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Chloe Kneedler
Portland State University

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A Critique of Ideas Advanced by Nicholas Georgescu-Roegen

Working Paper No. 81

Authored by: Chloe Kneedler

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Prepared for Professor John Hall

Abstract: This inquiry seeks to establish that ideas advanced by economist Nicholas Georgescu-Roegen fall short and are deserving of a critique. Certainly, Georgescu-Roegen provided a foundation for the area of inquiry known as Ecological Economics. As suggested with the title, *The Entropy Law and the Economic Process* (1971), in this book Professor Georgescu-Roegen relates the Law of Entropy drawn from Physics to the economic process, in an effort to raise his concern over the finiteness of resources. In the modern, industrial economic system that he considers, he regards that goods with low entropy are consumed, and that their entropy increases until reaching a state of annihilation. While indeed Georgescu-Roegen offers novel ideas, his efforts fall short by failing to consider economic systems of selected Indigenous communities that have been able to prevent the entropy process from reaching a state of annihilation within their ecosystems through conservation techniques.

Journal of Economic Literature **Classification Codes:** O44, Q01, Q32, Q57

Keywords: Ecological Economics, Entropy Law, Indigenous Conservation, Nicholas Georgescu-Roegen

This inquiry seeks to establish that key ideas advanced by economist Nicholas Georgescu-Roegen (1906-1994) have provided for an area of inquiry known as "Ecological Economics." In what in recent years has been further elevated as a field within the Discipline of Economics, Ecological Economics must be understood as "transdisciplinary" as it aims to study limited resources in a given ecosystem. Georgescu-Roegen authored the book titled: *The Entropy Law and the Economic Process*. In his inquiry he expresses a central concern; namely, that the economic process is limited by finite resources. He clarifies this and other concerns by applying the "Second Law of Thermodynamics"—also known as Entropy Law— to the economic process. Entropy has traditionally referred to the index of the relative amount of bound energy within a structure. If a given structure is deemed to have high entropy, this suggests that most, if not all, of the energy is bound. In contrast, a structure with low entropy has little if any bound energy. When energy is unbound or has low entropy, it is said to be in a more orderly state.

Georgescu-Roegen (1971, 1-2) challenged the mainstream economic models found in textbooks, which assume that the economic process can be thought of as a circular flow. In addition, he can be noted as the first economist to examine the economic system relying upon the Entropy Law and relationships between humans and the ecosystem. Georgescu-Roegen (1971, 19) offers brilliant and progressive insights into how to delay the entropic process of ecosystem degradation by being

mindful of the ways in which natural resources are consumed for economic activity; however, falls short. What his writings fail to consider are the ways in which certain entropic processes can be reversed or even created. For this we must consider conservation and preservation techniques relied upon by Indigenous communities.

Entropy Law

What Georgescu-Roegen (1971, 6) teaches us is that the Second Law of Thermodynamics assumes that entropy throughout the universe needs to be considered as irreversible and constantly increasing. More specifically, what this suggests is that energy is constantly evolving to become more bound and disordered. For example, if we were to place two gas substances in a chamber, what starts out as two distinct gasses, would naturally enter a higher state of entropy through mixing together. Assuming that the two gasses were to become chemically bonded, then it would prove incredibly difficult, if not impossible, to get back to the two original gasses. Another example of entropy could arise when a metal rod is heated on one side, but remains cold on the other. The predictable outcome would be that the energy of the heat would flow from the hotter side to the colder side, and this could be understood as the colder side was of relatively

lower entropy. The reverse could not be true because the Law of Physics notes for us that it is impossible for cold energy to flow towards heat.

Austrian physicist Ludwig Boltzmann (Geogescu-Roegen, 1971, 149) stated that a macrostate with a chaotic structure would naturally preserve that disorderly state. If there were no chaotic structure within the macrostate, then there would be a natural trend towards chaos. While it may seem like it is possible to reverse certain entropic processes, in reality this is often impossible. Even in situations in which it is possible to reverse the trend towards disorderly state, doing so would take a substantial amount of energy and effort, and would not ensure that the entropic process would continue all over again. The life of a living organism could serve as an example of an irrevocable entropic process. The organism always starts out as a seed or embryo, transforming into a live plant or creature, and eventually becomes deceased. An organism cannot be brought back to life after its death, and in extremely rare cases in which it is, the organism will again eventually reach the point of maximum entropy, meaning deceased.

