth with environmental sustainability. Although the rebound effect has often been considered to be modest in size and easily addressed, there has always been a minority of scholars who have argued that rebound effects frequently exceed 100% and can potentially eliminate all of the energy savings from improved energy efficiency. This is referred to as the Jevons Paradox (Ruzzenenti et al., 2019), which implies that, in the long term, an increase in efficiency in resource use will generate an increase in resource consumption rather than a decrease (Sorrell, 2009; Madureira, 2014).

The concept of sustainable consumption and production (SCP) and resource (eco-)efficiency must be further emphasised. They are significantly interconnected together as well as with the concept of decoupling. The concept of

sustainable consumption and production (SCP) has gained interest along with the concept of SD. Overconsumption, especially in developed countries, has been identified as a major challenge in moving closer towards SD and, therefore, moving closer towards the path of SD/sustainability will require a subsequent SCP to put it into operation. SCP will also require additional tools and processes to put it into operation. Several studies have dealt separately with the concept of sustainable consumption (SC), which has also received attention in relation to SD. Concerning the formation of the term sustainable consumption, the problems related to consumption have been recognised since the publication of The Limits to Growth in 1972. The consequences of a rapidly growing world population and finite resource supplies were modelled there, using a model to simulate the interactions between the Earth's and human systems (see section 2). Improvements in the eco-efficiency of consumption mean a reduction in resource consumption per consumption unit due to improvements in production processes or an efficiency friendly design. This is a weak SC approach. The second approach considers the need to achieve a change in consumption patterns and a reduction in consumption volume. Concepts of SC that integrate both developments are referred to as strong SC. In summary, concepts and definitions of weak SC emphasise increasing the eco-efficiency of consumption, while those of strong SC emphasise the importance of changes in terms of consumption patterns and volume for achieving SD. Moreover, the strong SC approach goes beyond its use in achieving SD within the current system of capitalism, and is closely related to the concept of degrowth. Nevertheless, the 10-year framework of regional and national SCP initiatives developed after the 2002 WCED favoured eco-efficiency (Berg, 2010). This weak SC approach is still commonly applied. The EU approach is also based on this, although its SD policies are considered to be among the strongest. The European Commission SCP policies put the emphasis on the production side.

The relationships between the concepts of SD, GE and GG should be further analysed to derive conclusions related to the aim of this work. As regards the concepts of green economy (GE) and green growth (GG), these concepts can be understood as the practical counterparts of the more theoretical concepts of sustainability and SD. Both GE and GG concepts have gained importance in political agendas at the national/global levels. GG can be understood as a political catchword, introduced to overcome reservations of the business sector against all kinds of *greenery*, regardless of the potential economic benefits. It is at the core of the GE concept (UNEP, 2011). The OECD has made it its new overarching slogan (OECD, 2011), although it has not been coherently applied. The concept of GG was championed by the Republic of Korea. Like SD, the GE and GG are multidimensional concepts. GE focuses on the potential trade-offs/synergies between economic and environmental dimensions without ignoring social issues. The first mention of the GE concept was from the late 1980's 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). The concept of the GE was revived in the time of the global financial and economic crisis (broadly: 2007-2011), without any consensus on its definition. In particular, 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 revived as an operational strategy enabling both economic recovery and more sustainable growth in the future. The UNEP, which institutionally promoted the concept at the international level, launched the Green Economy Initiative in 2008 and called for a Global Green New Deal in 2009 (Barbier, 2012; Bowen et al., 2009; Georgeson et al., 2017). When the UN General Assembly convened the 2012 UNCSD in 2009, it designated the GE as one of its two main focal areas. The UNEP defined an inclusive GE as *one that results in improved human wellbeing and social equity, while significantly reducing environmental risks and ecological scarcities* (UNEP, 2011). GE discourses were also seen as a way to cope with the decreasing traction of the SD concept on economic policymaking (Jacobs, 2013). The GG concept did not draw considerable attention before the 2000. The OECD adopted the Green Growth Declaration in 2009 (OECD, 2009) and published its Green Growth Strategy Package in 2011. Such a 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). Ferguson's study of GE discourses (Ferguson, 2014) concludes that GG discussions must be separated from GE discussions. The author identified many tensions in GE discourses as well as three categories of GE discourse: weak, transformational and strong. Part of this categorisation involves assessing measurement, focusing on its relationship to GDP. This classification is also related to the weak/strong differences from definitions of sustainability (see subsection 2.2). He assigned particular strategies to these discourses. The OECD's approach (Towards Green Growth, (OECD, 2011)) is referred to as weak and the UNEP's approach (Towards a Green Economy (UNEP, 2011) as transformational. Of the remaining strategies, it is worth mentioning the approach of the EU in Europe 2020: a strategy for smart, sustainable and inclusive growth (European Commission, 2010). GE was broadly defined as *smart, sustainable and inclusive growth*, which was again associated with weak/ transformational approach. Then, the approach of the World Bank in its report *Inclusive green growth* (World Bank, 2012)

is also weak and inclusive GG is referred to be the pathway to SD. There are also works supporting the transformational/ strong approaches, which involves the need that policies deliver economy-wide innovation and structural transformation (several publications of Barbier, e.g. Barbier (2011, 2015), or a clearly strong approach (several publications, e.g. Cato, 2009; Jackson and Victor, 2011), where academic strong GE literature varies from green and ecological economics to de-growth and no growth perspectives. Hence, it is confirmed again that a strong approach in this area is closer to the alternative concept of degrowth.

Thus, additional considerations are focused on degrowth and its local alternatives, i.e. the concepts which fit to specific communities, such as Buen Vivir (from Latin America) and Ecological Swaraj (Radical Ecological Democracy from India) and their relationships with the SD concept and the related concepts. These can be understood as alternatives to both SD and GE, involving an alternative to economic growth (the two latter – at a local level) (Kothari, Demaria and Acosta, 2014). Of the analysed concepts, these concepts can be identified as the major alternative to the SD concept.

