Attempts to Collect Environmental Approaches under the Sustainable Development Concept

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Abstract

Environmental awareness has particularly increased in the last twenty years. Besides most of the researchers focusing on the environmental Kuznets curve, the approaches relevant to environmental degradation are not limited to disposable income. The paper has theoretical approaches and puts forth all possible sources of pollution and degradation based on sustainable development dimensions. In this respect, free riders and the tragedy of the commons are on the social side. The Environmental Kuznets curve and pollution haven hypothesis are on the economic side. Moreover, entropy is the third law of thermos-dynamic and creates the physical basis for environmental deterioration. In addition, at the end of the process, the Anthropocene emerges because of these four issues. It declares the inevitable consequences of worldly human activities on the naming of ages. Political suggestions might require local, regional, and global support, solutions, and regulations because of multiple dimensions and scales. Public awareness, the seriousness of companies in fulfilling their responsibilities, and the interaction of countries can make a difference in a more sustainable today and tomorrow.

1 Introduction

Satisfying endless desires with limited resources is the basic definition of economics. Over time, the focus of attention is not only on the scarcity of resources but also on the devastating consequences of human actions on the environment. Scholars consider the link between environmental degradation and human actions that differ from the individual to the global scale. However, the sustainable development approach has made more visible the increasing environmental destruction and how we should build a more sustainable future for all of us.

If we look at the issue under the three dimensions of sustainable development, we try to classify the approaches/theories by using these dimensions. In this context, the social dimension consists of the free rider and the tragedy of the commons. The economic dimension might be related to the environmental Kuznets curve (EKC) and pollution haven hypothesis. In addition, the environmental dimension could be particularly connected to the entropy law.

Beyond sustainable development and these possible categorizations, the issue has multiple extents. In addition, all theories or approaches might be linked with each other and affect each other. Whereas the tragedy of the commons has a seemingly individual and social dimension, we can detect that this might constitute the roots of most communal or global problems by doing induction. Moreover, the pollution haven hypothesis is not only limited to the host and investor countries but also might distribute the pollution to all countries if investor countries use other countries as havens.

On the other side, Covert (2009) argues that the environmental free rider problem might nullify the shape of the EKC, Stern (2004) claims that the validity of the EKC is simultaneously a guarantee of environmental improvement and economic growth. Furthermore, entropy and the economic system have a close relationship due to the limited amount of natural capital. Namely, the accumulation of natural variables is limited because of biophysical laws (especially the law of entropy) (Smulders, 1995). To sum up, our aim to write this paper is to collect and classify all significant environmental approaches under the sustainable development concept. By designing it this way, we hope to reveal more clearly the levels of environmental relevance of human/society and global actions. Thus, the more evident problems and the connections we make, the more feasible solutions we can improve at the individual, local, regional, and global levels. The study is as follows, the first section illustrates the social dimension including the free rider problem and the tragedy of commons. The second section gives economic dimensions such as the environmental Kuznets curve and pollution haven hypothesis. The last section constitutes the environmental dimension as entropy law. The Anthropocene is under this section because of the massive environmental ruins of human actions.

2 Social Dimension

This section includes the approaches based on psychosocial motivation for environmental degradation. Hence, we think that the free rider problem and tragedy of commons might be suitable for this purpose.

2.1 Free rider problem

The free rider problem (FRP) mentioned in a seminal work of Mancur Olson (1965) is relevant to the group dynamics for public goods (Birdal, 2010). This problem occurs when an individual gets benefits from a good (or service) without bearing any cost (Pasour Jr, 1981). The non-excludable property of the public good is one of the main causes of FRP and there are different spatial ranges of public goods (others are national and regional) from local to global, but unclear delineation exists between the spectrum (Binger, 2003). These unclear delineations and non-excludability are sources of externalities and require public and even global interventions. In the aspect of environmental issues, the effects of a local or national FRP expand to the global level because of increasing interaction among the communities and other natural factors such as wind, and oceans... Global public goods such as the protection of the ozone layer or curbing global warming is not simple goal to achieve. Especially climate change, according to Sessions (2012), is like an umbrella collecting other many smaller issues. Moreover, the nature of this issue is a worldwide and complex issue that all nations must cooperate with today and in the future.

