NICHOLAS GEORGESCU-ROEGEN'S BIOECONOMICS: A CONTRIBUTION TO THE TRANSFORMATION APPROACH OF SUSTAINABLE DEVELOPMENT

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ABSTRACT: Transformation view on sustainable development advocates that a transmutation of society's environmental relations is necessary in order to avoid a deep civilization crisis or even its future collapse. Supporters of the transformation are convinced that reforms are not enough because many of the problems are viewed as being located within the very economic and power structures of society. In the present paper, I argue that Nicholas Georgescu-Roegen's bioeconomics brings a profound contribution to the transformation approach of a sustainable development.
KEY WORDS: bioeconomics, sustainable development, entropy, Nicholas Georgescu-Roege

1. INTRODUCTION

Nicholas Georgescu-Roegen, born Nicolae Georgescu (4th February 1906, Constanța, Romania – 30 October 1994, Nashville, Tennessee) was a Romanian mathematician, statistician and economist, who described the theoretical implications of entropy law on economic processes.

Best known for his magnum opus The Entropy Law and Economic Process (1971), his researches extended beyond well-known work on the thermodynamic foundations of economic systems and his career has been governed by the ambitious attempt to reformulate economic processes in a style of dialectical economic thought: as 'bioeconomics'.

Nowadays, he is considered one of the key intellectual progenitors of ecological economics and the author of a minimal bioeconomic program.

2. SUSTAINABLE DEVELOPMENT: DEFINITION, OBJECTIVE AND APPROACHES

2.1. Definition

Brundtland Report stressed that, for security and basic existence in an industrialized or a rural subsistence society, humanity depends on the environment. Bringing together environmental and socio-economic questions, the report expressed the most famously definition of sustainable development: "meeting the needs of the present without compromising the ability of future generations to meet their needs" [15].

This involves maintaining current rates of development while leaving suitable resources behind, for later generations to continue their development. In order to do that environmental problems must be tackled by considering their relationship with the state of the economy and the wellbeing of society, including everything that we need to consider for a healthy, prosperous and stable life.

Although sustainable development is about integrating the environment, society and economy, both economy and society exist within the wider context of the environment. The economy exists entirely within society, because all parts of the human economy require interaction among people.

However, society is much more than just the economy. Happiness, pleasure and well being do not stem solely from financial growth. Friends and families, culture, religion and ethics are important elements of society that are not primarily based on exchanging goods and services, but contribute to the overall quality of life.

Society, in turn, exists entirely within the environment. Our basic requirements - air, food and water - come from the environment, as do the energy and natural resources for housing, transportation and the products we depend on.

2.2. Objective

Till present, rising in standards of living has damaged the environment causing an increase in consuming resources and polluting the Earth with waste products. Though economic growth must remain the basis of human development, it must change its quality and become less environmentally destructive.

Hence, the goal of sustainable development is to harmonize the economic development, social equity and justice, and environmental protection, especially when those are in conflict with one another. Conserving and enhancing Earth's resource base, by gradually changing the ways in which we develop and use technologies, must become a priority.

2.3. Approaches

Across economic research there are long standing debates about goals and means within theories dealing with sustainable development approaches. It has been argued that Brundtland Report attempted to connect some of these debates by leaving a certain ambiguity, talking at the same time of the priorities of meeting the needs of the poor, protecting the environment and having a rapid economic growth. This allowed businesses and governments to favor sustainability and development without any fundamental challenge to their present course.

Following the debates, the first dichotomy appeared between two large intellectual approaches: strong and weak sustainability.

Weak sustainability sees natural and manufactured capital as interchangeable, technology being able to fill the gaps produced by man in the natural world (e.g. lack of resources or damage to the environment).

Strong sustainability, criticizing the weak sustainable view, points out that human made capital cannot replace the majority of vital processes such as ozone layer, water cycle or photosynthesis (Green Economists even argue that non-human species, natural systems and biodiversity have rights and values in themselves).

