Reflections on the paradigm of Ecological Economics for Environmental Management

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> "Once man expanded his biological powers by means of industrial artifacts, he became ipso facto not only dependent on a very scarce source of life support but also addicted to industrial luxuries."
> (Georgescu-Roegen, 1993, p.86)

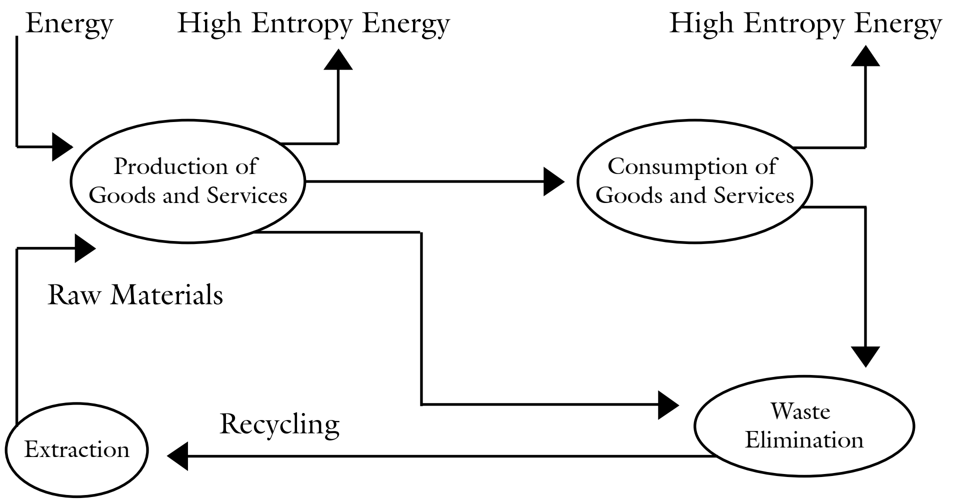
Introduction: The relative absence of Ecological Economics in the area of Environmental Management

IN RECENT decades, serious environmental problems related to pollution and depletion of resources has led to a growing demand for professionals in the area of Environmental Management. The academic world is aware of this trend, as can be observed by the increasing number of courses and the optimistic rhetoric about career opportunities, especially in developed countries. However, the number of institutions that teach Ecological Economics and the demand for these professionals are still limited (Viederman, 1994).[1] The main objective of this study is precisely to draw attention to the gap between the significant growth of Environmental Management and a noticeable lack of knowledge about the central concepts and issues of Ecological Economics. Aiming particularly for those engaging in the field of Environmental Management, it aspires to summarize the 'map of reality', still relatively unknown, that the new paradigm of Ecological Economics proposes for sustainability. This summary will highlight this school of thought's unique vision of the economic process (including the role of enterprises), of the resource base available to humanity, and of the crucial issue of scale of the global economic system.

This article will advocate that this view of sustainability contrasts considerably with the common rhetoric found in the Environmental Management literature, and that many professionals in this field who lack the knowledge of Ecological Economics are likely to remain in a state of optimistic naivety about the role and behavior of enterprises, as well as about the nature of the economic process. As a symptomatic example of this superficial view, this paper will highlight the frequent trend of the literature on Environmental Management to focus on "win-win" policies.[2] Finally, the author concludes with the thesis that, for those who turn to Environmental Management, obtaining knowledge of the central ideas of Ecological Economics will change how they perceive the concept of sustainability and pose difficult issues for their field.

Ecological economics: a new economic paradigm for sustainability

Georgescu-Roegen (1971) pointed out that, according to the first law of thermodynamics we can neither create or destroy matter or energy (Principle of Conservation of Matter and Energy) and consequently asked: What, then, does the economic process do? The answer is: *it absorbs, qualitatively transforms low entropy and releases it outside the economic system in the form of high entropy.*[3] That is, the economic system is a subsystem of the finite global ecosystem, on which it depends to both extract low entropy and, when using it, release it in the form of high entropy (Ayres, Nair, 1984, Constanza et al 1997).



Source: Ayres & Nair (1984).