In the sample of FRP, if there is no superior enforcement mechanism, free-rider (FR) countries take advantage without effort and thus, FR has positive externalities for that country (Birdal, 2010). At the same time, the total effects of struggles on environmental problems might be small because of limited participation. If we model the contribution of FRP to environmental degradation (ED);

$$Y_{ed} = f\{\pm\alpha_1 \sum_i^N X_{frp}\} \quad (1)$$

In equation 1, the α coefficient is negative and shows the sensitivity of environmental degradation to the logic of free riders. Sessions (2012) states that FRP might be the center of main environmental problems. Our failure to listen to low voices outside of rich communities, other creatures, and ecosystems. FRP comes into the equation by shutting our ears and eyes to the devastating consequences of our activities, such as spreading pollutants downstream or downwind. To stop the rot or mitigate it, international cooperation is necessary. However, the size of this cooperation is critical. Taiji and Hideo (2011) claim that the size of the coalition must be sufficient to stimulate the nations to work together and to prevent being FR. At this step, the size is represented by the N symbol. If the size is enough small for FR, the sign for the effect on environmental degradation is positive. In the inverse situation, it turns to the mitigating effect of degradation.

2.2 Tragedy of commons

Non-excludability of public goods is the source of another problem. In FRP, this is because of taking benefits without any cost." the tragedy of commons (TOC)" entitled by Garrett Hardin (1969) resulted from the over-consumption of common goods (Birdal, 2010). Both Hardin (1969) and Booth (2017) declared that the first sketch of the model belongs to the Political Economist William Forster Lloyd. He noticed this problem while he was searching for repetitive devastation problems common in 1833. The logic of tragedy, in a sense, is based on insatiable greed for maximization activities. All bad consequences inevitably will come after them and the inevitable situation shows itself as a tragedy (Hardin, 1969).

The mentality of human behavior for the commons is to be free and hasty to pursue his/her own best interest. Thus, if all humans in society have the same thoughts, the compensation capacity of nature depletes, and ruin will happen. The tragedy of environmental issues turns into a benefit for someone by keeping pollutants away, even though it harms others. Even if we must share the cost of waste processing before release, this will be smaller than the cost after diffusing (Hardin, 1969).

Liu and Hiller (2016) suggest that humans must shift from ‘the tragedy of the commons to a new level of consciousness meaning 'the promise of the commons. Although the old contains selfishness, oppressive, and unequal rights, the new one includes a contribution to sustainable ecological systems, greater equality, and commonwealth. TOC might be like two pairs of scales; the earth's ecology holds one side and individual benefits is holds the other. Selfish gains fight against collective losses and the heavy side determines the environmental consequences. (Horne, et. al, 2017). If the effect of TOC is illustrated in the equation.

$$Y_{ed} = f\{+\alpha_2 \sum_i^N X_{toc}\} \quad (2)$$

As seen in equation 2, there is no penetrating effect on environmental hazards whether the personal concern is for taking the benefit or escaping the cost. So, α has a positive sign in the equation. While the community manages global commons but while community undermines them with greed, poor regulation, and insufficient enforcement (Mcmahan and Nichter, 2011). In finding a remedy for this tragedy or common-pool resources, Ostrom (2008) underlines that no simple governance system is sufficient and recommends the consensus of the community, government, and private arrangements. On this issue, Booth (2017) says that private property rights do not solve every problem and emphasizes that we must keep the political economy in mind, especially for environmental problems. From this perspective, we have two key questions. The first question relates to the implementation of the privatization of natural resources. In addition, what kind of arrangement provides both the protection of natural resources and commercial gains for the owners? The second question concerns the extension of the private property regime while planning the commercial use of resources and protecting them.

3 Economic Dimension

Economic-based approaches searching for environmental destruction enclose consumption and production activities in the economy. In this context, the Environmental Kuznets curve and pollution haven hypothesis are related to the level of income and investment, respectively.

