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THE RELATIONSHIP BETWEEN NATURAL CAPITAL AND HUMAN EVOLUTION AND ITS IMPACT ON SUSTAINABLE DEVELOPMENT

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I reckon that the issue of natural resources utilization is both the fundamental brick of economics and one of the essential gems that is missing from the academic crown of this science can be succinctly and convincingly argued. If we agree upon a common definition of economy as the science studying the allocation of limited resources in the human community, it results the fact that resources (including natural) were a trigger in the development of economics, due to the relative penury in the first phase, and then due to absolute penury of certain forms of natural capital.

On the other hand, the rich modern economic literature, especially on a level of sustainable development, provides sufficient evidence to support the original statement. An interesting fact is that, viewed from this perspective, economics seems slightly suicidal as it was born out of a problem of shortage of resources and it is constantly seeking for the answer to a question to which if it had been found a solution, it would have accomplished the starting premise of the research, and thus closing the circle exhausting cognitive and economic research.

Of course, things are quite more complex, and the economy as a science has constantly evolved ever since its beginnings, branching into research directions that substantially differ from the initial problem of skimping resources, though, I dare to say that this remains crucial to any demarche in this domain.

If the problem of limited resources is fundamental and implied to any economic researches, the use and depletion of natural capital is rather more extensive customization of this dilemma. Unfortunately, this customization became increasingly conspicuous in the modern economic research. This is a sign that the problem is not satisfactorily resolved and also that the pressure on global human community is increasingly higher. On the other hand, all the researches on the natural capital are poured into a boiler filled with issues of sustainable development that now burn smoldering, but increasingly stronger.

Therefore, both concepts used in the title appear as a natural correlation: **natural capital** and **sustainable development**. The other concept used, and the last that can be identified as the major in the thesis title is that of **human evolution**. As the order of the presentation shows, I did not start the research with its implementation. Its necessity became evident with the treatment of the *natural capital in extended sense* in the course of the doctoral research.

This need will be developed in the following pages, but for the purpose of this introduction it can be said that the concept of the human evolution, largely foreign from the economic standard research, is necessary because it denotes the intrinsically interdisciplinary nature of the thesis, but it brings with itself a temporal component that is necessary to the research and which also invites to some epistemological and meta-scientific questions. At the end of the doctoral

road I realize that this syntagma can be taken as a proof of the perennial dependence of human communities of the use of natural capital, situation to which the environmental economics put a close, but unfounded expiry date.

In defending the thesis, I consider four essential aspects:

1. **Why I chose this topic?**
2. **How I realized the paper?**
3. **What we actually achieved on the subject?**

Therefore, this is the structure of the present paper.

1.1 Motivation approach

I chose this topic because literature on the account of the sustainability is vast, both in economy and other sciences. This intellectual effusion represents a proof of the fact that the research field triggers interest, but it is incompletely researched. Of course, the particular problem of the subject is that it also makes reference to an emotional background. Each individual is emotionally involved in the research that he develops, but he is more implicated if his research concerns the sustainability of tomorrow's society to which he or his followers will a part. From this point of view, we can say that the research in the realm of sustainability is topical in the modern scientific domain. It is also always an important concern for the individual who is interested in the genetic inheritance that leaves behind.

As for the natural capital, I was constantly wondered by the limited economic perspective that economic science has on this highly important ingredient for modern economies. In fact, it is clear to everyone that if we look at all forms of capital as finally generating human welfare, the benefits from the natural environment encompasses much more than a simple stock of raw materials *X* or *Y*. But the opening of the economy to the full panoply of benefits obtained after natural capital means both receipt of interdisciplinary approaches and the receipt of a considerable dose of mathematical non-determinism, since many such benefits are intrinsically unquantifiable. Probably, the issue of the natural capital, alongside other issues of economics that have no answer, will ultimately lead to a change of kuhnian paradigm. But such a discussion already exceeds the scope of this summary.

Far to an end, a very important point for me was represented by the interdisciplinary approach which was intrinsically necessary from the perspective of the natural capital. There is a certain illusion in the moment when the pieces of the puzzle fit accordingly to some results from several sciences.