Figure 1 – Matter and energy flows through the economic system

This entropic perspective of the economic process is the opposite of the mechanistic view addopted by standard economic theory. Unlike the Newtonian worldview - in which a system is time reversible, remaining identical -, the second law of entropy indicates an irreversible and unidirectional qualitative change: The amount of bound (or unavailable) energy in a closed system increases continuously. To decrease the entropy of a system, we need to obtain energy from outside the system, which means increasing the global entropic deficit.

Living organisms are no exception to the second law of thermodynamics, since they survive by absorbing low entropy from the environment to offset the increase in entropy to which they are subject. Thus, although living organisms temporarily avoid dissipation, they increase the entropy of the system as a whole, i.e., of the environment in which they exist. In other words, the presence of life speeds up the entropic process (Georgescu-Roegen, 1971, 1993).

Additionally, our behavior differs from that of almost all other living organisms, as these virtually live on the low entropy that surrounds them. With rare exceptions, all other species use only *endosomatic instruments*, i.e., genetically inherited instruments (e.g., legs, paws, wings). Humanity has evolved to the point of using *exosomatic* (outside the body) instruments (Georgescu-Roegen, 1993). According to Georgescu-Roegen, the exosomatic evolution generated social conflicts that characterize the human species, leading him to question whether we would be addicted to such instruments, and to conclude that because of them the problem of our survival, now different from that of other species, has turned into a bioeconomic issue.

The entropic vision of the economic process is equally incisive about the role of enterprises. These often manufacture products that are more complex than the inputs used to produce them. This could create the illusion of a reversal of the entropic process, since the inputs are less complex than the output. However, to structure their products, companies require energy, thus increasing the entropy of the system in which they operate, i.e., the environment. In entropic terms, the cost of any economic (or biological) activity is always higher than its product. (Georgescu-Roegen, 1971). *Producing, even in an eco-efficient way, accelerates the global entropy deficit.*

Georgescu-Roegen concludes that the economic struggle of man is an effort to seek out low entropy, and that our resource extraction leaves marks in human history, besides being a critical element for the long-term fate of humanity. This is due to the particular scarcity of low entropy, its limited quantity and irreversibility that we conceive inventions aimed at "reaping" ever more low entropy from the environment (ibid).

The entropic perspective of the economic process led Georgescu-Roegen (1993b) to distinguish the asymmetries of the sources of wealth of humanity and to develop his bioeconomic plan. The points below summarize his analysis:

- There are two different sources of energy: (1) the stock of free energy contained in mineral deposits; and (2) the flow of solar radiation intercepted by the Earth. Solar radiation, which allows for photosynthesis, is the largest source of energy for life.
- The terrestrial stock of low entropy is minimal compared to the flow of solar energy. In other words, the difference between the amount of energy from the solar flow and the stock of terrestrial energy is astronomical.
- We have almost total control over the terrestrial stock, and given the irrevocability of entropic degradation it could be exhausted in a relatively short time. However, we do not control the flow of solar energy and we cannot use the future flow either. In other words, the current

generation cannot change the amount of solar energy to which future generations are entitled.

- Only the terrestrial stock provides us with low entropy in the form of matter, for there is no viable procedure to transform energy into matter. This particular source of low entropy is required for us to produce our artifacts.
- For industrial use, solar energy has a disadvantage in relation to terrestrial sources: its low intensity compared to the high degree of concentration of terrestrial sources. This hindrance, however, can be overcome.
- We are the only species that has become dependent on exosomatic instruments, a fact that has not only increased our huge Econosphere, but also led to the extinction of numerous species.