According to one theory of Entropy Law advanced by Irish Astrophysicist William Hunter McCrea (Georgescu-Roegen, 1971, 202), total entropy in the universe may possibly be constant in the sense that new matter is always being created which forms low entropy, and that low entropy evolves into high entropy before reaching a point of annihilation. In biology, for example, it is widely

accepted that organic life stems from matter created from the sun. Although McCrea's theory does not completely reject the phenomena of the linear irreversible entropy processes, it does imply that with each annihilated entropy process, a new one starts.

Entropy Law and the Economic Process

Although entropy is primarily studied in the celestial realm, Georgescu-Roegen (1971, 276) stresses the importance of applying the Entropy Law to areas of our everyday lives, which includes economic activity. Georgescu-Roegen (1971, 6) notes that if the second law of thermodynamics were to not hold, humans could reuse commodities again and again without the fear of scarcity or degradation. For example, if oil is unlimited or reusable, we would be able to drive and fly as much as we would like to without having to worry about the planet running out of this resource, and relatedly, we would not be going out of our way to develop alternative transportation methods such as electric vehicles. Not only does Entropy Law apply to the scarcity of resources, but the law also applies to the consuming of resources on the large ecosystem. As oil is consumed, it emits carbon dioxide into the atmosphere which has already drastically altered Earth's climate patterns in recent years. The process of oil fracking is also known to place the surrounding

ecosystem at a higher stage of entropy with the irreversible harm it causes to the surrounding habitats, limiting biodiversity and contaminating freshwater.

In Georgescu-Roegen's words (1971, 277): "our whole economic system feeds off low entropy," because although highly ordered structures such as unconsumed oil serve as the most useful to society, they hold zero value once consumed. In cases in which resources can be reused, such as damaged fabric, the energy required to repair or recycle that damaged fabric would likely outweigh the energy that causes fabric to reach a point of damage. Within our modern economic system that makes humans consume resources that naturally depreciate over time, it is essentially impossible not to apply Entropy Law to the current economic process.

Georgescu-Roegen (1971, 1-2) criticizes neoclassical economists thinking in the traditions of W. Stanley Jevons and Léon Walras for viewing economics as a mechanical phenomenon, and failing to factor in the use and depreciation of natural resources into the economic process. Since classical mechanics only knows locomotion and reversibility, it assumes that the economic process can run through the same cycle forever, thereby failing to consider outside changes, such as shifts in the quality and quantity of natural resources the ecosystem provides. When economics is studied from a mechanical standpoint, this discipline assumes revocability, and this contradicts the second law of thermodynamics. According to

Georgescu-Roegen (1971, 199-200), the Entropy Law makes it impossible for any phenomena in nature, including the economic process, to move backwards or to repeat with ease.

In neoclassical economics, it has been assumed that the economic process is a closed circular process with households buying goods and services from firms, and the firms, in return, using that revenue to produce more for the households. Georgescu-Roegen (1971, 281-282) rejects the widely accepted theoretical construct that the economics process is actually circular, because the model only assumes a constant inflow of low entropy, while failing to show what the trend into high entropy entails. In the circular model, economic output is never viewed as an outflow of waste, but rather as the attainment of pleasure measured as utility. Since Georgescu-Roegen (1971, 281-282) views the entropic process as automatic and linear, he criticizes the fact that the circular flow model requires human activity to keep going. This circular flow model implies that economic cycles only repeat themselves, which directly contradicts Entropy Law. If the circular flow model were to function as the textbooks suggest, then turning high entropy into low entropy would be just as simple as converting low entropy into high entropy through economic activity, which is impossible. Even if the economic process were circular in nature, Entropy Law would not allow for the cycle to repeat in the same fashion as it did previously due to changes in natural resource availability.