In 2008, the First International Conference on Socially Sustainable Economic Degrowth for Ecological Sustainability and Social Equity took place in Paris. A number of scholars supporting the degrowth idea participated to develop the idea of degrowth and the *Paris Degrowth Declaration* was adopted. The term degrowth is used in different ways by different authors (e.g. van den Bergh and Kallis, 2012). Kerschner (2010) defined the main idea behind the concept as: *an equitable downscaling of production and consumption that increases human wellbeing and enhances ecological conditions at the local and global level, in the short and long-term.* This definition requires the reduction of production and consumption to a sustainable level, which should lead to a decrease in resource use and pollution, which in turn will improve environmental conditions. Degrowth involves two aspects in this definition. Tabellini (2019) defined it as the process of material downscaling of a society and the resulting reduction of its environmental impact on the planet's ecosystem (similar to Kallis, 2011). In compliance with that, degrowth cannot be a long-term goal for societies, but just a means to achieve a state of environmentally sustainable equilibrium with planetary ecosystems. Then degrowth can be understood as the means and a SE economy as the final goal (O'Neill, 2012). The author also defined an SE economy as a functionally stable economy in which *a constant stock of capital is maintained by a low rate of throughput that is within the regenerative and assimilative capacity of the ecosystem* (Daly, 2008).

The first aspect is the down-scaling of production as measured by the GDP indicator. This aspect is also referred to as GDP degrowth, economic degrowth, or planned economic contraction. The second aspect is the down-scaling of consumption, i.e., consumption degrowth. Besides these two main ideas, there are also additional aspects of degrowth and related definitions. Work-time degrowth requires a gradual change towards shorter working weeks, longer holidays, and earlier retirement. It is argued that increased labour productivity due to improved education, skills, labour division, and technological progress results in the production and consumption of more goods rather than an increase in leisure. As a direct effect, work-time degrowth would not only lead to a decrease in production and lower wages, and therefore less consumption, but arguably, also less work stress and more happiness due to increased leisure (Van den Bergh, 2011).

It can be concluded that the concepts of GE and GG can be understood as practical strategies created by international organisations. They should complement or even try to replace the SD concept. These terms can also be understood as theoretical concepts, which have certain identifying features developed over time based on these political concepts and strategies. The concepts of degrowth, Buen Vivir and Ecological Swaraj can be identified as the major alternatives to the SD concept. A main common feature of them is that the focus should be diverted from the quantitative economic variables, such as production, consumption and more generally, the macroeconomic indicator GDP. On the contrary, it should be shifted towards wellbeing, happiness, life satisfaction and other subjective variables. A deeper analysis of all the concepts is beyond the focus of this work. However, the basic analysis of the relationships between sustainability and SD must be added.

2.2. Sustainability versus sustainable development

Sustainability and SD represent two crucial contemporary discourses at global, international, EU and national policy levels. These concepts have attracted more interest at both national and global 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 outlined in the previous section, dealing with the origin and history of the concept of SD. 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* (the doctrine of foresters for two centuries) (Carlowitz, 1713; Grober, 2007). In compliance with that, Axelsson et al. (2011) described sustainability as a policy vision of the society with primary purpose of preventing the depletion of natural resources. Dovers and Handmer (1992) claimed that it is 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). The concept of sustainability is conceptual (Ekins et al., 2003) in general and hence often misunderstood.

The terms *sustainability* and *sustainable development* are often used interchangeably (especially in public debates) (Norton, 2005). However, many scholars, such as Axelsson et al. (2011), emphasised that the two terms have different meanings. According to some scholars, the issue of what sustainability means is much more complex currently (Kidd, 1992; Lee, 1993 Clark, 2002). According to several of them, this term includes ecological integrity, biodiversity conservation or ecological sustainability (Parotta et al., 2006; Ramakrishnan, 2001). Ultimately, this is linked to the potential of an exploited ecosystem to subsist over time (Reboratti, 1999), and continue to provide goods and values for humans. According to Sartori et al. (2014), sustainability is a process and mechanism to achieve the intended SD. Nevertheless, SD is about the societal process of moving toward collective economic, ecological and socio-cultural goals by multiple stakeholders (actors) with different powers at multiple levels of decision-making (WCED, 1987; Baker, 2006; Strange and Bayley, 2008). A shift from government to governance (Pierre, 2000, Peters, 2000), which requires collaboration between societal sectors at different administrative levels (Ostrom, 1990), is crucial to this process. The importance of the institutional aspects, and, more generally, of the institutional pillar of SD, results from the facts described above. Both concepts can also be understood as social learning and steering processes, both involving management and governance mechanisms (Lee, 1993). SD is also understood as a collaborative learning process, i.e. social learning (Keen et al., 2005) in the local to global community (Daniels and Walker, 2001; Pretty, 2003; Wals, 2009) with the aim of building social capital and capacity to address sustainability issues (Woolcock 1998). SD is multidimensional in scope (Slimane, 2012) and an integrated concept (Sartori et al., 2014). It is based on the principles of sustainability (Dovers and Handmer, 1992). The concept of SD is aimed at finding a balance between preserving the ecosystem and meeting human needs (Olawumi et al., 2018). It can be concluded that SD is one of the most challenging policy concepts developed (Turner, 1992). Its core objective is to provide to everybody everywhere and at any time the opportunity to have a dignified life in his respective society (a kind of ethical directive). This demand for a high quality of life is assumed to include a decent standard of living, social cohesion, full participation and a healthy environment (WCED, 1987). Although several scholars have described the relationships between the concepts of sustainability and SD differently, after an in-depth analysis several key approaches were identified in this work as crucial to explaining the relationships between the concepts of SD and sustainability.

The first approach is based on the necessity of that development (process of change) which is sustainable in order to achieve a desired state of sustainability. However, the final state of sustainability reached is not a static point, but is changeable and always evolving and developing if the path of SD is achieved. The meaning of the term sustainability in relation to SD as a *sustained yield*, as well as the views of different scholars dealing with this term in relation to SD are considered. The second approach to understanding sustainability in relation to SD recognized as the crucial one is based on several concepts of sustainability defined by particular criteria. In accordance with this approach, SD can be explained in relation to the criteria of very weak, weak, strong and very strong sustainability concepts and, 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. Although the first four types can be mainly associated with particular dimensions of SD, taking into account their interconnections and interdependence, the last two go beyond all the pillars of SD. Moreover, it should also be included in the first approach outlined above. Human sustainability, wellbeing and quality of life should be understood as the main aims of SD, and strategies and policies in this area.

