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ECOLOGICAL ECONOMICS AS A FRAMEWORK FOR THE ACHIEVEMENT OF ENVIRONMENTAL AND SOCIOECONOMIC SUSTAINABILITY

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ECOLOGICAL ECONOMICS AS A FRAMEWORK FOR THE ACHIEVEMENT OF ENVIRONMENTAL AND SOCIOECONOMIC SUSTAINABILITY

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SUMÁRIO

RESUMO

A economia ecológica é uma abordagem transdisciplinar que busca lidar com sistemas complexos e não lineares envolvendo seres humanos e a natureza, integrando aspectos da economia, economia ambiental, ecologia e estudos ambientais, entre outros campos do conhecimento. Este artigo apresenta inicialmente alguns dos conceitos dessa área do conhecimento descrevendo o Antropoceno e os limites planetários, a impossibilidade do crescimento econômico contínuo, a necessidade de redução dos níveis de desigualdade, falhas na alocação de mercado, e a natureza humana e o bem-estar. Além disso, o artigo ilustra políticas aplicadas à obtenção do tamanho ótimo do sistema econômico, de níveis de desigualdade mais baixos, e da diminuição de problemas de alocação de mercado, sempre tendo como particular atenção a realidade brasileira. Ademais, o artigo apresenta uma perspectiva pluralista da economia ecológica, incluindo debates entre pesquisadores de destaque na área. Assim, este artigo propõe-se ser uma introdução didática à economia ecológica ilustrada com aplicações do Sul Global.

Palavras-chave: economia ecológica; bem-estar subjetivo; decrescimento; desigualdade; Sul Global

Códigos JEL: Q57

ABSTRACT

Ecological economics is a transdisciplinary attempt to deal with complex non-linear systems of humans and nature, merging aspects of economics, environmental economics, ecology and environmental studies, among others knowledge fields. This paper introduces some of the concepts of this field initially describing the Anthropocene and planet boundaries, the impossibility of continuous economic growth, the necessity of decreasing inequality levels, failures of market allocation, and human nature and well-being. Besides, the paper illustrates policies addressing sustainable scale, inequality levels and problems of market allocation having as background the Brazilian reality. In addition, the paper presents a pluralistic perspective of ecological economics, including some ongoing debates among prominent researchers in the field. Hence, this paper proposes to be a didactic introduction of ecological economics illustrated with applications from Global South.

Keywords: Ecological economics; Subjective well-being; degrowth; inequality; Global South.

Classification-JEL: Q57

1. INTRODUCTION

Ecological economics is a transdisciplinary attempt to deal with complex systems of humans and nature with the goal of enhancing the wellbeing of all species on Earth. It addresses problems merging aspects of economics, environmental economics, ecology and environmental studies, among others knowledge fields. In addition, ecological economics is based on the systems approach and part of its origins is based on non-linear mathematics, non-equilibrium thermodynamics and ecosystem ecology (Costanza et al, 1997, 2020; Daly and Farley, 2004).

This paper introduces some of the concepts of this field of knowledge, describing: the Anthropocene and planet boundaries; the impossibility of continuous economic growth; the necessity of decreasing inequality levels; failures of market allocation and human nature and subjective well-being. Besides, the paper illustrates policies addressing sustainable scale, inequality levels and problems of market allocation having as background the Brazilian reality. In addition, the paper presents a pluralistic perspective of ecological economics, including some ongoing debates among prominent researchers in the field. Hence, this paper proposes to be a didactic introduction of the main concepts of ecological economics, illustrated with applications from the Global South. It also includes presentations of topics from demography and social economics that are directly linked to points discussed by ecological economics.

The paper was structured into 12 sections, including this introduction. Section 2 describes the Anthropocene and planet boundaries. Section 3 presents ecological economy as a framework to address the environment. Next sections discuss that the economic system is part of the Earth system, and the irreversibility of economic production. Section 6 discusses economic and population growth. Section 7 address p**olicies applied to achieve sustainable scale. Next section discusses inequality levels and p**olicies addressing distribution. Section 9 presents topics associated with human nature, consumption and wellbeing. In section 10, the paper describes market failures and policies addressing allocation. Section 11 presents some ongoing debates in the field of ecological economics. The last section concludes the paper.

2. THE ANTHROPOCENE AND PLANET BOUNDARIES

This section introduces the concepts of the Anthropocene and planet boundaries (PB). It is mostly based on three articles (Steffen et al., 2015a,b, 2018).

For most of human history, humans lived in small groups of nomadic hunter-gatherers. Gradually humans developed the technology to store larger quantities of food, and agriculture was developed. Individuals began to settle in small communities, which led to greater population concentrations and larger urban settlements. During this process the exchange of ideas increased and stimulated the creation of new technologies. More recently, the rate of technological progress intensified, culminating in the Industrial Revolution in the XVIII century, which had profound impacts on the economy, on society and on the Earth system. For the first time, human society became largely dependent on fossil fuels and other nonrenewable resources, human population grew rapidly, per-capita consumption escalated, and waste production intensified (Costanza et al, 2020; Daly and Farley, 2004).

The most recent period of this process described above greatly benefited from the stable and hospitable 11,700-year-long epoch of the Holocene and human development was facilitated by the climate predictability (Steffen et al., 2015b). Steffen et al. (2015a) discuss whether this stability of the Holocene was lost because of the human impacts on Earth, with the beginning of a human-dominated geologic epoch named the Anthropocene. According to these authors, the beginning of this epoch is most possibly associated with the dramatic changes of human´s imprint on Earth that were observed after 1950. They named these changes as Great Acceleration, as it marks the phenomenal growth of the global socio-economic system.

Unlike the Holocene, the Anthropocene characterizes very rapid human-driven modifications of several aspects of the Earth system pointing towards hotter climatic conditions. Steffen et al. (2018) explore the fact that self-reinforcing feedback could have serious and irreversible consequences for the Earth system, as temperature increases risk activating tipping elements in a domino-like cascade promoting further increases of the Earth's temperature. They examined evidence that thresholds might exist and, if crossed, the resulting planetary trajectory could be the irreversible conditions of Hothouse Earth, causing serious disruptions to ecosystems and society. To prevent this, collective human action is required to drive the Earth system away from a potential Hothouse Earth and to stabilize it in a habitable state, with actions that include: decarbonization of the global economy, behavioral changes, technological innovations, new governance arrangements, and transformed social values. This will be particularly challenging as the current dominant socioeconomic system is totally based on high-carbon economic growth and exploitative resource use.

