Economy, sustainability and measurement

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Abstract

Metrics are essential, because it is through them that social and natural phenomena are described, analyzed, predicted and evaluated or, more simply put, it is through them that we understand the world.The objective of this document is to review the way in which social and environmental phenomena are measured, pointing out their potentialities and weaknesses. The critical evaluation allows presenting a different metric linked to sustainability, with a reflection on the situation of the Amazon shared by Ecuador and Peru. The Amazon, a rich natural and cultural ecoregion, faces the attacks of extractivism, changes in land use due to deforestation and climate change.Economic growth, usually used to approach the well-being of a country, does not consider environmental limits and leaves aside social justice. Given that, for the cur-rent economic paradigm, the success or failure of a country is evaluated by the development of the Gross Domestic Product (GDP), this brings conflicts with conservation and equity, particularly in areas rich in biodiversity and culture, such as the Amazon.We advocate a holistic and biophysical approach through the use of information and indicators that allow us to measure a highly complex reality. The proposal for a measurement of good living is part of the socio-environmental transition in the Amazon. To achieve this transition, a plurality of approaches and methodologies is required.

Keywords: Amazon, biophysical indicators, metrics.

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Economía sustentabilidad y medición

Resumen

La métrica es esencial, pues es por su intermedio como se describen, analizan, predicen y evalúan los fenómenos sociales y naturales o, dicho de manera más simple, es por su intermedio como comprendemos el mundo. El objetivo del presente documento es examinar la forma como se miden los fenómenos sociales y ambientales, señalar sus potencialidades y debilidades. La evaluación crítica permite presentar una métrica distinta vinculada a la sustentabilidad, con una reflexión en la situación de la Amazonía compartida por Ecuador y Perú. La Amazonía, una rica ecorregión natural y cultural, enfrenta los embates del extractivismo, cambios en el uso del suelo por la deforestación y el cambio climático.El crecimiento económico, usualmente empleado para aproximarse al bienestar de un país, no considera los límites ambientales y deja de lado la justicia social. Dado que, para el actual paradigma económico, el éxito o fracaso de un país se evalúa por el desenvolvimiento del producto interno bruto (PIB), esto trae conflictos con la conservación y la equidad, en particular en zonas ricas en biodiversidad y cultura, como la Amazonía.Abogamos por un enfoque holístico y biofísico mediante el uso de información e indicadores que permitan medir una realidad con alta complejidad. La propuesta de una medición del buen vivir forma parte de la transición socioambiental en la Amazonía. Para lograr esta transición se requiere una pluralidad de enfoques y metodologías.

Palabras clave: Amazonía, indicadores biofísicos, métrica.

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1. More is not better

The objective of this document is to examine the way in which social and environmental phenomena are measured, pointing out their potentialities and weaknesses. The critical evaluation allows us to present a different metric linked to sustainability, with a reflection on the situation of the Amazon region shared by Ecuador and Peru. The Amazon, a rich natural and cultural ecoregion, faces the onslaught of extractivism, changes in land use due to deforestation and climate change. Lovejoy and Nobre (2018) have alerted the world that the Amazon would be condemned to savanization, which is serious considering that it is an integrated ecosystem. A central point of the transition towards the good Amazonian way of life consists of generating new indicators and indexes in order to monitor progress or setbacks towards sustainability (Sacred Watersheds Initiative, 2021).

The first section develops the idea that conventional economics in the 21st century has moved away from the analysis of pressing s ocial problems, and this is also expressed in the field of measurement. The second section points out the weaknesses of conventional metrics

centered on monetary indicators. The traditional measurement focused on expansion and not on the development of the qualitative elements of well-being tends to obscure the analysis. The third section proposes a methodology for examining measurement and reviews the debate surrounding social and environmental indicators. The fourth section proposes an alternative measurement of social and environmental phenomena. The proposal is part of a necessary socio-environmental transition, since measurement is not only a technical problem, but an ontological one. Finally, the fifth section synthesizes the conclusions. The article emphasizes and exemplifies the situation of the Amazon, given its global and local importance for planetary stability.

The economics and politics of the 21st century have moved away from the analysis of pressing social problems. The crisis of civilization, due to the overflowing of planetary limits, requires urgent action and a solid commitment from current and future generations. The overexploitation of natural and ecosystem resources, the human appropriation of diverse ecosystems, the expansion of land use and the loss of biodiversity are unprecedented in human history. The planet's capacity to assimilate waste from production and consumption has been exceeded, and this excess of natural limits causes disturbances on a global scale such as the accumulation of CO2 in the atmosphere and climate change (Rockström et al., 2009; Steffen et al. , 2015).

In prehistoric times people cultivated the land by considering factors such as climate, season of the year, etc. This was called sapience in social terms or prudence in religious terms. In reality, these people were doing economic planning before there was such an expression. Economics was not born with words but with activity, just as medicine was not born with Hippocrates.

2,400 years ago Aristotle, in his book *Politics*, wrote about economics. In Book One, Chapter III, "On the Acquisition of Goods," of that work he mentions the words economy and welfare (1874). The Greek meaning of economy was the "administration of the house", not only because of its etymology (*ekos*: house) but also because of its common sense; the house is where we live, from the home to the world. This logical conception of the economy was maintained until the eighteenth century in Europe. At that time of specialization of knowledge, the science of economics appeared. The so-called classical political economy (Adam Smith, Ricardo, Malthus) turned the "administration of the household", whose ultimate aim until then had been the welfare of the inhabitants of the household or of the city-state (*polis* in Greek, from which comes politics), into a study of prices and markets, in which producers and demanders freely transact.

In his books The *Theory of Moral Sentiments* (1759) and *The Wealth of Nations* (1776), Adam Smith deals with selfishness. Given the "invisible hand of the market", this human condition, under certain circumstances, leads to general welfare. His reasoning, often misrepresented (Aguilera Klink, 2015), is part of conventional economic thinking. Smith also proposed that a greater accumulation of capital is necessary to improve welfare. It is very

likely that he never imagined that these two characteristics would be central to the future of capitalism: selfishness and capital accumulation.

The nineteenth century was marked by the development of capitalism under harrowing social conditions, such as child labor and 14-hour workdays, as well as by the irruption of Marxist thought. Marx and Engels (1848), in the *Communist Manifesto*, developed an analysis of capitalism as a system based on private accumulation, defined history as a history of class struggle and proposed a revolution to be led by the worker and peasant proletariat. The revolutionary transformation was to permit the promotion by all means and with the greatest speed of the productive forces.

Then came the so-called "neoclassical revolution", as a response and as an attempt at innovation, but with an obligatory character. Neoclassical economics and its different variants have imposed themselves in the history of economic thought and in university teaching, and that is why it arrogantly (self-) calls itself the "mainstream" of economics. There have been very important attempts at de-branding within the economic box (Keynesian,[2] institutionalist, behavioral economics), but neoclassical economics has triumphed in the conventional way of understanding and applying economics; not surprising if it is the position of the ruling class, which controls most universities and almost all private companies.

Thus it was that the science of housekeeping moved further and further away from its initial objective. With neoclassical economics, economic analysis moved from production, supply and cost to consumption, demand and utility (Roll, 2002: 336). Demand formulations are sustained by consumer insatiability, unlimited needs and "more is better". Economic laws emulated physical laws -in particular equilibrium- and the historical character of the social and economic relations of societies was omitted.

Although neoclassical economics distanced itself from classical economics, that is, from the doctrines of Adam Smith, David Ricardo and the clergyman Malthus, it did maintain individual self-interest - the *homus economicus* - as a central aspect of its theoretical construction. The house was left behind. From now on, economics would only be concerned with the tenant.