Georgescu-Roegen (1971, 323) observes that neoclassical economic theories, such as the circular flow model, operate more from a business standpoint than a scientific view. The key assumption is that individuals primarily act with self-interest and the goal of attaining wealth. In communities which are heavily influenced by the neoclassical economic model, individuals tend to believe that their primary goals in life involve the growing of their wealth. Because of how preoccupied society is with gaining wealth, along with the limited awareness of the prevalence of the entropic process in our economic system, market participants often fail to recognize the impact their actions have on the rest of society. In the view of Georgescu-Roegen (1971, 284-285), this modern neoclassical economic view implies that attaining wealth serves as the main source of enjoyment, and that enjoyment has a measurable level of intensity at each instance. Because of these views, individuals also have the goal to stretch out high levels of enjoyment by increasing their use of consumer goods, while still maintaining their wealth over extended periods of time. While modern day consumers seek to maximize their own enjoyment, they fail to recognize the importance of stretching out the stages of low entropy in the ecosystem.

Georgescu-Roegen (1971, 12) points out that it proves altogether impossible to predict exactly when a specific event will occur in the entropy process, and such is due to the various factors that can either trigger or delay an event. He does,

however, highlight the importance of consuming certain natural resources in ways in which they would maintain a state of low entropy for a longer period of time. Georgescu-Roegen (1971, 19) also argued that if society had always been aware of how entropy law applies to the economic process, more people would be aware that "bigger and better washing machines, automobiles, and superjets must lead to bigger and better pollution." For these reasons, Georgescu-Roegen (1971, 295) offers insight on how society can take action to slow the trend towards a highly polluted ecosystem by stating that "the rate at which we may use our mineral reserves is largely a matter of our own decision." While it is not possible to reverse the impacts of climate change or predict its direction in the future, it is possible for humanity to take action to reduce or delay the effects by being mindful of what goods we consume and how we consume them.

Challenging Georgescu-Roegen's Perspective

Georgescu-Roegen's writings have indeed offered insights into key processes in our world, especially how societies could slow down and delay some of the negative effects of the entropy process in our ecosystem. Georgescu-Roegen (1971, 302) believed that the entropic process suggests that sustainable agricultural practices were essentially impossible, and that one would be mistaken if they thought that making good use of manure for fertilizer could reverse the entropic

process. Georgescu-Roegen (1971, 199-200) also held the pessimistic belief that no matter which actions society takes to combat climate change, the entropy process would continue pushing the ecosystem towards the eventual extinction of humanity.

What Georgescu-Roegen failed to consider in his writings was the conservation techniques that Indigenous communities have used to preserve their territory in order to not fall victim to the negative impacts of the entropy process. Georgescu-Roegen (1971, 23) held the misconception that Indigenous people were "scienceless" with a "weak utilitarian instinct." This particular misconception regarding Indigenous communities was unfortunately common at the time Georgescu-Roegen was thinking and writing on this subject-matter. It is not until recently that society has begun to realize the insightfulness and value of Indigenous knowledge. Georgescu-Roegen (1971, 36-37) pointed out that the life of a living organism is an irreversible entropic process; however, he failed to consider the fact that new organic life can often emerge from aged or deceased life.

Based upon Georgescu-Roegen's writings, one cannot deny the prevalence of the Entropy Law in the economic process and our ecosystem. However, research in the management of Indigenous communities, that have been able to preserve their territories for thousands of years, suggests that the entropic process of ecosystem degradation is not necessarily inevitable as Georgescu-Roegen has

purported. One example regarding how Indigenous communities preserved the ecosystem in their territories was through the controlled use of fire. While burning portions of one's habitat may seem counterintuitive, this activity proved essential in helping Indigenous communities increase biodiversity through reducing the buildup of harmful pests. A controlled use of fire is also known for creating room for the growth of new, young plants with some proving essential as food sources and medicine (Kimmerer & Lake, 2001). If these controlled burns were never to have happened, the ecosystem would inevitably enter a state of high entropy in which those residing on the territory would find it incredibly difficult to make use of natural resources given the relatively limited biodiversity. Although the burning practices can be seen as an example of how substantial energy and effort is required to restart the entropy process, benefits of increased biodiversity in the ecosystem greatly outweighed the negative effects of the controlled uses of fire. Regrettably, and likely related to misconceptions colonizers held regarding use of fire, Indigenous peoples are now banned from partaking in controlled burns.