Given this remarkable increase of the human's impact on Earth, we arrive at the question of whether our footprint is already above the planet´s limits (Steffen et al., 2015b). Based on the functioning and resilience of the Earth system, the planetary boundary (PB) approach has the objective to determine a safe operating space for the development of human societies. The PB framework aspires to be a guide to define the ecological space in which humanity may continue to develop and thrive without substantially jeopardizing climate stability and other aspects of the Earth system. There are at least three aspects that must be considered to define a PB. First, our current knowledge about the Earth system process is limited and plagued with uncertainties. Second, given the complex non-linear nature of the Earth system, predictability might be poor. Third, we should allow time for society to react to early warnings of the proximity of a threshold. The authors proposed nine PB. For some of these boundaries, the limits are not yet quantified, representing the highest level of our lack of knowledge in the subject. This is the case for the introduction of novel entities, atmospheric aerosols loading, and part of biosphere integrity (functional diversity). The other dimensions were classified as: still in the safe space (stratospheric ozone depletion, freshwater use and ocean acidification); in the risky zone of uncertainty (climate change and land system change); and already beyond the zone of uncertainty (biogeochemical cycles, and part of the biosphere integrity - genetic diversity).

3. ECOLOGICAL ECONOMY AS A FRAMEWORK TO ADDRESS THE ENVIRONMENTAL THREATS OF THE ANTHROPOCENE

The previous section described that human impacts on the Earth system are nowadays of such magnitude that some PB are already beyond safe space. Thus, humankind and the Earth are now facing many social and environmental challenges and threats that were not previously present in our species development. For the first time, humanity faces the challenge to continue to thrive socially within the safe and just space for humanity (SJSH) (Raworth, 2017).

Ecological economics is a remarkable approach to guide us through our future steps on Earth concerning the achievement of this space. It is a transdisciplinary attempt to deal with complex systems of humans and nature with the goal of enhancing the wellbeing of all species on Earth. It addresses problems merging aspects of economics, environmental economics, ecology and environmental studies, among others knowledge fields. In addition, ecological economics is based on systems approach, non-linear mathematics, non-equilibrium thermodynamics and ecosystem ecology (Costanza et al, 1997, 2020). Besides, economics is the core language for public policies, and ecological economics will play a decisive role in the design of policies for environmental and ecological present and future challenges (Daly and Farley, 2004; Raworth, 2017).

The approach described in the following sections is mostly based on papers written by Costanza et al. (1997, 2020), and on books published by Daly and Farley (2004) and Raworth (2017). This first book was an essential publication to consolidate the field of ecological economics and is a remarkable textbook. This perspective is the dominant in ecological economics, but it has been criticized by other authors in the field of ecological economics, and some of the ongoing debates were included in section 11.

Although different from mainstream economics, ecological economics draws much of its framework from traditional economics. Neoclassical economists devote a large part of their attention to mechanisms for allocating resources to alternative ends. Under certain circumstances, the market is efficient, and efficiency is so important that it is an end in itself. Environmental economics is a subset of neoclassical economics, hence still devoted to efficient allocation, but recognizes that welfare also depends largely on the ecosystem services (ES) provided by nature and that is negatively affected by pollution. Ecological economics takes a different approach and is focused on guaranteeing environmental sustainability while also securing resources for humans to achieve at least a minimum threshold of social well-being (Costanza et al., 1997; Daly and Farley, 2004; Steffen et al., 2015b).

Ecological economics has three basic goals. First comes sustainable scale, which requires a limit on aggregate throughput. After defining the scale comes distributive fairness, which requires a socially defined limited range of inequality. The criterion for scale is sustainability and the criterion for distribution is justice, both are non-market matters, but rather biophysical and cultural features decided politically. After considering scale and distribution, the market will determine prices to achieve efficient allocation, which will depend on the prior decisions. Thus, similarly to mainstream economics, efficient allocation is important, but far from being an ultimate end (Daly and Farley, 2004). These three topics are further detailed in this order in the next sections.

The doughnut diagram, presented by Raworth (2017), is a powerful representation of the long-term goal of humanity, assuring environmental sustainability and safeguarding that humans achieve at least a minimum threshold of social well-being. The outside of the doughnut is similar to the PB discussed by Steffen et al. (2015b) and represent the Earth's limits to resource use and waste absorption. The inside of the doughnut characterizes the basic human needs that must be fulfilled, such as the availability of clean water, decent sanitation, sufficient food, and being healthy and educated. In between the outside and the inside of the doughnut is where we should locate long-term development, without human deprivation and without causing critical planetary degradation, the SJSH.

4. THE ECONOMIC SYSTEM AS PART OF THE EARTH SYSTEM

In neoclassical economics, the economic system is the whole, while nature and the environment are a part of this greater system. Hence, the economic system can grow continuously, as its growth is essentially occupying empty space. Before the industrial revolution, the economic system was quite small and undemanding compared to the Earth system, and this perspective was quite reasonable. However, it does not hold in the Anthropocene, as the economic system is large compared to the Earth system. Thus, differently than mainstream economics, ecological economics and the Doughnut Economy, both described in the previous section, consider that the Earth system is the whole, and that the economic system is part of it.

In this perspective, the Earth is a finite system, closed regarding material exchange, as Earth has negligible exchanges of material with alter space, and open to energy, as the Earth receives an approximately constant rate of solar energy and release heat to the rest of the universe. Concerning this energy exchange, the sun is over 4 billion years, and it is expected to continue to irradiate similar amounts of energy in the next 4 to 5 billion years, well after our species will be long extinct. Given that the amount of solar energy arriving on Earth every year is well above all recoverable fossil fuel stocks, it is very likely that this source will substitute fossil fuels in the future.

Being part of the Earth system, the economic system is open to exchange matter and energy with it. Economic activity requires matter and energy as inputs for production, and waste and heat are released as outputs of the economic production process (Daly and Farley, 2004; Steffen et al., 2015a,b). Being contained by the Earth system, when the economic system grows, it occupies part of the Earth´s non-empty finite space. Thus, there is a trade-off represented by the opportunity costs associated with this expansion: the economy gains space, but the rest of the Earth system loses space. When the economic system is small with respect to the Earth, representing an empty world, ES are abundant and economic services are scarce. Hence, the opportunity cost of economic expansion is small, welfare gains associated with increases in the provision of economic services surpasses welfare losses of decreases in the supply of ES. Differently, in a world where some PB have already being surpassed because of the large size of the economic system, what characterizes a full world, economic services are abundant, and the provision of ES is small due to environmental degradation. Hence, further expansions of the economic system present large opportunity costs, and welfare increases due to increases in the provision of economic services may be smaller than welfare decreases because of losses of ES supply. Thus, because of this trade-off between the provision of economic services and of ES, there is an optimal size for the economic system as a proportion of the Earth system (Daly and Farley, 2004).

