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THE CARBON DIOXIDE EMISSIONS' WORLD FOOTPRINT: DIAGNOSIS OF PERSPECTIVES

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Purpose: The purpose of the article is to elucidate the multifaceted nature of the carbon dioxide emissions dilemma and underscore the urgent need for concerted action to mitigate their adverse effects.
Design/methodology/approach: This paper elucidates the methodology of footprint research, outlining its key components, approaches and principles. It encompasses a multidisciplinary approach, drawing on various methodologies and tools to explore alternative futures and identify strategic opportunities. Combining multiple methods has provided a more complete and detailed understanding of complex interactions.
Findings: This study aims to analyse the main indicators of the impact of the ecological footprint on the state of the environment, to determine their dynamics over time, to assess the prospects of the negative impact of humanity on nature. Emissions of greenhouse gases are of particular importance in this analysis.
Research limitations/implications: Ultimately, the goal is to inspire action and advocacy for policies and practices that prioritize environmental stewardship, social equity and resilience in the face of climate change. The implications of this study underscore the importance of stakeholder engagement and adaptive management for effective integration.
Originality/value: The footprint of carbon dioxide emissions encompasses a broad spectrum of impacts, spanning environmental, economic, and social dimensions. At its core, the rise in atmospheric carbon dioxide levels, largely attributed to human activities such as the combustion of fossil fuels and widespread deforestation, triggers a cascade of consequences with far-reaching implications. These results could be especially interesting for researchers whose studies are interdisciplinary.
Keywords: ecological footprint, economic development, carbon dioxide emissions, growth, sustainable development, deforestation.
Category of the paper: Research paper.
JEL: Q54, F60, Q57, F55, F64.

1. Introduction

In the contemporary discourse on climate change, few issues loom as large or have as pervasive an impact as carbon dioxide emissions. The global rise in carbon dioxide levels, primarily driven by human activities such as burning fossil fuels and deforestation, has become emblematic of the environmental challenges facing our planet. This article delves into the intricate web of consequences spawned by carbon dioxide emissions, exploring their far-reaching footprint across various spheres of the environment, economy, and society. From altering atmospheric composition to influencing weather patterns, from jeopardizing biodiversity to shaping geopolitical dynamics, the footprint of carbon dioxide emissions extends across myriad dimensions, underscoring the urgent need for concerted action to mitigate their detrimental effects. Through a comprehensive examination of these impacts, we aim to deepen our understanding of the multifaceted nature of the carbon dioxide dilemma and illuminate pathways towards a more sustainable future.

The footprint of carbon dioxide emissions encompasses a broad spectrum of impacts, spanning environmental, economic, and social dimensions. At its core, the rise in atmospheric carbon dioxide levels, largely attributed to human activities such as the combustion of fossil fuels and widespread deforestation, triggers a cascade of consequences with far-reaching implications. Environmental repercussions of carbon dioxide emissions are profound and pervasive. Elevated levels of atmospheric carbon dioxide contribute significantly to global warming, driving changes in climate patterns, including rising temperatures, altered precipitation regimes, and increased frequency of extreme weather events. Furthermore, carbon dioxide emissions exacerbate ocean acidification, threatening marine ecosystems and coral reefs, while also accelerating the loss of biodiversity on land and at sea.

The economic ramifications of carbon dioxide emissions are equally significant. The reliance on carbon-intensive fuels for energy production not only perpetuates environmental degradation but also engenders economic vulnerabilities, as nations grapple with the costs of climate-related disasters, diminished agricultural yields, and disruptions to vital ecosystems. Moreover, carbon dioxide emissions perpetuate social inequalities, disproportionately impacting marginalized communities who bear the brunt of environmental degradation and climate-related disasters.

Addressing the challenge of carbon dioxide emissions requires concerted action on a global scale. Transitioning to renewable energy sources, implementing sustainable land-use practices, and fostering innovation in clean technologies are imperative steps towards mitigating the detrimental effects of carbon dioxide emissions. Additionally, promoting international cooperation and equitable policies can facilitate the transition to a low-carbon future while ensuring social justice and resilience in the face of climate change.

