

# Indicators of Sustainability

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## **Introduction**

**A**lthough debates about the notion of sustainability have been multiplying in nearly all areas of knowledge, their roots lie necessarily in the reflections of two disciplines considered scientific: ecology and economics. As to the first, opposition arose almost immediately to the innocent idea that ecosystem sustainability corresponds to a supposed “equilibrium.” The controversy quickly ended in a compromise, resulting in the emergence of the concept of resilience: the ability of a system to endure disturbances while maintaining its functions and structure. That is, its ability to absorb, adapt to and even take advantage of shocks through adaptation and reorganization. An ecosystem can sustain itself if it continues to be resilient, however distant it is from an idealized equilibrium.

It was this theoretical convergence that introduced the comparison between the biocapacity of a territory and the pressures to which its ecosystems are subject due to increased consumption of energy and matter by human societies and their resulting pollution. This is the comparison that made the Ecological Footprint indicator so easily comprehensible and so increasingly popular.

Nothing similar occurred within economics, in which the divergences between three very different conceptions only increased. To begin with, there is the known collision between “weak” and “strong” sustainability. The former takes as necessary and sufficient the minimum rule that each generation bequeaths to the following the sum total of three kinds of capital that it considers entirely interchangeable or inter-replaceable: capital itself, natural/ecological capital and human/social capital. On the other hand, there is the “strong” sustainability that emphasizes the obligation to keep at least the services of “natural capital” constant.

A crucial variant of this second current rejects something both currents have in common: emphasis on stocks – with the same focus on the flows that half century ago enabled the rise and standardization of a national accounting system that permitted measuring the gross product of each country, the internal version of which became the yardstick of socio-economic performance. Its limitations were severely criticized, especially for considering only mercantile activities and ignoring the depreciation of natural and human resources. It was exactly this that provoked a process to find corrections and extensions with the objective of transforming it into an indicator of “sustainable economic well-being,” later renamed “indicator of genuine progress.”

To be accurate, it was in contrast to all previous perspectives that the biophysical perspective was erected, denying that the economy is an autonomous system and understanding it as a subsystem entirely dependent on Darwinian evolution and on the second law of thermodynamics on inexorable entropy. In this vision, there can only be sustainability by minimizing the flows of energy and matter that cross a subsystem, and, derivatively, by disconnecting qualitative social advances from never-ending quantitative increases in production and consumption.

Such verbal jugglery explains the absence of an economic indicator of sustainability that could gain minimal acceptance. However, after adoption of the Agenda 21 at Rio-92, demand for this type of indicator has intensified. And in 1996, a safe path seemed to have been found with the adoption of the “Bellagio Principles” (IISD, 2000). However, reports of the subsequent proliferation of indicators gathered by Lawn (2006) showed that the methods proposed for the evaluation and monitoring of sustainability remained elusive.

In these circumstances, there was strong propensity to select a few indices that, in combination, would allow an evaluation of sustainability in its various dimensions. And the most interesting proposal of this type arose in the recommendations of Murray Patterson (2002, 2006) to the government of New Zealand. He advocated that the economic dimension be measured by the Genuine Progress Indicator (GPI), the social dimension by the “New Zealand Deprivation Index,” and the environmental dimension by a new composite index to be developed, which would cover all aspects of the biophysical environment and ecological functioning.

This article reaches a different conclusion, although confirming the idea that sustainability indeed requires a tripartite group of indicators, since it can only be satisfactorily evaluated if there are simultaneous measurements of the environmental realm, of economic performance, and of the quality of life (or well-being). The principal differences are in the need to: a) replace GNP with a measure of available household income, rather than adopting some proposal for a corrected or adjusted GNP, such as the GPI; and b) look for a synthetic indicator of the quality of life that incorporates scientific evidence derived from a new branch of economics, the economy of happiness.

The means used to expound the arguments justifying such conclusion is the retrospective description, in four steps, of the nearly 40 years of search for indicators of sustainability.

