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A strong sustainability approach to development trajectories

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A strong sustainability approach to development trajectories

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Abstract
Sustainable development trajectories are at the heart of many policy debates: CDN and Net Zero trajectories, just transition, climate justice, biodiversity inclusion, etc. These trajectories mostly propose a nexus approach combining climate, ecological, social, technological, economic and political aspects. In this paper, we propose a suite of three guiding principle, inspired by a strong sustainability approach, to construct sustainable trajectories: *(i)* the a priori refutation of substitutability, *(ii)* the need to construct multidimensional diagnostics and analyses highlighting synergies and tensions between different indicators, and *(iii)* the recognition of the importance of building a social construct on the desirable "good condition" and on the trajectories to reach it. We then show how these principles can be applied in different disciplines and help policymakers in constructing development trajectories.

Keywords
Sustainable development, Development trajectories, Strong Sustainability

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Résumé
Les trajectoires de développement durable sont au cœur de nombreux débats politiques : trajectoires CDN et Net Zero, transition juste, justice climatique, inclusion de la biodiversité, etc. Ces trajectoires proposent le plus souvent une approche nexus combinant les aspects climatiques, écologiques, sociaux, technologiques, économiques et politiques. Dans cet article, nous proposons une suite de trois principes directeurs, inspirés d'une approche de durabilité forte, pour construire des trajectoires durables : *(i)* la réfutation a priori de la substituabilité, *(ii)* la nécessité de construire des diagnostics et des analyses multidimensionnels mettant en évidence les synergies et les tensions entre différents indicateurs, et *(iii)* la reconnaissance de l'importance de construire un construit social sur le "bon état" souhaitable et sur les trajectoires pour l'atteindre. Nous montrons ensuite comment ces principes peuvent être appliqués dans différentes disciplines et aider les décideurs politiques à construire des trajectoires de développement.

Mots-clés
Développement durable, trajectoires de développement, soutenabilité forte

Introduction

50 years after the "Limit to Growth" Meadows *et al.* (1972), the IPCC (2022) still feels the need to warn about the need to transit to a low-carbon and resilient economy. In fact, according to their latest report, we have three years to act. Similarly, the IPBES (2019) raises alarms on the worldwide deterioration of the biosphere and of its vital contributions to people. At the same time, the interactions between ecological, social and economic aspects are getting more and more traction in academic and public policy debates. The IPCC started to include inequality aspects into its report. The Declaration for a Just Transition, adopted at COP26, recognizes the importance of developing climate actions that are fully inclusive and benefit the most vulnerable.

The broad vision of sustainable development as portrayed in the SDGs remains widely recognized. The concept of sustainable development, which was thought to be outdated, is thus coming back to the forefront. In this paper, we argue that the strong sustainability approach, that is an approach that a priori refutes the substitutability between different types of capital (*i.e.* natural, social and manufactured), to sustainable development can shed a new light on the construction of development trajectories. The definition of strong sustainability remains however fuzzy with different stances on the degree of substitutability between the different types of capital for example. We thus propose a set of three guiding principles in order to construct strong sustainability trajectories, namely the a priori refutation of substitutability, the need to construct science based multidimensional analyses and diagnostics and finally the recognition that the "good condition" towards which a society decides to go is a social construct. We then show how these principles can be applied with different examples.

This paper is organized as follows: the next section traces back the emergence and development of sustainable development, section 2 discusses the concepts of weak and strong sustainability, section 3 proposes our guiding principle for the emergence of strong sustainability and highlights their interest through various examples and section 4 concludes.

1. Sustainable Development

1.1 Concept emergence and development

The Brundtland (1987) Report defined sustainable development as "development that meets the needs of the present without compromising the ability of future generations to meet their own needs" (p. 40). It is however a political notion, not a scientific one. It incorporates a principle of intergenerational justice, onto which has been grafted an objective of solidarity between people or territories (whose "needs" would not be met). It is therefore more a development framework, and the environment only appears as a limiting factor in the future: critical resources must be preserved for the future and to ensure that the capacity of the environment can support the increase in living standards.

The report points out the limits of growth patterns and highlights how environmental constraints have to be added and thus current trends have to be curbed (Tichit 2005). Incorporating the environment will hence redirect development patterns towards sustainable ones, thus accommodating socio-economic development and environmental sustainability. The report insists in particular on North/South relations and issues such as the fight against poverty, women's rights and social equity.