From the neoclassical economic perspective, the sustainability issue has at its core the phenomenon of market failure and its correction through proper resource pricing. Then, an intertemporal efficient allocation of environmental resources through price corrections based on individual preference value is required (Solow, 1974, 1986). Differences in disciplinary perspectives and in the philosophical and ethical interpretation of SD have resulted in concepts of sustainability which prioritize either economic or environmental objectives. In broader terms these concepts include the opposing paradigms of weak and strong sustainability (Hediger, 1999; Neumayer, 1999b; Pearce et al., 1994) which are based on different conceptions of capital theory. Victor (1991) indicated that one of the contributions that economists have made to the SD debate is the idea that by pursuing economic growth the depletion of environmental resources, i.e. source and sink resources, is akin to living off capital rather than income. Then, SD is defined as the maximum development that can be achieved without exhausting the capital assets of the nation, which represents its resource base. 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, K_e) 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). Nevertheless, it must be emphasised that some characteristics of these concepts (in a borader as well as in a narrower classification) are in practice less clearly defined and sometimes overlap (a detailed analysis of these concepts was elaborated on by the author (Drastichová, 2018).

Weak sustainability concept involves the necessity of maintaining the stock of total capital, including the man-made and natural capital, or, an economy's generalized productive capacity (Solow, 1986). In narrower terms, there is also a *very weak sustainability*, which requires that the generalized production capacity of an economy is 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, 2000; Opschoor, 1996; Pearce et al., 1994). This is not limited to sustaining a material standard of living or consumption, but it also includes values related to non-consumptive uses, i.e. existence and bequest values, and the public good character, i.e. amenity and recreational values, of the environment. 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, the very strong sustainability perspective is added. It calls for a steady-state economic system based on thermodynamic limits and the constraints imposed by them on the overall scale of the macroeconomy. Zero economic and zero population growth are required to achieve a zero increase in the scale of the macroeconomy. However, it is emphasised by supporters of the steady-state paradigm that development is not excluded and that social preferences, community-regarding values and generalised obligations to future generations can all be fully involved in the steady-state economy as it evolves. This requires the conservation of the moral capital (K_e), on which economic activity eventually depends (Hirsch, 1976; Daly and Cobb, 1989). The analytical descriptions of all concepts of sustainability are included in Table 1.

Table 1. Sustainability rules and indicators, source: Turner (1992), author's elaboration

	No critical natural capital	*Critical natural capital*
Very weak sustainability (VWS)	$\frac{s}{y} - \frac{d_k}{y} = SI$ $SI > 0$	Perfect Substitution: All K_n a K_m Growth Economy
Weak sustainability (WS)	$\frac{s}{y} - \frac{d_m}{y} - \frac{d_n}{y} = SI$ $SI > 0;\ \lambda > h; n > Z$	$SI > 0;\ \lambda > h;$ $n > Z; d_n^* \leq 0$
Strong sustainability (SS)	$d_n \leq 0; SI > 0$	$SI > 0;\ d_n \leq 0;$ $d_n^* \leq 0;\ d_{K_c} \leq 0$
Very strong sustainability (VSS)	Perfect Complementarity: All K_n and K_m Stationary State Economy	$SI > 0;$ $d_n \leq 0; d_n^* \leq 0;$ $h \leq 0;\ d_{K_c} \leq 0;\ d_{K_e} \leq 0$

Notes: K = total capital assets; K_m = man-made capital K_n = natural capital, s = savings; d_m = depreciation on man-made capital; d_n = depreciation on natural capital; λ = technical change; h = rate of population growth; n^* = critical natural capital: *no substitutes*; K_c = cultural capital; K_e = moral/ethical capital; Z = lower bound stock limit (determined via SMS) to ensure ecosystem stability; SI = sustainability index.

Moreover, Victor (1991) identified four schools of thought on the environment as a capital asset whose views range across a spectrum from very weak sustainability to very strong sustainability. These 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 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, 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 neither weak nor strong sustainability (Hediger, 2006, 2004). Then the position of the concept of SD would be between the concepts of WS and SS. However, it goes beyond all these concepts since it includes the requirement of meeting basic human needs.

Additional concepts which are based on particular criteria have also been developed. These concepts can be assigned to one or more dimensions of SD, or go beyond all the dimensions of SD and be affected by all of them (and also affect them). Environmental sustainability concept is associated with the deep ecology movement and it requires sustenance for every specific component of natural capital and every flow of particular natural resources. Hence this concept is characterised by the respect for the environment and prioritization of ecological concerns over economic development acknowledging the natural changes. The ecological sustainability goes even further towards the protection of natural capital (environmental assets) and it is interpreted as maintaining the composition, structure, and processes of an ecological system (Anderson, 2010, 2013). Human sustainability can be understood in narrower terms as a sustenance of the human capital that is needed to maintain levels of health, wealth, production, and thus also welfare (Spangenberg, 2002). In broader terms, the HD paradigm draws on the conceptual works of Sen (1985) and the Capability Approach (CA), among others. The CA is *a moral approach that sees persons from two different perspectives: wellbeing and agency* (Sen, 1985). People pursue wellbeing in that they seek to *function* well as human beings. People exercise *agency* in that they decide how to shape their lives and

environment. Hence, according to the CA, human wellbeing includes capabilities beyond functioning. HD paradigm builds on the work of the United Nations Development Programme (UNDP), and the publication of its annual reports, starting from 1990. It is an approach for advancing human wellbeing which is focused on expanding the richness of human life, rather than simply the richness of the economy in which human beings live. Accordingly, the HD paradigm is based on the understanding of development as being *development of the people by the people, for the people* (UNDP, 2022). The contribution of HD can be perceived in two main areas: the idea of moving development away from a purely economic-based perspective (one measured by GDP); and from a purely state-centred perspective, to one in which people become the main agents of development. As mentioned above, HD's shift to people-centred approaches was underpinned by the CA, especially articulated by Sen and Nussbaum (e.g. Nussbaum and Sen, 1993; Sen, 1999). The ideas of HD and more precisely of the CA have been gradually introduced to ecological economics in the mid 2000's. This kind of sustainability should have its place in the SD concept as its philosophy, purpose and ultimate goal. Thus, the HD approach must be included in every SD strategy.

Another kind of sustainability, which is more specific and human oriented, is social sustainability. It focuses on personal assets, including education, skills, experience, consumption, income and employment. Social welfare depends on citizens' ethics, discipline, tolerance and trust (among other factors). Institutional sustainability can be understood as an institutional pillar of SD when explicitly speaking about SD. It can also be understood as being aimed at interpersonal processes like democracy and participation (institutional mechanisms), distributional and gender equity (institutional orientations) or independent and pluralistic sources of information (organisations). (Spangenberg, 2002). All the types of sustainability introduced in this section have an importance for achieving SD either as part of the goal, the concept of SD, or as a part of the strategy (process) leading towards SD.