## **The Common Ancestor from 1972**

The scientific debate about indicators of sustainability was triggered nearly 40 years ago by a work that continues to be widely seen as seminal. It is the chapter “Is growth obsolete?” published in 1972 by William D. Nordhaus and James Tobin in the fifth volume of the series *Economic Research: Retrospect and Prospect* of the National Bureau of Economic Research (NBER) in the United States.

As the title suggests, the focus was not directly on indicators, but on the discussion about a hypothetical obsolescence of economic growth. And the argument was anchored on orthodox economic theory to refute a kind of debate over economic growth that grew in the 1960s and became particularly acute in the United States between 1968 and 1972. It appears early in the first paragraph of the text of Nordhaus & Tobin (1972, p.1), in the following passage that they attributed to ecologist Paul Ehrlich: “We must acquire a life style which has as its goal maximum freedom and happiness for the individual, not a maximum Gross National Product”<sup>1</sup> (GNP).

Even though no other opponent of growth is cited by Nordhaus & Tobin throughout the 80 pages of their work, they frequently use the plural to refer to those who were questioning whether future growth was desirable and possible (“those who question the desirability and possibility of future growth” [ibid, p.4]). And it’s a fact that many economists had already made serious critiques of the obsession with economic growth. Because of this, therefore, they were Nordhaus & Tobin’s true target, even if the pair avoided naming them.

Since it is from the same year (Meadows et al., 1972), we cannot include the famous report to the Club of Rome entitled *Limits to Growth* among these targets. But it is necessary to recall that the first edition of the classic *The Affluent Society* by John Kenneth Galbraith had been published in 1958. This book might even have been ignored by many economists on the basis that they considered the author, at best, a good political commentator. Nothing of the kind could have occurred, however, with Ezra J. Mishan, who published in 1967 a masterpiece about the costs of economic growth, translated in Brazil with a tragically erroneous title<sup>2</sup>.

The scientific controversy about growth as a dogma was certainly initiated by the long and intense debate that ensued between Mishan and Wilfred Beckerman. But even earlier, there had been the most incisive attacks against what later came to be called growth “mania” or “fetish,” motivated less by the costs pointed out by Mishan than by the advances in awareness of their socio-environmental limits, particularly in the major pioneering works published since the 1960s by William Kapp, Nicholas Georgescu-Roegen and Kenneth Boulding<sup>3</sup>.

In order to reply to these true underlying targets, Nordhaus & Tobin addressed the effect of population increase on the growth of production, as well as the inevitability of waste of natural resources caused by this growth. However, it was the question of the quality of metrics used for evaluating economic growth (the first question they chose) that would have much greater intellectual impact, making this work the first obligatory reference of any reflection on indicators of sustainability.

The intention of the pair was to demonstrate that “*The progress indicated by conventional national accounts [such as GNP or GDP] is not just a myth that evaporates when a welfare-oriented measure is substituted*” (ibid, p.13).

With this in mind, they introduced a series of corrections in the method of calculating the product (national or only domestic), so that – on one hand – they removed components that do not contribute to well-being; and – on the other – added some of those that do, even though they do not enter the conventional calculation because they are not part of production. They thus arrived at the “Measure of Economic Welfare” or MEW, a measure of consumption instead of production.

Clearly, the first step in these complicated corrections that take up the 35 pages of the first appendix was to turn to the net product instead of the gross, and consider the absolute necessity of depreciations. Soon afterward the idea of *per capita* level of consumption is introduced, one that does not exceed the tendency of increased work productivity, termed “sustainable” by the authors. For them, if *per capita* consumption exceeds this so-called “sustainable” level, it means that it is engulfing the fruits of future progress.<sup>4</sup>

In the conclusion, they compare the results from the Measure of Economic Welfare (MEW) with data on net product (NNP), instead of comparing them with the GNP, which would have been much more coherent in terms of the objective of their work. Had they had not used such a subterfuge, they would certainly have arrived at the opposite conclusion. And the worst is that it is difficult to believe today that the pair did not include estimates of any environmental damage or depletion of natural resources in the calculations of what they called “MEW-S”: “Measure of Economic Welfare - Sustainable.”

Even so, nothing prevents this concept from being considered the most remote ancestor of all later attempts to correct or adjust the GNP (or the GDP) to arrive at some aggregate measure of developmental sustainability.