Since the Brundtland report, the concept of sustainable development has spread and has retained an important place in the design of public policies. In 1992, it brought together, at the United Nations Conference on Environment and Development - the Rio Summit - the largest gathering of heads of state and government at the time. Conventions on climate change and biodiversity were concluded, and Agenda 21, a global program for sustainable development, was adopted. The UN Commission on Sustainable Development was established to advise, monitor and coordinate the implementation of this agenda.

In 1997, a special mission of the UN General Assembly met to assess the implementation of the resolutions taken at the Rio Conference. This "Rio + 5" meeting stressed the mixed results observed, as the 1990s had indeed seen many economic crises in developing and emerging economies, further exacerbating inequalities between countries and shifting the light away from environmental concerns. The story is rather different for developed economies with many examples of implementations of programs, policies and strategies such as the strategy of sustainable development adopted by the European Union in 2001 and revised in 2006.

In 2012, the Rio+20 Conference, also in Rio de Janeiro, set in motion the process that was to lead to the adoption in 2015 of the Sustainable Development Goals (SDGs), a central element of the United Nations 2030 Agenda. Its universal reach, compared with previous initiatives such as the Millennium Development Goals, not only recognized the common challenges such as climate change and the rise of inequality, but also highlights that high-income countries are increasingly faced with similar problems as low- and middle-income ones and need to rethink their development paths.

1.2 Several definitions of sustainable development

In spite of the consensus immediately reached worldwide on the definition of sustainable development, its practical application remains an enigma, as emphasized by Jacques Theys (2001). It is by construction impossible to know what the needs of future generations will be, what limits they will face, and more generally, to find simple criteria for arbitrage between generations or dimensions of development.

Jacobs (1999) argued that sustainable development, like other political terms such as democracy, freedom, and social justice, has two levels of meaning: a core of fundamental ideas that elicit consensus about their relevance to the concept, and a secondary set of contested interpretations of those ideas. In his core set of ideas fundamental to sustainable development, the author lists:

- Environment-economy integration: the requirement in policymaking to consider the economy and the environment together.
- The future: the requirement to consider, in policymaking, the impact of current activities on future generations.
- Environmental protection: the obligation to reduce the depletion and degradation of environmental resources.
- Equity: the requirement to seek social justice within and between generations.
- Quality of life: the recognition that the quality of human life is not only material and a function of economic growth.
- Participation: the requirement to allow people to be involved in the decisions and processes that affect their lives.

One can clearly see two guiding principles behind these core ideas: multidimensional analysis and the social construction of a final objective. The multidimensional nature is perceived along different axis: multidisciplinary perspectives (e.g. environmental, social, economic) with multidimensional indicators (e.g. within different ecological footprints such a carbon, land-use or water use), different time horizon (infra- and inter-generational) and different geographical and spatial consideration (local, national, international or polycentric). The last idea of Jacobs stresses the importance of participatory approaches to construct the final objective of sustainable development.

1.3 Current debates

Sustainable development remains criticized for its rather fuzzy nature (Chartier 2004). Is it only an *operator of neutralization of conflicts* (Krieg-Planque 2010), allowing conciliating different orthogonal objectives under a branding or can it lead to transformative processes and deliver on its promises? The literature on the interaction between SDGs and their targets highlights the importance to have a systemic and integrated approach, see Pradhan *et al.* (2017), Pham-Truffert *et al.* (2020) and Swain and Ranganathan (2021) among many others. Most papers insist that synergies among SDGs are more important than negative feedbacks between them. It is however interesting to note that most of the negatively impacted SDGs by the positive development of other SDGs are within the environmental ones (SDGs 11-15, that is: sustainable cities and communities, responsible

consumption and production, climate action, life below water and life on land, for more information see United Nations General Assembly, 2015) and that the strongest synergies lie mostly within non-environmental SDGs. For example, Pradhan *et al*. (2017) shows that within the top ten synergies only one is related to environmental SDGs (11 and 13 reinforcing each other) while all of the top ten trade-offs are connected to one or two environmental SDGs. Some of the trade-offs between targets of SDGs relate to historical non-sustainable development trajectories where social and human development are correlated with a larger environmental footprint. Addressing these trade-offs while leveraging on the synergies is thus crucial. One sees that the economic part of sustainable development is often predominant, leading sometimes to positive impacts on social sustainability when synergies exists.