Before continuing the discussion, I will describe in greater detail the concept of ecosystem service. Initially, a differentiation between ecosystem structure and ecosystem functions is made. The first refers to the individuals and communities of plants and animals comprising an ecosystem. The interactions between these individuals and communities present a myriad of characteristics composing a rather complex ecosystem with non-linear interactions. Given this complexity, the properties of the whole ecosystem cannot be predicted from the separate analysis of its components. These emergent features due to ecosystem interactions are the ecosystem functions, which include energy transfers, nutrients cycling, gas regulation, climate regulation, and the water cycle. The biophysical structure of ecosystems provides ecosystem functions that benefit humans, and an ecosystem service is an ecosystem function that has value for humans. A feature of these services is that the existence of substitutes for most of them is highly unlikely (Daly and Farley, 2004).

ES can be classified into three groups: those that provide material and energy for human needs; those that regulate and maintain the environment for humans; and those representing nonmaterial characteristics of ecosystems that affect human´s physical and mental states (Haines-Young and Potschin, 2018). The first group, the provisioning services, includes the provision of food, drinking water, water for other purposes, wood, fiber, genetic resources and biomass for energy. The regulating and supporting services include climate regulation, pollination, carbon storage (GHG regulation), water storage (supply and regulation), soil fertility enhancement (tree roots grinding rocks, organic matter decaying and nutrient recycling), coastal protection, purification of soil, water and air (absorption of organic wastes and pollutants), natural pest suppression, protection against soil erosion, storm and flood control, and living habitat creation. The last group includes cultural services, such as green recreation, natural scenery, symbolic and religions values and science and educational possibilities.

5. THE IRREVERSIBILITY OF ECONOMIC PRODUCTION

Neoclassical economics commonly presents its processes as reversible, for instance, the common diagram in economics textbooks with the continuous circular flows of values in an economy describing macroeconomic associations. Although useful didactically, this type of representation does not hold in a world governed by the requirement of natural resources and energy as inputs and the production of waste and heat as outputs, as described in section 4.

The First and Second Laws of Thermodynamics are decisive to address these points. The First Law of Thermodynamics states that matter and energy are constant in quantity. Einstein's equation, E = mC2, where E is energy, m is mass and C is light velocity, establishes the equivalence and interchangeability between matter and energy. The Second Law of Thermodynamics states that total entropy will never decrease. In an open system, as is the Earth system for energy, a system can only decrease its entropy if the entropy is increasing to a greater extent in another system (Daly and Farley, 2004; Raworth, 2017).

Given these two laws of thermodynamics, when low-entropy stock of minerals or fossil fuels is consumed, high-entropy waste and heat are generated. High-entropy materials can be recycled, refurbished and re-used becoming again low-entropy material, however, in this process, energy and/or matter is always lost from the system. Increasing levels of technology will surely affect such processes, decreasing the relative amount of energy/matter that is lost from the system. Hence, with more technology, fewer resources will be required, but the input of resources will always be needed.

Besides, nowadays, most economic activities are linear degenerative from resources to waste, implicating that the process related to recycling, refurbishing and re-using are in many aspects less relevant than they should be. This perspective is rather different from the processes observed in nature, which are essentially recycling systems powered by the sun. Thus, the economic system must have more resemblance to nature, and matter and heat loss must be minimized by regenerating and restoring cycles (Daly and Farley, 2004; Raworth, 2017).

6. ECONOMIC AND POPULATION GROWTH

Ecological economics has three basic goals, as mentioned in section 3, and the first one to be tackled is sustainable scale. Differently than ecological economics that pursue a steady state between the economic and Earth systems, mainstream economics tracks continuous economic growth, and this has been the focus of economics in the last decades. Economic growth is commonly measured by variations of Gross Domestic Product (GDP) or of Gross National Product (GNP). Notice that only market values are included in both measures. Household production for household members, such as cooking, cleaning and childcare, are invisible to both measures unless done by a paid worker (Marçal, 2017).

In this perspective of continuous economic growth, it is believed that technology will be able to solve the problems of energy and resource depletion and of pollution and waste production (Costanza et al, 1997). The main question to be addressed is whether the progress of technology will be able to overcome the problems of ever-growing consumption. If the economy increases more rapidly than the increase in the use of resources, relative decoupling is attained. This is the kind of green growth being pursued by many countries. However, this might not be sufficient to achieve a sustainable future in a world that has already surpassed some PB (Steffen et al., 2015a,b). A more radical change might be necessary as the one represented by absolute decoupling, with a decrease in resources use, even with an increasing economic system. This scenario may or may not be sufficient, although much better for sustainability than the previous one. Sustainability is achieved in the long run if the absolute decoupling trend is enough to reach the SJSH (Dale and Farley, 2004). Slamersak et al. (2024) addressed the required rate of energy-GDP decoupling to maintain the Earth within the 1.5 to 2.0 ºC warming range. With continuous and actual GDP growth, the scenarios would require unprecedented rates of decoupling, which are not probable. Differently, with the economy size tending to a steady-state and resembling a logistic curve instead of an exponential function, it is more feasible to decrease emissions by developing low-carbon energy infrastructure in a way that is consistent with this warming range (Raworth, 2017; Costanza et al, 1997).

Based on the above discussion, ecological economics can be seen as a necessary evolution of neoclassical economics and a critique of the pro-growth market economy. It proposes an end to economic growth based on an increasing flow of natural resources from the environment to the economy and the contrary flow of waste from the economy to the environment. Note that there are ongoing debates about post-growth, moving beyond growth-dependence, and degrowth, reducing economic production and consumption, especially in wealthy countries (Brand-Correa et al., 2022; Hickel and Kallis, 2019; Kallis et al., 2025; Slamersak et al., 2024). Notice, however, that the end of economic growth does not imply the end of social development, as there might be an increase in human well-being through an increase in the quality of goods and services produced by a sustainable use of natural resources and production of waste (Daly and Farley, 2004).