### **The First Major Turning Point in 1989**

It was only seventeen years after the seminal chapter by Nordhaus & Tobin (1972) that the “Index of Sustainable Economic Welfare” (ISEW) emerged, thanks to one of the most important elaborations by the prolific ecological economist Herman E. Daly. In this case, it was included in a book that resulted from a partnership with theologian John B. Cobb Junior: *For the Common Good* (1989).

Strictly speaking, in this long interval there were two other contributions that need to be mentioned for having been very helpful for Daly’s critical thinking. On the one hand, Japan’s pioneering initiative for calculating its “Net National Welfare” (NNW), published in 1974<sup>5</sup>; on the other, a work from 1981, which has also fallen into neglect, by Xenophon Zolotas, the now deceased Greek economist who in 1989 became interim Prime Minister<sup>6</sup>.

In contrast to these tentative previous studies, the ISEW proposed by Daly & Cobb Junior had enormous practical repercussions. It was later calculated in at least eleven other countries: Canada, Germany, United Kingdom, Scotland,

Austria, Holland, Sweden, Chile, Italy, Australia and Thailand. And in 2004, it was transformed into the Genuine Progress Indicator (GPI), created by the American NGO, Redefining Progress (<http://www.rprogress.org>).

Besides the detailed presentation of the two indices (ISEW and GPI), the book *The New Indicators of Wealth* by Jean Gadrey & Florence Jany-Catrice (2006) shows three graphs that illustrate well the relative declines in sustainable well-being per inhabitant between 1974 and 1990 in the United States, United Kingdom and Sweden. In the case of the United States, calculations for a 40-year period (1950-1990) were added to the second edition of the book *For the Common Good*, revised and updated in 1994. The *per capita* ISEW, which was 71% of per capita GNP in 1950, fell to 42% in 1990. In other words, while the *per capita* GNP had increased 121%, ISEW only rose 30% (Daly & Cobb Junior, 1994, p. 463).

The major problem affecting ISEW, which worsened in the case of the GPI, is that the price assessment of environmental damages and of gains in leisure and domestic or voluntary work, for example, remains highly speculative, however much conventional economists and some ecologists strive to perfect their valuation methods. Attributing monetary values to losses or gains that have no determined market price will always be an arbitrary exercise. Lacking an alternative, it is clear that a judge would prefer that the value of an indemnification be calculated by one of these methods. But it is something quite different to assume that there will be societal acceptance of the method when it comes to assigning monetary value to damages caused by pollution, to the work of fathers and mothers raising their children, or to family care for the elderly.

In addition, corrections to GNP or GDP might even result in a reasonable indicator that calls attention to the divergent evolution of the performance of a national economy and of the welfare or quality of life that it was capable of generating. But this has very little to do with the idea of sustainability, which necessarily refers to the future. Showing that the rate of increase of well-being is lower than the rate of increase of the GNP or the GDP says nothing with respect to the possibility that these both might be sustainable.

In this sense, the 2004 name change of the indicator that had been created by Daly & Cobb Junior in 1989 was propitious and can certainly provide a very reasonable evaluation of “genuine progress” being obtained by a nation, even if such progress cannot be understood as a “sustainable” increase in well-being.

In short, as much as we have advanced in relation to the ancestor of 1972, the 1989 turnaround did not generate an indicator that can effectively assess sustainability.

### **Three Parallel Movements after 1995**

What the indices mentioned here have in common is the idea of starting out from national accounting data that are traditionally used to calculate income

(whether domestic or national, gross or net) in order to reach some indicator of economic well-being, or of genuine progress. But not of sustainability. For this, it was expected that other paths would be explored in the effort to obtain indicators of sustainability.

This situation gave rise to three other approaches: a) construction of large and eclectic collections, or dashboards; b) composite or synthetic indices, with various dimensions, whose variables tend to be some data taken from the aforementioned collections; c) indices focused on the degree of overconsumption, underinvestment or excessive pressure on resources.

