RELATIONSHIP OF PER CAPITA GROSS DOMESTIC PRODUCT TO ENVIRONMENTAL CONSERVATION: AN APPLICATION IN LATIN AMERICAN COUNTRIES

Melva Inés Gómez-Caicedo*, Mercedes Gaitán-Angulo[1]**, Álvaro Luis Mercado Suárez*, Rosa Eugenia Reyes Gil*, Anderson Quintero** , Esmeralda Arroyave**
*Fundación Universitaria los Libertadores
**Fundación Universitaria Konrad Lorenz, Ph.D. of Business Administration,

ABSTRACT
Among the most relevant concerns of human beings nowadays is that of gas emissions, especially carbon dioxide emissions in developed and underdeveloped countries, authors such as Ghazvini, Dehghani Madvar, Ahmadi, Rezaei, El Haj Assad, Nabipour, and Kumar, R. (2020) argue that CO2 emissions related to energy are considered one of the most crucial problems and are rapidly increasing due to increased urbanization. It is important to highlight that different countries have enacted environmental regulations that generate a positive impact on development and ecological sustainability, but these regulations must be applied efficiently, it is of vital importance that political institutions play a leading role in the formulation and management of environmental regulations. Therefore, the following article aims to analyze the relationship of the Gross Domestic Product Per capita with environmental conservation, in Latin America, taking into account that its participation in the world economy according to data from ECLAC (2018) represents 8% of the Global GDP of the world population and we contribute to environmental degradation. For the development of this study, the Kuznets Environmental Curve was used, which allows generating a relationship between GDP per capita and CO2 emissions. The data used corresponds to 27 economies: Argentina, Belize, Bolivia, Brazil, Colombia, Costa Rica, Cuba, Dominica, Dominican Republic, Ecuador, Grenada, Guatemala, Guyana, Honduras, Haiti, Jamaica, Saint Lucia, Mexico, Nicaragua, Panama, Peru, Paraguay, El Salvador, Suriname, Saint Vincent and the Grenadines. This allows the generation of hypotheses based on the relationship between monetary amounts and the effect of a set of implications that arise as a result of the use of natural resources (Mosconi, et al. 2020), which may present the low efficiency of the processes. Among the most relevant findings, it can be concluded that the behavior of carbon dioxide emissions is closely related to the GDP per capita, indicating that the general Latin American income is based on environmental exploitation, agriculture and invasive livestock farming.

KEYWORDS; Sustainable Development Goals, Emerging economies, environment.

MSC: 62P05

RESUMEN
Entre las preocupaciones más relevantes del ser humano en la actualidad se encuentra la de las emisiones de gases, especialmente las emisiones de dióxido de carbono en los países desarrollados y subdesarrollados, autores como Ghazvini, Dehghani Madvar, Ahmadi, Rezaei, El Haj Assad, Nabipour, and Kumar, R. (2020) sostienen que las emisiones de CO2 relacionadas con la energía son consideradas uno de los problemas más cruciales y están aumentando rápidamente debido al incremento de la urbanización. Es importante resaltar que diferentes países han promulgado regulaciones ambientales que generan un impacto positivo en el desarrollo y la sostenibilidad ecológica, pero estas regulaciones deben ser aplicadas eficientemente, es de vital importancia que las instituciones políticas jueguen un papel protagónico en la formulación y gestión de las regulaciones ambientales. Por lo tanto, el siguiente artículo tiene como objetivo analizar la relación del Producto Interno Bruto Per cápita con la conservación del medio ambiente, en América Latina, teniendo en cuenta que su participación en la economía mundial según datos de la CEPAL (2018) representa el 8% del PIB Global de la población mundial y contribuimos a la degradación ambiental. Para el desarrollo de este estudio se utilizó la Curva Ambiental de Kuznets, la cual permite generar una relación entre el PIB per cápita y las emisiones de CO2. Los datos utilizados corresponden a 27 economías: Argentina, Belice, Bolivia, Brasil, Colombia, Costa Rica, Cuba, Dominica, Ecuador, Granada, Guatemala, Guyana, Honduras, Haití, Jamaica, República Dominicana, Santa Lucía, México, Nicaragua, Panamá, Perú, Paraguay, El Salvador, Surinam, San Vicente y las Granadinas. Esto permite generar hipótesis basadas en la relación entre los montos monetarios y el efecto de un conjunto de implicaciones que surgen como resultado del uso de los recursos naturales (Mosconi, et al. 2020), que pueden presentar la baja eficiencia de los procesos. Entre los hallazgos más relevantes, se puede concluir que el comportamiento de las emisiones de dióxido de carbono está estrechamente relacionado con el PIB per cápita, lo que indica que el ingreso general latinoamericano se basa en la explotación ambiental, la agricultura y la ganadería invasiva.

PALABRAS CLAVES: Objetivos de Desarrollo Sostenible, economías emergentes, medio ambiente.