Of course, any scientific product is only an approximation of the truth. Gaps are present in all the sciences, even in physics. Moreover, they exist in the economy. To search for corroboration in other sciences fails to make the final product to look veridical, though it can never be something more than an approximation. However, sciences are increasingly moving towards

convergence[1], so interdisciplinary method was somehow required.

2.1 Research questions

Once we defined the fundamental concepts, the research questions started to appear. In essence, there is only one fundamental and omnipresent question following the course of this thesis.

What is actually the natural capital and what is its real role in the whole consumption process of a human community?

Some questions which arise are like as follows:

Are there differences between what the economy internalizes into the analysis of the natural capital and the real contribution of natural resources?

Is the natural capital necessary and sufficient, necessary and insufficient, or non-necessary for the modern economic process?

Are there any limits (which differ from exhaustion) that have to be taken into account in order to allow to the natural mechanisms of control of ecosystems to exist in an undisturbed manner?

2.2 Concerned objectives

The concerned objectives are essentially corresponding to the four chapters of the thesis. Thus, they are:

1 See Wilson (1999) for the problem of the convergence in science and especially for the benefits brought by it, although the perspectives of a total integration of scientific branches seem rather illusory. This does not diminish the value of an interdisciplinary approach, as long as these contributions do not lead to reductionist resolutions.

- The highlighting of the shortcomings towards the concept of the natural capital, inclusively by calling a historical analysis of the relationship between natural capital and human evolution;
- Detailing the expanded concept of natural capital;
- Development of a conceptual matrix in order to integrate this extensive form of the natural capital in economics;
- Discussing the implications of the integration of the extensive form of the natural capital in economics for the sustainability of human community;
- Development of a case study on our country's area trough which a certain amount of extended benefits of the natural capital can be showed.

Nevertheless, I thought to a series of smaller goals, such as:

- A brief highlighting of the role of the physical natural resources in the process of human evolution, as well as the increased attention paid to them by the economic science;
- Discussing the two paradigms of sustainability because the natural capital is a central issue of this debate;
- Bringing examples through which can be proved the fact that the forms of natural capital are much more divers;
- Discussing, at a surface level, the complexity of the interdependencies that link the components of an

ecosystem, as well as the considerable dose of uncertainty and indeterminism arising out of this situation;

- I tried to highlight the issues related to the value of the natural capital;
- Discussing specific features of the concept of sustainability.

Apart from all these objectives, I wanted that this discussion have a practical end, so that at the end of the thesis there is a case study on unaccounted benefits derived from natural capital, in the case of Romania. At the end of the thesis there are four subjects that I consider to have substance. They were placed at the end of the paper because they have only tangential links with the theme of this thesis.

2.3 Methodological benchmarks

As you could see in the content, the logical structure of this thesis was to show in the first phase what is frail in the *mainstream* economic science. Since any critical remark that does not offer refreshment is practical null, I dared to add a wider perspective of the natural capital (the second part) in the parts II and III, as well as an attempt to integrate this wider perspective in the economic science (the third part). The method chosen was the one of dialectics since I have tried to be my first critic in the exposure of each part of the reasoning. I tried to offer as many such situations as possible in order to corroborate the words although no example definitively confirms a theory.

Also, I did not hesitate to make use of the most basic arithmetic expressions in order to facilitate the understanding of the message in the moment when I thought that the reasoning can be exposed in mathematical terms. I did not abuse this method as I do not consider that the arithmetization is viable in all circumstances. From this point of view, I was guided by a paragraph of a Romanian origin scientist named Nicholas Georgescu – Roegen: *"Whenever the arithmetization is possible there are no words to praise its merits. My personal opinion is that the integral arithmetization is possible, that there is valid knowledge even without arithmetization and that a false arithmetization is dangerous if it is sold as being genuine."* (1971, Georgescu – Roegen, p. 25)[2] Moreover, the work of the Romanian statistician is somehow the epistemological foundation of this work, although this situation did not prevent the writing of the subchapter entitled *View of the concept of entropy and its real significance for the economy*. This subchapter smoothes the teeth of the roegenian criticism regarding the science of that time, science which is valid nowadays too. I used lots of graphics in order to supplement the lacunary vocabulary for the same reason I occasionally used mathematical expressions.