Another key factor in achieving sustainable socio-ecological development is the human population size, as all else equal, more of us imply greater consumption and greater ecological stress. Global population trends depend on fertility and mortality levels, however, **future population growth is mostly determined by fertility rates, as mortality rates decrease before fertility rates. Total fertility rate (TFR) in the world decreased from close to 5 births per women in 1970 to the current level of a little above 2, close to the replacement level (approximately 2.1 children per women). That is, the global population with its overall fertility rate has already a tendency to stabilize. Most countries that have a TFR well above replacement level locate in Africa and the main tendency of these countries is also to decrease their fertility rate, implicating in a future tendency of population decrease in the world,** easing ecological footprints **(Roser, 2023, 2024). Fertility decline in Brazil was even more remarkable, and current levels are well below replacement level and still falling (**Coutinho and Golgher, 2018). **Thus, it is expected to see a shrinking population in the near future implicating that a stable GDP/GNP will represent an increase in per capita GDP/GNP.**

7. POLICIES ADDRESSING SUSTAINABLE SCALE

Previous section discussed the possibility of achieving sustainable scale. There are at least four types of policy to address sustainable scale: direct regulation, Pigouvian taxes, Pigouvian subsidies, and tradable permits.

Direct regulation is the most common environmental policy affecting scale. This type of policy determines the maximum quantity of an activity or of the presence of a substance. Failure to fulfil the regulations generally involves fines or other penalties. This type of policy is known as command-and-control (C&C) regulations. A basic requirement for economic efficiency is that marginal costs equal marginal benefits, and C&C regulations do not fulfill this requirement. For instance, different agents may have to decrease their pollution production by a similar relative amount, but technologies and costs, the marginal abatement costs (MAC), may vary remarkably between them. Thus, marginal benefits related to the reduction of pollution production are the same for all agents, but MAC differs among them. Another limitation of C&C regulations is that they ignore that policies should attempt to attain macro-control with the minimum sacrifice of micro-level freedom. In the above example, to obtain an overall decrease in pollution production (the macro-control), all agents were obliged to obtain a similar decrease (the sacrifice of micro-level freedom) (Daly and Farley, 2004).

To overcome such limitations, policies should take advantage of the equimarginal principle of maximization by equalizing MAC across agents and minimizing sacrifices of micro-level freedom. In addition, policies should provide incentives for agents to develop new technologies for further reducing environmental costs. In this vein, Arthur Pigou (1877–1959), a British economist, came with the solution of imposing a tax, the Pigouvian tax: agents can still pollute or harm the environment, but they must pay for their damage. The use of a Pigouvian tax forces the economic agent to account for the economic costs of environmental damage. When the tax is greater than the MAC, it is better for the agent to reduce its pollution production. When the tax is smaller than the MAC, the best choice is to pay the tax. Hence, the relative decrease in pollution production of each agent depends on its MAC. Agents with lower costs for reducing environmental damage tend to relatively reduce more their damage than other agents. Economic agents freely act accordingly to their possibilities, generating a cost-effective outcome that is desirable to society, and have incentives for further reducing their damage not to pay taxes. Thus, Pigouvian taxes tend to be superior to C&C regulations. However, it is difficult to predict how much the decrease of environmental damage will be for any given tax, and a trial-and-error process might be required. Public authorities can start with a lower tax and increase it afterwards if needed. This is an example that policies must recognize initial conditions and must adapt to changed conditions (Daly and Farley, 2004).

Besides Pigouvian tax, public authorities can use Pigouvian subsidies, which are payments to agents for environmental cost reduction. The tax perspective is that the agent pays to harm the environment, while the subsidy assumes that the agent has the right to harm the environment, and society must pay for it not to do it. Although quite different in perspective, Pigouvian tax and subsides have some common attributes, such as being cost-effective outcomes. Pigouvian subsidies or tax reliefs are very effective as an incentive to ecosystem restoration or protection. For instance, Pigouvian subsides might pay farmers not to decrease the natural forest cover of their property. Farmers have net private benefits when clearing forests for agriculture production. Thus, local, national and global public authorities may compensate farmers not to deforest their property, preserving ES, which benefits society at different spatial scales (Daly and Farley, 2004).

Finally, we address the cap-and-trade systems or tradable permits. First the maximum amount of pollution production or of resource depletion that is allowed is established. Then quotas are distributed among the polluters or resources users for free or auctioned off. Once the agents own the permits, they are free to trade them. Notice that the agents have micro-level freedom, and the policy is cost-effective. Permits can be issued annually or for other temporal perspectives, and agents will have the incentive to reduce their emissions or resource harvest so that they can sell part of its quota to other agents (Daly and Farley, 2004).

We further discuss these policies with the presentation of different studies with Brazil as subject. The objective is to illustrate applications of the four policies presented above.

Concerning C&C regulations, Neto et al. (2022) discussed the importance of promoting the conservation of private properties in Brazil. The authors described Brazilian laws that aim to protect them, in particular Areas of Permanent Protection (APP) and Legal Reserves (RL). The suppression of vegetation is prohibited in APP. They are important to protect aquatic ecosystems, as they are used to preserve areas along riverbanks, and around springs, lakes and reservoirs. In addition, these areas are present at hilltops, high altitude areas and steep areas. RL must preserve a percentage of the private property as natural cover, and the use is less restricted. The authors analyzed the “Projeto Formoso Vivo” in Bonito, Brazil. Most owners of rural properties in this area signed a Term of Conduct Adjustment (TAC) and committed themselves to respect the preservation laws of APP and/or RL. Some of them were later interviewed and, besides the C&C policies, they cited as important to accomplish the environmental protection Pigouvian subsides, the Payments for Environmental Services (PES), such as fiscal and financial incentives and facilitated financing lines. Hence, the authors emphasized that C&C instruments could be used conjointly with PES.

Gonzaga (2016) compared land-use changes in three different areas in Brazil: Extrema, Rio Claro and Bonito. The author prepared land cover maps for each area and its surroundings before and after the implementation of C&C and/or PES policies. The evolution of land-use in areas where the policies were implemented were compared with those at the vicinities without the policy. She observed significant improvements in forest cover in the areas that received PES in Extrema when compared with the control areas. Differences in Rio Claro between treatment and control areas were not significant. The areas in Bonito showed that C&C regulations were effective to prevent deforestation, and that PES policies had a significant but smaller positive effect.