A good panorama of the proliferation of indicators in these three directions can be found in Bellen (2005). The proliferation was so intense that it generated a kind of intellectual fog around the measurement of sustainability (environmental or developmental), as highlighted in Veiga (2009a). Three years earlier, however, there had been a much more detailed and much more profound treatment in the anthology edited by Philip Lawn (2006), which might have already confirmed that no indicator had yet emerged (and probably never would) that could simultaneously reveal the degree of sustainability of the socio-economic process and the degree of quality of life that derived from it. Even if they were two sides of the same coin, nothing suggests any accounting or statistical method capable of generating a single synthetic formula capable of expressing both.

As a result, one could conclude from a reading of Lawn (2006) that the best way to use such indicators in political orientation would necessarily require some type of combination. For example, using one of the indicators of welfare in tandem with another more focused on the pressure on resources. This might perhaps show whether a country is nearing or exceeding its optimal macroeconomic level. Or, more crucially, how far it might be from its maximum point of sustainability. The comparison of two indicators like these might even reveal possibilities of economic decline and ecological catastrophe.

The perspective of adopting two or three indices, however, was bound to run into the impossibility of finding them, that is, of choosing indicators capable of revealing something significant in a coherent form. Regarding the first of the cited approaches – the collections/dashboards –, there is no need for justification. They might be excellent as databases, but are so heterogeneous that, strictly speaking, they should not even be understood as indicators. Whoever doubts this is urged to consult the best of them, result of a tripartite work by Unecce/OECD/Eurostat (2008).

Because of this, we will only consider the other two approaches here: composite/synthetic indices and indices focused on the degree of human pressure on resources.

In the first category, the initiative that earned greatest reputation was the proposal of researchers from Yale and Columbia (Estes et al., 2005) to develop an Environmental Sustainability Index (ESI) and an Environmental Performance

Index (EPI). The first contains 76 variables that cover five dimensions. The second aggregates the same 76 variables with 21 intermediating indicators. As much as they might be reasonable ways to assemble a great amount of information and serve as an invitation to pay more attention to some of their components, all these kinds of exercises are highly precarious from a strictly statistical point of view. Even more so, when variables with an objective character, such as infant mortality rate, are mixed with subjective variables, such as a score assigned to the environmental agencies of each country...

Among the indicators focused on the degree of pressure on resources, two quite different ones have achieved great visibility: Adjusted Net Savings (ANS) and the famous Ecological Footprint.

ANS, also known as genuine savings, or genuine investment, is an indicator entirely aimed at evaluating of stocks of wealth, instead of flows of income, consumption or production (World Bank, 2006). Its theoretical root is in the idea that sustainability essentially requires maintenance of an ongoing stock of extended wealth: stock that aggregates natural resources, physical/productive capital and human capital. This assumes, of course, that full substitutability among them is possible, which is the most controversial idea. And in spite of all the efforts supported by The World Bank, this approach stumbles into the immense methodological obstacle of how to price many fundamental assets, especially strategic natural resources. Because of this, the results have been neither convincing nor persuasive.

The opposite happens with the Ecological Footprint, since it does not involve the type of juggling required by the monetary approaches, and, furthermore, conveys a notion that can be easily assimilated by everyone concerned with finding good indicators of sustainability. The Ecological Footprint only intends to show how much of the regenerative capacity of the biosphere is being used in human activities (consumption).

Initially proposed by Wackernagel & Rees (1995), this indicator has been promoted by the Global Footprint Network, by Redefining Progress and also by WWF, which publishes updates in its annual statement, the *Living Planet Report*. However, the apparent simplicity of the Ecological Footprint also hides serious technical problems that were emphasized in three recent reports: CGDD (2009), Le Clézio (2009) and Stiglitz-Sen-Fitoussi (2009).

There is no lack of incoherence in the Footprint methodology. For example: the biocapacity of a cultivated area is assessed by its observed yield, when it should be assessed by the yield that would preserve future soil fertility at a constant level, that is, by its “sustainable” yield. The same happens with evaluation of pasture biocapacity. Thus, within the national scope, the ecological deficit of these lands will always be equivalent to the trade deficit of the sector. And worldwide there will never be an ecological deficit or surplus in cattle breeding. This was one of the main arguments of Bergh & Verbruggen (1999) to demonstrate that the footprint is inherently biased against international

commerce. The inverse biocapacity of countries with high or low population densities – such as Holland and Finland – leads them to commercial exchanges that cannot be understood as indicators of non-sustainability, unless they intend to achieve some form of autarkical autonomy.