1. INTRODUCTION

[1] mercedes.gaitana@konradlorenz.edu.co

The beginning of the 21st century marked a fundamental trend in global socio-economic development, the introduction of new technologies generated tools that simplified communication between countries, as well as scientific exchange, leading to the generation of greater environmental awareness and Corporate Social Responsibility, supported by the Sustainable Development Goals (SDGs), to promote responsible consumption and production of goods and services offered. In this way, countries set their bases on economic, ecological, and social perspectives to provide global benefits in the long term.

Therefore, a large number of countries are joining the generation of an ecologically responsible business infrastructure; however, the ecological progress of emerging regions such as Latin America has been put aside to focus on the quality of life of the inhabitants and the economic benefits that can be obtained.

Thanks to the prioritization of these aspects, the immediate impact of the policies established by governments has been measured, of which economic models that establish a relationship between the Gross Domestic Product obtained by a country and the environmental degradation it generates stand out. One of them is Kuznet's environmental curve, which establishes that how the Gross Domestic Product per capita affects environmental degradation is based on three phases: (a) the growth between Gross Domestic Product and environmental degradation is proportional, which indicates that the commercialization of products expands continuously decreasing traditional domestic production; (b) supply and demand issues tend to be balanced so that at the moment when households adopt modern technologies domestic production is generated and mass consumption is maintained, as well as the ecological deficit; and (c) the technological growth of territories allows establishing efficient and sustainable alternatives whose implementation decreases environmental degradation.

If this theory is true, in emerging countries such as those of Latin America, the evolution of per capita income would reflect the fact that it is generated solely from environmental exploitation and the transition of these lands to cropland and livestock.

This is a particularly worrisome scenario since the export dynamics of globalization have generated a latent dependence on agricultural products, as well as a biological need for oxygen and water from the forests and jungles present in these territories, which if not satisfied would generate a biological and nutritional imbalance that would affect the entire land surface.

Authors such as Adebayo, Awosusi, Odugbesan, Akinsola, Wong, W. K., and Rjoub, (2021). They have studied the relationship between economic performance and environmental sustainability, under the influence of energy consumption, urbanization and trade openness in Brazil for which data spanning from 1965 to 2019 were taken into account, Wavelet coherence and gradual change causality tests were used to capture the causal link between economic growth and regressors, being able to capture the causal link between series at different frequencies and periods. Among the most relevant results, we find that urbanization, trade openness, CO 2 emissions and energy use can predict Brazil's economic performance.

Authors such as Laverde-Rojas, Guevara-Fletcher and Camacho-Murillo, (2021) indicate in their research that the impact of climate change is becoming more relevant and critical every day: floods, droughts, storms, heatwaves, sea-level rise, alteration of crop growth and interruption of water systems are some evidence of this phenomenon. It is important to recognize that there is a close relationship between CO2 and economic activities (Batjes, 2014) and industrial production leads to intensive energy consumption which increases gas emissions (Nordhaus, 2019).

Ghazvini, Dehghani Madvar, Ahmadi, Rezaei, Haj Assad, Nabipour, and Kumar (2020), indicate that energy linked CO2 emissions are a big problem and are increasing due to increased urbanization in cities, using a neural network model they applied the IWO-SVM method to model energy related CO2 emissions. In this regard, the consumption of different energy sources, such as renewables, natural gas, coal and oil, and the GDP of the G8 countries in several years (from 1990 to 2016). Within the most relevant findings, it can be concluded that the technological orientations of the G8 countries to mitigate CO2 emissions are determined by patent analysis.

Hence, the objective of this article is to study the possible repercussions of the annual Gross Domestic Product per capita on the environmental conservation of Latin American countries, and if there is any relationship with the generation of alternatives that support the sustainable development of nations.

This document is divided into three parts: the first part allows visualizing the importance of measuring economic growth through the Gross Domestic Product and its relationship with the environment; the second part presents a descriptive study of the data, both the evolution of the GDP and carbon emissions; this to identify possible atypical data and the possible generation of biases in the information in Latin American countries. In the third part of the study, validation with the theory of Kuznet's environmental curve is

generated, contrasting CO2 generation as a function of GDP per capita, by territory and globally in the 25 Latin American countries available in the database, to identify holdings and relationships between the two variables. Finally, the conclusions of the study are presented.

2. THEORETICAL FRAMEWORK

For centuries, science has analyzed the phenomena surrounding humanity from different perspectives or visions. Thomas Kuhn (1974) has called them paradigms, which have allowed to provide models that facilitate the solution of problems of economic, social, political, and environmental nature, which are the basis for the promotion of the growth of nations.

Thus, in 1956, Solow (cited by Schiliro, 2017), defined economic growth as a process that facilitates the accumulation of income obtained as a result of the efficient use of productive factors, highlighting labor, entrepreneurial and technological capacity.

For Samuelson (cited by Boianovsky, 2020), economic growth is defined as the expansion of the production of each country, which can be expressed in better salaries and living standards for its inhabitants; but without recognizing the impacts on the environment and the capacity for renewal and natural restoration.