In between these two radical positions, there are three broad perspectives on the nature of the changes necessary in the human-environment relationships to achieve sustainable development: status quo, reform and transformation (Figure 1).

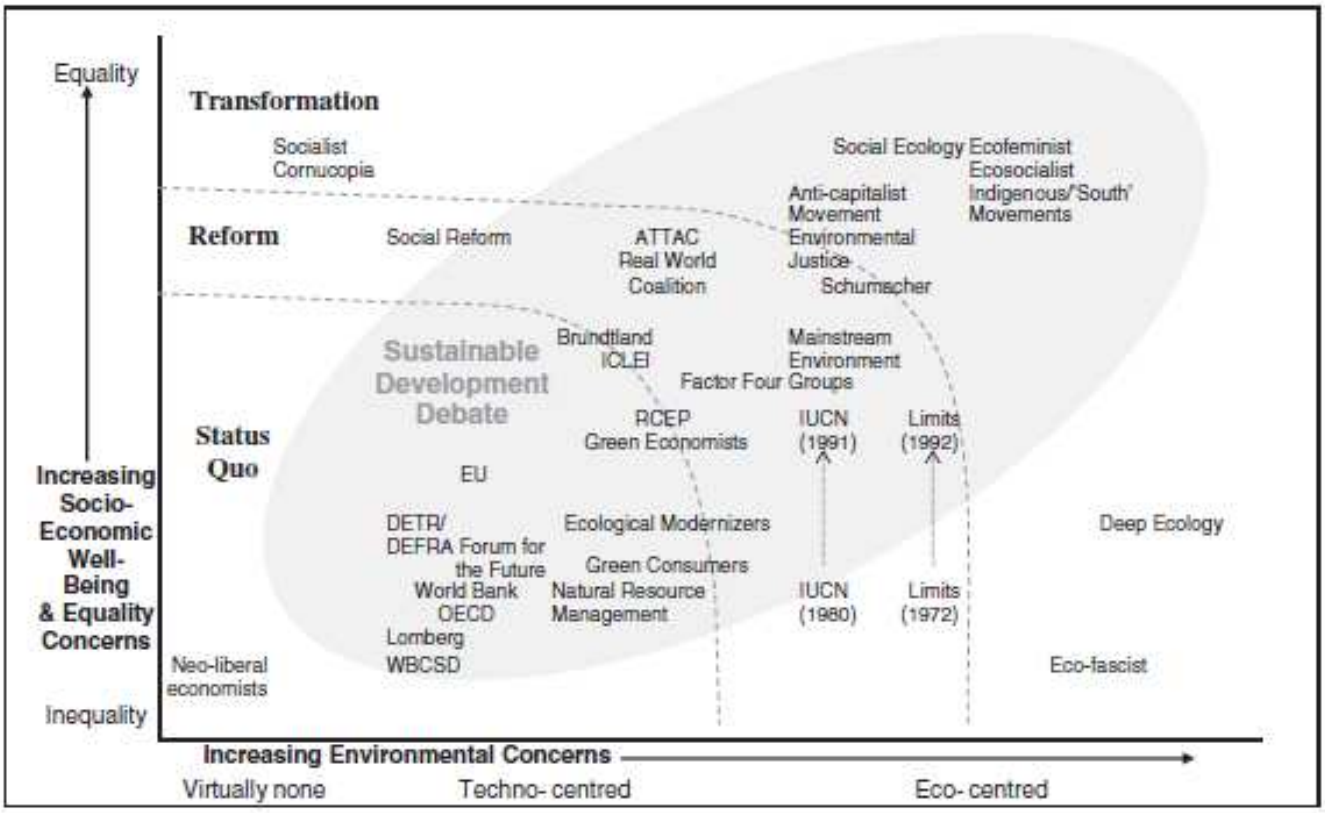

Figure 1. Sustainable development approaches (O'Riordan, 1989)

2.3.1. Status quo

Advocates of the status quo „recognize the need for change but see neither the environment nor society as facing insuperable problems. Adjustments can be made without any fundamental changes to society, means of decision making or power relations."[9].