New, alternative and complementary concepts should be considered when dealing with SD, quality of life and wellbeing. Innovative ideas and strategies but also systemic changes in the longer period should be included. EL economics can provide a platform for a transformation towards a new socio-economic model respecting the environment (biophysical planetary boundaries), and improving wellbeing and quality of life (challenging current forms of economic growth and taking the above-mentioned concepts into account). Moreover, sustainability science has already been established as a discipline (see more in section 3). As recent developments have shown, functioning health and social systems are essential for SD, wellbeing and quality of life, and this will be a crucial challenge for the near future.

2.3. Summary approaches to the definition of sustainable development

Resulting from the crucial definition of WCED (1987), SD is a global development concept giving top priority to the satisfaction of human needs, in particular of the global poor, while respecting environmental limits. As it is stated in the second part of the WCED (1987) definition, it contains within it two key concepts. It is the concept of needs, in particular the essential needs of the world's poor, to which overriding priority should be given; and the idea of limitations imposed by the state of technology and social organization on the environment's ability to meet present and future needs.

Building on previous knowledge, three major approaches to SD have been developed (United Nations et al., 2003) since the adoption of the WCED report (WCED, 1987):

1. 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, because each of the three pillars is independently crucial and the three pillars are interlinked.
2. The ecosystem health approach regards the economic and social systems as sub-systems of the global environment. The capacity of ecosystems must be sustained to respond with resilience to external effects. The health of ecosystems must be protected and enhanced. This approach is focused on:
    - The *pressures* put on ecosystems by human activities, which are often the cause of reduced ecosystem health. This is reflected in degraded service flows.
    - The *responses* of ecosystems to these pressures.
3. The resources/capital approach considers SD to be 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 physical and social sciences to include measures of human, social, natural and environmental capital (Goossens et al., 2010).

Although each of these approaches emphasises a particular view of the concept, they are significantly interconnected with one another. The first approach places the same importance on each of the pillars, which are interconnected, while the second one also takes into account that socio-economic systems exist within ecosystems.

Although the three-pillar conception of social, economic, and environmental sustainability in the SD concept represented as three intersecting circles with overall SD/sustainability at the centre has become universally used. It can be concluded that there is no single point of origin of the three-pillar conception. Rather, a gradual emergence can be seen, which is related to various critiques of the economic status quo in the early academic literature from

both social and environmental perspectives, and to research into the possibilities of using economic growth as a solution to social and environmental problems at the UN level (Purvis et al., 2019). To identify the origin and theoretical foundations of this conception, it is necessary to study historical sustainability literature (see section 2). The three-circle diagram (see Figure in section 3) seems to have been presented first by Barbier (1987), although with differences to modern interpretations. A more detailed analysis of these aspects in relation to the practical application of the concepts of SD/sustainability, including some additional aspects of their critique, is included in section 3.

The third approach defines different kinds of capital assets related to the pillars of the previous two approaches. The last approach also includes a general consideration of the sustainability of the use of different forms of capital (already mentioned in the introduction). 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 life continuing life on Earth as it is (Millennium Ecosystem Assessment, 2005; see more in Drastichová, 2022).

Moreover, the fourth institutional dimension is emphasized 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 for 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.

Although there are many different interpretations by various scholars of what the particular dimensions of SD include, it is clear that there must be a balance between these dimensions. This should be achieved in such a way as to minimize the collateral impact on the environment; human activities aimed at increasing social wellbeing (quality of life) should not exceed the carrying capacity of ecosystems. In compliance with the WCED report (WCED, 1987), SD is future oriented in that it is aimed at ensuring that future generations are at least as well off as current generations in terms of wellbeing (welfare). In economic terms it is a matter of intergenerational equity and not just efficiency. The distribution of rights and assets across generations determines whether the efficient allocation of resources sustains welfare across human generations (Howarth and Norgaard, 1990). The concrete challenges of SD are heterogeneous and complex due to the diversity of human societies and natural ecosystems, and the limitations to 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.

Despite a continuing debate on 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 the rights of future generations should be considered. The second is a long-term view emphasizing the precautionary principle according to the Principle 15 of the Rio Declaration, i.e. w*here there are threats of serious or irreversible damage, lack of full scientific certainty shall not be used as a reason for postponing cost-effective measures to prevent environmental degradation* (UNEP, 2016c). Thirdly, SD embodies understanding, integration 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 other, but recognizing the interdependence of these three SD pillars (Drexhage and Murphy, 2010), also taking into account the role of the institutional pillar.

3. Sustainability science and possible design of the concept of sustainable development

In the previous sections, there was an attempt to outline crucial milestones in the history of the sustainability/SD concepts in order to derive their importance for humanity. Then, their deeper aspects were analysed and their crucial features were derived. Subsequently, it is necessary to deal with aspects of the form of science which would deal with issues of sustainability/SD from a scientific and methodological point of view (subsection 3.1), as well as the appropriate form for their inevitable practical application (subsection 3.2).

3.1. Possibilities of sustainability science

There is a demand to create a science that would address sustainability/SD recognising the fundamental link between science and the economy, while remaining free of political bias, in an attempt *to be responsive to the needs and values in society while preserving the life support systems of planet Earth* (Kates et al. 2001; see also Komiyama and Takeuchi 2006). It has been intensively discussed whether sustainability science would be a subtopic of other sciences, a cross-cutting question, or a completely new discipline (ICSU [International Council for Science], 2002; Clark and Dickson, 2003).

It is essential to advance and improve the methodology of the measurement in the field of the SD and related concepts, which is a particularly challenging task. These concepts are inevitable for meeting the needs and maintaining the wellbeing of future generations at current levels, but also for the survival of humanity in general. Other features include the multidimensionality of the concepts (including at least three basic dimensions plus the institutional dimension), flexibility and the resulting flexible application by different units, an overall lack of clarity, ambiguity and vagueness, and the comprehensiveness and broadness of the concepts, among other features. Another crucial feature is the development of a number of alternative concepts, often in the form of practical counterparts of these concepts due to deficiencies in their practical application, or, on the contrary, more scientific concepts changing the philosophy of these concepts where it is considered by advocates of alternative concepts that sustainability/SD have deficiencies. These and other factors, which are often interconnected, cause that the measurement and the methodological aspects related to it represent a really challenging task. Resulting especially from the first characteristic of other concepts, i.e. the inevitability of the concepts for the wellbeing and survival of humanity, putting them into operation is a crucial task. However, as results from their features, the knowledge from many scientific disciplines will be required and also quality policies, strategies and institutions. So on the one hand, transdisciplinary approach is likely to be required (for many aspects included) and on the other hand, institutional background to put the concepts into operation and integrate them into policies must be developed carefully.