In this sense, said the concept is articulated with economic development, which is not limited to the construction of wealth that implies growth, but includes the notion of well-being, understood as the capacity to satisfy psychological and physiological needs in the present, as well as for the fulfillment of expectations or longings in the future (Duarte and Jiménez, 2007).

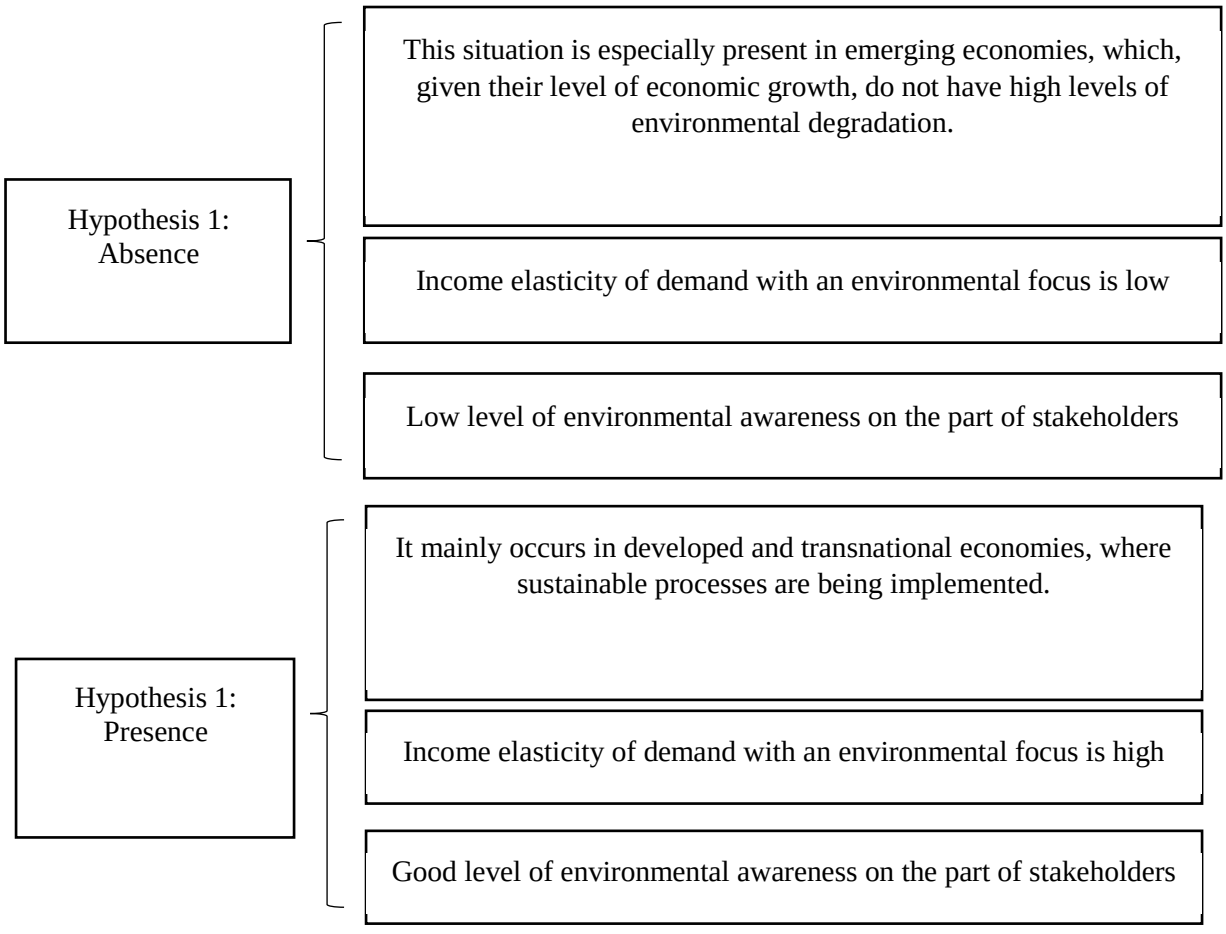


Figure 1. Hypotheses proposed for the countries according to EKC measurement results.
Source: From Shahbaz and Sinha (2018).

Hickel and Kallis (2020) state that although growth is related to the new trends that are presented around the process of economic evolution, and that gives rise to the measurement and comparisons that can be made

between indicators such as Gross Domestic Product (GDP) and carbon emissions (Haberl, et al, 2020); are processes that require the accompaniment and generation of actions that in the short and long term can be considered as a determining factor in countries, due to the economic, social and environmental policies that can be implemented (Robledo and Olivares, 2013; Marjanović, Milovančević, and Mladenović, 2016; Lane, 2011).

Likewise, these two perspectives: growth and economic development, have been associated with the exploitation of natural resources (Havranek, Horvath and Zeynalov, 2016) and the increase in consumption (Czapla, 2020), which has generated the degradation of the natural conditions of ecosystems, the loss of biological species due to multiple factors that have fractured the natural dynamics, the inadequate exploitation of natural resources, the increase in the intensity of natural phenomena, their impact on human life, among others (Castaño and Reyes, 2020; Zaidi, et al, 2019); generating interest in studying phenomena related to the development and its implications with sustainable processes (Martínez Idrobo and Figueroa Casas, 2014).