Satisfied by the changes in the role of government over recent decades, they ask for the reduction in the progressive nature of taxation, cuts in social wage, privatization and reduction of regulation. Their arguments are that business is the driver towards sustainability and that the best means to achieve it is by increasing the volume and quality of information, changing values, improving management techniques and innovative technology, et cetera. Reluctant to use laws and regulations, they believe that consumers, informed about sustainability issues and responsible for their lifestyle choices, will cooperate with 'green' capitalists, who practice 'corporate citizenship' and ethical business, to achieve a sustainable development.

2.3.2. Reform

The reform approach "accepts that there are mounting problems, criticize current policies of most businesses and governments trends within society, but does not consider that a collapse in ecological or social systems is possible or that fundamental change is necessary." [9]

The "reformers" think that the root of the problem is not in the nature of present society, but in imbalances and a lack of knowledge and information, remaining confident that things can and will change to address these challenges. Large shifts in policy and lifestyle, many very profound, will be needed at some point and will be achieved over time with the present social and economic structures. The solution proposed is to persuade the governments and international organizations, using reasoned argument, to introduce major reforms and focus on markets, technology, science and information.

Reformers recognize governments' key role in moving economy towards sustainable development. Among solution offered can be found: stimulating the businesses, controlling taxes and subsidies, targeting scientific research and disseminating the results or reforming the political system to increase involvement in the democratic process.

2.3.3. Transformation

Transformation view on sustainable development „sees the mounting problems in the environment and society as rooted in fundamental features of society today and how humans relate with the environment."[9] It argues that that a transformation of society's relations with the environment is necessary in order to avoid a mounting crisis or even a possible future collapse.

Advocates of this view are convinced that reforms are not enough, because many of the problems are viewed as being located within the very economic and power structures of society. They consider that humans are not primarily concerned by sustainable wellbeing or environmental sustainability and that a political action is needed to involve all social classes.

3. THERMODYNAMIC ENTROPY AND IT'S MAJOR CONSEQUENCE ON ECONOMICS: A PRECONDITION FOR THE APPEARANCE OF BIOECONOMICS

The concept of entropy is defined phenomenological by the second law of thermodynamics and states that the entropy of an isolated system always increases. Thus, entropy is also a measure of the tendency of a process to proceed in a particular direction determining that thermal energy, in the form of heat, always to flow spontaneously from regions of higher temperature to regions of lower temperature. These processes reduce the state of order of the initial systems, and therefore entropy is an expression of disorder or randomness.

Inspired by entropy law, Nicholas Georgescu-Roegen generalized the entropic transformations of matter and energy and discovered the forth law of thermodynamics. The law can be summarized in two ideas: first, postulates that inaccessible matter cannot be recycled and second, that a closed system cannot perform a mechanical work constantly and indefinitely. The same amount of matter and energy or entropy can be used only once.

While it proclaims for matter what the second law of thermodynamic does for energy, the difference between this two laws is that, in an isolated system, instead of its tendency to thermal death, there is a trend to chaos that appears or all matter-energy becomes inaccessible. Just as energy transforms, from usable energy (low entropy) to unusable energy (high entropy), a part of used matter can be reused through recycling while the rest becomes inaccessible.

Therefore, human system is probably the most endangered subsystem of the Universe. Inducing the consumption of higher rates and amounts of Earth's resources (material and energetic) than natural processes (stocks of mineral terrestrial crust – solar accumulated energy - or even solar flows of energy) can recover, two major dangers lower the Earth's entropy: growing population and industrialization. Thereby, the problem of economic scarcity transforms into a low entropy issue and economy becomes the process of transforming low entropy in high entropy.

The consequences are harsh: any child born or any car produced in the present means a human life less in the future. "Ceteris paribus, population growth and industrialization shortens human's race life because it causes a rapid consumption of its natural dowry" [7], meaning that life on Earth is directly proportional to the land reserve of matter-energy and inversely proportional to the speed average that consumes this stock.