A growing number of publications on sustainability/SD has led to the perception of sustainability science as a distinct field of science (Kates et al., 2001; Komiyama and Takeuchi, 2006; Schoolman et al., 2012; Kajikawa et al., 2014). Sustainability science has developed into an important discipline, with scientific conferences, journals and scientific societies having dealt with research into this area of interest. Although an *umbrella term* (Kastenhofer et al., 2011), sustainability science has arisen as a *not yet mature* (Ostrom et al., 2007), but distinctive, vibrant and maturing field of research, defined by problems rather than by the disciplines it employs (Clark 2007; Kajikawa, et al., 2007). It has emerged as a discipline with sustainability at the core of its distinctive worldview (Kauffman, 2009) – a dynamic and evolving transdisciplinary discipline addressing the symbiosis between human activities and the environment (Rapport, 2007), and providing visions and scenarios for transition towards global sustainability (Komiyama and Takeuchi, 2006) while explicating relevant decisions and agents (Raskin, 2008). So, it is defined by its research purpose rather than by a common set of methods or subject matter. Currently, sustainability science is usually understood as research providing the necessary insights to make the normative concept of sustainability operational, along with the means to plan and implement this.

Sustainability science can be perceived as embracing two elements. It can be divided into the more traditional disciplinary-based science for sustainability, and the transdisciplinary science of sustainability. The first one consists of more descriptive, analytical and basic science, whereas the latter is characterized by reflexivity and applicability. On a meta level, the emergence of the latter is like a new stage in the evolution of science. Science for sustainability can be monodisciplinary or multidisciplinary, but it must be at least interdisciplinary-ready. Its implementation should take into account the meaning of a broader concept of sustainability, and therefore be ready for integration with results from other disciplines. It addresses key sustainability challenges including much of basic science. These challenges include unsustainable trends (global problems), such as climate change, biodiversity losses or ozone layer depletion (among others). This science attempts to strengthen the dialogue between society and science, which should increase the benefits provided by science to society. It also supports the processes of investigating sustainable solutions. It assesses the impacts of current decisions and identifies the actions needed to reach a certain state in the future. As this science has a purpose, which is the pursuit of sustainability/SD, it is teleological, aimed at the goals of SD. It is heterogeneous in scope and practice, and it endeavours to reassess interactions across domains and scales, primarily those between nature and society, between global and local aspects, and between the past, the present and possible futures (Jerneck et al., 2011). This determines the choice of the methods applied. In compliance with this, a key means for analysing interaction is the use of scenarios. (see e.g. Raskin, 2008). A place-based analysis of problems, considering the global and intertemporal context, is necessary to discover solutions. The structure, methodology and content of this science must differ fundamentally from other disciplines, since reductionist methods will not be sufficient to develop solutions to the sustainability/SD challenges (Weinstein, 2010). It must be admitted that the research carried out in this science can only provide partial knowledge and depends on contributions from other disciplines

Table 2 displays differences between science for sustainability and science of sustainability. The emergence of science of sustainability can be understood as part of a larger trend in the evolution of science (Spangenberg and O'Connor, 2010). It is part of a paradigm shift emerging from a scientific sub-current that characterises the evolution of science in general – a shift from mode-1 to mode-2 science (Martens, 2006). Accordingly, mode-1 science is completely monodisciplinary and academic in nature, whereas in mode-2 science research is but one component of an extensive process of knowledge production (Nowotny et al., 2001). The first one can provide a necessary analytical and methodological background and a simpler view of reality, while the second one, being a transdisciplinary science, a detailed view of interactions between human, economic, institutional and environmental (ecological) systems.

Table 2. Two branches of sustainability science and their distinctive features. Source: Spangenberg (2011)

Science for sustainability: Mode-l sustainability science	**Science of sustainability: Mode-2 sustainability science**
Monodisciplinary; Highly focused; Normal science; Curiosity driven and problem solving; Academic; Academic peers; Certainty; Hierarchical logic; Scientific proofs, unequivocal results; Top-down, command and control; Stakeholders affected.	Interdisciplinary and transdisciplinary; Broadly based; Post-normal science; Critical research; Academic and social; Extended peer community; Uncertainty and ignorance; Relational logic; Discursive processes, ranges of options; Discursive process of opening up and closing down; Stakeholders involved.

A crucial area of interest in the economics (in terms of all the disciplines indicated or no matter which one is considered) should include searching for a balance between the public and private goods that will also determine a path towards sustainability/SD or alternative goals, such as steady state. Environmental research must include knowledge and tools for better understanding of ecosystem processes, including effective ecosystem management (Jerneck et al., 2011). It is also essential to consider the interconnections with the social and economic pillar. Among other factors, this should involve an understanding of societal preference change mechanisms in the transition towards sustainability and the factors of quality of life in general in the social pillar. As regards economics and the economic pillar, sustainability macroeconomics and microeconomics should be gradually developed. There should be a continual search for a balance between mainstream neoclassical economics, including traditional environmental and resource economics (ERE), and transdisciplinary ecological economics. The first one can provide a necessary analytical and methodological background and a simpler view of reality, while the second one, being a transdisciplinary science, a detailed view of interactions between human, economic, institutional and environmental (ecological) systems. A crucial area of interest in the economics (in terms of all the disciplines indicated or no matter which one is considered) should include searching for a balance between the public and private goods that will also determine a path towards sustainability/SD or alternative goals, such as steady state.

Sustainability science is applied science. Its results should be directly or indirectly instrumental in solving sustainability which determines the subjects of its interest and the methodology. However, there is a difference in the interpretation of results and their application between science for and the science of sustainability, while in the former the traditional scientific paradigms prevail (see more in Spangenberg, 2011). In the science of sustainability, situations where scientific input is needed are often described as cases where stakes are high, decisions urgent, facts uncertain and values disputed. Hence, the use of post-normal science is required, which differs from the normal science approach (Kuhn, 1962).