However, the egoistic foundation of economics has been the subject of multiple controversies. At the end of the nineteenth century, the American philosopher Thorstein Veblen (2014) questioned in his book *The Theory of the Idle Class* (written in 1899) the "conspicuous waste" of consumption of the rich class of society and the dominance of selfishness in the predatory stages. Work in certain fields is despised and leisure is accepted as an ennobling aspect of civilization. "However widely, equally or equitably the wealth of

[2] The ruptures posed by Keynesian theory with the neoclassical school are very strong, both at the epistemological level and at the methodological level. (in the latter, so much so that he promoted a new branch of economics - macroeconomy - from the theoretical notion of aggregate, i.e. the whole system of national accounts, including the piB, whose paternity is attributed to James Meade and Richard Stone, both laureates with the Nobel Prize in Economics and Keynes' disciples.

the community may be distributed, no general increase of it can advance a step in the direction of satiating this need whose foundation is the individual desire to exceed each other in the accumulation of assets" (2014: 24). According to Veblen, consumption, as a demonstration of wealth, is essential in economic and social reproduction (ideas, values, concepts, etc.) through the incentive to pecuniary acquisition and emulation. The consumption of the "upper" class provokes a "demonstrative effect" for the rest of society, especially the working classes. "Relative success, measured by a favorable comparison with others, becomes the end of the effort that is accepted as legitimate and, therefore, the repugnance for futility is largely collated with the incentive to emulation" (2014: 25). Thus it is established that consumerism is the dna of the conventional economy, the engine of unlimited growth.

The principles of neoclassical economics have been retained and form part of conventional microeconomic theory. For example, the assumption is maintained that consumers always prefer a larger quantity of a good or service to a smaller one, leading to indiscriminate use and rapid programmed obsolescence. In practice, this has obstructed any constructive dialogue with other currents of thought that uphold solidarity, altruism or complementarity. Again, the fault lies in hiding the house and only seeing the tenant.

Since the 1970s, ecological economists such as Nicholas Georgescu- Roegen (1971) and Herman Daly (1973) have proposed abandoning monetary measurements focused on economic growth. Ecological economics brings together the insights of economics and ecology to examine the economy as part of a larger system: nature. In other words, this interdisciplinary field of study highlights the house we live in and our relationship to it. The relationship between the natural and economic system is studied from the social metabolism, i.e. from the input of materials and useful energy to the economic system and the output of residual heat and waste product of human activities, which can be partially recycled. Thus, the economy is not sustainable but entropic, but less degrading economic practices can be promoted by limiting consumption and reducing growth, particularly in rich and industrialized societies.

In the renowned *book Small Is Beautiful: A Study Of Economics As If People Mattered*, Schumacher (1973) proposed obtaining a maximum of welfare with a minimum of consumption. This postulate is still valid today. The logic of today's civilization, which encourages us to consume and produce more, without respecting natural, social and ethical limits, must be modified. Basically, the values of life must be above market values.

2. Red or blue tablet?

The movie *The Matrix* (1999) aptly summarizes the *impasse* of choice, when the protagonist is offered the choice between the blue pill and the red pill. The former will allow him to forget the past and remain in virtual reality, and the latter will allow him to return to the real

world. As long as we measure reality with obsolete standards, we will not be able to clearly visualize our understanding of the world. The reality of the 21st century continues to be measured with antiquated tools. Thus, for example, economic indicators continue to be used as indicators of well-being, even though it has been proven and accepted that they are not. The Matrix reloaded.

In 2008, in the midst of the capitalist crisis, former French President Sarkozy asked several experts to give their opinion on the measurement of the economy. In the Report of the Commission on the Measurement of Economic Development and Social Progress, Stiglitz, Sen and Fitoussy (2009 and 2010) reached a consensus: PIB does not assess economic well-being and even less is it an indicator to measure social and environmental well-being. If we want to measure the well-being of a country and we start with the PIB, we start from an erroneous premise, as Stiglitz, Sen and Fitoussi (2009 and 2010) warn. Therefore, the use of socioeconomic indicators that also include data on sustainability is recommended.

Economic growth is a veil or fog that hides the social and environmental reality; therefore, traditional economics cannot make predictions without making mistakes. Considering consumption as the only element of well-being[3] limits the achievement of broader and more integral objectives in a society. For example, the increase in resource consumption and pollutant emissions as a result of economic growth is incompatible with biodiversity conservation (Otero et al., 2020).

The prevalence of a single, dominant economic thought has colonized the debate and obscured reality with the use and dissemination of a set of dominant indicators. Arturo Escobar (2015) reminds us that economic growth is part of this prevailing development model. Economics has colonized the rest of disciplines and knowledge. Traditional economics was not satisfied with being the scientific discipline of economic relations. Economics observes reality and only sees the chrematistic (pecuniary interest). It even meddles with human values. Its strange way of reasoning would be inadmissible in other disciplines or sciences.

It is also necessary to discuss the essence of the problem: capitalism, its excessive accumulation and greed. Uncontrolled economic growth is part of the definition of capitalism. This explains the high consumption of energy and materials by a minority sector of the population, consumerism and programmed obsolescence.[4]

[3] The Royal Spanish Academy (2020) defines well-being as: 1) Set of things necessary to live well; 2) Loose life or supply of what leads to having a good and quiet time; 3) State of the person in whom the proper functioning of his somatic and psychic activity is made sensitive.

[4] The most current case is that of cell phones. The large transnational communications companies, with their advertising strategies, push consumers to constantly change mobile phone models, with the consequent environmental burden of waste. Manufacturers program them so they don't last too long. The first batteries, for example, were removable and had short life spans. That's how they sold more batteries. When cell phone sales went up, removable batteries started to disappear. The new batteries no longer lasted a few months, but a couple of years or so. But, once finished, they could no longer be replaced. And the same goes for other components of the phone. After a few years, the brand stops manufacturing parts.

And there is another global threat: consumerism is steadily increasing the use of materials, minerals and energy and the burning of fossil fuels such as coal, gas and oil, which is causing the Earth to warm at an alarming rate. The ice at the poles is beginning to melt. But not only that. There will come a time in the 21st century, if we don't do something, when sea levels will rise so much that many coastal cities will be under the sea, affecting millions of people living there.

Environmental awareness is currently being created in daily life: not using plastics, sorting garbage for recycling and, especially, not consuming in excess, but it is not enough. Overconsumption does not depend only on how much one person consumes, but on how many people consume. The larger the population, the more consumption; the more consumption, the more pollution. It is a problem of the growth and development model, so the current system is the one that must change. Technology can reduce the use of energy and materials, but it cannot reduce the environmental impacts on the Earth to zero. On the other hand, greater energy efficiency per unit of product (e.g., more efficient cars) has led to greater global use of energy and materials (there are more and more cars on the planet). This is known as the Jevons paradox.

Excessive consumption only benefits in the short term a minority sector of the world's population, which accentuates inequalities. Economically, it reduces workers' real wages by creating false needs, to the detriment of real needs. Socially, it creates resentment, precariousness and dissatisfaction. Environmentally, it is destructive.

The GDP reduces a complex reality, which could perhaps be described by a broad set of variables, to a single economic indicator, which is not the synthesis of all variables. When it comes to questions of material well-being, the GDP even obscures reality. For example, a worker in the United States has a higher income than a worker in Latin America. In addition, high-tech products such as smart TVs are cheaper in the United States. Both facts are measurable in monetary values. However, one needs to know whether both workers have free health insurance or enough days off. None of that is known only by examining GDP. It does not consider non-monetary values, such as unpaid work, like that of women in the home. The need to highlight this unpaid work has been claimed by the environmental and feminist movements. Nor does it measure children's health or the quality of education. Social inequalities are also hidden.

Economic growth leads to a misguided misunderstanding of the goals to be achieved as a society. Higher consumption leads to the expansion of GDP, since it accounts for the sum

of macroeconomic aggregates.[5] This could encourage consumerism instead of responsible consumption.

The GDP can grow at the cost of liquidating the natural patrimony. An increase in deforestation in the Amazon would be valued or measured as economic growth, because of the timber available for sale and the wages paid to the labor incorporated in this "productive process". Similarly, an oil spill would also be measured as an increase in GDP due to clean-up activities and labor. In conventional accounting it is usual to omit, in the calculation of GDP, the negative externalities or social and environmental liabilities inherent to the extractive, productive or consumption processes, which are not incorporated in market prices. The environmental goods and services provided by ecosystems are also undervalued.