The environmental aspects and the definition of environmental sustainability have developed their own path via the process of IPCC and IPBES. Accommodating economic and climate sustainability is however a complex exercise with tensions between what is considered as economically desirable and what is considered as sustainable from a climate science perspective. A good example of these tensions relates to the economic consequences of climate change (what is often called damage functions). When conducting a survey, Nordhaus (1994) confronted academics from different field with the question: "what would be the economic consequence of a rise of 3°C of average global temperature with respect to the pre-industrial period?", natural scientists gave answers 20 to 30 times higher than those of economists, see Keen (2021) for a discussion on the discontent between economists and climate scientists.

Recently, social sustainability has been brought back to light as a consequence of the increase of inequality. The combination of social and environmental sustainability is also in the forefront of the political debate with calls for just transition or climate justice. The concept of Just Transition emerged in 1973 within the Petroleum, Chemical and Atomic Workers Union in North America, with the realization that the environmental and social crises are linked and that the ecological transition must take into account the workers and the poorest populations. Adopted by a growing number of institutions, the concept is expanding, evolving and taking on fundamentally different forms. From the 2000s onwards, the Just Transition gradually gained ground in international bodies up to the recent declaration for a just transition signed during COP26 (see, for example ILO, 2015; UNFCC 2016). The concept of just transition is however used by different actors with definitions ranging from "a simple demand for job creation in the green economy, to a radical critique of capitalism and the refusal of market solutions" (Barca, 2015). One can synthesize the different positions into two extreme approaches: an 'affirmative' just transition, insofar as it seeks to redistribute environmental, economic and social burdens within the given socio-economic paradigm, and a 'transformative' just transition, insofar as it seeks to restructure the entire system of production and ownership with a view to democratizing the distribution of environmental risks and reintegrating the economy into society.

2. Revisiting sustainable development under the lens of strong sustainability

Approaches trying to provide a nexus perspective conciliating two or more of the sustainability aspects (environmental, social and economic) are currently widely debated. It is however useful to see how the economic literature has historically led to the emergence of two schools of sustainable development economics - neoclassical environmental economics and heterodox ecological economics – with competing interpretations of sustainability called "weak" or "strong" environmental sustainability.

2.1 Economic growth models with natural resources

This distinction between environmental economics and ecological economics emerges initially in response to the seminal work "Limits to Growth" by Meadows *et al.* (1972). The critiques to the Meadows report can be broadly categorized into three aspects (see Nordhaus 1973, Beckerman 1972, Solow 1974, among others):

1. Lack of empirical considerations such as lack of empirical validation of most of the functional forms in the model, but also the fact that what is perceived as desirable from environmental scientists and is not acceptable from an economic point of view and hence is not empirical or realistic,
2. Lack of technological progress and hence a pessimistic point of view of future prospects, and
3. Lack of market-based mechanisms and of substitutability between resources and capital, again leading to too pessimistic perspectives.

Nonetheless, the "Limits to Growth" launched a literature on the inclusion of natural resources, mostly seen as exhaustible, in growth models, see Stiglitz (1974), Hartwick (1977) and Solow (1974) among others. At the core of these exercises lies the idea of dealing with scarcity and inter-generational compensation mechanisms, substituting the depleted natural resources by another manufactured capital. Most of the dynamics of these models respond to the limitations pointed out to Meadows and co-authors. First, the environment was included as a capital stock, along with manufactured capital, and social or human capital. Second, capital in all its forms is perceived as the main source of income, and hence needs to be maintained. Third intergenerational compensation rules allows replacing depleted natural capital. Fourth, technological progress allows removing, at least partially, the dependence to capital and is an important source of growth.

Substitution between the different forms of capital plays a crucial role in this literature. It is because elements of capital are substitutable that compensation mechanisms between generations are possible. This substitution can take place between different types of capital, within the same type of capital (between exhaustible and renewable resources), spatially (between stocks of the same type of capital in different places) or within time (see Tichit 2005 for more details). This form of sustainability was called "weak" by its detractors.