Since the middle of the 20th century, multiple scientific publications, conventions, conferences, and international agreements have exhorted nations about the implications of living in this paradigm and the need to generate changes in the policies and actions proposed by the economic models. Indeed, from the Stockholm Conference (1972) to the present, the countries that confirm the United Nations Organization have discussed a change of paradigm that contemplates and resolves the constant controversy that exists between the impacts of the current development model and its negative impacts on the environment and the community.

Hence, the effects generated by consumerism on the growth of economies and its impact on the environment are studied, especially generated after the industrialization process that has promoted the massive use of resources (Wall, 2006; Dinda, 2014), without taking into account their use, limitations, consequences of misuse and direct and indirect effects that may be generated.

Thus, according to Kasperowicz (2015), economic growth is directly associated with pollution levels, which increase as GDP increases, due to the levels of consumption and thus the resources that are used during production (Parra, 2016).

Therefore, models arise such as the one established from the theory developed by Kuznets in 1955, which establishes an indirect relationship between the resources used and the economic benefits obtained represented through the GDP per capita (Dasgupta, et al, 2002; Cole, Rayner and Bates, 1997). However, according to Stern (2017) and Andreoni and Levinson (2001), this behavior can be reversed to the extent that as there is an improvement in the level of income, countries tend to have more efficient policies and therefore, resources are efficiently used, resulting in a decrease in environmental pollution, which makes the Environmental Kuznets Curve (EKC) tend to be an inverted U.

In this sense, according to Shahbaz and Sinha (2018), the results generated from the generation of the EKC can lead to the statement of two hypotheses that give rise to the following interpretations (Figure 1):

In this way, the importance of generating environmental awareness in all actors is evident, since this has an impact on the efficiency of resource use and, therefore, on the reduction of pollution levels and increases in income for the countries (Chen, Huang and Lin, 2019).

This leads to raising the importance of generating activities that promote the improvement and use of productive processes in a sustainable way, with responsible consumption (Bringezu, 2019; Hatfield-Dodds, et al, 2017). From there, the effects that will result in benefits for all actors involved in the economy will be derived.

Thus, the development of economically sustainable policies that, in addition to generating economic growth, favor care for the environment, are objectives that countries have proposed to develop to obtain greater benefits in the future.

The excessive emission of greenhouse gases (GHG) has generated the phenomenon of global warming, which has arisen because man has managed to increase the presence of gases in the troposphere to levels that are unusual, resulting in different climatic phenomena that affect humanity economically, culturally, and environmentally, in the short, medium and long term, without forgetting that they are increasing every day due to human activity. Carbon dioxide, nitrous oxide and methane, together with hydrofluorocarbons, perfluorocarbons and sulfur hexafluoride are the largest group used for different industrial and chemical processes and play a role that continuously aggravates global warming, taking into account the above, the world has been implementing various changes to improve the situation and prevent this phenomenon from worsening, so we want to guide production processes through the generation of more sustainable energy, All this starting with the signing of the United Nations Framework Convention on Climate Change, which obliges countries to take precautionary measures to take good care of the environment and avoid spreading pollutants on the planet. Ahmadi, Dehghani Madvar, Sadeghzadeh, Rezaei, Herrera, and Shamshirband,.(2019).

Electrical systems, degeneration and different machines have had a potential development in recent years as they are indispensable for the power system in addition to different operations that different companies use daily, this system is a nonlinear device that is quick to use and has different inputs and outputs, in addition, it is stable and solves different artificial neural situations being a key artificial intelligence technique for the reduction of global warming phenomenon as it manages to analyze the presence or absence of different variables and preset parameters for the study. Rezaei., Sadeghzadeh, Alhuyi Nazari, Ahmadi and Astaraei, (2018).

Environmental care aims that the consumption and production of the forces that are considered driving forces of the economy count on a moderate, natural use, which avoids destructive effects on the planet on which we live, But not only companies must make a change but also each person must have a more sustainable pattern of consumption and production, Therefore, we must raise awareness to increase the efficiency of resources and that humanity has a sustainable lifestyle, life is sustainable also collaborates indirectly in reducing poverty and achieve a transition to green economies that enhance and achieve lower carbon emissions. During the COVID-19 pandemic, it was emphasized that the relationship that people should have with nature should be clean, limited and valued to establish limits so as not to generate a negative impact on the planet, which are reflected in consumption and production through sustainability. Ahmed, Ahmad, Rjoub, Kalugina, and Hussain (2021).