Both sustainability science disciplines contribute to the key research issues. Three core topics for sustainability science can be identified, and they should also be put into a policy context. The first topic involves adaptiveness, vulnerability and resilience in complex socio-ecological systems. Sustainability is dependent on building and maintaining the adaptive capacity needed to deal with the shocks as well as longer-term structural transformations. New instruments and concepts that facilitate management of these aspects for the interlinked socio-ecological systems are inevitable. The second one is sustainability in complex production-consumption systems. This is a core component part of the effort towards sustainability/SD and is also one of the practical ways of moving closer towards them. Additionally, it is a crucial component of other ways of putting these basic concepts into operation, including the decoupling of environmental aspects from economic activities and the circular economy. The circular economy also leads to decoupling. An integrated understanding of the relationships between consumption and production is required. The third topic involves institutional aspects, such as rules, procedures and institutions which support the shift towards sustainability/SD. These are crucial and must be taken into consideration. Transforming and redesigning existing institutions and methodological backgrounds are necessary prerequisites for a functioning sustainability science in the future. The advance of science and technology itself or the widening of competitive markets is not likely to encourage a path towards SD/sustainability (Spangenberg, 2011).

The science of sustainability requires not only the re-evaluation and rearranging of the approaches and methodologies of science, but also the interlinking of concepts between different disciplines, linking biosciences and geosciences with social and economic sciences. The crucial disciplines, which have developed over time, include ecological economics (Martinez-Alier, 1987; Söderbaum, 2000), industrial ecology (Ayres and Simonis, 1994), social ecology (Fischer-Kowalski, 1996); resilience theory (Berkes et al., 2000), transition theory (Rotmans et al., 2001), world system analysis (Wallerstein, 1974), and technology assessment and science and technology studies (Kastenhofer et al., 2011). This is partly in compliance with the concepts and systems considered by Beeks (2016) presented in subsection 3.1. Overall, it can be concluded that since SD/sustainability concepts are multidimensional, they will interfere with a number of theories and concepts, not only those summarized in this work. However, such concepts and theories are often applied in a static manner, considering a certain state of other systems as an external constraint in system analysis (Jerneck et al., 2011). It is necessary to investigate the dynamics and mutual dependencies of co-evolving systems, and how the resilience of the metasystem of *society – economy – nature* depends on the contemporaneous resilience and dynamics of the subsystems.

A new management approach is also required. In the science of sustainability, it is necessary to balance the approaches and make scientific results meaningful by involving non-scientific expertise without abandoning scientific quality. For the future, crucial challenges for SD should be involved in sustainability science themes, including those meaningful aspects arising within the key alternative concepts, which should lead to the advancement of the concept of SD (and certainly not the undermining of this concept). Not only the clusters and their themes, which can be researched in detail in mode-1 science, but also their interconnections from the inter- and transdisciplinary perspective must be studied, especially within mode-2 science. Within both modes, the unsustainable trends leading to global environmental trends, including biodiversity losses, climate change and ozone layer depletion, as well as environmental problems at lower levels, should be investigated. Hence a detailed knowledge of ecosystems, including climatic and geochemical and other cycles involved in ecosystem processes, is required. Consequently, a justified determination of planetary boundaries is inevitable. The detailed studies of interactions between human, economic, institutional and environmental (ecological) systems will be crucial. With regard to research on the interaction of society and economy, value systems and power structures and their interaction with environmental systems and sustainability objectives, the Millennium Ecosystem Assessment (MA, 2005), the IPCC's Assessment Reports (IPCC, 2007) or and the UNEP GEO 4th report (UNEP, 2007) should be emphasised.
Resulting from the previous knowledge, it is also crucial to consider SD in terms of systems science to derive the appropriate form of SD and to understand its deeper essence. In this respect, SD requires synchronisation with a metasystem and its complex and evolving subsystems, including nature, economy and society (Bossel, 1998) over a long-term period and including distant effects (WCED, 1987). The SD concept must cope with non-linear effects and delayed responses, which means that the system operates beyond cause-effect logic, with feedback loops and also extensive temporal-spatial heterogeneity (Allen, 2001). The interlinkages among dimensions must be considered (Weaver and Rotmans, 2006), and each of these systems needs to be sustainable in itself and able to deal with the dynamics of the system environment (Bossel, 1996), while not limiting the other systems' ability to do this as well. Only then can development of the metasystem be sustainable. Taking these aspects into account, systems science is a promising approach to developing a coherent description of sustainability (Weinstein, 2010).

3.2. Possible design of SD/sustainability concepts: relationships with related concepts

Resulting from the previous analysis, possible forms of understanding of the SD concept are summarized. Two additional relationships with the related concepts analysed in this work which are also of practical importance for achieving the goals of increases in wellbeing and quality of life are added. All these aspects are displayed in Figure 1.
Sustainability/SD remain concepts with a number of interpretations and context-specific understanding. Purvis et al. (2019) argued that the emergence of the three-pillar paradigm, with little theoretical foundation, is mainly a product of the specific origins of sustainability as a concept, aided in part by the agenda of the various actors that helped to shape its early history. A prevalent description involves three interconnected *pillars* (e.g. Moldan et al., 2012; Schoolman et al., 2012; Boyer et al., 2016), *dimensions* (e.g. Carter and Moir, 2012; Mori and Christodoulou, 2012), *components* (e.g. Du Pisani, 2006; Zijp et al., 2015), *stool legs* (e.g. Dawe and Ryan, 2003; Vos, 2007), '*aspects*' (e.g. Goodland, 1995; Lozano, 2008; Tanguay et al., 2010), *perspectives* (e.g. Brown et al., 1987; Arushanyan et al., 2017), etc. encompassing economic, social, and environmental (or ecological) factors or *goals*. These competing terms are principally used interchangeably. This three-dimensional description is often presented in the form of three intersecting circles of society, environment, and economy, with sustainability being placed at the intersection (right, below in Figure 1). Alternative descriptions include the three nested concentric circles (right, above in Figure 1) or literal *pillars* (right, in the middle, in Figure 1) (among others). The message provided by these diagrams and the wider *pillar* conception can often be unclear, although it is a simple depiction. The conceptual origins of this description, the reasons of inclusion it into the mainstream, and its exact meaning have not been clarified. The discourse around sustainability has predominantly formed around the three-circle depiction without transforming it into a more comprehensive meaning of sustainability (Thompson, 2017). The three pillars themselves were explicitly incorporated into the formulation of the SDGs (UN 2012a). It must be concluded that a theoretically rigorous description of the three pillars is not available. It can be due to the nature of the sustainability discourse having arising from broadly different schools of thought historically. The absence of such a theoretically solid conception frustrates approaches towards a theoretically rigorous operationalisation of sustainability (Purvis et al., 2019).
The first picture on the left side above displaying a GE as understood by the EEA, which is included in the *Roadmap to a Resource Efficient Europe* (European Commission, 2011) should indicate that transforming the economy into a resource-efficient path will bring increased competitiveness and new sources of growth and jobs through cost savings from improved efficiency, innovations and better management of resources over their whole life cycle. This requires policies that recognise the interdependencies between the economy, wellbeing and natural capital. Although clearly based on the weak SC approach, this picture at least shows, how the more theoretical three interconnected pillar description of SD can be displayed in a more practical way of GE which also enhances human wellbeing (see subsection 3.1.)