The primary objective of this article is to elucidate the multifaceted nature of the carbon dioxide emissions dilemma and underscore the urgent need for concerted action to mitigate their adverse effects. By exploring the extensive footprint of carbon dioxide emissions across various spheres of the environment, economy, and society, the article aims to deepen understanding of the interconnectedness of these impacts and illuminate pathways towards a more sustainable future. Through a comprehensive examination of the environmental, economic, and social ramifications of carbon dioxide emissions, the article seeks to raise awareness about the pressing need for global cooperation and innovative solutions to address the challenges posed by climate change. Ultimately, the goal is to inspire action and advocacy for policies and practices that prioritize environmental stewardship, social equity, and resilience in the face of climate change.

2. An overview of the literature

Many scientists of the world offer valuable insights into the methodologies, implications, and challenges associated with assessing and mitigating humanity's footprint on the planet. They serve as foundational literature for understanding the complexities of sustainability and guiding future research and policy interventions.

The role of footprint examined by Le C. Quéré et al. (2018). This paper provides an extensive analysis of global carbon emissions, sinks, and trends. It offers insights into the main drivers of carbon dioxide emissions, such as fossil fuel combustion and land-use changes, and assesses their implications for climate change mitigation strategies.

The authors M.Wackernagel and W.Rees (1996) introduce the concept of the ecological footprint as a measure of humanity's demand on nature and its ecosystems. This foundational work explores the methodology behind calculating ecological footprints and its relevance for sustainability assessments. Another investigation, highlights areas where resource consumption exceeds ecological limits and proposes strategies for achieving ecological balance (Wackernagel et al. (2004). The scientists' study focuses on evaluating the ecological footprint and biocapacity of the United States, providing valuable insights into the country's sustainability challenges and opportunities.

The concept of the ecological footprint, pioneered by Mathis Wackernagel and William Rees, provides a comprehensive measure of humanity's impact on the environment by quantifying the amount of biologically productive land and water required to sustain human activities and absorb waste. As human populations grow and consumption patterns intensify, the ecological footprint expands, placing increasing pressure on natural resources and ecosystems. Factors contributing to a larger ecological footprint include unsustainable consumption habits, overexploitation of natural resources, habitat destruction, and land-use change.

The G.P. Peters and E.G. Hertwich (2008) present a pioneering analysis of the carbon footprint of nations, considering not only domestic emissions but also emissions embodied in international trade. Their findings reveal the interconnected nature of global carbon emissions and highlight the importance of addressing emissions embedded in global supply chains.

Another investigator, M.A. Curran (2013) examines various methods for calculating carbon footprints and discusses factors influencing their accuracy and reliability. The paper also explores practical applications of carbon footprint assessments in industry, policy, and consumer behavior. A group of scientists with A. Galli conducted a comparative analysis of ecological footprints and biocapacity across European countries, shedding light on regional disparities in resource consumption and environmental impact. The study identifies key drivers of ecological overshoot and offers recommendations for sustainable resource management (Galli et al., 2012).

M. Lenzen and others (2012) insist that there is the relationship between ecological footprints and water scarcity, emphasizing the need for integrated water and land management strategies to ensure sustainable resource use. The paper offers insights into the complex interplay between human activities, resource consumption, and environmental degradation.

According to the literature review and what the author was able to find, there are no studies referring and reporting on carbon dioxide emissions as a paramount concern, reflecting their widespread influence on our planet. That is why it is so important to analyse the main indicators of the impact of the ecological footprint on the state of the environment, to determine their dynamics over time, to assess the prospects of the negative impact of humanity on nature. This article investigates the intricate ramifications stemming from carbon dioxide emissions, delineating their extensive footprint across environmental, economic, and societal domains. By exploring the extensive footprint of carbon dioxide emissions across various spheres of the environment, economy, and society, the article aims to deepen understanding of the interconnectedness of these impacts and illuminate pathways towards a more sustainable future. Through a comprehensive examination of the environmental, economic, and social ramifications of carbon dioxide emissions, the article seeks to raise awareness about the pressing need for global cooperation and innovative solutions to address the challenges posed by climate change.