In addition to the complications of measurement, there are discrepancies arising from different valuation systems. The loss of biodiversity or cultural heritage, damage to human livelihoods, human rights violations, the sacredness of territory, indigenous territorial rights or environmental security are incommensurable.

3. Status of the situation

3.1. Methodology

The methodology of the article is based on differentiating the measurement of social, environmental and other welfare-related problems. Social measurement already has a trajectory, since the broad debates on development. For environmental measurement it is necessary to distinguish between weak sustainability and strong sustainability. This conceptual distinction makes it possible to operationalize sustainability through the use of monetary and/or biophysical indicators or indices.

Conventional economics promotes weak sustainability, that is, the possibility of substitution between natural heritage and economic or human-made capital. Substitution implies valuing natural heritage, environmental services and externalities in economic terms. Acceptance of this assumption leads to the use of monetary indicators, such as green corrections to national accounting, to measure the depletion of "natural capital".

Ecological economics advocates strong sustainability, which means that monetary substitution between natural heritage and economic capital is not possible. Natural heritage is irreplaceable and must be preserved for current and future generations. This leads to the use

[5] GDP is the amount of final goods and services produced in a given period, measured in monetary terms (current or constant dollars). Obtained in accounting form by three methods. First, by the method of expenditure or the summation of large macroeconomic aggregates in a given period. GDP = consumption (public and private) + investment (public and private) + exports - imports. Second, for the sum of the added values of the different economic sectors: construction, industry, agriculture, fisheries, Petroleum, mining tourism, services, etc. To the added values are added the indirect taxes and the subsidies are subtracted. Thirdly, because of the functional distribution of income, that is, the income received by employers, workers and the government.

of biophysical indicators to measure the depletion of natural resources and the application of methodologies focused on socio-environmental metabolism.

This is certainly not the only way of operationalizing sustainability - for example, one could differentiate between single-criteria indicators and multi-criteria indicators - but the differentiation between weak and strong sustainability makes it possible to organize the different indicators and to specify other forms of measurement related to well-being. Finally, this section reviews the possibilities of aggregating biophysical information in order to achieve a better understanding of reality.

3.2. Social indicators, sustainability indicators and other forms of measurement related to wellbeing

The search for and application of new indicators and indexes is progressing steadily. Progress can be summarized in four areas: i) social indicators; ii) calculations to correct conventional macroeconomic accounting and obtain a green GDP (weak sustainability); iii) biophysical indicators (strong sustainability); and iv) new indicators associated with well-being.

3.2.1. Social indicators

Current social exclusion, poverty and inequity have led to a wide dissemination of social indicators. The countries, through statistical institutes or entities, have permanent measurements, although not with the same level of depth, of poverty (by income, consumption, unsatisfied basic needs, subjective poverty,[6] among others), extreme poverty and inequality (measured by the Gini coefficient,[7] the Theil index, etc.).

Distinct from economic growth, development takes a more comprehensive view. Amartya Sen (2000) defined development as the construction of human capabilities (education, health, etc.) in a sustained manner, in accordance with endowments (one's own or with the support of public action). Thus, the functionings (the things one can do or be) of people can be converted into human capabilities. On this conceptual basis, the United Nations has been preparing the human development index (HDI) every year since 1990.[8]

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[6] Subjective measurements have allowed interesting interpretations of reality and contributions such as Easterling's paradox. Using data from the United States, Easterling (1974) demonstrated a decoupling between increased per capita income and happiness. Beyond a certain limit, income growth does not increase happiness. In colloquial terms: money does not buy happiness.

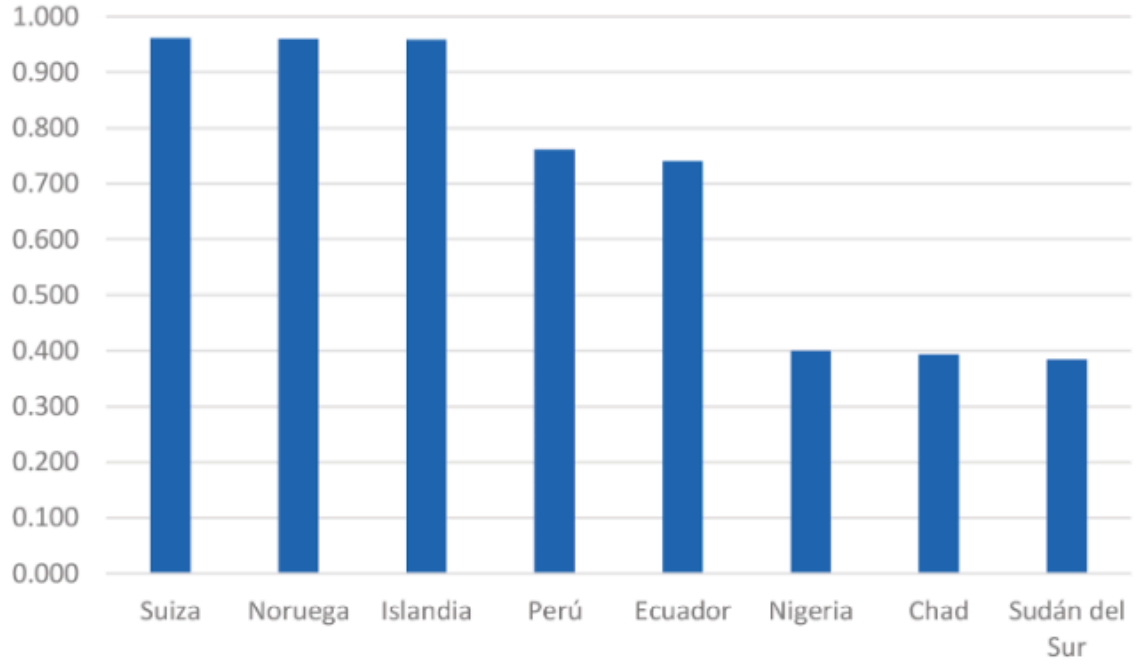
[7] The Gini coefficient, which fluctuates between 0 and 1, can be calculated for income, consumption or emissions of CO2, etc. Absolute inequity corresponds to a value of the Gini coefficient 1 and the total absence of inequity (that is, absolute equality) is valued at 0.

[8] HDI, which varies between 0 and 1, is the synthesis of life expectancy at birth (years), average schooling and expected years of schooling, and gross national income per inhabitant ($). The United Nations Development Programme (UNDP) also presents, in its annual human development reports, inequality-adjusted HDI, the HDI, gender inequality index and multidimensional poverty index.

Graph 1 shows the three countries with the highest HDI (Switzerland, Norway and Iceland) and the three countries with the lowest HDI (Nigeria, Chad and South Sudan), as well as the data for Peru and Ecuador (0.76 and 0.74).

Graph 1

Selected countries: Human Development Index (2021)



Source: PNUD, 2022.

The concept of *development* summarized in HDI is limited. Although it adds social indicators, it avoids the relationships of human beings with the natural environment. The material footprint, measured by the amount of materials extracted in tons per habitant, is higher the higher the HDI.

The United Nations corrected this error at the end of 2020. The Human Development Report 2020 (UNDP, 2020) adjusts the HDI by a material footprint index and a CO2 emissions index (based on production). When considering planetary pressures, the adjusted values of the HDI are increasingly negative as the human development. Countries with higher levels of human development cause greater material footprint[9] and higher scales on the planet.

These essential debates about development are amplified when we move to *sustainable development*, since the term implies a contradiction, because different conceptual bases are combined: the capacity of burden (maximum population that can support ecosystems) that comes from biology, and development. Therefore, it is necessary to approach measurement from environmental sustainability.

[9] The material footprint measures the amount of materials (biomass, fossil fuels, metallic and non-metallic minerals) extracted by a country in its territory or abroad and used to meet the final domestic demand for goods and services of that country.

3.2.2. Weak sustainability: corrections to national accounting

Methodologies for achieving *green GDP* are based on corrections and adjustments made in the middle of the last century to the current system of national accounts developed by the United Nations. Applications are based on the strong assumption that it is possible to value in monetary form the wear and tear, depreciation or depletion of "natural capital," negative externalities and/or contributions of goods and services, and environmental functions. The calculations are in the notion of sustainability in the weak sense of the term, that is to say that the so-called "natural capital" can be replaced with economic capital or made by humans (Falconí, 2000).