Pereira et al. (2020) analyzed the Bolsa Floresta Program (BFP) that was implemented in Protected Areas of the state of Amazonas in Brazil. The program's objective is to compensate traditional populations for conserving the forest, while quitting income generating actives that cause deforestation. The Uatumã Sustainable Development Reserve was the chosen area of study. The mothers of the families that decided to participate in the program signed a commitment agreement and started receiving a fixed amount per month. The program has some conditionalities, the most important one is the zero net deforestation of primary forested areas. The authors concluded that, based on their estimation of opportunity costs, the BFP should pay at least an additional US$76 per month/family. Besides, PES receivers were seldom punished for not stopping converting forest to other land uses.

Mardones (2022) analyzed Pigouvian taxes to internalize environmental damages from Chilean mining. Chile was the main copper producer in the world, and its extraction has environmental costs associated with the depreciation of natural capital and damages to the population's health. A mining royalty was introduced in 2005 with a progressive rate according to production volume. They used a computable general equilibrium model with different tax simulations that replace the mining royalty with Pigouvian taxes. They observed that the application of these taxes would cause a reduction in GDP, in particular because of the reduction of competitiveness of Chilean copper mining industry at the international market. Hence, an increase in poverty would be expected, and policies positively affecting income distribution should be implemented conjointly with Pigouvian taxes. On the positive side, these taxes contributed to reducing GHG emissions.

Finally, I now turn my attention to cap-and-trade systems. Lessmanna and Kramer (2024) estimated the effects of introducing cap-and-trade in the power and industrial sectors in California. This policy began its operation in 2012 with the power plants and expanded afterwards. The authors compared the actual GHG emissions with a synthetic counterfactual reality to apprehend the effect of cap-and-trade policy on emissions. For the power plants, they observed that GHG emissions fell below the counterfactual by 7% annually. Part of this reduction was caused by carbon leakage, as firms are usually able to relocate to neighboring states, but even considering this reallocation, the power section in California decreased GHG emissions due to the policy. Differently, the industrial sector showed a slight increase in emissions. The authors concluded that the generous allocation of free allowances might explain this result, as regulated entities have received free permits to prevent carbon leakage and to provide transition assistance.

8. INEQUALITY LEVELS AND POLICIES ADDRESSING DISTRIBUTION

Ecological economics has three main goals, as discussed in section 3, being the first one to achieve sustainable scale. The second, which is discussed in this section, is to attain distribution fairness. One major consequence of focusing on continuous economic growth, which is the main goal pursued by mainstream economics, is to effectively postpone the issue of income and wealth redistribution, because when the economy grows with similar levels of inequality, everyone is potentially better off. However, the economic system cannot grow forever on a finite planet, as discussed in previous sections, and, in addition, a sizable proportion of the world´s population does not yet hold the necessary minimum income and wealth to fulfill basic human need. High levels of income and wealth inequality push humanity to overcome the planet´s ecological boundaries, as described in Steffen et al. (2015a,b, 2018), while not fulfilling basic human needs for all, hence locating humanity further from SJSH in both directions. For instance, Khalfan et al. (2023) discuss how inequality negatively impacts carbon footprint, while Sen (2000) discusses how inequality negatively impacts socioeconomic welfare.

Income inequality in the world measured by the Gini Index increased in the 19th century, was mostly stable with fluctuations in the 20th century, and decreased in the beginning of the 21st century. Although this recent decrease in income inequality may seem encouraging, the world is still highly unequal (Chancel et al., 2022). Therefore, contrary to population variations that show promising trends for achieving sustainability, a reasonable equal society is still a very far goal. Notice, however, that some inequality is inevitable and may even be considered desirable, as some individuals might work harder than others and/or have greater abilities (Dale and Farley, 2004).

It was believed that the least developed nations presented low inequality levels and that nations in their development process had to pass through a high inequality period before reaching a more developed level with more equity. This tendency is well-represented by the Kuznets curve, an inverted-U relationship between income per capita and inequality. Recent studies challenged this perspective and nowadays many economists do not accredit this view anymore. Countries do not necessarily have to become more unequal to later become more developed and equal, and inequality is not an unequivocal consequence of development. Hence, plans to promote redistributive flows that emerge from economic interactions must be part of development (Raworth, 2017).

The Kuznets curve discussed above associated development level with inequality. Similarly, there exists a Green Kuznets curve. This curve relates per capita income with environmental degradation also with an inverted U relationship. It is based on some assumptions: that individuals with higher income may show greater concern about environmental issues; that industries located in higher income countries will use cleaner technologies; and that the industrial sector in more developed areas will be replaced by the cleaner service sector. However, this last curve also does not hold under closer scrutiny. It is true that local extraction of raw materials decreased in higher income countries; however, the figure changes if international trade is considered (Raworth, 2017).

There are many reasons why inequality and poverty should drop: poor individuals might not care about sustainability as they are struggling to attain their own basic needs; very rich individuals consume large amounts of the world's finite resources, potentially depriving future generations of valuable resources; individuals commonly exhibit status through notable consumption, and the status race is relational to others' positions and is a zero-sum game; economies with higher levels of inequality do not grow more than others as hitherto believed. Besides, social inequality promotes status competition and erodes social capital, both necessary to reinforce environmental legislation (Daly and Farley, 2004). In addition, nations that are more unequal tend to have deteriorated social fabrics with: more cases of teen pregnancy, mental disorder, drug abuse, obesity and school dropout; greater rates of morbidity, mortality and crime; and lower levels of well-being (Wilson, 1987).

Hence, high levels of inequality should be avoided, and many policies have been created with this purpose. Some policies implemented in the 20th century had as their main purpose redistributing income, and they are extremely decisive to increase the well-being of less privileged individuals. For instance, cash transfers that are given to households that have resources below the threshold considered enough for a life in dignity are widespread and publicly funded social safety nets. An example is the Bolsa Familia Program in Brazil, which is a conditional cash transfer program (CCTP) that was implemented in 2003. This type of program seeks to reduce poverty, food insecurity and income inequalities and, because of its conditionalities, it also intends to expand access to health, education, and citizenship. The Brazilian program is among the largest CCTP in the world, benefiting around 14 million families in all Brazilian municipalities. The benefits consist of a monthly basic amount given to all eligible households and a variable amount for eligible households with children and adolescents (Neves et al., 2020).

Other types of policies include unemployment insurance for the unemployed, and minimum wages for the employed. Saboia and Hallak Neto (2018) analyzed the effects of the evolution of the real value of minimum wage (MW) on income inequality in Brazil. The MW real value based on 2014 values increased from approximately R$ 350 reais in 1995 to around R$ 800 reais in 2014. This remarkable increase played an important role in improving income distribution in the period both through labor market factors and due to modifications of transfer mechanisms values. On the negative side, this real value increases negatively impacted on public finance as MW is used as a value floor for official pensions, retirements and other benefits.