3. Research methods

The main methods that were used during the conduct of this study to assess the ecological footprint of humanity and greenhouse gas emissions are as follows: literature review, data collection and analysis, case studies, synthesis and Interpretation, policy implications and recommendations. The research methodology is based on the system method, analysis and synthesis, economic analysis and the dialectical method. For example, the methodology of this article begins with an extensive review of existing literature on carbon dioxide emissions and their impacts. This includes scholarly articles, reports from international organizations, and relevant policy documents. By synthesizing information from diverse sources, the author aims to provide a comprehensive overview of the subject matter.

Data Collection and Analysis – data pertaining to carbon dioxide emissions, atmospheric concentrations, climate trends, economic indicators, and societal impacts are collected from reputable sources such as the Intergovernmental Panel on Climate Change (IPCC), the World Bank, Statista and national environmental agencies. Statistical analysis and modeling techniques may be employed to elucidate trends and patterns in the data.

The analysis of practical cases is also the basis of this study - how successful countries solve the problem of ecological footprint within their economies, so that it does not negatively affect the well-being and health of the population. In order to illustrate the real-world implications of carbon dioxide emissions, case studies from different regions and sectors have been examined. These case studies provide valuable insights into the specific challenges and opportunities associated with mitigating carbon dioxide emissions and adapting to climate change.

The findings from the literature review, data analysis, case studies, and expert interviews are synthesized to provide a holistic understanding of the footprint of carbon dioxide emissions. Key themes, trends, and implications are identified and interpreted in the context of current debates and policy discussions surrounding climate change.

Finally, based on the synthesized findings, the article offers policy implications and recommendations for mitigating carbon dioxide emissions and addressing their impacts. These recommendations are informed by evidence-based research and aim to contribute to ongoing efforts to combat climate change at local, national, and global levels.

Various methods and formulas based on the results of the analysis of footprint indicators, can be used to help evaluate various aspects of future development and reduce negative environmental impacts on nature and the population, below are some of them:

1. Greenhouse Gas Emissions (CO_2, CH_4, N_2O):

$$E=P\times E_F\times(1-E_R) \tag{1}$$

where:

E – greenhouse gas emissions;

P – production or consumption volume (e.g., amount of fuel used);

E_F – emission factor for the specific source (grams per unit of production or consumption);

E_R – emission reduction factor due to energy-efficient technologies or emission reduction programs.

2. Carbon Footprint (F_c):

$$F_c=\sum(E\times P_{GWPs}) \quad (2)$$

where:

F_c – carbon footprint (expressed in amount of CO_2 equivalent emitted);

E – greenhouse gas emissions (CO_2, CH_4, N_2O);

P_{GWPs} – global warming potentials for each gas.

3. Natural Resource Use (U_{NR}):

$$U_{NR}=\sum(U\times F_E) \quad (3)$$

where:

U_{NR} – natural resource use (measured in hectares or water areas);

U – amount of resources used (e.g., amount of land used for urbanization);

F_E – equivalence factor reflecting the environmental impact of using each resource.

4. Ecological Footprint (F_E):

$$F_E=\sum(P\times E_{Fp}) \quad (4)$$

where:

F_E – ecological footprint (measured in hectares);

P – amount of production or consumption (e.g., amount of land used);

E_{Fp} – functioning equivalence reflecting the ecological impact of each type of land use.

These formulas aid in quantitatively assessing the impact of human activities on the environment and determining which aspects of consumption and production need improvement to reduce the footprint.

4. Main Results

In recent decades, the world has witnessed escalating environmental degradation, manifested in phenomena such as climate change, deforestation, loss of biodiversity, and pollution. This deterioration of the environment is driven by a complex interplay of human activities, including industrialization, urbanization, intensive agriculture, and fossil fuel combustion. Among the key contributors to this degradation are the ecological footprint – the measure of humanity's demand on nature – and greenhouse gas emissions, which trap heat in the Earth's atmosphere, leading to global warming and climate disruption. Understanding the relationship between these factors is crucial for devising effective strategies to mitigate environmental degradation and ensure a sustainable future for generations to come.