2 In 1889, Henri Poincaré himself was demonstrating that there were issues related to classical dynamics that could not be solved trough integrable systems (1889, Poincaré). One of these issues is the one of the three astronomical bodies, on which I made some comments at the end of thesis.

3.1 The chapters of the thesis

This thesis is divided into four chapters (the latter being a case study), and their purpose is:

- **Chapter I:** it discusses the role of the natural capital in the evolution of the human community and how its physical part was the most visible and therefore the most analyzed in the economic science. In this chapter we consider the situations of alterity of the natural capital, in the context of a wider temporal perspective and the issues related to the natural environment components. The chapter ends with a brief analysis on the theoretical perspectives on the natural capital and, in a broader sense, on sustainable policies; one of these perspectives is analyzed in a practical sense in the case of Republic of Nauru.

Subchapters:

- *Homo sapiens sapiens* in the history

➔ it highlights the human dependence to physical, tangible natural resources.

- Natural resources and the economic science

➔ it explains why the economic science focused almost exclusively on tangible natural capital.

- Utility, disutility and the passing of time

➔ it demonstrates the alterity of the events and their impact on the community. Something that today generates utility it can generate disutility over decades and vice versa.

- The problem of environmental components

➔ it reinforces the previous chapter with examples and it establishes preliminarily the role of natural components in the context of this alterity.

- Perspectives regarding the natural capital and their impact on visions of sustainability of human community

➔ it exposes the two major perspectives that aim the issue of the sustainability: weak sustainability and strong sustainability.

- The shortcomings of the current perspective on the natural capital in the context of the sustainability of the human society

➔ Its preliminary explains through a concrete example why the perspective on the sustainability is limited.

- **Chapter II**: the issue of the natural environment components and the evolution development between them is resumed and analyzed in depth. In this respect, the ecosystem is defined as creative matrix of the natural capital and this sets the benefits of the natural capital in a new broadened perspective. It is here where the complex nature of the ecosystems is being discussed and it is here where the means of interaction between man and the ecosystem are being analyzed and the profound interconnections of this interaction is being highlighted. The current methods of evaluation the benefits of the natural environment are being presented towards the end;

Subchapters:

- Sustainability, genetics and..Lev Tolstoy

➔ it takes the issue of the role of natural components in the context of the benefits obtained by the human community and makes few analogies of similar complexity taken from Genetics. It introduces the Arrow-Fisher uncertainty reasoning;

- The ecosystem, the creative matrix of the natural capital

➔ it introduces the concept of ecosystem that is connected with the natural capital. It emphasizes the complex role of the natural environment.

- Ecosystems as environments with nonlinear and irregular feedback

➔ it develops the previous chapter by highlighting the chaotic features of the ecosystems. Practical examples are exhibited and the conclusion that can be drawn is that each ecosystem is unique.

- The natural capital extended: physical and metaphysical side

➔ it is built on the scaffolding of the first chapter and places a concrete boundary between the two forms of the natural capital: physical and metaphysical. Concrete examples which support this division are brought.

- Man's relationship with the natural environment: psychological and biological side

➔ it develops on the previous issue by highlighting the preliminary and incomplete mechanisms by means of which man interacts with the two sides of the natural capital.

- The financial estimation of the benefits gained from the natural environment

➔ here are presented the main means of quantifying the benefits arising from the natural environment as well as the shortcomings

- **Chapter III:** given the particularities of the ecosystems, the issues of the sustainability measurement are being investigated. Some features concerning the sustainability is being analyzed as well as some implication related to the practical implementation. The special of developing countries is discussed here and the relevance of the substitution hypothesis is being discussed in the context of more acute issues. At the end, there is the proposal of conceptual integration matrix of natural capital in the broadened economic analysis;

Subchapters:

- Measuring sustainability under uncertainty

➔ taking into consideration the vulnerabilities underlined in the last subchapter, the weakness of indices measuring sustainability are being presented. The

analysis is placed in the context of uncertainty and specific examples are provided.

- Determinism, uncertainty and indeterminism

➔ here we introduce notions of determinism and indeterminism as well as of partial determinism, which is an intermediate threshold. There are discussed the impact and the relevance of these notions on the theoretic apparatus of Economical science, on the level of sustainable development.