Unfortunately, future generations have no voice and, in view of these circumstances, the main message from Georgescu-Roegen in relation to research for the towards sustainability is evident: *Instead of trying to find more efficient ways to use our terrestrial resources, we should direct all our efforts toward improving the direct use of solar energy. Every step that brings us closer to an economy based on solar energy will also potentially reduce the monopoly of the present over future generations for terrestrial resources.* (ibid)

Thus, it can be argued that the accelerated extraction of terrestrial resources needed for our development, especially during the twentieth century may yet be a very bad sign for future generations. Georgescu-Roegen questions even the mechanization of agriculture, a process required to meet the population increase of the last century. However, mechanization demanded the intensive use of terrestrial resources (e.g., tractors and fertilizer) instead of the use of animal traction and natural fertilizer. Consequently, this dynamic, though unavoidable today, would be uneconomical in the long run. (Georgescu-Roegen, ibid, 1971)

This sector, however, would be just one example. Taking into account the current trend, our survival will increasingly depend on non-renewable terrestrial resources, our scarcer source of low entropy. The main problem of humanity will be to reduce the low-entropy terrestrial stock since, given the disproportion between the amount of energy available from the sun and the terrestrial stock, even with a very frugal use of the stock, the industrial phase of man's evolution will cease long before the Sun stops shining (Georgescu-Roegen, 1993, p.85). In view of this dynamic, it is ethically questionable to use this source for the production of superfluous objects, since it will mean fewer 'shovels and plows' in the future. (Georgescu-Roegen, 1993, 1971) The key question is whether we would be willing to dispense with such luxuries to help humans in the distant future.

The summary above is critical for understanding the *bioeconomic plan* of Georgescu-Roegen (1993b, p.104):

- Stop all wars and prohibit the use of any resources for the production of instruments of war. These resources should be directed to international aid, i.e., used for purposes of ensuring intragenerational equity.
- Through the use of these resources, developed nations should help the others to achieve a good standard of living. Note that this does not amount to a life of luxury or conspicuous consumption.
- The planet's population should gradually lower itself to a level that enables the use of organic agricultural (degrowth).
- All waste of the energy generated by terrestrial sources should be avoided, and, if necessary, regulated.
- Give up conspicuous and superfluous consumption. Lower demand will mean lower supply.
- Abandon the lifestyle centered on fashion.
- The necessity that durable goods be made still more durable by being designed so as to be repairable.
- Abandon the lifestyle based on the "circumdrome of the shaving machine".[4]

Kenneth Boulding, another thinker of huge influence in Ecological Economics was also adamant about the need for changing the economic behavior of humanity.[5] In his book "The Meaning of the Twentieth Century", Boulding (1964) sustains that the twentieth century marked a period of great transition for humanity. Some of the symptoms of this transition include: i) extremely high rate of resource extraction by the modern economic system; ii) tremendous upsurge in the world's population; iii) extraordinary ability of modern societies to recover from disaster (e.g., postwar Germany and Japan); iv) extension of loyalty from the kinship group to the national State, or even to the world as a whole; v) in advanced contemporary societies birth rates have decreased, which has been both positive and necessary due to the increase in life expectancy and the fall in infant mortality; vi) in the first major transition, from the Paleolithic to the Neolithic, there was a certain degree of uniformity on the planet as a whole.[6]

This transition, however, will not necessarily lead to ethical or moral advances, nor can we state that it is inevitable. Boulding advocates the thesis that there are a number of traps such as population, war and the nature of man itself. *In relation to the latter, the possibility of a tragic outcome would occur due to the rapid depletion of non-renewable resources. In this case, our high standard of living as well as the population explosion of the twentieth century would be a brief episode in the history of humanity*: "It may therefore be that… in a thousand years… our descendants will inhabit an exhausted and ravaged Earth. Man will then be pushed back into a low-level society" (Boulding, 1964, p.150).

Boulding, however, concludes that another outcome is also possible, so that the current period can be perceived as an opportunity where the accumulated geological capital is used to produce enough knowledge for humanity to maintain a high standard of living without exhausting it. This uncertainty, of course, leads him to disqualify spending on futile consumption and the waste of resources for the production of instruments of war. For if there is only a small probability of attaining such knowledge, all efforts should be focused on obtaining technology that preserves resources and works based on the flow of solar energy (Boulding, 1993; Fuks, 1992, 1994).