3.1 Environmental Kuznets curve

Although the first draft of the Kuznets Curve in 1955 demonstrates the relationship between income inequality and economic development, the second draft has suggestions about the relationship between environmental pollution and economic growth. After the first draft of Simon Kuznets, Grossman and Krueger (1995) developed the model for per capita income and pollutive gas emission (Stern, 2004). The assumption of an inverted-U-shaped environmental Kuznets curve (EKC) indicates insensitive economic activities aiming only for quantitative growth at the early stage of development. Environmental issues are not a concern until satisfying income level. As countries become richer and more developed, environmental awareness improves. Hence, leading industries make their production process and products greener. As income increases, the number of pollution decreases (Dasgupta, et. al, 2002).

Low environmental degradation is accompanied by low development levels. As the level picks up and natural resource depletion becomes bigger than regeneration, detrimental wastes increase. At higher levels of development, remarkable reductions in environmental degradation result from structural changes in industries, technological improvement, ecological awareness, necessary regulations, etc (Panayotou, 1993). Berthe and Elie (2015) investigate the EKC in the context of income inequality. The relationship between income inequality and the environment has three reflections. The first reflection mentions that as individuals get richer, they gain a higher level of awareness and sensitivity toward the environment. They choose environmentally friendly products and consumer goods. The second includes the tendency to maintain a more qualified standard of living. Thus, individuals consume more energy and luxury goods. As a result, they generate more waste. The last reflection states that the environment is irrelevant to income level. The shape of the relationship appears to be concave in the first case, a linear or non-linear curve with a positive slope in the second case, and a vertical line parallel to the environmental degradation axis in the last condition.

In the determination of pollution level, variables such as awareness and regulations are effective only with proximate variables like scale, output mix, input mix, and state of technology in the work of Stern (2004). Any growth in the scale of production might directly cause an increase in pollution levels even if there are no changes in technology. Furthermore, how big the scale is also important because some anti-pollution techniques might not be efficient under the small scale of production. As for the output mix, shifting from agricultural activities to heavy-industrial ones is the main driver of economic growth and environmental consequences, too. However, the shift from an industrial economy to a service and information economy, polluting production activities might fall noticeably. The third proximate, input mix is mostly related to energy sources for production activities. The order of pollution source levels from the highest to lowest are coal, oil, natural gas, and renewables. The state of technology might have two kinds of effects on the environment. For one effect, the technology could raise productivity thus per unit pollution decreases, or for another effect, technology innovates directly environmentally friendly production process. To sum up, we include all these variables in income calculations in equation 3;

$$Y_{ed} = f\{\pm\alpha_3 \sum_i^N X_{ekc}^e\} \quad (3)$$

Equation 3 shows the relationship between income and environmental destruction. Independent variable has exponential symbol $'e'$ beneficial to draw EKC like U, inverse-U, N, inverse-N, etc. For example, conventional EKC having inverse-U shape requires $e = 1; \alpha < 0$ and $e = 2 ; \alpha > 0$ (Alvarez-Herranz and Balsalobre-Lorente, 2015). The t index is necessary to reflect the effects and development on ecology over time.

3.2 Pollution haven hypothesis

The motive behind this hypothesis is the development enthusiasm of countries having insufficient internal capital accumulations. Thus, we might have the possibility of outsourcing. On one side of the theory, the host country having a lack of capital accumulation needs to loosen environmental legislation for the sake of attracting investment. On the other side, investor countries must take a considerable cost because of environmental regulations. Hence, developed country/investor wants to switch harmful industries to the developing/host country in which the manufacturing industry is like a 'pollution haven' (Cole, 2004; Birdal, 2010). This phenomenon is called the pollution haven (heaven) hypothesis (PHH).

The first developers of the theory, Copeland and Taylor (1994) found a link between strict environmental regulation and pollution in their work on North-South trade (Gill, et. al, 2018). Despite they state that free trade causes pollution, there is no agreement on the validity of PHH (Cole, 2004).