Hence, production goods are ephemeral because – sooner or later – they disappear either through consumption or by naturally entropic decay. Sooner or later all economic goods transform in high entropy, meaning that inaccessible matter-energy for humans will be dissipated in the Universe).

In the future, useful matter, more than energy of our closed system, will become a bigger ecological problem.

As Nicholas Georgescu-Roegen has shown, matter has a bigger importance than energy due to the fact that it is indispensable for energy capture.

Due to the existence of entropy law, Georgescu-Roegen goes further on and distinguishes between stock, flow and fund, an analytical framework which he expanded in his book The Entropy Law and the Economic Process (1971).

Fund elements are those productive agents unchanged in the process, that enter and exit in a similar an economically form (e.g. labor).

Flow elements are those inputs changed by fund agents into productive output, which is the focus of economic inquiry. The former represents the material base of the production process and the latter the transformation achieved with the services of this base. Although the distinctions can be sharply drawn, Georgescu-Roegen was quick to point out that the analytical boundaries could render: a commodity a flow in one process and a fund in another.

A stock is a type of productive input that may be used to generate flows at any given rate. For example, we may burn a ton of gas a day for 30 days, or we may burn the entire 30 tons in one day to produce the same total quantity of heat.

A fund, on the other hand, may be used to generate services only at a limited rate. An individual laborer may dig one ditch a day for a month, but cannot dig 30 ditches in one day. The water filtering capacity of a wetland decreases if the amount of water flow exceeds some maximum rate.

A stock is capable of producing a physical flow at any desired rate, but a fund is capable of producing a service only at a limited rate. It is limited by the time dimension as well as by biophysical and institutional contexts.

Funds are the "agents of production" that transform the flow of natural resources into a flow of economically valuable products. Funds must be maintained by the sustaining functions which support Ricardian land, labor power and capital.

In an environment as our planet, life is an open system which benefits from an enormous stock and flow of solar energy (low entropy), but a finite stock and flow of terrestrial energy (low entropy). Unfortunately, on a long perspective both will be transformed in waste (high entropy).

As for an analogy, Earth's environment can be represented as an hourglass, that cannot be inverted, in which the available energy at the top becomes unavailable as, continuously, the content on the upper part flows irreversibly to the lower one (Figure 2).

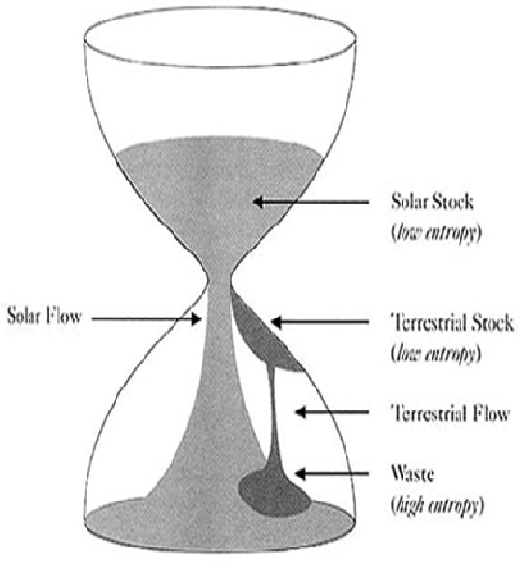

Figure 2. Stock and flow hourglass analogy

Inspired by thermodynamics, Georgescu-Roegen recognized the fundamental importance to (economic) development of qualitative change, which standard (neoclassical) economics failed to analyze it.

He pointed out that qualitative change, a central theme of life sciences, eludes mathematical schematization rooted in the mechanistic epistemology of neoclassical economics because of the novelty emergence in economic processes

In their effort to sustain their life, by sorting low entropy, all living beings other than man use their endosomatic instruments – a term proposed by the famous biologist, Alfed Lotka, to call those instruments (legs, wings, claws, et cetera) which belong to the individual organism by birth. Along known history, human beings are the only ones that extended their endosomatic arm, increasing its power. At that point in time, humans' evolution transcended the biological limits and extended on exosomatic instruments - instruments produced by man but not belonging to his body.