In his most renowned text, Boulding (1993) indicates that we would be going through a long transition period in relation to the image we have of the environment. Until the first half of the twentieth century, we had a perception of the Earth as unlimited space and resources (this would be the cowboy economy). We would still be adapting to the notion of the Earth as a closed system, in which no matter enters or leaves, allowing only for the exchange of energy. It should be pointed out that in such a system the output of all parts is connected to the inputs of other parts.[8] In the famous metaphor of spaceship Earth, our planet is a spaceship used for a long trip (sustainability), without unlimited reservoirs (to extract low entropy or release high entropy) and with a limited amount of resources onboard.

In this astronaut economy, even without escaping the need for the flow of solar energy, passengers have to establish a system capable of maintaining the resource base. *Production and consumption are no longer perceived positively;* the goal now is to develop technology that will maintain a given stock, making less use of throughput, i.e., with less consumption and production.

The reader can clearly notice the influence of Georgescu-Roegen and Boulding in an excellent summary of the points of consensus of Ecological Economics developed by Constanza et al. (1997, p.79):[9]

The four points of consensus of Ecological Economics:

1. The planet is a closed thermodynamic system, which does not grow from the standpoint of matter. The economic system is a subsystem of the global ecosystem, i.e., there is a limit to the amount of throughput that we can get from and release into the environment.
2. Respecting the limits imposed by (1), the prospect of a sustainable future for the planet, with high quality of life for all - both humans and other species.
3. The recognition that in the analysis of complex systems such as the Earth, at any scale in time and space, the uncertainty is big and irreducible and certain processes are irreversible. Consequently, it is necessary to adopt a precautionary approach.
4. Institutions and management must be proactive, rather than reactive, resulting in adaptive policies of simple implementation, based on a sophisticated understanding of the systems to which they refer, and fully recognizing the underlying uncertainties.

Considering these points of consensus, some authors advocate certain minimum conditions for sustainability: i) the rate of extraction of a renewable resource must be equal to its regeneration rate; ii) the rate of waste emission must not exceed the assimilation capacity of the environment in which they are discarded; iii) the rate of extraction of non-renewable resources must be equivalent to their replacement by renewable resources (Daly, 1990b; Pearson & Turner, 1994). Constanza et al. (1994) are equally clear about the need to maintain the total natural capital (TNC) at its current level, as a minimum condition for sustainability. This approach, called strong sustainability, is derived from the view that natural capital and man-made capital, albeit sometimes substitues, are essentially complementary.

For these authors, as well as for Boulding, human evolution has gone from an era in which the capital generated by humans (i.e., man-made, manufactured capital) was the limiting factor for economic development, to an era in which the remaining natural capital has become the limiting factor. With an increasing population and the consequent expansion of the global economic system, we have gone from an empty-world economy to a full-world economy. *Unlike in the past, in this new world the scale of the global economic system (population times the per capita rate of resource consumption), measured in physical units, becomes a critical issue for the carrying capacity of the biosphere not to be eroded over time* (Costanza et al. 1997; Daly, 1990b, Daly et al. 2007).

Additionally, the priorities for the human species are clear. The magnitude of the scale of the global economic system, currently determined by the markets, should be the result of a social decision that includes the carrying capacity of the biosphere. That is, allocative efficiency does not guarantee sustainability.[11] Once the primary condition of the global economic system scale is met, the price system can be used to allocate scarce resources. The cap-and-trade schemes (e.g., Kyoto) serve as an example, since they initially determine a maximum physical limit for emissions. Finally, in relation to distribution, the aim is to achieve a "fair division, or at least one that limits inequality to an acceptable standard" (Constanza et al., 1997, p.80-83; Daly & Cobb, 1990; Daly 1990b).