Yoon and Heshmati (2017) evaluate PHH according to the industry in which foreign countries invested. If the investor chooses a service industry such as a research center to invest in, PHH does not probably exist. However, the manufacturing sector especially heavy industries cause environmental consequences throughout both the production process and outputs. Also, they require to loosen legislation related to environmental protection.

Siebert (1980, 2011) declares three dimensions of PHH explanation. The first one is the most known dimension related to transferring of pollution intense industries from developed countries to developing ones. The second dimension is the elimination of harmful byproducts (wastes) in developing countries. The last one is the extraction of conventional energy sources without any limitations in developing countries (Isik, 2019).

The motivation of PHH generally is based on the mobility of industry and strict environmental regulations. From a different perspective, Dou and Han (2019) use industry transfer and innovation. They explore the PHH and whether the industry is strongly or weakly mobile. If an industry has reasonable relocation costs, it is strongly mobile. Moreover, if it is a sensitive environmental cost, that industry moves to another country with lax environmental obligations. PHH might exist in this way. Besides, if that industry could not change the place of establishment easily, it must improve innovative activities to reduce environmental damages instead of bearing taxes and other costs; hence, PHH is not valid. The net effect of pollution industries is a combination of two effects.

Taguchi and Murofushi (2011) explain the theory according to the repeated or learned mistakes by developing countries. When developing countries take benefits from the spillover effect of environmental know-how, talents, and techniques, we call that 'latecomer's advantages. Contrary to these advantages, if global rivalry forces developed countries to follow stringent environmental regulations, they might have to apply for outsourcing and shift their pollutive productions to developing countries. They must search for pollution-haven countries. This condition turns the situation of developing countries into the 'latecomer's disadvantages. From all these explanations, we can draw the effect of PHH on the environment in equation 4;

$$Y_{ed} = f\{\pm\alpha_4 \sum_i^N X_{phh}\} \quad (4)$$

The coefficient is positive reflecting the pollutive leading of foreign investment/strong mobile industry/ latecomers' disadvantages in equation 4. On the reverse side, it is negative for pollution penetrating investments/weakly mobile industry/latecomer's advantages.

4 Environmental Dimension

As the second law of thermodynamics, we can accept entropy as the physical reason behind environmental degradation. This chapter first explains this subject and then moves on to the concept of the Anthropocene.

4.1 Entropy law

In producing economic value, human beings combine their knowledge and techniques with physical units (such as natural sources, and raw materials). Hence, the economy and nature always contact each other. Providing that environmental quality diminishes, various problems occur such as resource depletion, the loss of species, global warming, etc. Due to the interaction between the environment and economic activities, a feedback effect arises where they can sometimes facilitate and sometimes hinder each other. On the economic side, production activities destroy the environment; at the same time, the depletion of natural resources can disrupt the economy (Smulders, 1995). In this perspective, when natural resources are an input for the economic process; waste (pollution) is inevitable output (Georgescu-Roegen, 1975).

The origin of the entropy term is the third law of thermodynamics and the investigation of heat losses caused revealed the law. In the first half of the 19th century, works on steam engines led to thermodynamics to develop. Meanwhile, Sadi Carnot's detected the losses of heat in the machines working with an efficient level of less than a hundred percent. Meaning that there was no equality between heat (input) and work (output) (Tao, 2016).

In 1854, Rudolf Clausius extended his work and formulated the first and second rules of thermodynamics (Tao, 2016). While the first law is about energy conservation in an isolated system, the second law is about entropy expressing continuous and irreversible available energy decay in that system (Georgescu-Roegen, 1986). Energy is divided into available/free convertible to work and unavailable/bond energy. Moreover, the process of energy transformation from one kind to another continues until heat energy. After that, heat disappears into the atmosphere and cannot come back (Georgescu-Roegen, 1975).

The introduction of entropy to the field of economics by Nicholas Georgescu-Roegen in his work "The Entropy Law and the Economic Process" in 1971. His statement is the first conceptualization and proposal for entropy as a form of the disorder. It describes the economic process that involves the transformation from a low entropy level to a high level by producing irreversible waste (Tao, 2016). In other words, if an economic system/process does not meet sufficient energy, it must stay in a high disorder environment. Besides, if the system consumes the energy sources, it reluctantly generates a large amount of waste but reaches a low disorder.