- The question of sustainability and its partially moral solution

➔ here it is underlined the ethical background on which the theoretical argumentation of environmental Economics is based

- Sustainability – more than a question of a function's maximisation

➔ here the idea of the sustainability of the society by optimisation of a single pillar (economic, ecologic and social) is being refuted. The arguments tend to lead towards the idea of compensation. Sustainability will most certainly be a game of managing the resources and splitting them between numerous needs with distinct intensity and importance.

- The substitution theory: from a theoretical approach to its real impact

➔ the substitution theory, the keystone of the whole theoretical edifice of Environmental Economy, is being analysed and criticized for the lack of integration of all the elements of natural capital. The development of this theoretical mainframe had been realised by limiting those elements which are either hard to quantify, or are impossible to be introduced in the economical analysis. This artificial development facilitated the appearance of the present theoretical matrix.

- Why does sustainability seems unfair for the developing countries?

➔ taking into consideration that most of the biodiversity and biomass are mainly located in countries considered as being underdeveloped, it has been argued that these state should be compensated for the environmental services brought by these ecosystems at a planetary level. This has a moral ground, taking into consideration that in most of the developed countries the progress was made in an irresponsible manner, without taking into consideration the environmental issues. Such compensational payments would not only allow the regeneration of the environmental balance but will serve as a viable stimulant for implementing other eco-friendly means for economical development.

- The integration of the natural capital in the economical analysis and the relevance of the substitution hypothesis

➔ based on the life-support function, which is specific to all ecosystems, it is stated an advanced preliminary mechanism of integration of the natural capital (physical and metaphysical) in the economical analysis. Given that this function is not affected by the anthropogenic activities, chances are that the ecosystem is not damaged. If the sustainability capacity is kept in good operating parameters, there is a high chance that other gains of humanity (some of them hard to quantify) will not suffer.

- **Chapter IV (case study):** since the purpose of the case study was to reveal what was said up to that point, all the calculations in this last part of the thesis wanted to show the relevance of the natural capital in a wider sense for the modern economies. An implicit conclusion of this case study, which corroborates what was said in the previous chapters, is that the assumption of the substitution is not feasible.

Subchapter

- View on the issue of Rosia Montana and shale gas by hydraulic fracturing

➔ using an already existing methodology which is incomplete, but relevant, we can calculate the value of the contribution brought to the country's GDP by all the forms of the natural capital. It is also discussed the real

opportunity of Rosia Montana's mine development, as well as the exploitation of shale gas by hydraulic fracturing. In support of these analyses and it is brought the Arrow-Fisher reason of uncertainty.

Conclusion

- Argument: why the market can not solve the problem of the natural capital?

➔ it is considered that the market is much better adapted to issues of individual interest that belong to the economic pillar. In this respect, although the state does not lack of flaws, it is argued the fact that the communitary perspective is specific to it and consequently the sustainability policies should leave the state.

- View on the concept of entropy and its real significance for the economy

➔ it is reanalyzed the roegenian model of the entropic degradation. Recent researches in physics are brought to support a critical analysis of it. Also, a series of calculations reveal that, although the entropic process is largely valid and has a certain impact on the economy, the actual amount of energy received by the Earth from the Sun is much more than current consumption. Of course, the model is a limited one as it does not internalize the energetic consumption of non-anthropogenic biomass. Further research may elucidate this aspect.

- Economy as science – particularities and opportunities

➔ lot of epistemological or methodological criticism was brought to the economic science. This subchapter presents the particularities of economy as science, *causa eficiens* of the interdisciplinary academic diatribes. The emphasis is rather on the opportunities that arise from this situation.

- Durable development: philosophic considerations

➔ finally, the discussion on sustainable development has to leave the economy's boundaries. The relevance of all the savant attempts of economic sustainability of the society is discussed here.

Sources:

1. Georgescu-Roegen, N. (1971). *The law of entropy and the economic process*. Cambridge: Harvard University Press.
2. Poincaré, H. (1889). Sur les tentatives d'explication mécanique des principes de la Thermodynamique. *Comptes rendus hebdomadaires des séances de l'Académie des Sciences*. **108**, pp. 550-553.
3. Wilson, E. (1999). *Consilience: The unity of knowledge*. New York: Vintage Books.