For this reason, more recent versions of the methodology to calculate the footprint emphasize that the ecological surplus of a nation cannot be interpreted as a criterion of sustainability. Moreover, authors of the methodology have gone on to insist that the footprint of each country should be compared to global, rather than national, biocapacity (Moran et al., 2008). This then forces the Ecological Footprint to be understood as an indicator of the contribution made to global non-sustainability, rather than an indicator of sustainability of this or that country, region or locality.

There are similar flaws in the calculation methods for constructed areas, forest areas and fishing. However, more important than criticizing them is to call attention to the fact that in the concept of the footprint there is an underlying or intrinsic proviso. Is it reasonable to admit that the relative importance of the forests is only 9% and of fish stock, meager 3%? Furthermore, according to this conception, it is granted that replacing forests with cultivated lands would increase available biocapacity, thereby alleviating the ecological deficit, which makes absolutely no sense.

For these and other reasons, what is necessary to grasp is the basic idea of measuring the various human pressures on ecosystems in order to compare them to the latter's support capacity. But without aggregating them. In other words, comparing, for example, carbon emissions with the area of forest that would be necessary for their absorption.

Finally, this brief presentation of the three parallel movements could not omit reference to the efforts to establish environmental accounts connected to the national accounting system (*green accounting*). In 2007, the magazine *Ecological Economics* (61) was dedicated to Sea-2003 (System of Environmental and Economic Accounts), showing that the old controversies about this project tend to increase rather than decrease.

## **The Second Great Turnaround in September 2009**

It is no longer possible to speak seriously of indicators of sustainability without starting from the messages and recommendation contained in the *Report by the Commission on the Measurement of Economic Performance and Social Progress* (Stiglitz-Sen-Fitoussi, 2009).

The first major contribution of this Commission was to show very clearly the existence of three quite different problems, which should have neither been mixed nor isolated, as all indicators have done for almost 40 years. One thing is to measure economic performance, another is to measure quality of life (or welfare), and a third is to measure developmental sustainability. And for these three points



the report provided much more radical guidance than was assumed by almost all observers:

- 1) The GDP (or GNP) should be entirely replaced by a precise measure of available household income, not of gross product;
- 2) Quality of life can only be measured by a very sophisticated compound index that incorporates the most recent discoveries of this new branch, the economy of happiness;
- 3) Sustainability requires a small group of physical indicators, not juggling acts that artificially try to assign prices to things that are not merchandise.

In other words, the report proposes overcoming production accounting, opening the pool of the quality of life, and all the pragmatism possible with sustainability. Since the two first issues are not part of the central scope of this article, readers interested in them should consult the fourth chapter of Veiga (2009b), which contains a summary of the report. However, it is important to not lose sight of the fact that the recommendations about sustainability assume that economic performance and quality of life will also be measured by new indicators – indicators that have nothing to do with today’s GDP and HDI (Human Development Index).

The commission chose to deal with sustainability from a much broader standpoint than the adjective “sustainable” usually suggests when used in combination with any other term. For example, when it says that the already difficult assumptions and normative choices become even more complicated by the existence of “interactions between the socio-economic and environmental models adopted by different countries” (§192, p.77). Or when making reference to an “economic’ component of sustainability” related to the “overconsumption of wealth” (§198, p.78).

It is necessary to remember that the idea originally expressed by the adjective “sustainable” referred to the need for the socio-economic process to conserve its natural bases or its biocapacity. It was from the progressive abandonment of the adjective in favor of the noun that the idea of non-biophysical “components” of sustainability arose. And this has various implications, especially when biocapacity has come to be understood as (natural) capital alongside human/social capital and physical/constructed capital.