Genuine savings, developed by The World Bank (2022), are part of weak sustainability. Graph 2 shows the evolution of adjusted net savings (ANS) as a percentage of gross national income, between 1990 and 2020, for the world. The data indicate that the world has a positive ANS. Net monetary savings (consumption less income) plus investments in education are greater than the sum of the depletion of "natural capital" and the costs of pollution. In other words, economic savings and social investments compensate for the loss and deterioration of nature. The ANS is higher in high-income countries, which generates another wrong message. High-income countries have a higher capacity for net monetary savings, compared to low-income countries; in turn, they are net importers of energy. The ANS in rich countries is high because the depletion of energy sources is accounted for in oil or mineral extracting countries, which ignores the environmental burden of international trade.

Graph 2

Adjusted net savings in the world (as % gross national income)

Source: The World Bank (2022).

While calculations immersed in weak sustainability suffer from dubious assumptions, such as the determination of a discount rate,[10] can bring us closer to depletion of natural resources. For example, the user cost method of El Serafy (1989, 1991). In 2020, the ratio of proven reserves to oil extraction in Ecuador was 7.4 years (Bp, 2021). According to the El Serafy method, the flow of net income, that is to say discounted production and transport costs, by sale of oil should be divided into two parts. The first part, 33.7% total, would be real income, should be counted in the GDP and would be at the free availability of government authorities. The second part, the remaining 52.3% would be the cost of use (with a 5% discount rate), which should be excluded from GDP and would not be considered as oil revenue; moreover, these resources should be invested in an oil fund or in productive projects that ensure a return to perpetuity of 5% when oil is depleted.[11] This way you would get a *real GDP*. Table 1 shows an application for several Latin American countries.

Table 1

Application of the El Serafy method for oil extracting countries (2020)

[10] A positive discount rate underestimates future environmental damage due to the formula for obtaining the current net value of a monetary flow.

[11] It is clear that the oil fund, deposited in a national or foreign bank, would not be accounted for in domestic investments. Moreover, "investment in gross fixed capital formation" should also not be accounted for in GDP, since, in this case, it corresponds to the exchange of one fixed asset (oil underground) with another fixed asset (productive infrastructure).

Países	*Reservas probadas de petróleo (miles de millones bbl)*	*Extracción petróleo (miles de bbl por día)*	*Relación reservas/ extracción (años)*	*Ingreso "verdadero" X/R*			*Costo de uso 1-(X/R)*		
				Tasa de descuento			*Tasa de descuento*		
				2.5%	5%	10%	2.5%	5%	10%
Argentina	2.5	600	11.4	26.4%	45.4%	69.4%	73.6%	54.6%	30.6%
Brasil	11.9	3.026	10.8	25.2%	43.7%	67.4%	74.8%	56.3%	32.6%
Colombia	2.0	781	7.0	18.0%	32.4%	53.4%	82.0%	67.6%	46.6%
Ecuador	1.3	479	7.4	18.8%	33.7%	55.2%	81.2%	66.3%	44.8%
México	6.1	1.910	8.7	21.4%	37.9%	60.5%	78.6%	62.1%	39.5%
Perú	0.7	131	14.6	32.0%	53.4%	77.5%	68.0%	46.6%	22.5%
Venezuela	303.8	540	1.541.3	100.0%	100.0%	100.0%	0.0%	0.0%	0.0%

Source: Bp (2021)

Thus, there is a battery of indicators in so-called weak sustainability. The conceptual approach is supported by monetary valuation and the search for "green" macroeconomic accounting.

3.2.3. Strong Sustainability

The state of the environment and the impacts of socio-environmental conflicts require the use of conventional and unconventional indicators expressed in physical and/or monetary units. There is a growing and fruitful spread of non-monetary indicators grouped in so-called strong sustainability. Under this premise, natural heritage cannot be replaced by economic or human capital. In addition, it is proposed that a significant portion of natural heritage should be legacy for future generations.

The analytical basis of non-monetary indicators is social metabolism, since it makes it possible to link the study of the socioeconomic process with the biophysical process, which allows understanding the relationships between society and nature. Economic systems constantly degrade energy, and by the laws of thermodynamics, they are entropic. Social metabolism includes the use of energy and materials, and the transformation into waste and dissipated heat. This includes extensive scientific approaches to measure, analyze and model biophysical stocks and flows, as well as the services they provide to society (Haberl et al., 2019).

The ecological economy has developed biophysical indicators such as human appropriation of net primary production (HANPP), the flow of materials and energy (direct and indirect material inputs and outputs measured in tons), exergy (the amount of useful work in the energy used in extractive processes), virtual water (the amount of water required in production processes), the relationship between time and energy.

One of the most widespread physical indicators is the ecological footprint, which measures consumption (food, wood products) and emissions of CO2 in space (in global or biologically productive hectares). The pioneering work comes from Wackernagel and Rees (1996). Global Footprint Network (2021) notes that globally we have a planetary ecological deficit since the early 1970s, when the ecological footprint surpassed the planet's biocapacity. If the citizens of the world lived like those of the United States, it would take five planets Earth to meet the global need for resources. If the lifestyle of other industrialized nations of Europe and Asia were universal they would be used between 4 and 2.5 Lands. The Chinese standard of living would mean that 2.3 Lands would be consumed (Buchholz, 2021).

Since it is a consumption, not production, measure, it omits the environmental implications of foreign trade and the magnitude of the impacts associated with consumption. This has also provoked strong questioning of the assumptions and simplifications used in its construction (Saltelli, 2014).

Water is a global priority. The goods and services we consume need many liters of water to be produced. *Virtual* water is the amount of water needed to obtain a product (Allan, 1998), directly or indirectly throughout the production chain. In its original meaning, it was used as a mechanism to solve water scarcity processes in those countries with water deficits, and therefore with food and *virtual water* import needs (Allan, 1993). In the final products or services we do not observe the required water, and that is why it is called virtual. For example, a cup of coffee requires 140 liters of water to produce, package and send the beans to a *coffee bar* in Europe (this is equal to the water needs of one inhabitant a day). A hamburger needs 2,400 liters of virtual water (17 times more than a person's daily need). Allan's formulation is not without critical glimpses because of the various ways of interpreting and measuring virtual water (Stack Whitney, and Whitney, 2018).

The water footprint, on the other hand, is the amount of water (rain, surface and underground) that we humans consume (Hoekstra and Hung, 2002).

Accounting for foreign trade material flows compiles material inflows to an economy (biomass, fossil fuels, metallic and non-metallic minerals) from the environment or other economies, changes in material stocks within the economy, and the departure of materials from the economy to the environment or to other economies.

Vallejo (2010) demonstrated, through the analysis of direct flows of materials, a recurrent negative physical trade balance of Ecuador. A study of the CEPAL (Leon, Lewinsohn and Sanchez, 2020) concludes that in the long term the region presented an increase in the consumption of domestic materials in tons and a reduction in the productivity or efficiency of materials, which put pressure on the environment and natural resources.

Infante, Urrego and Tello (2020) demonstrate a historical decapitalization of Latin America. Over a long period of time (1900-2016), based on the accounting of the flow of physical materials in 16 Latin American economies, they find that the region is a net supplier

of materials to the rest of the world (exports greater than their imports in tons [t]), and also that the material deficit has not stopped growing until today.

This is the same reality for Ecuador and Peru. Data from UNEP-IRP (2018) show that Ecuador has increased its extractive volume by 6.3 times between the years 1970 and 2017 (from 27.2 to 172.5 million tons), and Peru by 3.8 times in the same period (from 135 to 509.5 million tons). The extractive volume per capita increased from 4.5 to 10.1 tons in Ecuador, and from 10.1 to 15.6 tons in Peru (1970-2015).