Wealth inequality tends to be even higher than income inequality. Land control, which is highly concentrated, is among the main factors directly linked to wealth concentration, and redistributing landownership is a policy to reduce wealth inequality. The most valuable lands are in dense regions, such as in large metropolises, due to the proximity to infrastructure, goods and services, and because humans are social animals. Therefore, land value derives mostly from external characteristics to the plot that are caused by positive externalities of other individuals' actions. Moreover, land supply is nearly constant and increases in demand because of population and/or wealth growth creates an upward trend for prices. In addition, the expectation that prices will rise promotes speculation, and part of the land is left idle, further increasing prices. Thus, society creates land value because of positive externalities and landowners should pay part of their land returns as land taxes. These taxes increase the cost of owning land, make land speculation less profitable, and decrease land prices (Dale and Farley, 2004).

Another factor direly linked to wealth concentration is money creation. Money (M) function as a medium of exchange, facilitating the exchange of one commodity (C) for another (C*): C—M—C*. However, there are other possibilities for the use of money. For instance, someone starts with a sum of money M, uses it to buy or make commodity C, and then sells it for the presumably greater amount M*: M—C—M*. In the last equation, money is not a means for facilitating exchange, but an end in itself. This was dwarfed by currency and financial paper speculation, trades of paper purchasing paper, M—M*, with a value much larger than the value of global production of marketed goods and services, implicating in a magical growth of money. Surely, these money dynamics brings remarkable income and wealth inequalities, and greater taxes on destabilizing industries such as those associated with speculative trading could be implemented (Dale and Farley, 2004).

Some policies can be implemented to decrease income and wealth inequalities. For instance, progressive income and consumption tax redistributes resources and are used worldwide. The maximum personal income tax rate in Brazil (27.5%) is much lower than in many countries, what suggest that there is room for increasing the Brazilian personal income tax. Besides, individuals pay taxes on real estate and cars worldwide, and other types of tax on highly concentrated wealth could be imposed, for instance, to inherited goods. In Brazil this last tax was 8% in 2024. In addition, taxes revenues in Brazil are largely due to consumption. Hence, given the larger propensity to consume in less privileged population stratum, poor individuals in Brazil actually expend a greater proportion of their income on taxes than the very rich individuals. Therefore, taxes in Brazil could be revised and simplified, putting less emphasis on consumption (Palomo et al., 2025).

9. HUMAN NATURE, CONSUMPTION AND WELLBEING

Neoclassical economics and ecological economics also differ in how they describe the human agent, what is directly linked to the distributive aspects of the economy, consumption levels and well-being. Mainstream economics is based on the traditional homo economicus, which is a solitary insatiable agent, promoting more is better. Although very useful for didactic and modelling purposes, this perspective is rather too narrow to deal with human complexity. Instead of being a solitary and self-interested unit, we are socially interrelated beings, who exchange all sorts of things, and have a propensity to trade and cooperate, as proposed by ecological economics (Costanza et al, 2020; Raworth, 2017). People´s day-to-day behaviors include sympathy and commitment. In the former, concern for others directly affects one´s personal welfare, while the latter appears when something does not make the person better or worse, but he/she decides to act on its behalf due to cultural and ethical issues (Sen, 1997). This last perspective of humanity eases the achievement of a less unequal society.

Per capita GDP is commonly used as a welfare indicator in mainstream economics. Nonetheless, this indicator is a measure of economic activity, and economic welfare is only part of total welfare, as welfare is also derived from non-economic features. Moreover, per capita GDP is limited to measure depletion of natural capital that might have impacts on welfare. In the past, per capita GDP was more correlated to welfare because consumption was one of the most limiting factors in enhancing welfare, but evidence suggests that this is no longer the case, at least in developed countries. For poor individuals or countries, absolute consumption is important as basic human needs are still being fulfilled, but above a certain economic level, an increase in per capita GDP doesn't increase welfare levels much. Given these characteristics, environmental sacrifices to increase GDP justifying welfare gains are at most a limited perspective (Dale and Farley, 2004; Layard, 2008).

Subjective well-being is much more determined by a matrix of human needs after the basic needs have been fulfilled, as discussed by Max-Neef, such as being healthy, sheltered, nourished, and protected and nurtured by friendships and family (Dale and Farley, 2004). In Brazil, happier and more satisfied individuals gave more importance to the family, had better levels of health, had greater levels of self-determination, had a better financial situation, trusted more friends and acquaintances, and showed greater religiosity (Golgher and Coutinho, 2021). Moreover, being married and employed were also among the main factors related to subjective well-being in Brazil (Golgher and Coutinho, 2020). Notice that most of these factors described as the main factors related to subjective well-being require few material resources. Thus, similar levels of happiness and life satisfaction can be achieved with much lower consumption levels (Verhofstadt et al., 2016).

Other authors investigated the relationship between energy use and well-being. Brand-Correa and Steinberger (2017) proposed a novel analytic framework of how to decouple human eudaimonic human needs from energy use. Baltruszewicz et al. (2023) investigated how household energy use is related to well-being outcomes in the UK. They observed that high well-being is possible to achieve with energy amounts that are less than UK´s national average energy footprint, however half of the households with low energy footprint had low well-being.

In this vein, there are other indicators that are much more related to welfare than per capita GDP. For instance, Sen (2000) promoted a more humanistic perspective for development, emphasizing that it should promote human life richness rather than economic wealth. The emphasis should be in enhancing the possibilities of human´s life and the individual's capabilities, such as being healthy, empowered and creative, what is partially captured by the Human Development Index (HDI) (United Nations, 2024).

10. MARKET FAILURES AND POLICIES ADDRESSING ALLOCATION

Following the three main goals of ecological economics, after considering scale and distribution, we arrive at the third one: markets will determine prices to achieve efficient allocation. Many economic analysts believe that governments should only create conditions to allow markets to function properly, as competitive markets utilize individual self-interest to efficiently allocate resources via prices. Nonetheless, markets are only efficient for excludable and rival goods. Thus, most goods and services provided by natural capital do not have these characteristics and will be poorly provided by markets, and specific policies and institutions must be implemented to lead to their efficient allocation. For instance, markets are limited to providing pure public goods, which are non-rival and non-excludable, and anyone can use them without payment.