The globalization and liberation of different trade barriers allows the elaboration of different transactions in order to import and export raw materials and hydrocarbons to continue with the progress and development of the different countries, however, the organization in the growth of the city implies that geographical, social and economic factors are taken into account in order to expand the availability of resources and thus collaborate with international trade achieving importation to any part of the world, Urban sustainability presented an increase in international trade due to its results where a change in the flow of matter and energy is seen without negatively affecting the quality of the planet, by means of different studies it has been possible to propose a multidisciplinary innovation that allows socio-environmental changes and does not seriously impact the planet, but on the contrary, it is immersed in a new world order bringing strategies of substitution of energetic and environmental sources to improve in this way any process. Adebayo, Awosusi, Odugbesan, Akinsola, Wong, and Rjoub (2021).

The energy problems considerably affect the environment making a change of energy that comes from fossil fuels for clean energy that is positive for the environment and strengthen a developing society, the strategy proposed is to use solar energy in different regions that pose power shortages in addition to places that have the technological advancement and can help implement this mobile solar panel using the resource remains the sun. The mobile solar panel brings clean energy and has the function of chasing the sunlight wherever it moves based on algorithms that use the rotation and translation of the earth as a basis for balancing where the sun would point, for the moment it is only as an educational tool but it is important to start with its implementation. Ahmed, Ahmad, Rjoub, Kalugina, and Hussain, (2021).

Climate change accelerated the average temperature of the planet due to carbon dioxide and the fundamental causes are fossil sources such as carbon, gas and oil, At first, the fossil sources collaborated for the first world to achieve a high standard of living, however, However, the rest of the countries managed to imitate this development and now it is a serious process for the environment and future generations. That is why it is necessary to reduce the global emission of carbon dioxide into the atmosphere and that the consumption of these products be reduced in such a way that it is essential to create new sustainable processes to correct the environmental impact using environmental indicators that show how the quality of life of the country has been affected.

Carbon left an important footprint during global warming, causing droughts, floods, extreme weather phenomena and thaws having a high impact on agriculture, water, ecosystem, quality of life and food, however, correcting this carbon footprint would be in a sustainable way and would bring a series of competitive opportunities for different businesses correcting inefficiencies in productive processes participating in more demanding value chains and improving the scenario of many countries before the environment and the business world. Also, there is the strategy of strengthening governments and food exporters so that both products and services are also sustainable by issuing agro-exportable products. Li, Geng, Shinwari, Yangjie, and Rjoub, (2021)

3. METHODOLOGY

Sustainable Development is one of the most studied topics nowadays, and on which a relationship with the economy, society and the environment is sought to be generated. Therefore, the Gross Domestic Product (GDP) is an indicator that allows for measuring the amount of goods and services produced in a country during a given period; and that besides being recognizable and quantifiable for the analysis and comparison of the levels of economic growth (Krugman, 2019); it can be compared with indicators of ecological deterioration that has highly unstable dynamics due to the innumerable factors, some independent of the human being.

Thus, in this study, the Kuznet Environmental Curve was used, which allows for generating hypotheses based on the relationship between monetary amounts and the effect of a set of implications that arise as a result of the use of natural resources (Mosconi, et al. 2020), which may present the low efficiency of processes.

Given the instability of environmental change, some regions could suffer greater effects of polluting entities in the territories, while, for other regions, the perception of change may be almost imperceptible, in such a way, global units were generated that do not depend on the territorial or economic context of the countries but the polluting emissions of the same.

In this sense, to identify the monetary benefit produced by a country, the Gross Domestic Product per capita was used, defined as the total value of all goods and services produced by a country in a given year, divided by the number of people living in it (Krugman, 2019). Likewise, for the calculation of ecological deterioration, it was necessary to study and identify different metrics that allow standard monitoring of all territories.

Organism studied

As previously established, many parameters allow monitoring climate change and the increase of pollutant emissions in the territories, however, some are difficult to quantify, and others are based on the individual perception of the observer. Thus, in this study, three metrics of deterioration that establish territorial ecological capacities were considered:

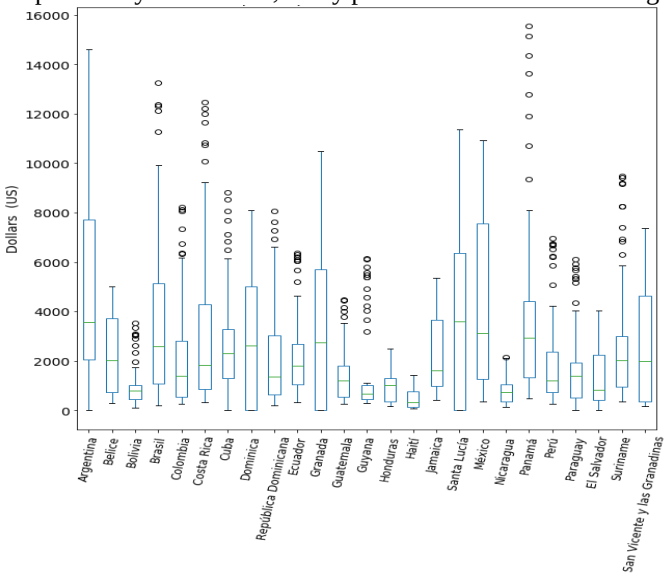


Figure 2. GDP per capita distribution since 1960

a. Biocapacity, according to Global Footprint Network (2021) is a measure that has as a unit the biologically productive hectares that are regenerated annually and refer to the resources that can be generated by ecosystems to meet the needs of the inhabitants of a territory.

b. The ecological footprint is a measure that allows the identification of the hectares that an individual or community requires to subsist, produce, and relate to others (Global Footprint Network, 2021).