The Prevalence of Optimistic Rhetoric in the Discourse of Environmental Management

It can be argued that the main contribution of Ecological Economics, i.e., the inclusion of and emphasis on the issue of Econosphere (Cechin & Eli da Veiga, 2010; Costanza et al., 1997, p.89) is a topic to be addressed by governments, and it is not appropriate for companies to include it in their decision making.[12] But although the magnitude of the throughput demanded by the global economic system falls outside the scope of operations of any corporation, there is no doubt that this issue should be a core part of the training (knowledge) of professionals engaged in Environmental Management. However, much of this literature underestimates the issue of the system's scale, choosing to emphasize the assumption that is "ubiquitous in Environmental Management studies, that environmental protection has to always generate benefits for the company (payoff)" (Müller-Christ, 2011, p.48). Instead of realizing that the continuous growth of the Econosphere cannot be used as a panacea for our problems - because precisely the opposite occurs today – we plunge into the myth of the ubiquity of the "win-win hypothesis."

There are, in fact, situations in which this hypothesis may prevail, and textbooks, academic research and Environmental Management reports often work - sometimes almost exclusively - to reinforce this view as a mantra.[13] Likewise, there is no doubt that win-win outcomes, which generate Pareto improvements, should be explored. This complementarity between profit and environmental protection can occur in two situations: by reducing costs or by raising the level of business (ibid.). Reducing the use of material and energy resources and waste per unit of output would be an example of cost reduction. On the other hand, raising the level of business assumes that environmental protection would be associated with new products and markets (innovation); stronger brands; reduction of both capital cost (due to additional appeal to funding agents) and of legal liabilities. If reality is made up chiefly of "win-win" situations, then the implementation of Environmental Management Systems (EMS) by companies becomes clearly rational, even necessary, for increasing profits. From this perspective, it is not surprising that a typical textbook on Environmental Management points out that EMS implementation is merely a matter of good management (Blackburn, 2007, p.35).[14]

However, the emphasis placed on the "win-win hypothesis" is questionable because: (i) often the most important factor in decision-making by executives is legislation; and (ii) if there is significant trade-off between environmental protection and profit, the pressure for short-term financial results will likely prevail (Müller-Christ, 2011, p.31 and p.51). Additionally, it is impossible to predict (or measure) how much complementarity between socio-environmental protection and profit can help us in terms of reducing the throughput used by the Econosphere, because our supporting capacity is the ultimate bottom-line. It is possible, for example, to achieve great advances in terms of eco-efficiency and simultaneously raise the global throughput per capita. Considering the improvement in the standard of living in developing countries, it will not be surprising if this is the outcome in the next decades.[15]

Conclusion: Environmental Management cannot dispense with Ecological Economics

The exponential growth of the Econosphere during the twentieth century has transformed the relationship between humanity and the environment[16] (Boulding, 1964, 1993). In about 207 years, from 1804 to 2011, the world population leaped from one billion to seven billion. Adding to this fact is the consumption boom that gained momentum especially from the second half of the twentieth century in developed countries and, more recently, in BRIC economies (Brazil, Russia, India and China).

It is obvious that this dynamic has only been possible because of an tremendous increase in throughput, i.e., in the low entropy flow that the economic system requires to keep operating and which, through its use, is returned to environmental sinks in the form of high entropy. As a result, today we live with both the threat of exhaustion and the imbalances of sinks, which can no longer absorb the amount of pollution emitted by the global economic system.[17]

This dynamic, in turn, has generated a host of reactions as a gradual process of social awareness of sustainability, especially in the last forty years; the greater commitment of political institutions (at local, national and global level) to the environment and the growing acceptance by the business sector that the implementation of Environmental Management Systems (EMS) can be an efficient and cost-effective strategy to address the negative socio-environmental effects produced by enterprises in their operations.

However, serious doubts remain about humanity's degree of awareness of both environmental preservation and intra and intergenerational justice. In particular, with regard to the actual size of the Econosphere, some recent studies indicate that the global economic system is already likely to have gone beyond the sustainable scale (Meadows et al. 2004; Wackernagel, 2008). This means that we are still far from making the transition from the cowboy economy to the astronaut economy. Indeed, from the publication of Boulding's classic text to the present date, the world population has doubled; frivolous consumption has not been constrained and poverty, despite some improvements, remains a critical problem that affects about 20-25 percent of the planetary population. Nor, so far, have we developed an economy based on the flow of solar energy, with a view to reducing the effects of the monopoly of the present generation, as Georgescu-Roegen and Boulding had hoped for.