Critics of weak environmental sustainability

Weak environmental sustainability is popular because it is in theory easy to put it into practice. It underpins the widely used "inclusive wealth" indicator, the “new wealth of nations” (World Bank 2021) as well as the ecosystem services value accounts being pushed by the European Union, the United Nations and the World Bank (European Commission 2020, United Nations. 2021). It has a very optimistic view of sustainable development, see Victor (2020) for example. It underestimates ecological constraints because of the possible substitution between natural capital and manufactured capital and trusts the market (prices allowing to adequately dispose of natural capital) and technology (productivity gain reducing the criticality of natural capital) to solve problems. It proposes a simple way of distributing the constraints between actors, at the level of countries, individuals or generations. One important advantage is that it does not impose very strong constraints on present generations, except in terms of investment and taxation, and that it is therefore socially and economically acceptable, a priori. This, however, comes at the cost of a series of strong assumptions (Theys and Guimont, 2019):

- The fact of being able to value natural capital via external effects;
- The right prices reflecting correctly externalities (i.e. abolition of subsidies and inclusion of ecological taxation);
- Continued growth in resource productivity, through significant investment in technology;
- The possibility of deploying efficient substitution strategies (e.g. replacing non-renewable resources by renewables, products by services…);
- The perfect knowledge of what constitutes natural capital [1] ;
- A well-known yield of this natural capital (with a reliable monetary estimate);
- The mathematical regularity of the accumulation or decumulation of this capital.

The problem is that it is based on largely invalidated hypotheses, and that the confidence it places in the market and in technology has long since been invalidated to a large extent by what is happening in the real world (Keen, 2011):

- Many of the functions performed by nature and even many of its components cannot be substituted or even evaluated;
- Their substitution, if possible, requires the use of other resources;
- The truth of prices is not realized and they do not reflect long-term rarity;
- The fiscal corrections that should be made are not made; and
- The signals produced by the market do not allow for timely investments and changes in activity that would be necessary.

The result is that actions under such a conception are reduced to win-win or immediately acceptable strategies that do not ensure sustainable development for future generations at all. One could say that this is because effective market mechanisms are not in place. For

[1] This item is different from the first one because of the uncertainty regarding natural capital. Many natural processes are highly uncertain, in the sense that the conditions for their continued existence and functioning are not always known. Natuarl capital, as considered e.g. by environmental accounting, thus simplifies sometimes the contributions from nature. La Notte (2022) discusses for example how different frameworks for ecosystem services influence the overall valuation of natural capital.

the proponents of strong environmental sustainability, it is however an illusion to think that they could ever be (Victor 2020).

Victor (1991) notes that it has been recognized in economics since Marshall that manufactured capital is fundamentally different from environmental resources. The former is manufactured by humankind and can be reproduced in desired quantities; the latter is the "free gift of nature" and in many categories its supply is fixed or limited. The destruction of manufactured capital is very rarely irreversible (it would only happen if the human capital, or knowledge, that created the manufactured capital had also been lost), whereas irreversibility, with processes such as species extinction, climate change, or even the burning of fossil fuels, is common in the consumption of natural capital. Moreover, to the extent that manufactured capital requires natural capital for its production and that its normal use always lead to a form of depreciation, it can never be a complete substitute for resources.

Strong environmental sustainability approaches will seek to dispense with these assumptions, and consider in particular that substitution possibilities are often limited.

Strong environmental sustainability and substitution between capitals

Strong environmental sustainability thus criticizes the mathematical assumptions imposed by weak environmental sustainability approaches. Proponents of this approach will consider that the substitutability between different types of capital, e.g. natural capital and manufactured capital, is severely limited by environmental characteristics such as irreversibility, uncertainty and the existence of "critical" components of natural capital, which make a unique contribution to well-being and to the possibility of life on earth. Clive Spash (2012) advocates the embedding of the economy in biophysical processes and stresses the importance of social factors to avoid ontological reductionism[2].

A whole range of nuances of strong environmental sustainability

A whole spectrum of possible critical positions exists between proponents of perfect substitutability of capital and proponents of zero substitutability such as Herman Daly. For Daly (1992), the stock of natural capital must be kept constant, defining a “conservationist” approach. This position hence proposes a hierarchical vision where economic and social concerns are secondary to environmental constraints.

Victor, Hanna and Kubursi (1998) identify the elements of natural capital, such as water, air, minerals, energy, space or genetic material, that are essential for life as we know it. Some substitution of these essential elements by manufactured and human capital can be envisaged, but their total substitutability, as implied by weak environmental sustainability, seems unlikely, at least with current knowledge and technology. In fact, if the process of industrialization is considered as the application of human, social and manufactured capital on natural capital to transform it into human and manufactured capital, it is possible to consider the current environmental problems as evidence that this substitutability is not

[2] Spash (2012, p. 43) explain reductionism, citing Georgescu-Roegen « That elephants are constructed of physical and chemical components does not mean elephants' behaviour can be understood by analysis of or reduction to those components (Georgescu-Roegen, 2009 [1979]: 109) ». He thus argues that embedding economics within social sciences (and biological within physics) is required to understand planetary boundaries.

complete.[3] Ekins (2003) distinguishes between critical capital whose destruction is irreversible and non-substitutable and non-critical capital whose potential degradation is reversible on a small scale and can be treated with traditional economic efficiency criteria.