CO2 or carbon dioxide emissions

c. measure the number of tons that are emitted when using fossil fuels and greenhouse gases (Global Footprint Network, 2021).

Although the three metrics are linked to the general evolution of the territories and measure the progressive degradation of biologically productive land, the parameters used to establish the ecological footprint and biocapacity are based on the productive viability of the land and not only on the ecological deterioration of human beings.

Thus, the metric used to monitor progressive environmental degradation was CO2 emissions, since it is a standard quantity specifically dependent on human economic production and technological development.

Data description.

Data for both GDP per capita and carbon footprint emissions were retrieved from World Bank repositories (World Data Bank., 2019; Oak Ridge, 2019).

The information was downloaded in Excel format files and each database was distributed in three sheets, Metadata - Indicators, Metadata - Countries and Data, the latter possessing annual information for 267 regions in which countries, continents and a global summary were found. The records for each territory had information from 1960 to 2018.

For carbon emissions, the units set were kilotons, while for GDP per capita the unit set was dollars.
From the totality of the regions, only the available Latin American countries were filtered, which were: Argentina, Belize, Bolivia, Brazil, Colombia, Costa Rica, Cuba, Dominica, Dominican Republic, Ecuador, Grenada, Guatemala, Guyana, Honduras, Haiti, Jamaica, Saint Lucia, Mexico, Nicaragua, Panama, Peru, Paraguay, El Salvador, Suriname, Saint Vincent and the Grenadines.

Study development

This study will be divided into two parts. In the first part, a descriptive study of the data will be carried out, both the evolution of GDP and carbon emissions in order to identify possible outliers and the possible generation of biases in the information. In addition, the descriptive study will identify the Latin American distribution of income and carbon dioxide emissions.
The second part of the study will focus on generating a validation with the kuznet environmental curve theory, contrasting CO2 generation as a function of gross domestic product, by territory and globally in the 25 Latin American countries available in the database, to identify holdings and relationships between the two variables.
For the behavioral adjustment, a model was established according to the evolution of the phenomenon under study, whose parameters will be adjusted by means of a maximum likelihood minimization method known as Monte Carlo Markov estimation.

4. RESULTS

From the rescued data, per capita GDP distributions through 2018 are shown in Figure 2.
According to the data, GDP per capita maintains a general range except for Panama, which has the most irregular and highest outliers in all of Latin America, while Argentina is the country with the most volatile gross domestic product. On the other hand, the distribution of the carbon footprint is shown in Figure 3.

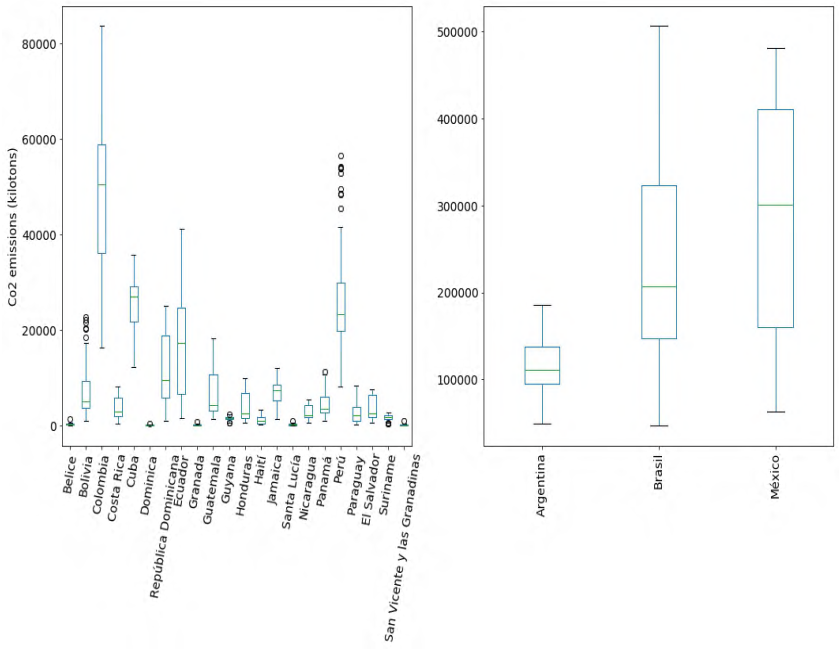


Figure 3. Distribution of Co2 emissions since 1960.