Boltzman (1974) accepted the idea of entropy as a disorder persisting especially in microstates such as atoms and molecules. In the case of the macrostates level, he mentions chaotic structure, either the state has or tends to it. Furthermore, entropy is the logarithmic value of microstates (Tao, 2016). Thereafter, with the increasing environmental awareness movements in the 1970s, Eugene Odum applied the thermodynamic principle to ecology. Ecosystems and subsystems demonstrate low entropy or sustain a high level of internal order. Despite the internal decreasing rate of entropy, external rates increase (Tao, 2016).

If we regard entropy as an index of disorder, movements and changes turn out at fewer regular levels. In this step, energy input is a requirement to increase the order level (Ayvaz, 1991). Odum (1971) says that a system can reach a low level of entropy by continuous diffusion from high energy utility (light, for instance) to low energy utility (heat) (Tao, 2016). When an order (equilibrium) of a system breaks down, more energy is necessary for a higher level of order. Making a system stable requires continuous energy input however more energy consumption causes more waste. Hence, this process results in a vicious circle, and the entropy of all universes tends to raise (Ayvaz, 1991). As countries develop and all energy-consuming devices/techniques increase in number, the destruction of natural resources and pollution rise to an unignorable level of pollution (Georgescu-Roegen, 1975). The phenomenon of entropy has an increasing rate and might be a nonlinear function. We picture this criterion as follows.

$$Y_{ed} = f\{+\alpha_5 \sum_i^N X_{ent}\} \quad (5)$$

In equation 5, as energy requirements rise to sustain any system equilibrium (economic, social, etc.), output as a pollution waste or the amount of destruction to the environment increases, and the disorder level rises. The economy uses low-entropy natural sources (capital) such as solar energy, geothermal wells, and underground and surface minerals and extracts high-entropy waste (Daly and Farley, 2011).

4.2 Inevitable end: Anthropocene

The cumulative disrupting consequences of human activities beget a shift from the "Holocene" to the "Anthropocene” in the definition of the planetary epoch. Although the best-known disruption is climate change, this term also emphasizes on biodiversity decline, waste generation, a huge amount of resource expulsion, deforestation, etc. A new age definition has been mentioned since the 2000s but particularly intensified last decades. The title of this new age is Anthropos: human and -cene: new or recent coming from \textit{kainos) belong to Ancient Greek terminology. This Geologic Time Scale had been taken the attention of scientists who are not only climate scientists, geologists, archaeologists, historians, and ecologists but also writers, activists, the arts, and poets, etc (Malhi, 2017).

The first usage of the Anthropocene term entitled by Crutzen & Stoermer (2000) and Crutzen (2002) refers to the "geology of mankind" or "the age of man" (Malhi, 2017; Mishra, 2017). This naming is only a tiny part of the context. Reasons for a new epoch terminology and starting date are crucial elements of the Anthropocene. Human behaviors and activities, such as the usage of energy sources and land, food consumption, and trade induce disruption and hinder basic planetary functions. Therefore, there will be an interaction between human and non-human systems through human dominance (Malhi, 2017). The figure 1 depicts proposals for the dating.