Ecological Economics emphasizes that tough choices are necessary because our scale and (intra- and intergeneration) distribution problems cannot be solved merely by the markets, much less by the myth of the ubiquity of the "win-win hypothesis". Environmental Management professionals who have the opportunity to learn the central concepts and issues of Ecological Economics and work in the private sector will be facing complex questions – for example: How to invest our capital so that our operations may function via the use of solar energy? How essential are our products (or services)? What about their durability, reusability and recycling potential? Are we minimizing the use of non-renewable material and energy? When we use non-renewable resources, are we using part of the revenue to develop renewable substitutes? Are our operations damaging natural capital in any way? Are we including in our estimates all the benefits of natural capital? Are we conducting life cycle analysis to assess the environmental impacts of our products? Do we endorse the producer's extended liability policy in order to internalize the environmental impacts of our products?

Some of these questions are already being asked today, but it's no coincidence that most of these fit the "win-win hypothesis" scenario. However, it is by coming into contact with Ecological Economics that one is able to understand the economic process as an entropic process; the asymmetries in the allocation of the resources available to us; and the crucial issue of scale of the Econosphere. In short, we have the vision of a new paradigm that seeks to analyze the relationship between humanity and the environment aiming at the sustainability of our planet. If this is, in fact, our primary goal, those who decide to engage in the field of Environmental Management cannot dispense with Ecological Economics.

Notes

5 It is not surprising, since the International Society for Ecological Economics itself was established in 1988 and the Journal of Ecological Economics was launched the following year. Although early studies of Ostwald and Soddy (separately), among others, sought to associate thermodynamics with economics in the early twentieth century, it was only during the second half of that century that this line of thought was established and institutionalized a new field of research (Ropke, 2004).

6 According to the Theory of Games, there are games in which all players (agents) might end up profiting ("win-win"). In our case, this hypothesis implies that both the company and society win. More specifically, we have both a reduction in socio-environmental damage per unit of output and, simultaneously, an increase in profits. This dynamic is often described as "eco-efficiency", i.e., economic and ecological efficiency. For an exceptional critique of the use of the "win-win hypothesis" by Environmental Management, see "Quo Vadis, Environmental Management?" (Müller-Christ, 2011, chapter 2).

7 Entropy can be defined as a measure of the unavailable energy in a thermodynamic system. Unavailable means that this energy cannot be used for doing work. For example, when we use any type of fossil fuels, we are not reducing its chemical energy, but rather transforming it from available energy into heat and ash, that is, into unavailable energy. This transformation can be described in a different way: "Free Energy [available] implies some ordered structure ... Bound energy is energy dissipated in disorder ... Therefore, entropy is also defined as a measure of disorder" (Georgescu-Roegen, 1993, p.77). Ecological Economics as an interdisciplinary vision of science uses the idea of concept migration, a relevant topic in current Philosophy of Science studies.

8 The circumdrome of the shaving machine can be summarized as follows: to shave oneself faster so as to have more time to work on a machine that shaves faster so as to have more time to work on a machine that shaves still faster, and so on ad infinitum.

9 Although Georgescu-Roegen and Boulding disagreed about the concept of entropy, the congruence between the works of these two thinkers is evident. The sharpest disagreement lies in that Boulding advocates the possibility of a closed system for matter without its dissipation and powered by solar energy. This difference makes Boulding's view (potentially) less tragic than Georgescu-Roegen's (see Cechin & Eli da Veiga, 2010; Cleveland, 1999; and Fuks, 1992, 1994).

10 In this text, Boulding seems to produce an embryo of the global village concept developed at that the same time by McLuhan.

11 See Boulding (1993, p.298). In fact, the Earth is an open system that exchanges energy and matter (e.g., meteors) with the rest of the universe. However, it is assumed that any possible exchange of matter with the rest of the universe is negligible, which makes sense for those who engage in the study of the relationship between Econosphere and biosphere. See also Pearce & Tuner (1994, chapter 2 "the circular economy"). The city of Kalundbork, in Denmark, established this circular system, one of the most renowned projects in Industrial Ecology (see www. Symbiosis.dk / en).