With the entropy process naturally leading ecosystems to late succession stages which offer limited biodiversity, it has become increasingly difficult for Indigenous communities to make use of the natural resources their territories provide. When Indigenous people did consume a product provided by the ecosystem, such as a plant or an animal, they made sure that there was still some of

the plant or animal species leftover so that the life would continue to replenish itself for later use by the community. If a particular natural resource did become scarce, a part of the territory would be blocked off to allow the biodiversity to recover and flourish (Kimmerer & Lake, 2001). Since Indigenous people never consumed natural resources that could only be used once—such as coal or oil—their groups seldom faced situations of scarcity to the extent that the world is facing today.

Another technique Indigenous communities relied upon to maintain their territory's biodiversity was through specific hunting practices. The Massai people, an Indigenous group located in today's Kenya and Tanzania, faced competition with lions for natural resources. In order to secure their share of natural resources, the Massai people held lion hunting rituals, and these activities significantly helped control the regional lion population (Goldman, 2011). This practice of hunting lions helped the Massai people keep the ecosystem in their territory at a low entropy state, not only because they were able to maintain access to essential resources, the lions were also signaled away from areas of the territory in which those resources were kept. After the government banned lion hunting, the boundary between the habitats of lions and the Massai people got lost, meaning that the Massai people no longer had a way of protecting their resources. Similar to the example of two gas substances mixing together in a chamber to reach a higher state

of entropy, the criminalization of lion hunting in Africa led to the disorderly state of two keystone species, lions and humans, with both competing for the same resources in the same habitat. This entropy process has already reached a point of annihilation because the Massai people have lost such a large portion of their resources from the lions, the government has had to compensate them so they can afford food from supermarkets.

While it is almost always true that the timeline of events in a given entropic process can be sped up or delayed, Georgescu-Roegen (1971, 12) assumed that reversing the process proves either impossible or not worth the effort. Based on the methods developed by Indigenous groups to jump back to lower stages of entropy to utilize resources, it becomes clear that when it is possible to reverse the entropy process, the benefit yielded by low entropy often outweighs the energy and effort to go back to that stage. Georgescu-Roegen (1971, 282) also held on to the doubtful assumption that it is not possible for matter to be created to produce low entropy. Reexamining McCrea's (Georgescu-Roegen, 1971, 201) theory that matter is continuously created to form low entropy, as but one example, matter created by the sun allows for the growth of species on Earth. Not only were Indigenous communities able to manage their consumption of those resources based upon how quickly the entropy process was restored, these groups were able to alter the ecosystem in ways that allowed for the transformation of the sun's matter into low

entropy. Because of the fact that Indigenous communities were able to maintain stable ways of living stretching over tens of thousands of years without degrading their ecosystems, the entropic process of human existence, contrary to the pessimistic beliefs of Georgescu-Roegen (1971, 199-200), does not always entail consistent degradation of the environment that leads to annihilation. Due to the misconceptions and lack of knowledge of the Indigenous ways of living at the time Georgescu-Roegen lived, we can understand how he turned a blind eye to the importance of Indigenous conservation techniques.

Conclusion

This inquiry has sought to establish that ideas advanced by Nicholas Georgescu-Roegen provided for the foundation of the area of inquiry known as Ecological Economics. Georgescu-Roegen needs to be appreciated as the first economist to relate Entropy Law to the economic process, and along the way he also challenged modern neoclassical thinking that is largely based upon the use of a circular flow model. The progressive ideas that Georgescu-Roegen brought to the table sounded off alarms that helped us to consider pollution and climate change as being a real and irreversible process. However, since Georgescu-Roegen developed his ideas at a time that Western society was not aware or even open-minded regarding the highly valuable knowledge of Indigenous conservation techniques,

he held the false belief that no matter the life styles practiced, Entropy Law would inevitably lead to our own extinction.

This inquiry has advanced the challenging view that parts of Georgescu-Roegen's understanding related to the Entropy Law in the economic process and ecosystem do not always hold true. However, let us not reject his thinking completely. With the way our modern economic system is structured, the entropy process is inevitable, and the more ignorant that members of society continue to be towards the entropic process of consumption and ecosystem degradation, the faster humanity will indeed realize its extinction. For this reason, it remains critical that we not only take steps to reduce and delay the negative effects of a high entropy environment, but we must also learn the appropriate conservation and preservation techniques that come to us as legacies drawn from Indigenous people. With Indigenous territories continuously being harmed and destroyed by current economic activity, knowledge and the ability to partake in traditional conservation practices are quickly being lost. With this in mind, it proves critical that we take action sooner rather than later.

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