The concept of humanity's "footprint" refers to the cumulative impact that human activities have on the environment, typically measured in terms of resource consumption, land use, and environmental degradation. When discussing carbon dioxide emissions and their connection to humanity's footprint, it pertains to the amount of greenhouse gases, particularly CO_2, released into the atmosphere as a result of human activities such as burning fossil fuels for energy, industrial processes, transportation, and deforestation.

To illustrate this concept, consider the following examples what tools do countries use to reduce their environmental footprint (tab. 1). The burning of fossil fuels, such as coal, oil, and natural gas, for electricity generation, heating, and transportation, releases significant amounts of carbon dioxide into the atmosphere. The more energy-intensive our lifestyles and industries become, the larger our carbon footprint grows. The widespread use of cars, trucks, airplanes, and other forms of transportation that rely on fossil fuels contributes substantially to carbon dioxide emissions. For instance, a single international flight can produce as much carbon dioxide as an average person emits in a year through other activities. Forests serve as vital carbon sinks, absorbing CO_2 from the atmosphere through photosynthesis. However, deforestation, driven by agricultural expansion, logging, and urbanization, reduces the Earth's capacity to sequester carbon dioxide. When forests are cleared, the stored carbon is released back into the atmosphere, exacerbating climate change. Various industrial activities, including manufacturing, cement production, and chemical processes, release carbon dioxide. These emissions contribute to the overall carbon footprint of human civilization, particularly in regions heavily reliant on industrial production. Agricultural practices such as livestock farming and rice cultivation produce methane and nitrous oxide, potent greenhouse gases that contribute to global warming. Additionally, the use of synthetic fertilizers releases nitrous oxide, further adding to humanity's carbon footprint.

In essence, humanity's footprint encompasses the full spectrum of activities that release greenhouse gases into the atmosphere, exacerbating climate change and its associated impacts. By understanding and mitigating this footprint through sustainable practices, renewable energy adoption, afforestation efforts, and policy interventions, we can work towards reducing our collective impact on the planet and fostering a more sustainable future. These examples illustrate the varying levels of impact different countries have on the environment through their footprints.

Table 1.
The content of the ecological footprint instruments in different countries of the world

Direction	The content of the ecological footprint	Countries	Financial instruments and initiatives
Energy con-sumption	The burning of fossil fuels for electricity generation, heating, and transportation.	USA, China, India	Green bonds, carbon pricing, renewable energy subsidies
	Increased energy-intensive lifestyles and industries lead to larger carbon footprints.	EU, Japan, South Korea	Energy efficiency incentives, clean energy investments
Trans-portation	Widespread use of cars, trucks, airplanes, and other fossil fuel-dependent transportation.	USA, Germany, Brazil	Investment in public transportation, electric vehicles
	A single international flight can produce as much CO_2 as an average person emits in a year through other activities.	UAE, Australia, Canada	Aviation emissions trading, fuel efficiency standards
Defo-restation	Deforestation due to agricultural expansion, logging, and urbanization.	Brazil, Indonesia, Democratic Republic of Congo	REDD+ initiatives, forest conservation programs
	Reduced capacity of forests to absorb CO_2, leading to increased atmospheric carbon.	Malaysia, Papua New Guinea	Forest restoration projects, sustainable land management
Industrial processes	Industrial activities like manufacturing, cement production, and chemical processes.	China, United States, Germany	Carbon capture and storage projects, clean technology investments
	Emissions of CO2 as a byproduct contribute significantly to the global carbon footprint.	India, Japan, South Africa	Emissions trading schemes, carbon offset programs
Agri-culture	Agricultural practices such as livestock farming and rice cultivation.	Argentina, Nigeria, Vietnam	Sustainable agriculture initiatives, methane capture projects
	Production of methane and nitrous oxide, potent greenhouse gases, exacerbating climate change.	Australia, Mexico, Kenya	Agroforestry programs, soil carbon sequestration projects
	Use of synthetic fertilizers also contributes to the release of nitrous oxide.	France, China, Ethiopia	Fertilizer efficiency programs, organic farming subsidies

Source: The data is based on the latest available statistics from Galli et al., 2012; European Commission, 2024; Le Quéré et al., 2018; Wackernagel, Rees, 1996; Yakymchuk et al., 2020; Curran, 2013; Peters, Hertwich, 2008; Lenzen et al., 2012.