There are different ways in which the criticality of natural capital can be assessed. Among the first one to work on the topic, Pearce and Turner (1990) propose to set rules by broad categories (pollution, renewable, non-renewable, biodiversity…). Following on this concept, Rockström *et al.*, (2009) define global limits, based on nine earth processes (climate change, biodiversity loss, biogeochemical, ocean acidification, land use, freshwater, ozone depletion, atmospheric aerosols and chemical pollution), which if transgressed would lead to dramatic impacts for life on earth.

On a different line, Hueting (1991) and others subsequently (e.g. Moldan, Janoušková, and Hák 2012; Häyhä *et al.* 2016; Ekins *et al.* 2003) propose using sustainability norms to be achieved, or in other words, "minimum safeguard norms," or "environmental sustainability standards." Sustainability norms are broader than the planetary boundaries both in scope (some include social or economic aspects for example) and scale (the norms can be defined at very granular dimensions). In this perspective, environmental goods and services are no longer considered as natural capital, but as a collection of possible uses called "environmental functions" (see De Groot 1992 for the first definition of environmental function). The use of one function leads to losses of environmental functions if it is at the detriment of another function or itself. They then estimate sustainability costs based on preservation costs.

The great difficulty of strong environmental sustainability approaches lies in fact in the definition of sustainability: what exactly should be conserved for future generations? The notion of a global stock of "natural capital" has only a very limited meaning; it mixes elements, functions, spaces, temporalities that have nothing to do with each other. Under the strong sustainability paradigm, there is no aggregator, such as currency for weak environmental sustainability, allowing for comparison and compensations. It is therefore necessary to keep track of all the critical components of natural capital in order to monitor and control its sustainability. Usubiaga-Liaño and Ekins (2021a) survey the literature and find a whole series of proposals of what is important to maintain in a strong environmental sustainability approach, ranging from maintaining capital (Goodland 1995) to maintaining nature's services at an appropriate level (Moldan *et al.*, 2012). The need for different concepts emerges notably from the fact that maintain a capital stock constant is impossible for abiotic (i.e. physical rather than biological) resources, which cannot be replenished.

To what extent is natural capital really substitutable?

Which perspective of sustainability more validly describes reality? The resolution of this question should be empirical rather than theoretical or ideological. Cohen, Hepburn, and Teytelboym (2019) review the empirical literature on the degree of substitutability between

[3] Of course, one could always argue that the fact that there has not been any substitutability in the past makes does not mean that substitutability is impossible. Evidence regarding decoupling between economic growth and environmental footprints in general however indicates that even when there are efforts to try to substitute natural capital for manufactured one, these are usually fruitless, see Parrique *et al.* (2019) for a comprehensive survey on the matter.

natural capital and other forms of capital. They find that most available substitutability estimates do not stand up to scrutiny, and that it is particularly difficult to produce accurate substitutability estimates for unpriced or poorly priced resources. Given the above, the try to proxy the level of substitutability with an assessment of efficiency of input factors, particularly natural ones, in two specific case: use of energy in industrial sectors (pulp and paper, iron and steel and cement). They show that the substitutability of natural capital with other forms of capital is low to moderate at best. In the industrial energy case, energy intensity has been decreasing by approximately 1-1.5% annually while energy demand has increased by 1.3% annually suggesting low substitutability. In the case of land use they observe closing yield gaps in different region in the world suggesting that "further increases in yield may prove to be costly on already well irrigated and intensely fertilized lands" (p. 428).

What is more, if substitutability is assumed a priori, it is impossible to show ex post whether this assumption was justified or not. The underlying assumption of weak environmental sustainability is that there is no essential difference between different forms of capital, or between the types of welfare they generate. This allows, in theory at least, to express all types of capital, and the services and well-being they generate, in the same unit, e.g. monetary. In practice, there may be insurmountable difficulties in carrying out the necessary monetization and aggregation across all the components involved, but the theoretical position is clear and considerable efforts are being made to make it operational, see for example Spash and Hache (2021). The figures that emerge from these efforts can however only show whether or not weak environmental sustainability has been achieved, i.e. whether overall well-being has been maintained. They cannot explain whether the initial assumption of commensurable and substitutable capital was justified. By assuming at the outset of the economic analysis that there are no differences, there is no way to establish later whether these differences were significant.