In other words, instead of emphasizing the indispensable environmental sustainability of the process usually called development or social progress, this specific kind of sustainability is treated alongside various others, in what could be a quite long list, contributing to a serious dilution of the original idea. A good example is in the already mentioned three-part Unece/OECD/Eurostat approach (2008), where the indicators are separated into two exclusive “domains,” one called “foundational well-being” and the other “economic well-being.”

And indicators normally considered environmental are distributed among these two domains. In the first, there are deviations of temperature, ozone and

particle concentrations, availability of water, or fragmentation of natural habitats, together with indicators of education and health-adjusted life expectancy. In the second, indicators of energy, mineral, timber and marine resources, along with indicators of capital (produced, human and natural) and of foreign investments. In other words, the aggregate of sustainable development indicators proposed by this workgroup consolidates two groups: one that is socio-environmental with six indicators, and another, economic-ecological with eight (Box 3, p.80-1).

The most important guidance of the report on sustainability was to emphasize that any monetary indicator should remain focused only on strictly economic aspects. Not only because the most relevant elements lack market-defined prices, but also because even for those that have there is no guarantee that the prices reveal their importance for future welfare (§197, p.78).

In other words, contrary to what seems to be suggested in the rough draft of the report released in early June, 2009<sup>7</sup>, the Commission's final report wound up moving away from the approach advocated by the World Bank: ANS: Adjusted Net Savings. The major agreement is that the combination of indicators that might measure sustainability should provide information concerning the variation of stocks that sustain human well-being. But the strongest emphasis of the Commission's final report is the absolute necessity that the properly environmental aspects of sustainability be accompanied by use of well chosen *physical* indicators. And it is the "principle of precaution" that the Commission evokes to justify this emphasis, "given our state of ignorance" (§199, p.79).

The message is clear: we should seek good non-monetary indicators of impending dangerous levels of environmental damage, such as those associated with climate change. It is possible, then, to infer that if the carbon emissions of the economies are calculated correctly, they could become indicators of national contributions to global non-sustainability. It would be even better if there were to arise similar measurements for the commitment of water resources and for the erosion of biodiversity. Perhaps these three would be enough to show how far we still have to go on the road to sustainability.

Finally, last but not least, there is a definition of sustainability found on page 250: [...] the sustainability issue is about what we leave to future generations and whether we leave enough resources of all kinds to provide them with opportunity sets at least as large as the ones we have had ourselves."<sup>8</sup>

In short, these are the messages and recommendations of the report referring to indicators of sustainability:

Message 1: Measuring sustainability differs from *standard* statistical practice in one fundamental aspect: for proper measurement, not only observations but projections are necessary.

Message 2: Measuring sustainability also necessarily requires some prior answers to *normative* questions. In this aspect also there is great difference from the standard statistical activity.

Message 3: Measuring sustainability also involves a further difficulty in the

*international context*, since each country's sustainability cannot be evaluated in isolation. Because the problem is global, above all in its environmental dimension, what is of greatest interest is the contribution that each country might be giving to global non-sustainability.

Recommendations: a) evaluation of sustainability requires a small set of well-chosen indicators, quite different from those used to evaluate quality of life and economic performance; b) the fundamental characteristic of the components of this set of indicators should be the possibility of interpreting them as variations of stocks, not of flows; c) a monetary index of sustainability can even be included, but should remain exclusively focused on the strictly economic dimension of sustainability; d) the environmental aspects of sustainability must be specifically followed-up by physical indicators.

## Conclusion

Even if we do not agree with the recommendation of Patterson (2002, 2006), the retrospective description made in this article confirms the general line of his proposal, recently strengthened by the final report of the Stiglitz-Sem-Fitoussi Commission (2009).

Evaluation, measurement and monitoring of sustainability will necessarily require a tripartite conjunction of indicators, since it is statistically unthinkable to merge in the same index only two of its three dimensions. The resiliency of ecosystems can certainly be expressed by non-monetary indicators, for example, in relation to carbon emissions, to biodiversity and water safety. But the degree of ecosystem resiliency will not say much about sustainability if it cannot be collated with the other two. First, economic performance cannot continue to be evaluated in terms of the old bias of economic production, but rather by the measure of available family income. Second, it will be necessary to have a metric for quality of life (or well-being) that incorporates scientific evidence of this new branch called economy of happiness.