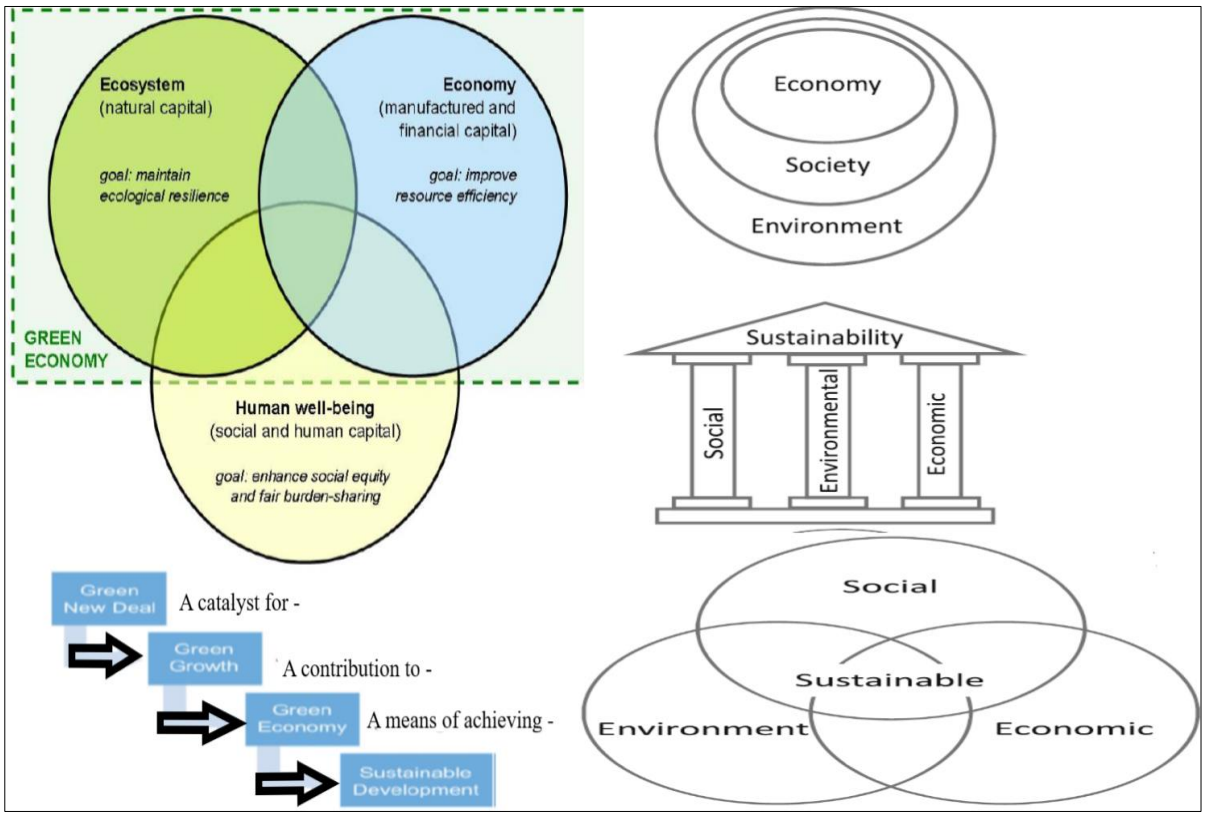

Figure 1. Left side above: Green economy chart (left, above); 2. Right side: Sustainable development scheme: a) typical presentation of SD as three intersecting circles (right, below). Alternative depictions: b) literal *pillars*, c) a concentric circles approach; 3. Left side below: The hierarchy of GE concepts (based on the conceptualisation of TEEB in ten Brink et al. 2012), source: European Environment Agency (EEA) (1.); Purvis et al. (2019) (2.); ten Brink et al., (2012), Georgeson et al. (2017); author's elaboration

The second picture on the left side below displays the fact that the GE must coexist with the SD concept, the related concepts and strategies. The Economics of Ecosystem and Biodiversity's (TEEB) GE report describes a clearer hierarchy (ten Brink et al. 2012), represented by this part in Figure 1. According to this hierarchy, there is no conceptual inconsistency with the SD concept, challenging the artificially imposed barriers around policy debates. However, these terms are not often used in alignment with this hierarchy. Nevertheless, the conclusion that GE and GG are the more practical counterparts of SD is confirmed. And above that they all can serve for policy purposes, such as achieving a Green New Deal (introduced in subsection 3.1), which also currently has its concrete form in the EU.

To finalize with more practical aspects, it is concluded that many countries at different stages of development have adopted their SD strategies, but with different priorities and conceptual foundations, since they have faced different socioeconomic and biogeophysical situations, but also differences in priorities, since SD strategies affect interests of various stakeholders differently. A rationale behind that was already indicated in *Our Common Future*, (WCED, 1987), where in chapter 2, it is stated that *the goals of economic and social development must be defined in terms of sustainability in all countries – developed or developing, market-oriented or centrally planned. Interpretations will vary, but must share certain general features and must flow from a consensus on the basic concept of sustainable development and on a broad strategic framework for achieving it*. Although searching for win-win situations forms a basis of such strategies, a solution maximizing gains for all stakeholders can be hardly achieved. Trade-offs are unavoidable and compensations by complementary measures are necessary. Usually no single simple solution exists and waiting for a win-win situation seem to be inappropriate. From a more theoretical point of view, it can also be concluded that the SD concept and all the related and alternative concepts, including the theoretical (scientific) and practical concepts, should still support wellbeing and in broader terms, quality of life, while living in environmental limits of the planet, which can be determined by planetary boundaries or alternative concepts, or at best by the combination of a number of ways. The problematic aspects associated with the SD concept resulting from its complexity and multidimensionality (among other aspects), which also related to the concepts of wellbeing and quality of life, affecting the methodology used and their measurement, should not mean that a shift towards SD (or even to the aims of alternative concepts) and improvements in wellbeing and quality of life are unnecessary. Rather, there is a need for place- and culture-specific measures. Although SD is a multidimensional concept,

achieving progress in wellbeing and quality of life through SD (or in combination with a path resulting from alternative concepts) is a required goal. However, a one-size-fits-all approach to SD and quality of life is not an appropriate one. The success of SD initiatives depends on how closely they comply with and contribute to a sense of place in a given space.