12 See in particular Chapter 3 "From empty-world economics to full-world economics" by Constanza et al. (1997, 1991) (Cechin & Eli da Veiga, 2010.

13 Weak sustainability, often associated with standard economics, assumes that human and natural capitals are fundamentally substitutes. Consequently, there would be no need to preserve the natural capital at a certain level, but simply to maintain the sum of the two types of capital constant. Theoretically, natural capital could be reduced to an infinitesimal amount, as long as it were replaced by a sufficient amount of manufactured capital (Hartwick's rule) (see Solow, 1974; Ayres et al., 1998).

14 Daly (1990b) uses the metaphor of a boat with a Plimsoll line to illustrate the fact that allocative efficiency does not necessarily imply sustainable scale. The Plimsoll line is used to indicate the limit to which the boat may be loaded, i.e., its "carrying capacity". In Daly's metaphor we have a well balanced boat, but with the Plimsoll line hidden by the sea, i.e., sinking because of excessive weight.

15 This is the position of Elkington (1997, p.28 and p.38): "The problem is that even the very largest, global corporations have little control over key elements of the sustainability agenda"; " Systemic Reasoning indicates that sustainability tells us that sustainability cannot be defined for a single corporation ... [but] for a complete economic–social–ecological system, and not for its component parts." It is worth mentioning that unlike most of the literature on Environmental Management, Elkington at least recognizes the issue of scale by mentioning the works of Meadows et al. (2004, p.59) and, en passant, those of Boulding and Ehrlich. Finally, Elkington (1997, p.88) goes as far as suggesting that "the health of the global ecosystem represents the ultimate bottom line".

16 Blackburn (2007) and Porter & Kramer (2011) are great examples of the fetish for the "win-win hypothesis."

17 "This is the point: an operational sustainability system is just good management (ibid, p.35). In Chapter 3 of "The Value of Sustainability: Why Bother?" Blackburn (2007) uses some ninety pages to "prove" that the implementation of an EMS is beneficial for companies. According to the author, those who do not follow this path will be abdicating major sources of profit and risking being outcompeted by more sustainable rivals.

18 The World Business Council for Sustainable Development (WBCSD, 2008) recognizes this trend: "Current global consumption patterns are unsustainable. Based on the facts and trends ..., it is becoming apparent that the efficiency gains and technological advances alone will not be sufficient to bring global consumption to a sustainable level; changes will also be required to consumer lifestyles, including the ways in which consumers choose and use products and services."

19 According to Boulding (1993), the "world set" is a set that includes all objects that can be identified, while the Econosphere is a subset of the "world set" that includes, at any one moment, the total capital stock, that is, the set of all objects, people, organizations, and so on, which are of interest from the point of view of the system of exchange."

20 In view of the above problems, it becomes possible to do a historical Khunian interpretation of the emergence of Ecological Economics based on the concept of paradigm (Kuhn, 1970). The consequences of the growth of the Econosphere gave rise to a series of problems to which the paradigm of standard economics was unable to provide a satisfactory explanation, thus leading to the emergence of new paradigms. A paradigm is a worldview, a set of basic reference points that define what problems are legitimate and which solutions are appropriate. There is also the position advocated by Tietenberg (2006, p.7), that it is possible to think of complementarity between the two paradigms, "which does not mean complete acceptance. Significant differences exist not only between these two fields, but also within them."

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Abstract – This study draws attention to the lack of knowledge regarding Ecological Economics amongst the growing number of professionals graduating in the field of Environmental Management. The author offers a synthesis of the main principles of Ecological Economics, with particular focus on two of its main thinkers (N. Georgescu-Röegen and K. E. Boulding) and indicates why such knowledge is of fundamental importance for Environmental Management. The paper argues that environmental managers cannot ignore Ecological Economics; else they may fall prey to the myth of the win-win hypothesis and thus have an incomplete perception of the difficulties involved in establishing a sustainable society.

Keywords: Ecological economics, Sustainability, Business administration, Others.

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