In front of this evidence, that from the beginning of its evolution, humanity has transgressed the mode of biological (or endosomatic – bodily metabolism) evolution and moved into an entirely new mode of development, relying on exosomatic (external or detachable) resources (natural environment, manufactured instruments and products). Georgescu-Roegen even stressed that major institution (like market, money, credit, enterprises, state, et cetera) and their internal logic emerged in response to the progressive evolution of humankind exosomatic orientation.

In essence, evolution can be described as an endosomatic progress of all living structure's entropic efficiency. The Romanian economist's opinion is that entropic indeterminacy makes life possible because it shows the direction of evolution.

In turn, life is compatible with moderate entropy. In a very low entropy environment, a living organism cannot withstand to the onslaught of free energy. On the other hand, in a very high entropic environment it wouldn't be enough free energy to sustain its life.

In the field of biology struggle for life is the consequence of the entropy law. It is carried between species, individual of the same species. Only in the human race took the form of social conflict.

The same conclusion can be expressed about the mankind exosomatic evolution. Exosomatic tools enable man to achieve the same amount of low entropy spending less of its own free energy that if they used only endosomatic organs. Therefore, exosomatic evolution can be described as the improvement of entropic efficiency during mankind's economic processes. But, since the exosomatic instruments are not the natural and inseparable property of the individual advantage, their improvement has become the source of inequality between individuals and human communities. So, the universal income distribution created a problem whose importance continued to grow till had transformed production in a social activity.

Nicholas Georgescu-Roegen also observed that exosomatic evolution generated two fundamental and irrevocable changes upon the human species: irreducible social conflicts and dependence on exosomatic tools.

The dependence is not only biological nor only economic. It is bioeconomic, and relies on the multiple asymmetries existing among the two sources of low entropy man has it to its disposition: the free energy received from the sun and the free energy and ordered material structures stored in the Earth's crust.

The first asymmetry has in attention the fact that the terrestrial component is a stock, whereas the solar one is a flow. For example, iron in situ is a stock because it's free to use it all today or over the centuries while the future part of solar radiation flow cannot be used in the present. "Moreover, the flow rate of this radiation is wholly beyond our control; it is completely determined by cosmological conditions, including the size of our globe. One generation, whatever it may do, cannot alter the share of solar radiation of any future generation. Because of the priority of the present over the future and the irrevocability of entropic degradation, the opposite is true for the terrestrial shares. These shares are affected by how much of the terrestrial dowry the past generations have consumed" [18].

Second, „there is an astronomical difference between the amount of the flow of solar energy and the size of the terrestrial free stock of energy" [18]. At present, the available solar energy resource is around 120,000 TW (terawatts). Less than 0.02% of available resources are sufficient to entirely replace fossil fuels and nuclear power as an energy source. At a human scale is enormous and represents the most important resource of sustainable energy.

Third, since there is no technological procedure to transform energy into matter, entropy law will reduce future generations' chances to satisfy their material need.

Fourth, „from the viewpoint of industrial utilization, solar energy has an immense drawback in comparison with energy of terrestrial origin. The latter is available in a concentrated form; in some cases, in a too concentrated form. As a result, it enables us to obtain almost instantaneously enormous amounts of work, most of which could not even be obtained otherwise. By great contrast, the flow of solar energy comes to us with an extremely low intensity, like a very fine rain, almost a microscopic mist. The important difference from true rain is that this radiation rain is not collected naturally into streamlets, then into creeks and rivers, and finally into lakes from where we could use it in a concentrated form, as is the case with waterfalls"[18].

Fifth, „the use of any terrestrial energy produces some noxious pollution, which, moreover, is irreducible and hence cumulative, be it in the form of thermal pollution alone. By contrast, any use of solar energy is pollution-free" [17], although on the long run will become dissipated heat that can't be used by economy.