Thus, to properly allocate ES, which are mostly non-rival and/or non-excludable, using markets, a proposed solution by traditional economics is to determine monetary values for them. However, it is not easy to determine such prices, in part also because of our uncertainties about evaluating ES, and because the evaluative process may be quite expensive and demanding. Ecological economics argues that it might be inadequate to capture ES values and that it is impossible or unwise to give monetary values for ES, as discussed lengthier in the next section.

Despite these evaluative limitations, environmental economics (and some ecological economists) discuss different methodologies for monetary evaluating ES. These evaluations may be important to capture public and policy makers' attention and can offer insights into appropriate policies (Selivanov and Hlaváčková, 2021). These authors described many methods based on use and non-use values. The non-use values include bequest value, the value attributed to maintaining the benefit for future generations, and the existence value, which is the satisfaction from knowing that ecosystems exist.

The evaluation methods can be divided into three main groups: direct market valuation methods, indirect market valuation methods, and non-market valuation methods. The direct market valuation methods use data from existing markets with different approaches, such as market price-based methods and cost-based valuation approach. Concerning the first, it is based on products that are traded on markets, for instance, timber, and the proxy for the ES monetary value is estimated by the product´s price in the market. The cost-based valuation approach can be defined by the avoided costs because ecosystems services exist. For instance, the value of a mangrove forest is the cost avoided by the ecosystem because it prevents damages caused by storm waters (Selivanov and Hlaváčková, 2021).

The indirect market valuation methods are based on observable consumer behaviors that reveal preferences. Among them, for instance, the hedonic pricing method assumes that the value of real estate properties reflects the value of ecosystems services (Selivanov and Hlaváčková, 2021). For example, the value of urban streams rehabilitation was measured by real estate price variations in specific neighborhoods in Belo Horizonte, Brazil (Golgher et al., 2023). They estimated the total real estate value of all 1651 transactions in ten years in the rehabilitation catchments and compared this value with the value if the price evolution was similar to the rest of the municipality. They observed an increase of more than US$50 million, with a mean value of more than US$ 25 thousand per transaction, which is much higher than the US$ 14.5 million cost of rehabilitation efforts.

The nonmarket valuation approach is used when no market prices are available. Among the methods of this approach, contingent valuation methods are commonly used and include willingness to pay (WTP), which asks people how much they would be willing to pay for an ecosystem service, and the willingness to accept (WTA) that asks individuals how much they are willing to accept as compensation for the loss of the ecosystem service (Selivanov and Hlaváčková, 2021). Reis et al (2022) used WTP to evaluate the value of an aquatic ecosystem in the Pontal basin, Brazil. They applied a survey for a random sample of working age inhabitants with questions regarding the individual's socioeconomic background, whether the person was willing to pay for the environmental conservation of the ES. For those who answered positively this last question, they asked the amount they were willing to pay. They observed that individuals were willing to contribute around US$ 2 dollars per month.

11. SOME ONGOING DEBATES

Environmental economics appeared devoid of novelty and influence in the late 1980s, and ecological economics offered to be a new and exciting prospect to rethink environmental issues (Spash, 2013). Ropke (2005) presents trends in the development of ecological economics between this period and the early 2000s. The field first attracted socio-economists with different heterodox traditions. Afterwards, there was the attraction of mainstream environmental and resource economists, followed by ecologists who began to treat ecosystems integrated with human activities. She argues that a scientific field is not a framework achieved peacefully, but rather a social process that can be highly competitive among different groups and ideas.

In this context, following Spash (2013), a long-standing problem was left unaddressed: what type of economics should constitute ecological economics? Some researchers were satisfied with the use of orthodox economics, however, efficiency was no longer enough to achieve a sustainable future, and other concepts, such as scale and distribution, were added as independent goals. This group constituted the new resource economists. Differently, the social ecological economists were those who rejected this direction and called for new theoretical foundations, and they questioned consumer sovereignty, corporate structure and power politics, and included a deeper understanding of human psychology. In contexts closer to heterodox economic schools of thought, there was the recognition of common and universal human needs, as summarized by Max-Neef. A third group was happy to take an active and practical approach, searching for solutions for environmental problems while seeing no need for deep theoretical foundations, regarding environmentalism as a practical problem-solving activity, and not as a fundamental critique of human relationships with Nature. They composed the group of new environmental pragmatists.

Similarly to the first group, this last group promotes their environmental message in a marketable form, they use the concept of ES, and Nature became natural capital. Hence, the first and third groups mostly based their perspective on mainstream economics, the utilitarian approach, and valuing Nature. Spash (2013) argues that some of the main researchers in ecological economics, such as Daly and Costanza, follow this perspective. This approach is the leading perspective in ecological economists nowadays and it was described in the previous sections.

This utilitarian approach is based on three propositions. The first is the clear-cut human-nature divide, which has become a core of Western culture since the Age of Enlightenment. The other two are anthropocentrism, with an established hierarchical relation between humans and nature, and the predominance of instrumental values towards nature. These three propositions are embedded in the notion of Green Economy, which is a popular perspective among environmentalists using this perspective (Muradian and Gómez-Baggethun, 2021).

However, given that this perspective is limited and partial, this section further describes some of the aspects that are more related to the social ecological economics agenda and the transition to an alternative political economy. The acceptance of pluralism and different quantitative and qualitative approaches might be a richer perspective for ecological economics, what means being aware that utilitarianism is a very specific ethical and instrumental system.

The utilitarian framing has some limitations and assumptions besides being restricted to what is useful for humans: Nature is assumed to be a definable entity upon which humans can express preferences about; it is assumed that what has price is automatically protected; it is believed that monetary evaluations promote political action and fulfil information deficits (Spash and Smith, 2021).

Muradian and Gómez-Baggethun (2021) argued that the failure to overcome the current ecological crisis is at least in part due to limitations of using these utilitarian arguments based on concepts of Western culture and its influence on global capitalism while dealing with environmental issues. In addition, indigenous peoples and local communities (IPLC), individuals that challenge this hegemonic discourse and represent non-Western forms of non-instrumental reasoning do not enter significantly in the evaluative process (Spash and Smith, 2021).

In this vein, recent advances include the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES), with the proposed concept of Nature's Contribution to People (NCP). However, these developments, which are based on interpersonal relations, loving and caring, have confusing overlaps with the dominant perspective (Spash and Smith, 2021). The IPBES` conceptual framework was proposed to be more inclusive, nonetheless, NCP has a high degree of similarity with ES, being nearly synonymous and sharing similar philosophical foundations. Hence, these changes can be regarded as mostly apparent. Instead, the environmental movement should: aim to change the allocation of rights; include the participation of nature in the community of justice; modify moral consciousness; and challenge power structures. Thus, it is time for environmentalism to move from a morality based on utility to a morality founded on care, and self-restraint and empathy are key concepts to attain a more harmonious relationship with nature by creating psychological proximity with non-humans (Muradian and Gómez-Baggethun, 2021).