The approach of assuming strong environmental sustainability at the outset does not suffer from this serious flaw in scientific methodology. By keeping the different types of capital distinct from each other from the start, it can examine the particular contribution of each of them to well-being. This examination may reveal that, in some cases, the welfare derived from one type of capital is fully commensurable with the other types of welfare derived from production and can be expressed in monetary form. In these cases, substitutability with other forms of capital exists and the weak environmental sustainability condition of a non-decreasing aggregate capital stock is sufficient to maintain welfare. In other cases, the outcome of the examination may be different. The important point is that, starting from a strong environmental sustainability assumption of non-substitutability in general, it is possible to move to a weak environmental sustainability position when appropriate. But starting from an assumption of weak environmental sustainability does not allow us to identify exceptions. In terms of scientific methodology, strong environmental sustainability is thus much preferable as an a priori position.

3. A strong sustainability framework to construct long-run trajectories

Dietz and Neumayer (2007) list four reasons why the strong approach to environmental sustainability may be preferred to the weak one: risk and uncertainty, irreversibility, risk aversion and the ethical non-substitutability of natural capital consumption. We argue that in the context of long-term strategies, these four reasons are even more relevant, particularly when considering the low-carbon transition (see for example Bachner *et al.* (2020) on the impact of uncertainty on the results of integrated modelling studies of the low carbon transition). Aware that the concept of strong sustainability might carry different perceptions, we propose three guiding principles rather than a precise definition.

1. **No a priori substitutability**, although substitution might be possible in some cases and according to some principles. This does not mean that there is no space for arbitrage across different types of objectives.
2. **Multidimensional diagnostics and analyses**, to be understood in the sense of indicators with different units and measuring potentially related but different concepts, but also in geographical, time and multidisciplinary senses. These science-based diagnostics and analyses should allow for the identification of synergies and tensions between different indicators.
3. The need for a **social construction** of a "good condition", i.e. standards describing a desirable sustainable condition (taking environmental, social and economic perspectives) based on the multidimensional diagnostics and analyses mentioned before and of one or many trajectories towards such a good condition. This construction inevitably takes place around a social contract explicitly addressing the synergies and tensions identified beforehand and needs to be adapted and revised to different spatial and temporal contexts.

These three principles can be found, on their own or combined with others, in the literature discussing sustainable development in general, and strong sustainability in particular. We believe that using them when designing and implementing development trajectories will help give a strong backbone to the supporting policies. These principles can be applied in all contexts while recognizing that these contexts are different and hence might require differentiated approaches when implementing these principles.

How to start constructing strong sustainability trajectories?

Using the proposed framework, one can start building multidimensional diagnosis highlighting the constraints, arbitrage and opportunities entailed by development trajectories. This section presents three different approaches: a multidimensional inequality analysis, the ESGAP indicator of environmental sustainability and an analysis of socio-economic vulnerabilities of countries in the context of a low carbon transition. These examples will show how the first two principles can be applied in different fields. The existence of such multidimensional analyses and diagnostics is critical to allow then a policy debates around the construction of a desired “good condition” and the different

paths to reach it. The ways to build such a participatory approach will be discussed in the next section.

Multidimensional inequality

The reduction on inequality has made its way as a clear objective of development strategies and inequality not only is no longer seen as a natural phenomenon accompanying development processes (Milanovic, 2016), but its role as a constraint for prosperity is widely acknowledged (see Chapter 3 of IPSP, 2018). However, the concept of inequality is highly complex and lacks the comprehensive and normative approach that related concepts, such as poverty, have. While most of the debates, policies and discourses seem to focus on income inequality, the questions of inequality among whom and inequality of what quickly appear. Taking Sen's capability approach (Sen, 1992) as a point of departure, Oxfam and the London School of Economics proposed the Multidimensional Inequality Framework[4] (MIF), which aims to bring together these questions under a multitude of indicators grouped under seven life domains going from financial security and dignified work to participation, influence and voice. Similarly, the Inequality Diagnostics, developed by the African Center of Excellence for Inequalities Research in partnership with the Agence Française de Développement (Shifa and Ranchhod, 2019), are comprehensive reports on multidimensional inequalities which provide an in-depth analysis of the trends and patterns of socioeconomic inequality in a given country. These inequality diagnostics take income (or consumption) inequalities as a starting point of analysis and further examine how different types of inequalities, such as those linked to the labor market, to land or to access to basic services, intertwine across different groups and geographical boundaries. These approach thus apply the first two guiding principle in that inequality is not reduced to a single indicator substituting different forms of inequality and offer multidimensional diagnostics and analyses highlighting the synergies and tensions between the different forms of inequalities, leading to more relevant policy questions as we will see hereunder.