Unlike GDP per capita, CO2 emissions do not have a large amount of isolated data, and the overall standard deviation is lower than the average. Of the countries of note in carbon dioxide emissions are Argentina, Brazil and Mexico, which have a much larger scale than the overall average, as well as a much larger deviation. The distribution of annual emissions indicates that countries are generating more and more carbon dioxide and cases such as Colombia have a very unstable growth rate compared to other countries. Contrasting carbon dioxide as a function of per capita GDP in each of the countries gives the results shown in Figure 4.
Figure 4 shows how the evolution of carbon dioxide emissions visually appears to have a logarithmic relationship in cases such as Argentina, Brazil, Colombia, Costa Rica, Cuba, Dominica, Dominican Republic, Ecuador, Grenada, Guatemala, Honduras, Jamaica, Mexico, Nicaragua and Panama. While the remaining countries have linear, exponential, or no apparent relationship, however, these countries are less represented and may not be representative in the Latin American total gross domestic product and carbon emissions. Thus, a general analysis was made based on the Latin American average, whose annual evolution is shown in Figure 5.

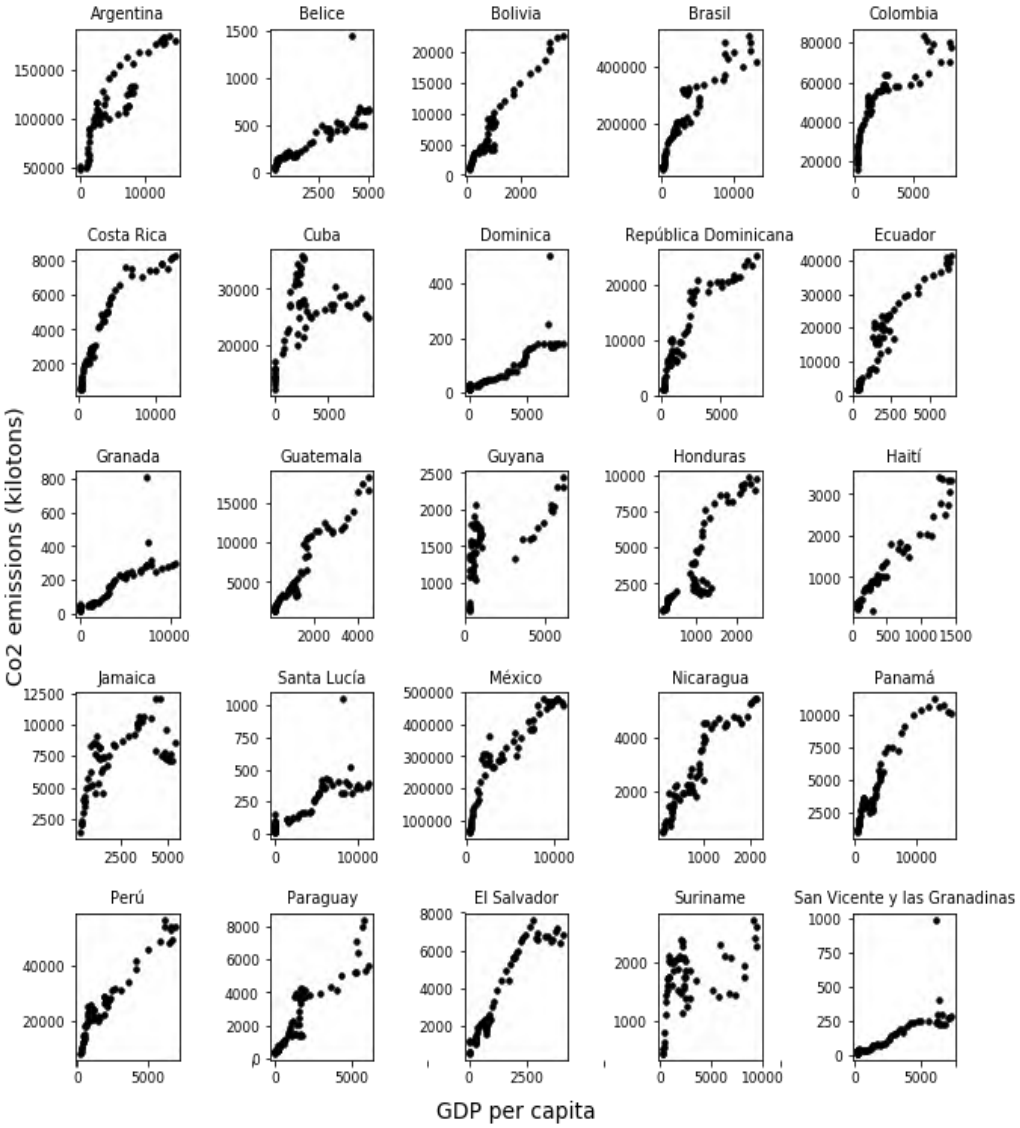
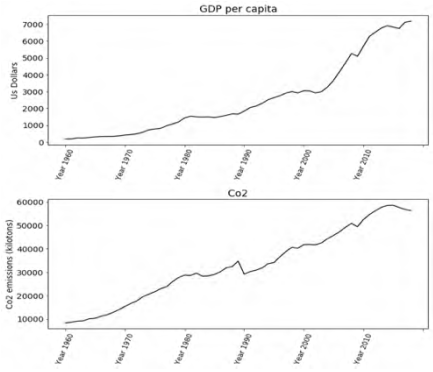


Figure 4. Carbon dioxide emissions as a function of GDP per capita.