Røpke (2019) comments that human history has passed phases with increasing use of energy. However, the current environmental crisis limits the future use of fossil fuels, and a new phase of energy use must be achieved with not only radical technological transformations but also with new societal arrangements. Therefore, sustainability might not be achieved with reforms in the capitalist framework and more radical positions might be necessary, such as the one proposed by the post-growth and degrowth literature (Brand-Correa et al., 2022; Hickel and Kallis, 2019; Kallis et al., 2025; Slamersak et al., 2024).

Besides, this ever-growing global metabolism based on the development promoted by the utilitarian perspective of Western societies is causing an increasing number of local environmental conflicts, which are not only conflicts of interest but also conflicts on values (Martinez-Alier, 2002). In particular, poor people defend their livelihood while also protecting the environment, claiming for environmental justice, such as Chico Mendes' fight in Brazilian Amazonia.

Other authors also addressed the limitations of the utilitarian approach. Norgaard (2010) argues that the use of market representations in ecological economics was important to increase public awareness of natural processes and the environmental crisis. However, the stock-flow framework inspires such approach and is only one of the many ways ecologists address ecosystems. Ecologists have other perspectives while dealing with their complexity that could also be used in alternative ecological economics approaches, such as those related to population dynamics, food webs, energy flows, biogeochemical cycles, interactions and spatial organization across landscapes, and co-evolutionary processes. Besides, the author argues that the concepts of the utilitarian approach were forged using a partial equilibrium framework on a project-by-project basis. Instead, he proposes using a more encompassing general equilibrium framework. He also discusses that the use of market-related concepts prevents us from designing new global institutions promoting effective environmental governance. He concluded that the ES can be a part of a larger solution but should not dominate the perspectives to find solutions for the complex environmental challenges we currently face. Similarly to the proposed by Muradian and Gómez-Baggethun (2021), Norgaard (2010) argues that marginal adjustments in the economy through market-based concepts will not be sufficient to overcome the current environmental crisis, and we need to totally reassess our development path by dealing with ethical issues and environmental justice.

11. CONCLUSION

Ecological economics aspires to create a prosperous and ecologically equilibrated global economy, which must be based on distributive and regenerative designs. In this process, many economic sectors will surely need to shrink, such as mining, oil and gas production, cattle production and speculative investments. Other sectors must increase, such as renewable energy, public transportation, common-based circular manufacturing and retrofit buildings. Besides, our society that is financially addicted, as investors expect a net return for their investments, will have to change, as continuous accumulation is contrary to the Second Law of Thermodynamics. We are also socially addicted to the exponential growth of economic systems due to our increasing aspirations and consumerism culture, and this also cannot hold in the long run. Finally, we should focus on what really matters for our well-being, in particular the non-market aspects (Dale and Farley, 2004; Raworth, 2017; Golgher and Coutinho, 2020, 2021; Verhofstadt et al., 2016).

Ecological economists generally assume the position that intergenerational resource distribution is an ethical issue. At the very least, future generations have an inalienable right to have sufficient resources to provide a satisfactory quality of life. Renewable resources should be extracted in a sustainable way, or substitutes must be produced to compensate for the reduction in future harvests. The essential life-support functions of ecosystems must be maintained, including waste absorption capacity of the environment. Regarding nonrenewable resources, their use must respect the limits of the waste absorption capacity of the environment, they should be efficiently recycled, and the development of substitutes is an imperative. At least the risk of catastrophic outcomes for future generations in exchange for nonessential benefits today should be totally avoided (Dale and Farley, 2004; Raworth, 2017; Steffen et al., 2015a,b, 2018).

Biologists, which are the economists of nature, should not avoid issues related to economics and politics, as their background is a most needed one to address questions of today's full world. In addition, the economist´s perspective has a limited scope focused on the human species, as it lacks the background in natural sciences to deal with non-human species within complex non-linear socioenvironmental systems (Czech et al., 2004). Hence natural and social scientists are needed if the modern interlinked world wants to avoid the fate of many civilizations and cultures that collapsed due to inadequately addressing environmental issues that arose from inappropriate socioeconomic developments (Diamond 2005).

The emergence of modern science in the Renaissance decisively changed how people interpret nature, when a sense of human control over nature was created through the development of atomistic perspectives represented by the split of knowledge in many disciplines. Concomitantly, liberal social thinkers favored the accomplishment of free individuals, what required financial independence and the ownership of private property. The idea of progress switched toward the possibility of material abundance for all, which coevolved with the increase in energy use through access of fossil fuels. Today we live in an era deeply influenced by neoliberal economistic beliefs, such as individualism, materialism, property, markets and economic growth, and economism is a necessity if we still want to feed the current global population (Norgaard, 2019).

However, humans need a new assessment to support their relationship with Earth, as we cannot overcome the current crisis created by economism by using the same economistic beliefs that created a path dependent development. Fortunately, paradigmatic shifts have previously occurred when human societies changed from hunter-gatherers to agricultural societies, when we changed from agricultural societies to nation-building societies, and finally when humanity swapped from building nations to economism. Thus, a fourth change in consciousness is now required to assure environmental sustainability, social justice, and meaningful lives. Noorgard (2019) proposes four ways to achieve this. We should: change from material progress to holistic survival and morality, as wellbeing increases little with further material assets after basic needs are met; adjust from knowledge hubris to knowledge humility, as we have limited knowledge of the geosphere, the biosphere and the sociosphere in ever-changing systems; switch from individualism to cooperation and care, building empathy, trust and social responsibility; and change from private property to global commons.

Following Kallis and Norgaard (2010), the world is plagued by development betrayals, such as environmental degradation, political impasses addressing the environment, and intensification of cultural and ethnic hatred. Regarding these betrayals and associated with the four positions above-mentioned, economics traditionally treat human cooperation as rare, but humans are a cooperative species, and multi-level selection and coevolutionary models contribute to this. Natural selection operates simultaneously at different levels, for instance, from genes, to groups, species, communities or even ecosystems, and only the lowest levels favor selfish behavior, the others favor cooperation, deeply needed to overcome the current environmental crisis.

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