The sixth asymmetry „involves the elementary fact that the survival of every species on earth depends, directly or indirectly, on solar radiation (in addition to some elements of a superficial environmental layer)" [17]. But humankind, because of his exosomatic addiction depends on mineral resources as well, for the use of these competing with no other species. Some species have in fact been brought to the brink of extinction merely because of man's exosomatic needs or his craving for the extravagant.

Ultimately, Georgescu-Roegen envisioned the necessity of shifting the world's economy from one based on terrestrial stocks on energy to one based on the flow of solar energy. Thus, his minimal bioeconomics program offered eight concrete recommendations to move human society in the right direction [18]:

I. The production of all instruments of war, not only of war itself, should be prohibited completely. It is utterly absurd (and also hypocritical) to continue growing tobacco if, avowedly, no one intends to smoke. The nations which are so developed as to be the main producers of armaments should be able to reach a consensus over this prohibition without any difficulty if, as they claim, they also possess the wisdom to lead mankind. Discontinuing the production of all instruments of war will not only do away at least with the mass killings by ingenious weapons but will also release some tremendous productive forces for international aid without lowering the standard of living in the corresponding countries.

II. Through the use of these productive forces as well as by additional well-planned and sincerely intended measures, the underdeveloped nations must be aided to arrive as quickly as possible at a good (not luxurious) life. Both ends of the spectrum must effectively participate in the efforts required by this transformation and accept the necessity of a radical change in their polarized outlooks on life.

III. Mankind should gradually lower its population to a level that could be adequately fed only by organic agriculture. Naturally, the nations now experiencing a very high demographic growth will have to strive hard for the most rapid possible results in that direction.

IV. Until either the direct use of solar energy becomes a general convenience or controlled fusion is achieved, all waste of energy – by overheating, overcooling, over speeding, over lighting, et cetera – should be carefully avoided, and if necessary, strictly regulated.

V. We must cure ourselves of the morbid craving for extravagant gadgetry, splendidly illustrated by such a contradictory item as the golf cart, and for such mammoth splendors as two-garage cars. Once we do so, manufacturers will have to stop manufacturing such "commodities".

VI. We must also get rid of fashion, of "that disease of the human mind", as Abbot Fernando Galliani characterized it in his celebrated Della Moneta (1750). It is indeed a disease of the mind to throw away a coat or a piece of furniture while it can still perform its specific service. To get a "new" car every year and to refashion the house every other is a bioeconomic crime. Other writers have already proposed that goods be manufactured in such a way as to be more durable. But it is even more important that consumers should reeducate themselves to despise fashion. Manufacturers will then have to focus on durability.

VII. Closely related to the preceding point, is the necessity that durable goods be made still more durable by being designed so as to be repairable.

VIII. In a compelling harmony with all the above thoughts we should cure ourselves of what I have been calling "the syndrome of the shaving machine", which is 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. This change will call for a great deal of recanting on the part of all those professions which have lured man into this empty infinite regress. We must come to realize that an important prerequisite for a good life is a substantial amount of leisure spent in an intelligent manner.

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5. CONCLUSIONS

Nicholas Georgescu-Roegen bioeconomics contributes to the transformation approach of sustainable development by:

• accentuating the connection which entropy establishes between man and environment<

• awakening human consciousness on the importance of rarity and irreversible degradation of the economic resources;

• establishing a new role for man in the economic process: as a fund;

• introducing two biological concepts, endosomatic and exosomatic instruments, into economic reflections and, thus, centering the new paradigm on the human’s crucial need of low entropy;

• discovering numerous asymmetries two sources of low entropy man has it to its disposition: the free energy received from the sun and the free energy and ordered material structures stored in the Earth’s crust;

• emphasizing the necessity of shifting the world's economy from one based on terrestrial stocks on energy to one based on the flow of solar energy;

• forwarding to politics and civil society a minimal bioecomic program.

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