Measures have also been implemented to capture the environmental burden of external indebtedness. Nature cannot grow at the same rate as financial flows (Martínez-Alier, 2011) and this causes a real decapitalization. One way to establish this situation is through the construction of the Mapral indicator (raw materials for Latin America) developed by Schatan (1998) that relates debt amounts and payments to exports in tons. In a recent update of the Falconi study (2011), it is obtained that, between 1990 and 2018, monetary indebtedness increased 2.9 times, while physical sales of primary products (in [t]) increased 2.3 times. Exports of primary products per capita increased from 1.1 to 1.5 [t]. The service of the debt (interest and repayments) in monetary value increased 9.7 times (from US $557 to 5.414 million) and in Maprec it grew 3.3 times (from 2.7 to 8.9 million [t]).

In summary, the different calculations associated with strong sustainability show direct and indirect water flows, the removal of materials directly and indirectly, changes in land use, deforestation, loss of biodiversity, social and environmental damage to extractive processes. The limitation is that on many occasions these are synthetic indices, with questioning in the assumptions used in aggregation. The methodology for constructing biophysical indicators (such as material flows) does not include the intensity of environmental impacts. For example, the extractive process, the techniques used and the ambiental impact of hydrocarbons and metals are different. Despite their limitations and controversies, biophysical indicators have great utility in visualizing the social and environmental behaviors hidden in monetary valuation.

3.2.4. Other forms of measurement related to well-being

Happiness in the philosophical sense - in which, by the way, there is no single form of understanding - is the pursuit of pleasure (pure hedonism) or that which enables happiness or eudaimony (in the broadest and most complex sense proposed by Aristotle).

Happiness is a "state of pleasant spiritual and physical satisfaction," or the "person, situation, object or group of them that contribute to making happy" (Real Academia Española, 2020). In the 22nd edition, the definition of happiness was primarily material: the "mood that is pleased in the possession of a good." If happiness is conceived as a spiritual state, it would be wrong to pretend to measure it: a state of spiritual satisfaction is immeasurable. But if it is that happiness defined in the last drae "(... object or set of them that contribute to make happy), "their measurement would be one of the challenges proposed by

Stiglitz, Sen and Fitoussi (2009, 2010), that is to say paying more attention to measurements of human well-being and individual satisfaction (if you want, pay less attention to crematistics as the pecuniary wealth of individuals, and more attention to the welfare conditions of human beings in a broad and not only monetary way).

An attempt to calculate happiness in "objective" form is the Happy Planet Index. According to a report published by the New Economics Foundation (Jeffrey, Wheatley and Abdallah, 2016), as of 2016, the happiest countries were Costa Rica, Mexico, Vanuatu and Vietnam. Ecuador is in 10th place and Peru is in 21st. The least happy were Togo, Luxembourg and Chad. Now, even within the simplistic meaning of happiness, care should be taken. The HPI is an index that, given certain arbitrary weights, aims to synthesize reality in order to sort countries according to the adopted criteria.[12]

Before proclaiming these measurements, it would be useful to specify what is being done and clarify what is not being considered. And above all, to emphasize that these exercises do not go from being essays towards the goal of measuring human well-being, which could be conceived as a subset of the concept of happiness in the sense of DRAE, but not its philosophical meaning (be it the individualistic pursuit of pleasure or all that allows to achieve happiness in the broadest sense). Trials such as HPI, if not contextualized and narrowed, only tend to consolidate a confusion around measurement.

In the Andes we have a telluric tradition of social welfare: the Sumak Kawsay or good living that is based on respect for the community, life and the cosmos. Good living is an alternative to the Western idea of development, conceived as a mere extension of economic growth without respecting human cultures or biophysical boundaries. It is a concept of collective well-being that arises, on the one hand from the post-colonial discourse, critical to development, and on the other from the cosmovisations of the Andean original peoples. Individual and community happiness is the ultimate goal of their ethical system and in the Andean case much importance is given to respect due to nature. The Chakana or Andean cross symbolizes the natural norms of good living.

3.3. Biophysical aggregation and multicritery analysis

How to interpret indicators that in certain situations indicate a situation of improvement and others of environmental deterioration? Conflicts can occur not only in the different dimensions of sustainability (for example, between the social and environmental: income increases, but also deforestation), but also in the same dimension. Thus, in a city, in a year the emissions of sulphide dioxide could be reduced by the increase in income of the inhabitants, which allows to consume gasoline with lower sulphur content, which is positive; but in turn

[12] HDI = [(well-being (a scale of 0 to 1) x life expectancy (years)) x inequity in income distribution (%)]/ecological footprint (global ha per person). Well-being is a subjective perception that is captured through surveys for each country. See New Economics Foundation (2016). Subjective perception is that, a perception that may or may not correspond to reality.

they could increase carbon dioxide emissions. So the question is: do we move closer or back towards sustainability?

Let's look at an example for agriculture. Ramos and Falconí (2020) have proposed differentiating between conventional and biophysical approaches to the case of the behavioral of agricultural systems. The conventional approach uses agricultural productivity (usually measured in tons per hectare [t/ha], dollars per tonne [$/t] or tons per worker [t/p]). From a biophysical perspective, productivity can be expanded and complemented by other types of information, as studied by Giampietro (2003) and Giampietro et al., (2014). In Ecuador, export-oriented agriculture, such as bananas, has productivities (t/ha) similar to or even higher than world averages, while domestic market-oriented agriculture has a low productivity (potatoes, onions, tomatoes, etc.). However, if the concept of productivity is changed to an energy input/output ratio, these results are changed. The energy inputs or needs of domestic market-oriented agriculture, measured in energy units (machinery, irrigation land, fertilizers, etc.), are lower than agriculture oriented to the external market. By linking inputs (in food calories) to the product (in food calories), peasant agriculture is more efficient than export-oriented agriculture, since it uses less fossil energy. Markets underestimate (in relation to relative prices) this contribution of peasant agriculture to the environment and to public health.

Export agriculture makes it possible to accentuate these differences. Unequal exchange of prices (impoverished countries sell raw materials and food at prices that are devalued on the world market, and buy processed and technological goods at increasing prices), studied by the Latin American dependent and structuralist school, was a great contribution to the theory of international trade and to the understanding of asymmetric power relations between countries. However, such a way of interpreting trade only gives a perspective of reality. The green economy has broadened the approach with categories such as ecologically unequal exchange (impoverished countries are increasingly exporting by weight, implying increased extraction and environmental liabilities)[13] and unequal exchange of calories. Falconi, Ramos and Cango (2017) have shown that Latin America and the Caribbean export high nutritional quality calories at low prices, while importing low nutritional content calories at high prices. This has implications for the diet and the prevalence of diseases such as malnutrition or obesity.

In this way another question arises: how to organize the information? We can add dissimilar information related to diverse areas, qualitative and quantitative variables or numerical, units. One option is to use aggregation models such as the per (pressure-state-response) developed by the Organization for Economic Cooperation and Development (OECD, 1994). For the bioregion Ecuador and Peru, Cuesta, Peralvo and

[13] See Muradian and Martinez-Alier (2001a, 2001b); Samaniego et al. (2017).

Baquero (2020) and Cuesta, Peralvo and Suárez (2020) have related applications with models per.

Consumption of resources per inhabitant can also be linked to biophysical limes (at the country or planet level), in order to obtain social welfare thresholds (Hickel, 2018).

Mario Giampietro has developed the integrated multiscale analysis of social and ecosystem metabolism (Musiasem), which allows describing the metabolic pattern of a society in relation to its viability when analyzing biophysical and socioeconomic factors. Giampietro, Aspinall, Ramos-Martín and Bukkens (2014) offer an integrated multiscale relationship between energy, food, water and land uses.

Another possibility to add information is multicritery analysis (AMC). The conventional approach uses monocriterial decision tools, such as cost-benefit analysis (ACB). The ABC values with a single criterion, monetary, costs and benefits, with highly questioned assumptions.[14]

The AMC, on the other hand, integrates the different dimensions of reality into a single framework of analysis, to achieve an exhaustive look. Munda (2008) is one of the most recognized authors in the development of multicritery social evaluation. AMC is a tool for decision-making in situations that include social and economic conflicts and conservation objectives. In it a plurality of measurement es-coves converge: physical, monetary, qualitative (Vallejo et al., 2015; Buraticet al., 2017). Ultimately, there are multiple options from an integrated biophysical approach.