## Notes

- 1 (“*We must acquire a life style which has as its goal maximum freedom and happiness for the individual, not a maximum Gross National Product*”). Although cited between quotes, there is no bibliographic reference in Nordhaus & Tobin about Erlich's affirmation. As a matter of fact, he is not even identified as an ecologist. Perhaps this is because he was widely known at the time and his words were taken from some large circulation newspaper or magazine.
- 2 *Affluent Society*, by John Kenneth Galbraith, was translated in the same year (1958) as *Sociedade afluente* by Editora Expressão and Cultura, Rio de Janeiro. *The cost of economic growth*, by Ezra J. Mishan, was published in 1967 by F. A. Praeger, New York, and was only translated in 1976 with the title *Desenvolvimento. A que preço?* [*Development. At*

*what price?*] by Ibrasa, São Paulo. On the opposite side, Wilfred Beckerman began in 1971 with the article “Why do we need economic growth?” in *Lloyds Bank Review*, v.102, p.1-15.

- 3 The German Karl William Kapp was the first, with *The Social Costs of Business Enterprise*, 1963, by Asia Books. In 1966, it was Geogescu-Roegen and Kenneth Boulding’s turn. In a long introduction to his first book, *Analytical Economics*, Geogescu anticipated the ideas developed in his 1971 book *The Entropy Law and the Economic Process*, both published by Harvard University Press. Boulding published some thirty books between 1941 and 1993, but his first major contribution was also in 1966: “The economics of the coming spaceship Earth” (in Jarett, 1966).
- 4 It is interesting to note that the adjective “sustainable” to qualify development only began to be used in international debates seven years later (1979). As a matter of fact, it was only widely used after 1987, with publication of the report “Our Common Future,” by the Brundtland Commission, and not enshrined until 1992 in the famous Rio Conference. In the year following the publication of the work by Nordhaus & Tobin, as one knows, there was a frustrated attempt to adopt the expression “ecodevelopment.”
- 5 The report about NNW was published in 1974 by the Minister of Finance of Japan (available at: <[http://openlibrary.org/b/OL4284823M/Measuring\\_net\\_national\\_welfare\\_of\\_Japan](http://openlibrary.org/b/OL4284823M/Measuring_net_national_welfare_of_Japan)>). It was inspired by the pioneering work by Nordhaus & Tobin to calculate the annual NNW of the period 1955-1970, when there was very strong economic growth, without entirely dismissing certain environmental damages and with addition of an item about the cost of highway accidents. In the first five years, the discrepancy was quite significant: average annual growth of 8.9% of GDP against only 6.3% of NNW. But in the last five years it greatly diminished: 14.9% against 13.5%, respectively.
- 6 Zolotas’ book, *Economic Growth and Declining Social Welfare*, was published in 1981 by New York University Press. It proposes an Index of Economic Aspects of Well-Being (EAW), very similar to the MEW by Nordhaus & Tobin. The EAW was computed up to 1977 and reveals an increase in the discrepancy with GDP growth rates.
- 7 CMEPSP – Commission on the Measurement of Economic Performance and Social Progress – Draft Summary (Provisional and Incomplete), June 2, 2009.
- 8 “[...] *the sustainability issue is about what we leave to future generations and whether we leave enough resources of all kinds to provide them with opportunity sets at least as large as the ones we have had ourselves*” (p.250).

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*ABSTRACT* – This retrospective description of a scientific debate of almost 40 years shows the necessity of a set of three new sustainability indicators able to simultaneously evaluate the resilience of ecosystems, quality of life and economic performance.

*KEYWORDS*: Sustainability, Indicators, Sustainable Development, Ecodevelopment, Ecological Economics.

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Received on 2.17.2010 and accepted on 2.22.2010.

Translated by Cary Wasserman and Valéria Wasserman. The original in Portuguese is available at [http://www.scielo.br/scielo.php?script=sci\\_issuetoc&pid=0103-401420100001&lng=pt&nrm=iso](http://www.scielo.br/scielo.php?script=sci_issuetoc&pid=0103-401420100001&lng=pt&nrm=iso).