Initiatives such as these two indeed allow to analyze how different inequalities overlap and mutually reinforce each other. Low levels of consumption inequality can hide highly unequal access the labor market and to basic services, which can result in an overall perception of high inequality and contestation of policy changes needed for a transition to more equitable and sustainable societies. For a long time, the profession thought that reducing inequality should not be an objective per se as it will be reduced during the development process. We know today that not only it is not true, but that patterns of growth which are built on unequal distributions of outcomes and opportunities contribute to entrenching inequalities. Understanding the various dimensions of inequality is key not only because they determine deprivation and vulnerabilities, but because climate responses and sustainability trajectories will be shaped by institutions which reflect these structural imbalances. Economic inequality more often than not comes with political inequality, which means that those who make the political choices concerning the transition scenarios will be more inclined to protect their own interests thus perpetuating the concentration of wealth and voice. This is also true of gender inequality for instance because if climate adaptation scenarios are developed without a gender lens, gender inequalities will

[4] https://sticerd.lse.ac.uk/inequality/the-framework/media/mif-framework.pdf

increase as women are more vulnerable to climate change across different dimensions: they have less access to resources such as land which would enhance their coping capacities, they are more dependent on natural resources and they represent the majority of the poor.

ESGAP

The discussion in section 2 highlighted both the importance of including environmental dynamics and their interactions with socio-economic ones and the difficulty to construct indicators that allow to reflect these environmental dynamics and their consequence for life on earth (see Ekins *et al.* 2019 for a comprehensive discussion on the limits of existing indicators).

Major global environmental assessments —for example the UN Global Environmental Outlook (GEO) and Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES)— highlight the extent to which human activities result in a widespread and increasing degradation of the components of natural capital. Thus, for development to be sustainable, it should ensure that critical environmental functions provided by nature persist over time, which requires maintaining the capacity of the natural capital stock to provide those functions. To reflect the extent to which countries are close to environmental sustainability, indicators need to meet three conditions. First, they need to take the form of a distance-to-target indicator, *i.e.* the indicator needs a reference point against which performance can be compared. Second, this reference point needs to represent the conditions under which the provisions of critical functions of natural capital are maintained. Third, the indicator needs to be defined at the national level, as it is the level at which most environmental policy is implemented.

These conditions also ensure that the approach fulfills the first two guiding principles set above. The range of environmental functions to be monitored represent the different environmental dimensions that require our attention when constructing development trajectories, without substituting them. Each one of them is important in itself, so aggregation needs to be done as a distance-to-target. But this target is not always well known, requiring specific processes to devise legitimate targets based on science.

The Environmental Sustainability Gap (ESGAP) framework sets the basis to measure countries' environmental sustainability performance, based on standards meant to represent the situation at which natural capital can maintain its functions over time. It is composed of 21 indicators, all supported by scientific standards of environmental sustainability, that can ultimately be aggregated into a single index (the SESI, for Strong Environmental Sustainability Index) that represents absolute environmental sustainability performance or progress over time. See Usubiaga-Liaño and Ekins (2021a, 2021b) for a detailed description of the framework and the indices.

For all the identified critical components of natural capital, the ESGAP framework computes the gap between the current state and a sustainable state, a state compatible with a sustained functioning of the underlying critical processes necessary for preserving life, human activities and welfare. The sustainable states, or "standards of good environmental condition" are conceptually related to the "science-based targets" developed in the wake

of the Paris Agreement for climate (Andersen *et al.*, 2020). The ESGAP uses broad sustainability principles as a provisional way of deriving environmental standards across a wide range of relevant environmental and resource issues, with the standards expressed in most cases as indicators of the condition of natural capital or as the pressure exerted upon it. Setting environmental standards is not a straightforward task, and in the ESGAP studies, even if 21 standards were found (at least one per subtopic, and suited only to European countries in most cases), more environmental standards need to be set, suitable for a range of situations and country contexts where either data availability is an issue, or where the representation of a good condition of environmental functions is not well integrated in policies or development strategies.