4. Towards a more realistic economy and measurement

The point that we are interested in highlighting is that the measurement of social and economic phenomena is based on this particular way of understanding economics: the values of selfishness, the microeconomic motto that more is better. Success according to this version of life depends on economic growth and the increase in gross domestic product (GDP). Capitalist accumulation is sustained by economic growth, which is not related to distributive aspects or environmental deterioration. Economic growth has ceased to be profitable in the countries of high consumption, argues the ecological economist Herman Daly (2008), if they are examined from the vision given by indicators of biophysical sustainability.

An alternative measurement of social and environmental phenomena should recover the essence of Aristotelian economy. This Aristotelian idea of managing the house has been taken up by the Catholic Church in its encyclical *Laudato Si*, a call to humanity to save the planet this 21st century. Returning to the theme of the new measurement, with it the economy would abandon the principle of individual selfishness as the engine of the well-being of societies and scientific arrogance, and could become a discipline with a vision closer to

[14] They come into question: the monetary valuation of environmental costs and benefits, the determination of the discount rate, the time horizon for updating future damages, among others.

reality. The promotion of the active participation of decision-makers and the pursuit of happiness would return the practical character to the economy, today turned into a quasi-sporting discipline, with much martial art and little social science. It must abandon the utopian pursuit of unlimited growth, towards a stationary economy: the maintenance of capital stocks, both of production goods and durable consumption, and the population.

The orientation of economic growth or "growthmania," to say the ecological economist Herman Daly (2019), should be changed: from quantitative growth (more is better) to qualitative growth, and achieve a stable economy or a "stationary condition" of population and capital, as suggested by John Stuart Mill in the 19th century. The consumption of "natural capital," environmental damage and defense expenses belong to the cost and not to the income account, as Daly (2013) has also explained.

> The classic notion of the steady state considers as given the biophysical dimensions - population and stock of capital (durable goods of production and consumption) - and adapts technology and tastes to these objective conditions. The neoclassical notion of the "steady state" (proportional growth of available capital and population) considers technology and tastes to be given, and adapts to them through the growth of biophysical dimensions, considering that needs are unlimited, and technology as powerful a means to make the world infinite. The classical notion considers the human being as a creature that must adapt to the limits (finitude, entropy, ecological interdependence) of the Creation of which he is part. The neoclassical perspective considers that the human being, the creator, will exceed all limits and can remake Creation according to his subjective and individualistic preferences, considered as the root of value. Ultimately, economics is religion (Daly, 2008).

That is the view that John Stuart Mill had in 1848, one of the last exponents of classical political economy (2014:593 and 594):

> I cannot, therefore, consider the steady state of capital and wealth with the unaffected aversion so generally manifested towards this by political economists. I am inclined to believe that it would be, taken together, a very considerable improvement in our present condition. Only in the backward countries of the world that increased production remains an important object; in the most advanced, what is needed economically is a better distribution, of which an indispensable means is a stricter restriction of the population.

And the economy must complement studies, analysis, research and prescription of social and environmental phenomena with biophysical indicators, in order to discard the association between well-being and growth of GDP. It is a question of uniting a positive economy and a normative economy (the difference between "facts" and "values," between "being" and "duty to be," "between declarative and supposedly objective propositions to interpret the world and prescriptive assessments of its various states"), which suffered a rupture since the mid 19th century (Blaug, 2001:51). Ultimately, it is something bigger: to unite economics with ecology in a science that is the basis of a planetary technology.

Since a long time ago it has advocated other ways of measuring the well-being or good living of a country, evaluating each of the elements that make the human being happy and subtracting points in areas with notorious inequality (Falconí, 2002).

4.1. Measurement and Amazon

Is everything material priced? Perhaps that mania of putting a price on everything has led us to underestimate what has no price, when it is the other way around: what has no price is more valuable because it is not easy to replicate, sometimes it is irreplaceable.

Real life has a high dose of uncertainty, high decision stakes, and more variables than a controlled experiment usually presents. This has caused social scientists, in particular, to propose a post-normal science. The concept of normal science was developed by the philosopher Thomas Kuhn (1962). It is a form of understanding of applied science with low decision bets and uncertainties and with an organized scientific community that pushes knowledge. One of the greatest exponents of post-normal science is the philosopher Silvio Funtowizcz, who proposes to go beyond normal science and move towards post-normality, to recognize the values under dispute, the different types of uncertainty consistent with global environmental risk and the incorporation of new participants in political dialogues that have implications for society and science (Funtowicz and Ravetz, 2000:24 and 25). In a widely circulated article published in *Ecological Economics*, Funtowicz and Ravetz (1994) ask themselves: how much is the singing of the nightingale worth? The question leads to questioning the way social and environmental phenomena are usually measured from conventional economics. It's free if I live in the country, or maybe it's worth something if I record it and upload it to YouTube.

In the Amazon, we might ask ourselves: how much is the roar of a jaguar that makes us tremble at night? or how much is an Amazon bird concert worth that wakes us up every morning, compared to Amazon's $20 alarm clock? Surely we would reach the same conclusion as Funtowicz and Ravetz (1994). These thinkers stated that we cannot measure everything in market prices, because there are plurality of values between different goods and even immeasurable goods.

The fallacy of current measurement among economists is part of the civilizing crisis we face as humanity. The metric is essential, because it is through it that social and natural phenomena are described, analyzed, predicted and evaluated.

The new metric cannot be too simple, because it will measure a reality with high complexity. Complexity is understood as the possibility of connecting different planes of a reality and the use of several units of value to evaluate the development of social or environmental behaviors. What is expected is that it brings together the main components of reality.

We need a change of focus to describe the problems in the Amazon. We are locked in a globalized capitalist scheme and that dominant economy drives a society based on the

accumulation and selfishness of the conventional neoclassical economy, which despises nature. The indigenous way of life is characterized by the values of coexistence, co-evolution, good living and flourishing.

The measurement system must question the traditional methodology of approaching well-being from economic growth to sustainable development. It is a different conceptual approach that acts without anchoring itself in monetary indicators or classical indicators, but flows freely and is complemented by more realistic indicators such as biophysics. If you want to measure the efficiency of the budget you may want to know the efficiency of the expenditure in dollars in relation to the objectives set, but if you want to evaluate the health of the ecosystems, it is better to know the number of species or know the regenerated area (physical information).

Measurement can focus not only on the material conditions of people (such as poverty, inequity, employment, housing, food and more), which are substantive, but also on other information that makes it possible to visualize this community flourishing. This information includes their life plans, their positive actions to confront the onslaughts of climate change, or the number of species protected in indigenous territories.

In practical aspects, it means addressing reality in multidimensional terms, with rigorous discussions of what the economic or social or socio-environmental field means, and indicators that can give contradictory signs of the same reality. Understanding a system as complex as the Amazon requires a complex set of demographic, economic, social, environmental and cultural indicators. See the forest without neglecting the trees.

The proposal for a measurement of good living is part of the socio-environmental transition in the Amazon. It is part of other recommendations such as economic decline, universal basic income or citizen income, moratorium on external debts (many of them acquired unfairly in terms of law), eco-taxes and taxes on wealth, fair trade, alternative exchange systems and the search for a different international intellectual property regime, which takes more effect with the covid-19 pandemic, in particular by the debate on access to vaccines.

Achieving this transition requires a plurality of approaches and methodologies. From pressure-state models and responses. Also the approaches of socio-environmental metabolism, that is, similar to how the human body is fed to acquire energy and dispose of waste, in societies. The use of multicritery analysis (several criteria and alternatives to generate the best social or environmental decisions) can be useful. These approaches must relate to society and its institutional structure, in a holistic approach that integrates the human with the cosmic.

5. Conclusions

In environmental matters, the worst is to come, as has been warned in multiple reports about the climate and global crisis. This is not a mood but a certainty about the movement of environmental indicators. Nor can one fall into false technological optimism. The current moment demands new interpretations to move forward during and after the covid-19 crisis, as proposed by the Dutch Manifesto (Feola, 2020). Ecuador proposed a more metric associated with good living (Senplades, 2013). In 2019, New Zealand presented a panel of indicators associated with the living standards framework, to go beyond GDP. Canada has already proposed broader measures of progress, such as happiness and well-being (Tomaselli and Pai, 2020).