4. Conclusions

Generally, if an activity is sustainable, in practice it can continue forever, which is in compliance with a general definition of sustainability in relation to the SD concept. Sustainability and SD represent two crucial contemporary discourses at global, international, EU and national policy levels. The work was aimed at clarifying of the essence and deeper significance of SD on the basis of an analysis of the history of the concept, key scientific works and practical policies, strategies, and actions.

On the basis of the analysis (including the first part, i.e. Drastichová, 2022), the three most used approaches to SD were summarized, i.e. the three-pillar approach, the ecosystem health approach and the resources or capital approach. All these approaches reflect the origin and development of the concept, the approaches to its operationalization as well as methods of its measurement. Despite the continuing debate on the meaning of the SD concept, certain common principles have been emphasized. The first is a commitment to equality and fairness, in which priority should be given to improving the conditions of the poorest in the world and the rights of future generations should be considered. The second is a long-term view emphasizing the precautionary principle according to Principle 15 of the Rio Declaration. Thirdly, SD embodies understanding, integration, 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, also recognizing the role of the institutional pillar.

Although several scholars have described the relationships between the concepts of sustainability and SD differently, after an in-depth analysis several key approaches were identified as crucial to explaining the relationships between the concepts of SD and sustainability. The approaches to sustainability and its relation to SD derived from the analysis in this work involve the necessity of such development (process of change) which is sustainable in order to achieve a desired state of sustainability. However, the final state of sustainability reached is not a static point, but is changeable and always evolving and developing if the path of SD is achieved. The second approach to understanding sustainability in relation to SD recognized in this work is based on several concepts of sustainability defined by particular criteria. In accordance with this approach, SD can be explained in relation to the criteria of very weak, weak, strong and very strong sustainability concepts and, 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. Although the first four types can be mainly associated with particular dimensions of SD, taking into account their interconnections and interdependence, the last two go beyond all the pillars of SD. Moreover, it should also be included in the first approach outlined above. Human sustainability, wellbeing and quality of life should represent the main aims of SD, and strategies and policies in this area. From the more sophisticated point of view, both SD and sustainability concepts are not positive analytical concepts, but the normative ones, describing parameters of economy, society and environment considered to be sustainable, i.e. optimal based on concrete aspects. It is an utillitarian concept and can also be understood as an ethically justified utopia.

The concepts of practical approaches to moving closer towards SD involve appropriate structural reforms that include the engagement of the concepts of decoupling environmental degradation from economic activity, which is closely related to resource/eco-efficiency, and that of sustainable consumption and production (SCP). In summary, concepts and definitions of weak SC emphasise increasing the eco-efficiency of consumption, while those of strong SC are based on reductions in the amount of consumption and changes in consumption patterns in order to achieve SD. Moreover, the strong SC approach goes beyond its use towards achieving SD in terms of the current system of capitalism and it is closely related to the concept of degrowth. As regards the more practical, political strategies, the Inclusive Green Economy (GE) and Green Growth (GG), also applying the previous concepts, must be emphasised. The concept of circular economy is also a crucial concept, and a system, which applies decoupling, is based on SCP, can operate within GE or GG and helps shift economies closer to SD. All of them represent practical approaches of moving closer towards SD. It is also concluded that in all the concepts related to SD, including sustainability, GE, GG, SC, CR economy, etc., which were not assessed as the alternative concepts to SD, if there has been formed a strong approach within these concepts, it usually gets closer to the alternative concept of degrowth, or some of its alternatives, including the more comprehensive concepts, than to SD.

It is essential to advance and improve the methodology of the measurement in the field of the SD and related concepts, which is a particularly challenging task. These concepts are inevitable for meeting the needs and maintaining the wellbeing of future generations, but also for the survival of humanity in general. However, the features of the analysed concepts include the multidimensionality of the concepts (involving at least three basic dimensions plus the institutional dimension for SD), flexibility and the resulting flexible application by different units, an

overall lack of clarity, ambiguity and vagueness, and the comprehensiveness and broadness of the concepts, among other features. All these aspects make the measurement and the practical application difficult. Hence, another crucial feature is the development of a number of alternative concepts, often in the form of practical counterparts of these concepts due to deficiencies in their practical application, or, on the contrary, more scientific concepts changing the philosophy of these concepts where it is considered by advocates of alternative concepts that sustainability/SD have deficiencies. Many alternative concepts and systems to the concept of SD/sustainability and their practical counterparts have arisen. Although an economic system influenced by alternative economic systems that supports wellbeing and quality of life and not increase in quantitative macroeconomic variables, such as GDP or employment, can be required, it is still and utopia. A significant change would be required, including that in moral and cultural values to move closer to the concept of degrowth or its local counterparts, such as Buen Vivir, or Ecological Swaraj.

A growing number of publications on sustainability/SD has led to the perception of sustainability science as a distinct field of science. Within sustainability science as well as in the practical application of sustainability/SD strategies, the challenges for the future include addressing crucial sustainability problems and advancing research, methodological aspects and the institutional background for putting the sustainability/SD concepts into operation, and on the basis of this thoughtfully responding to public sustainability concerns.

Future economic systems should encompass both capitalist and socialist characteristics and various economies can move closer to one or another, constantly evolving over time, taking into account the complexity of the interactions between the economy, people, and the environment. It cannot be assumed that any given system can be adopted uniformly across the world, and in a particular country, the system may remain static. It is highly likely that many indicators related to SD, wellbeing, and quality of life will change significantly following the current global situation. This includes economic (economic recession, inflation, economic problems generally etc.), social (especially with regard to health, poverty, and social inclusion), and environmental indicators (short-term and long-term impacts), as well as those indicators generally related to quality of life and wellbeing. The concepts of SD, wellbeing and quality of life, as well as policies towards them, must further take into account and engage with these aspects. They should be adjusted to the new development and challenges affecting these, related and alternative concepts.

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