As can be seen in Figure 5, the similarities between the annual growth of both variables generate similar behaviors, both in growth and stagnation, such is the case of the years between 1980 and 1990 that present a slight decrease in common and a maximum peak between 2010 and 2018.

Finally, Figure 6 shows the contrast between GDP and average carbon emissions in Latin America, the trend is clearly described under a logarithmic behavior which was approximated from the function.

$$y = 13975.23 \times log(x) - 70299.29$$

Figure 5. Average annual evolution of gross domestic product and carbon emissions in Latin America.

Where X represents GDP per capita, as well as Y, is the estimated carbon emissions.

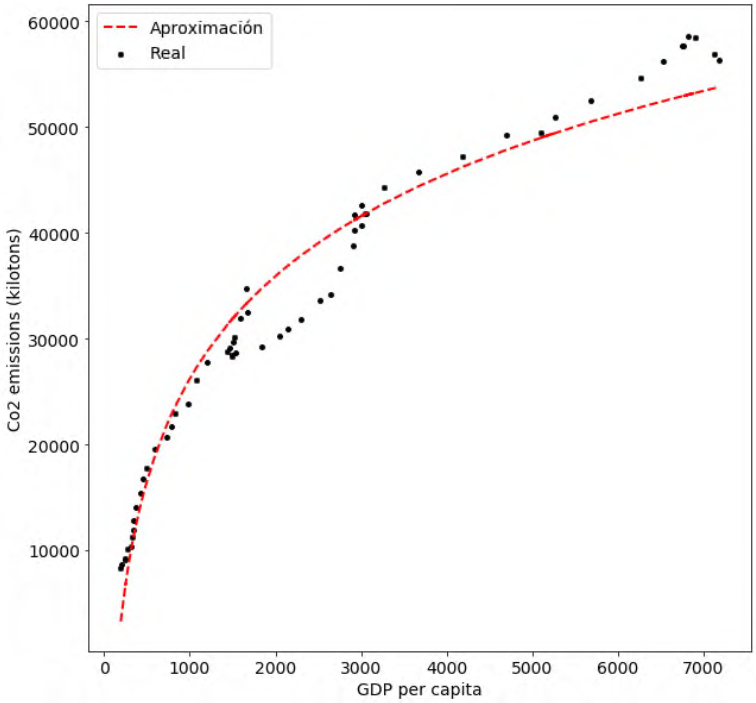


Figure 6. Carbon emissions as a function of GDP

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For this model, the value 13975.23 represents the growth ratio, so each unit of growth in GDP represents a high level of increase in CO2 emissions, and this behavior is increasing and tends to be less and less controllable.

One of the peculiarities of the logarithmic models is that, despite the fact that the behavior is fully increasing, there is a point of stability that allows for a deceleration of the behavior.

However, given the nature of the phenomenon, the self-regenerating properties of the environment as measured by the biocapacity of the environments only allow to cover a small percentage of the overall damage done on the world's lands

Thus, the logarithmic model seems to adjust a process of uncontrollable growth taking as the only variable of interest the evolution of GDP and its increase based on inflation assuming technological stagnation, a hypothesis validated for developing countries such as those found in Latin America.

5. DISCUSSION AND CONCLUSIONS

The results of the study indicate that the initial phase of the Kuznet curve is satisfied by the Latin American global, however, given that the growth trend of both variables has not shown a significant reduction for the last 50 years, it is improbable to know the future behavior when applying technologies that support the reduction of environmental deterioration.

The behavior of carbon dioxide emissions is closely related to GDP per capita, indicating that Latin America's overall income is based on environmental exploitation, agriculture, and invasive livestock farming.

Although replacing current economic policies and strategies by applying new technologies is a slow process that requires technological and territorial conditioning, which can be even more complicated in developing countries, to generate a relevant change in territorial development it is necessary to invest more in science, as well as in rural development and focus it on promoting livestock farming that is friendly to forest lands.

In the absence of the necessary technologies for ecologically responsible development, it would be appropriate to establish guidelines so that new business models and innovations learn to measure and quantify the environmental impact, biocapacity and ecological footprint of their work activities to identify the actions that have the greatest impact on the environment.

Future research will address the use of technological support and how this would significantly affect the evolution of the model, for this it would be of vital importance to use sophisticated simulation methods through artificial intelligence and contrast it from countries with a high technological level that have managed to reduce their ecological footprint through intelligent patterns and sustainable technological development.

It is important to make a change in tourism, turning it into sustainable tourism that contributes to the conservation and reduction of the exploitation of natural resources, being tourism an indispensable economic source in different countries it is important to keep it afloat in the best possible way. Energy and climate change must adapt to the different challenges that bring both the 21st century and future generations because here everything that is currently being done is excessive and makes the planet urgently needs a change to transform what affects the world in sustainability.

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