The aim of the article was to examine how social and environmental phenomena are measured. To this end, a methodology was defined to organize and interpret the information. The critical evaluation shows the weaknesses of the metric associated with weak sustainability and allows to recognize the strengths of the metric linked to strong sustainability, which is based on biophysical indicators based on a reflection of the situation of the Amazon shared by Ecuador and Peru.

In the case of Ecuador and Peru, this region is integrated into the world market as a provider of natural resources. Strong sustainability indicators allow a more comprehensive view of their socio-environmental reality. Between 1970 and 2007, Peru has increased its extractive volume by 3.8 times and Ecuador by 6.3 times (most of the oil extracted in Ecuador comes from the Amazon). This extractive increase has caused biophysical pressure and has historically been a permanent source of socio-environmental conflict. All these elements support the need for a socio-environmental transition.

The traditional measurement focused on economic expansion rather than on the development of qualitative elements of well-being tends to obscure the analysis. Conventional monetary indicators, associated with a positive valuation if income or consumption increases, are questionable.

We advocate a holistic and biophysical approach through the use of information and indicators that allow for more real approximations to the use, management and disposition of materials and energy in a society and interaction with human systems. Biophysical analysis necessarily leads to a rethinking of growth objectives, and rather leads to the need for social justice, with environmental balance in middle-income and low-income countries and to a decline with prosperity (Jackson, 2011) in rich and industrialized countries, while enabling alternatives to socio-environmental transitions.

Concrete public policy decisions ignore and omit these new advances in understanding social or environmental phenomena. The budgetary allocation is made taking into account conventional monetary indicators. Inequality indicators are not systematically used to assess a country's achievements or setbacks. Almost no president in the world, nor the leaders of local governments, put in their annual reports data on deforestation, or the loss of services and environmental functions key to life.

A country must meet essential needs of the population (nutrition and medical care, education, health, social security). In education, there must be access to basic knowledge, information and communications. A country must respect the rights of nature and maintain an environmental policy consistent in its laws. And the most urgent thing: to give opportunities to all people to achieve the achievements that correspond to their potential, with maximum inclusion.

In the case of the Amazon, shared by Ecuador and Peru, it is necessary to update diagnostics on social inequity, changes in land use, environmental damage, as well as propose viable solutions related to the regeneration of terrestrial and river ecosystems. Diagnostics and proposals cannot be supported by conventional economic indicators, but rather have to be linked to social and biophysical behaviour.

Bibliographic references

Aguilera, K. (2015). Economía y naturaleza humana, volviendo a Smith y Marx. *Polis, 14*(41): 255-276. Santiago.

Allan, J. (1993). Fortunately there are Substitutes for Water, Otherwise our Hydro-Political Futures Would be Impossible. *Priorities for Water Resources Allocation and Management* (pp. 13-26). Londres: Overseas Development Administration.

——. (1998). Virtual water: A strategic resource. Global solutions to regional deficits. Groundwater, 36(4): 545 y 546. https://doi. org/10.1111/j.1745-6584.1998. tb02825.x

Aristóteles. (1874). *La política*. (Traducción de Patricio Azcárate). Philosophia Perennis.

Banco Mundial. (2011). *The Changing Wealth of Nations: Measuring Sustainable Development in the New Millennium.* Washington, dc: World Bank.

Blaug, Mark. (2001). *Teoría económica en retrospección*. México, DF: Fondo de Cultura Económica.

British Petroleum (Bp). (2021). Statistical Review of World Energy 2021.Buchholz, K. (2021). *The World is not enough*.https://www.statista.com/chart/10569/number-of-earths-needed-if-the-worlds-population-lived-like-following-coun-tries/?utm_source=Statista+Newsletters&utm_campaign=5524244246-All_in-fographticker_daily_com_am_kw16_2021_fr&utm_medium=email&utm_ter-m=0_662f7ed75e-5524244246-314894145

Burbano, R., Larrea, C., y Latorre, S. (2017). Análisis multicriterial sobre alternati-vas para el desarrollo en la Amazonía. En Carlos Larrea (coord.), *¿Está agotado el periodo petrolero en Ecuador? Alternativas hacia una sociedad más sustentable y equitativa: Un estudio multicriterio*. Quito: Universidad Andina Simón Bolívar/Ediciones La Tierra.

Cuesta, F., Peralvo, M., y Baquero, F. (2020). *Áreas prioritarias para la conservación de la biodiversidad en la Amazonía del Ecuador.* Quito: Fundación Pachamama.

Cuesta, F., Peralvo, M., y Suárez, C. (2020). *Áreas prioritarias para la conservación de la biodiversidad en la cuenca del Marañón,* Perú. Quito: Fundación Pachamama.

Daly, H. (1973). *Toward a Steady-state Economy*. San Francisco: wH Freeman & Company

.——. (2008). *A Steady State Economy. A failed growth economy and a steady-state economy are not the same thing; they are the very different alternatives we face.* Sustainable Development Commission, ru. https://base.socioeco.org/docs/una_econo-mia_de_estado_estacionario_h._daly.pdf

——. (2013). Top ten Policies for a Steady States Economics. *The Daly News,* 28 de oc-tubre de 2013. https://steadystate.org/top-10-policies-for-a-steady-state-economy/

——. (2019). Growthism: Its ecological, economic and ethical limits. *Economics and the Ecosystem*, núm. 87, pp. 9-22.

El Serafy, S. (1989). The Proper Calculation of Income from Depletable Natural Re-sources. En Ahmad Yusuf, Salah El Serafy y Lutz Ernst (eds.), *Environmental Accounting for Sustainable Development.* Washington, *DC*: Banco Mundial.

——. (1991). The environment as capital. En Robert Costanza (ed.), E*cological Economics: The Science and Management of Sustainability.* Nueva York: Columbia University Press.

Easterlin, R. (1974). Does Economic Growth Improve the Human Lot? En Paul A. David y Melvin W. Reder (eds.), *Nations and Households in Economic Growth: Essays in Honor of Moses Abramovitz.* Nueva York: Academic Press, Inc.

Escobar, A. (2015). Degrowth, postdevelopment, and transitions: A preliminary conversation. *Sustainability Science*, 10(3): 451-462. https://doi.org/10.1007/s11625-015-0297-5

Falconí, F. (2001). La pesada carga material de la deuda externa. En C. Jonick, *Las otras caras de la deuda* (pp. 181-190). Quito: cdes.

——. (2002). *Economía y desarrollo sostenible: Matrimonio feliz o divorcio anunciado.* Quito: FLACSO.

Falconí, F., Ramos-Martin, J., y Cango, P. (2017). Caloric unequal exchange in Latin America and the Caribbean. *Ecol. Econ.*, núm. 134, pp. 140-149. https://doi.org/10.1016/j.ecolecon.2017.01.009

Feola, G. (2020). Manifesto for post-neoliberal development: Five policy strategies for the Netherlands after the Covid-19 crisis. *Ontgroei,* 16 de abril de 2020. ht-tps://ontgroei.degrowth.net/manifesto-for-post-neoliberal-development-five-po-licy-strategies-for-the-netherlands-after-the-covid-19-crisis/

Funtowicz, S., y Ravetz, J. (1994). The worth of a songbird: Ecological economics as a post-normal science. *Ecological Economics*, núm. 10, pp. 197-207.

——. (2000). *La ciencia post-normal. Ciencia con la gente*. Barcelona: Icaria Editorial.Georgescu-Roegen, N. (1971). *The Entropy Law and Economic Process*. Cambridge: Harvard University Press.

Giampietro, M. (2003). *Multi-Scale Integrated Analysis of Agro-ecosystems*, *Crop Science, Advances in Agroecology*. Boca Raton, Florida; crc Press. https://doi.org/10.2135/cropsci2006.0003br

Giampietro, M., Aspinall, R. J. J., Ramos-Martin, J., y Bukkens, S. (2014). *Resource Accounting for Sustainability Assessment: The Nexus between Energy, Food, Water and Land Use*. https://doi.org/10.4324/9781315866895

Giampietro, M., y Saltelli, A. (2014). Footprints for nowhere. *Ecological Indicators*, núm. 46, pp. 610-621.