Socio-economic vulnerabilities to the low carbon transition

The low carbon transition is de facto an important restructuration of our economies with sunrise industries benefiting from it and sunset industries seeing loss of production and even facing disappearance. In order to understand the current socio-economic exposure of all the economies of such a restructuration, Espagne *et al.* (2021) have constructed a model based on environmentally extended multi-regional input-output matrices. The model computes three vulnerability indicators (share of net exports, share of employment and wages and share of production dependent on sunset industries). Their results show how the vulnerabilities faced by developing economies vary in magnitude and in nature. Some countries, such as Algeria or Saudi Arabia, might face external vulnerabilities while other such as France or Madagascar are not displaying any vulnerabilities or on the contrary might be exposed to all the three aspects in the case of Bolivia or Venezuela.

The approach highlights the fact that countries are facing multidimensional vulnerabilities to the low-carbon transition, with both magnitude and nature depending on their context. The first guiding principle proposed above thus allow the author to first recognize that policy makers have multiple objectives, such as sustainable balance of payment, public debt or employment levels, when conducting macroeconomic policies and these cannot be meaningfully synthetized into one aggregate objective. Furthermore, by proposing a multidimensional diagnostic and analysis, the author show how policy makers, when deciding to construct long-term strategies, will face different arbitrages regarding environmental ambition, economic development and social protection. Understanding how these vulnerabilities pan out is thus crucial to identify, design and implement different transition policies.

The "good condition" as a social norm: a participatory approach

Widespread concerns about our planet's limited resources and current changes in the perception of nature contribute to making the operationalization of strong sustainability appear achievable. When it comes to sustainable development, there is however often a gap between the policies as they are expressed on paper and the way in which they are implemented in practice across various territories (Theys, 2002). This is mainly due to two factors. First, sustainable development policies tend to be insufficiently detailed on social objectives and their temporal implementation. Second, their operationalization is frequently reduced by the use of regulatory or economic instruments that do not by themselves guarantee sustainable development. The processes of social construction of both

objectives and instruments are therefore key to strong sustainability's political implementation.

Defining a good (ecological and social) condition, agreeing on what should be done in the short, medium and long term, connecting immediate emergencies with the needs of nature and future generations call for citizens to participate alongside states and the private companies. This collective intelligence should contribute to building, territory by territory, answers to the following operational questions: who decides, establishes and enforces ecological limits; who decides what essential functions must be preserved and how this is debated; how is the definition and monitoring of compliance with these limits organized, at what scales, by whom and according to which time frame?

By relying on the capacities of all actors to organize themselves and define ad hoc governance mechanisms, the commons approach is centered on the search for negotiated consensus. It allows the identification of reforms and public policies that support the implementation of specific sustainable development paths. First of all, it makes it possible to recognize, beyond state action and market mechanisms, the many forms of direct actions that create, preserve or access goods and services "in common" (Ostrom, 1990). It also allows us to broaden our reflections towards polycentric governance, where different social institutions for decision and action contribute to governance, from states to user groups, inhabitants, citizens (Ostrom, 2009). Finally, it opens up alternatives to exclusive property rights in the form of shared rights and rights of use (Ostrom and Hess, 2010), and thus offers a new way of "dwelling" or inhabiting the world (Vanuxem, 2018).

Conclusion

Sustainable development is back in the spotlight. Recent policy debates around sustainable development goals, just transition, climate justice or the alignment of climate and biodiversity objectives, etc., highlight the importance of nexus approaches combining environmental, social and economic perspectives, hence going back to the roots of the definition of sustainable development. Sustainable development is however a fuzzy concept and can be interpreted in many different ways thus leading to very diverse policy recommendations. Fundamentally, the question of substitutability between objectives of different nature is at the core of the debate, returning to the economic literature of the 70s and 80s.

In order to start designing strong sustainability trajectories, we proposed in this paper a set of three guiding principles: a priori refuting substitutability between objectives, conducting multidimensional diagnostics and analyses, and finally recognizing that the desired "good condition" and the trajectories to reach it are a social construct, based on the diagnostics and analyses conducted beforehand. These three principles, we argue, allow to make explicit the tensions or synergies between environmental, social and economic objectives and can thus help in proposing adequate policy recommendations, following a participatory approach. While it is difficult to offer a one size fit all set of policies to ensure the emergence of sustainable development, we think that the proposed principles will ensure that policy recommendations will be decisive steps towards strong sustainability.

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