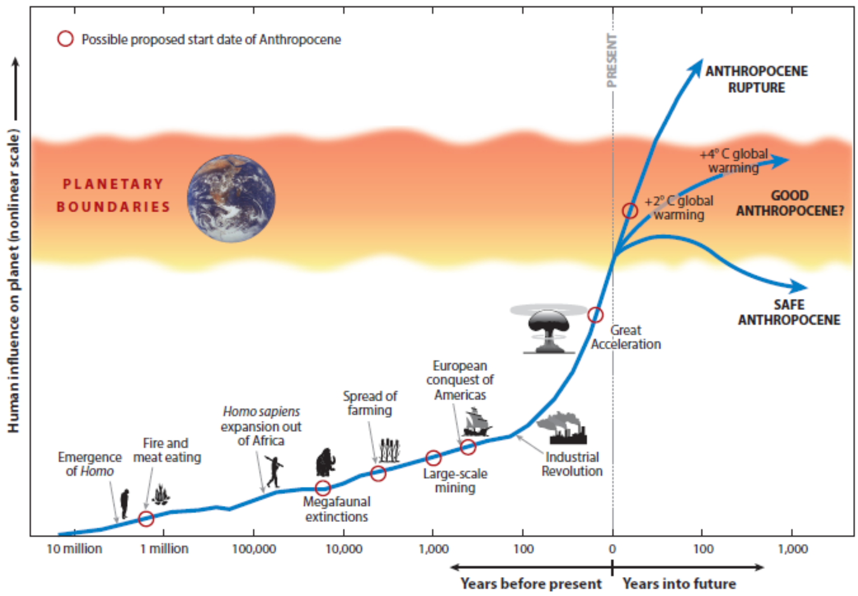

Figure 1. *A timeline of increasing human influence on the Earth system, start dates proposals for the Anthropocene,* ***Source:*** *Malhi, 2017*

According to figure 1 the starting date of the Anthropocene changes depending on the opinions of scholars. Although initial trials focused on effects at the local scale, subsequent attempts have shifted the focus from the local to the global scale. Hence, discernible human influences are from local effects like ecosystems and biodiversity to the global environment like changes in planetary albedo. It is obvious from the figure that the process accelerated with the industrial revolution and the atomic bomb caused an increase in the velocity of anthropogenic activities (Malhi, 2017; Crutzen, 2021).

Beyond the historical perspective, various scientific perspectives investigate the features of this age such as earth system science, biosphere, geological, cultural, and philosophical perspectives. Earth system sciences focus on disruptive human activities on planetary functions. These disruptions are mainly related to warming consequences causing the shift from one age to another. Moreover, variability in glacial layers, climate changes, and biogeochemistry properties are also massive human impacts (Malhi, 2017). Mishra (2017) states that different reports produced by working groups argue that the interrelation rate between human activities and climatic and hydrologic changes is above the % 80 on average. The biosphere perspective enlarges the previous approach and adds significant changes in planetary biodiversity. The geological perspective is helpful for the historical perspective by detecting stratigraphic traces. Perspectives so far try to measure or depict the symptoms of the Anthropocene; cultural and philosophical perspectives have the dimension of managing the challenges and directing the explorations based on pessimistic or optimistic ideas. Challenges spread from the ideas to further civilizations for progress level. Explorations try to solve what is human and what is nature (Malhi, 2017; Purdy, 2015).

5 Conclusion

All problems generally start from an individual scale and expand to greater scales such as local, regional, territorial, and global values in time. The theories mention the relevant sources of environmental destruction with different aspects. In the social dimension of sustainable development, the free rider problem illustrates the selfishness of humans meanwhile the tragedy of commons puts insatiable greed in the center for demolition.

When we investigate environmental problems in the economic dimension. The focus of the Environmental Kuznets curve is on income and unequal distribution. Moreover, the pollution haven hypothesis studies possible reasons for making a country a haven for dirty industries. On the environmental side, the physical dynamics of pollution are the subject of entropy law. The Anthropocene might be a destination for the reckless behaviors of humans.

Solving environmental problems and developing beneficial policies and methods depend on the diagnosis of problems. Tao (2016) emphasizes the physical roots of pollution and states that instead of making each other eternal enemies, political actors and corporate entities can contribute to a more equal share of responsibility and a more harmonious world. Similarly, some problems cross national borders and require supranational consensuses like as ozone depletion and climate change. Additionally, some problems necessitate international support such as acid rain and the pollution of many international rivers and seas. Coordination among the countries is inevitable for efficient remedies (Folmer, et. al, 1993). On the other side, possible solutions for the issue need an interaction between biophysical and social, psychological, and economic limitations that are significant for a sustainable future (Smulders, 1995).

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