Global Footprint Network. (2021). *Supply and Demand*. https://data.footprintnetwork.org/?_ga=2.209478546.1246369133.1619202171-1905832764.1587930510#/ex-ploreData

Haberl, H., Wiedenhofer, D., Pauliuk, S., Krausmann, F., Müller, D. B., y Fischer-Kowalski, M. (2019). Contributions of sociometabolic research to sustainability science. *Nature Sustainability*, 2(3): 173. https://doi.org/10.1038/s41893-019-0225-2

Hoekstra, A., y Hung, P. (2002). Virtual water trade: A quantification of virtual water flows between nations in relation to international crop trade. *Value of Water Re-search Series*, núm. 11. Delft, The Netherlands: UNESCO-IHE.

Hickel, J. (2018). Is it possible to achieve a good life for all within planetary bounda-ries? *Third World Quarterly*, 40(1): 18-35. https://doi.org/10.1080/01436597.2018.1535895

Iniciativa de Cuencas Sagradas. (2021). *Plan Biorregional 2030. Transiciones para la vida en las Cuencas Sagradas de la Amazonía en Ecuador y Perú*. Quito.https://cuencasagradas.org/wp-content/uploads/2021/10/esp_resumen-pbr_10-2021.pdf

Infante, J., Urrego, A., y Tello, E. (2020). Las venas abiertas de América Latina en la era del Antropoceno: Un estudio biofísico del comercio exterior (1900-2016). *Diálogos. Revista Electrónica de Historia*, 1(2): 177-214, julio-diciembre. Doi: 10.15517/dre.v21i2.39736

Jackson, T. (2011). *Prosperidad sin crecimiento: Economía para un planeta finito*. Barcelona: Icaria.

Jeffrey, K., Wheatley, H., y Abdallah, S. (2016). *The Happy Planet Index: 2016. A global index of sustainable well-being.* Londres: New Economics Foundation.

Kuhn, T. (1962). *La estructura de las revoluciones científicas*. México, dF: Fondo de Cultura Económica.

Lange, Glenn-Marie, Wodon, Quentin, y Carey, Kevin. (2018). *The Changing Wealth of Nations 2018: Building a Sustainable Future.* Washington, DC: World Bank. https://openknowledge.worldbank.org/handle/10986/29001

León, M., Lewinsohn, J., y Sánchez, J. (2020). *Balanza comercial física e intercambio, uso y eficiencia de materiales en América Latina y el Caribe*. Santiago de Chile: cepal.

Martínez-Alier, J. (2011). Macroeconomía ecológica, metabolismo social y justicia ambiental. *Revista de Historia Actual*, núm. 9, pp. 149-168.

Mill, J. S. (1951). *Principios de economía política* (1848). México, dF: Fondo de Cultura Económica (de la traducción al español).

Munda, G. (2008). *Social Multi-Criteria Evaluation for a Sustainable Economy.* Berlín/Heidelberg: Springer. https://doi.org/10.1007/978-3-540-73703-2

Muradian, R., y Martinez-Alier, J. (2001a). Trade and the environment: From a "Southern perspective". *Ecological Economics*, núm. 36, pp. 281-297. https://doi.org/10.1016/S0921-8009(00)00229-9

——. (2001b). South-North Materials Flow: History and Environmental Repercussions. *Innov. Eur. J. Soc. Sci. Res.*, núm. 14, pp. 171-187. https://doi.org/10.1080/713670544

New Economics Foundation. (2016). *Happy Planet Index 2016: Methods Paper*. https://static1.squarespace.com/static/5735c421e321402778ee0ce9/t/578dec7837c58157b929b3d6/1468918904805/Methods+paper_2016.pdf

Nobre, C. A., y Lovejoy, T. H. (2018). Amazon tipping point. *Science Advances*. https://advances.sciencemag.org/content/4/2/eaat2340

Organisation for Economic Cooperation and Development (OCED). (1994). O*ECD Core Set of Environmental Indicators.* París: OCED.

Otero, I., et al. (2020). Biodiversity policy beyond economic growth. *Conservation Letters*, núm. s, p. e12713. doi: 10.1111/conl.12713

PNUD (2022). *Informe sobre Desarrollo Humano 2021/2022. Tiempos inciertos, vidas in-estables: configurar nuestro futuro en un mundo*. New York: United Nations Devel-opment Programme.

Ramos, J., y Falconí, F. (2021). *Biophysical approaches to food system analysis in Latin America*. Por publicar.

Real Academia Española. (2020). *Diccionario de la lengua española*, 23ª ed. [Versión 23.3 en línea]. <https://dle.rae.es>

Rockström, J., et al. (2009). Planetary boundaries: Exploring the safe operating space for humanity. *Ecology and Society*,14(2). https://bit.ly/3sLrv5y.

Roll, E. (2002). *Historia de las doctrinas económicas*. México, DF: Fondo de Cultura Económica.

Samaniego, P., Vallejo, C., y Martínez-Alier, J. (2017). Commercial and biophysical deficits in South America, 1990-2013. *Ecological Economics*, núm. 133, pp. 62-73. https://doi.org/10.1016/j.ecolecon.2016.11.012

Stack Whitney, K., y Whitney, K. (2018). John Anthony Allan's 'Virtual Water': Natu-ral Resources Management in the Wake of Neoliberalism. *Environment & Society Portal,Arcadia*, núm. 11, primavera. Rachel Carson Center for Environment and Society.

Schatan, J. (1998). *El saqueo de América Latina*. Santiago de Chile: Colección sin Norte, Serie Punto de Fuga, Edición Arcis-LOM.

Schumacher, E. (1973). *Small is Beautiful: A Study of Economics As If People Mattered*. Londres: Blond & Briggs Ltd.

Sen, A. (2000). *El desarrollo como libertad*. Bogotá: Planeta.

Senplades. (2013). *Plan Nacional del Buen Vivir 2013-2017*. Quito: Secretaría Nacional de Planificación y Desarrollo (Senplades).

Steffen, W., et al. (2015). Planetary boundaries: Guiding human development on a changing planet. *Science*, 347(6223): 1259855. doi: 10.1126/science.1259855.

Stiglitz, J., Sen, A., y Fitoussi, J. (2009). *Report by the Commission on the Measurement of Economic Performance and Social Progress*. París.

——. (2010). *Mismeasuring our lives: Why gdp doesn't add up*. Nueva York: The New Press.

Temper, L., Leah, Del Bene, D., y Martínez-Alier, J. (2015). Trazando las fronteras y las líneas del frente de la justicia ambiental global: Las EJAtlas. *Revista de Ecología Política*, núm. 22, pp. 255-278.

The World Bank. (2022). *World Development Indicators*. The World Bank Group. Sitio web de The World Bank: https://datacatalog.worldbank.org/dataset/world-devel-opment-indicators

Tomaselli, F., y Pai, S. (2020). Seeking a more balanced indicator, Canada set to leave gdp in the dust. *Independent*, 17 de marzo de 2020. https://www.independent.co.uk/extras/lifestyle/canada-gdp-economic-growth-environment-a9391551.html

United Nations Environment Programme-International Resource Panel (UNEP-IRP). (2018). *Global Material Flows Database*. UN Environment Programme-International Resource Panel. http://www.resourcepanel.org/global-material-flows-da-tabase

Vallejo, M. C. (2010). Biophysical structure of the Ecuadorian economy, foreign trade, and policy implications. *Ecol. Econ*., núm. 70, pp. 159-169.

Vallejo, C., Burbano, R., Falconí, F., y Larrea, C. (2015). Leaving oil underground in Ecuador: The Yasuní-itt initiative from a multi-criteria perspective. *Ecological Economics*, núm. 109, pp. 175-185.

Veblen, T. (2014). *Teoría de la clase ociosa*. Madrid: Alianza Editorial.

Wackernagel, M., y Rees, W. (1996). *Our Ecological Footprint: Reducing Human Impact on the Earth*. New Society Publishers.