Global warming is largely caused by increased emissions of carbon dioxide and other greenhouse gases into the atmosphere. Temperature anomalies are generally more important in the study of climate change than absolute temperature, as they are less affected by factors such as station location and elevation. Annual anomalies in global land and ocean surface temperature from 1880 to 2023, based on temperature departure in degrees Celsius has been represented in fig. 1.

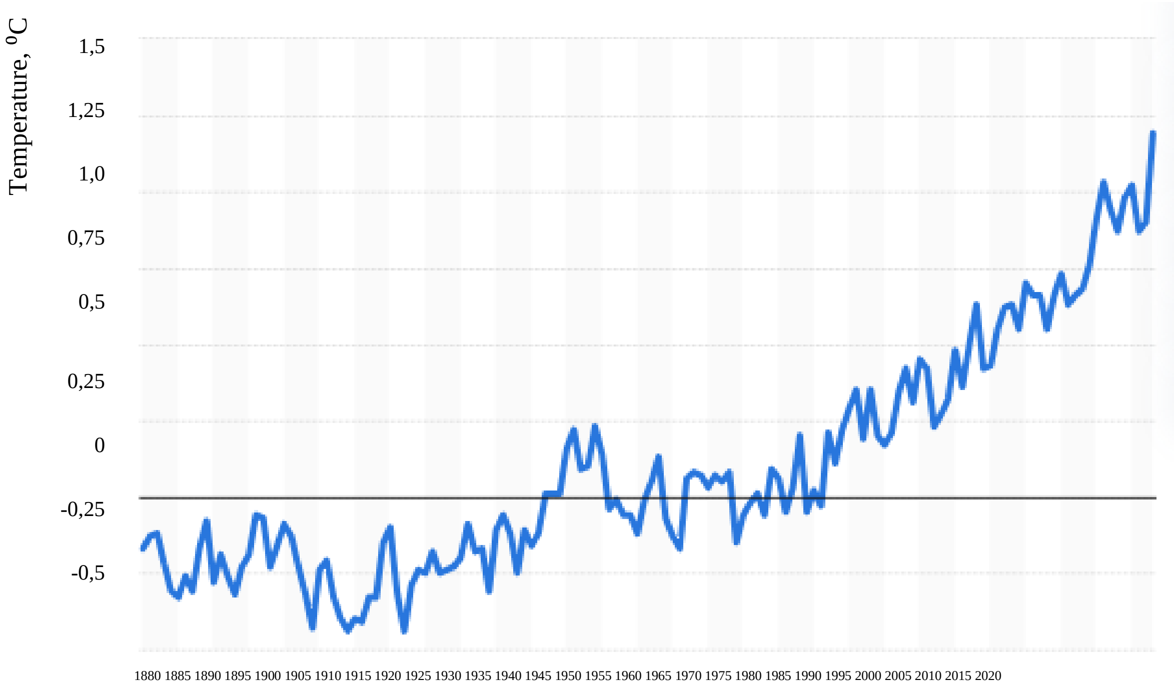


Figure 1. Global land and ocean temperature anomalies, 1880-2023.

Source: The data is based on the latest available statistics from Statista, 2024; European Commission, 2023.

Positive anomalies show that the observed temperature was warmer than the baseline. Land surface temperature anomalies are generally higher than ocean anomalies, although the exact reasons behind this phenomenon are still under debate. The annual temperature departure from average since the 1980s has been consistently positive. In 2023, the global land and ocean surface temperature anomaly stood at 1.19 degrees Celsius above the 20th century average, the largest recorded across the displayed period. The highest temperature anomaly was observed in 2023. Such climate changes are evidenced by the melting of sea ice areas in the Northern Hemisphere. As a result, temperature increases and weather changes become characteristic of other world regions, and therefore the level of warming increases. Today, warming and ice loss are most evident in the Arctic region compared to Antarctica (Statista, 2024).

Ecological footprint per capita worldwide in 2017, by region (in global hectares per capita) has been presented in fig. 2.

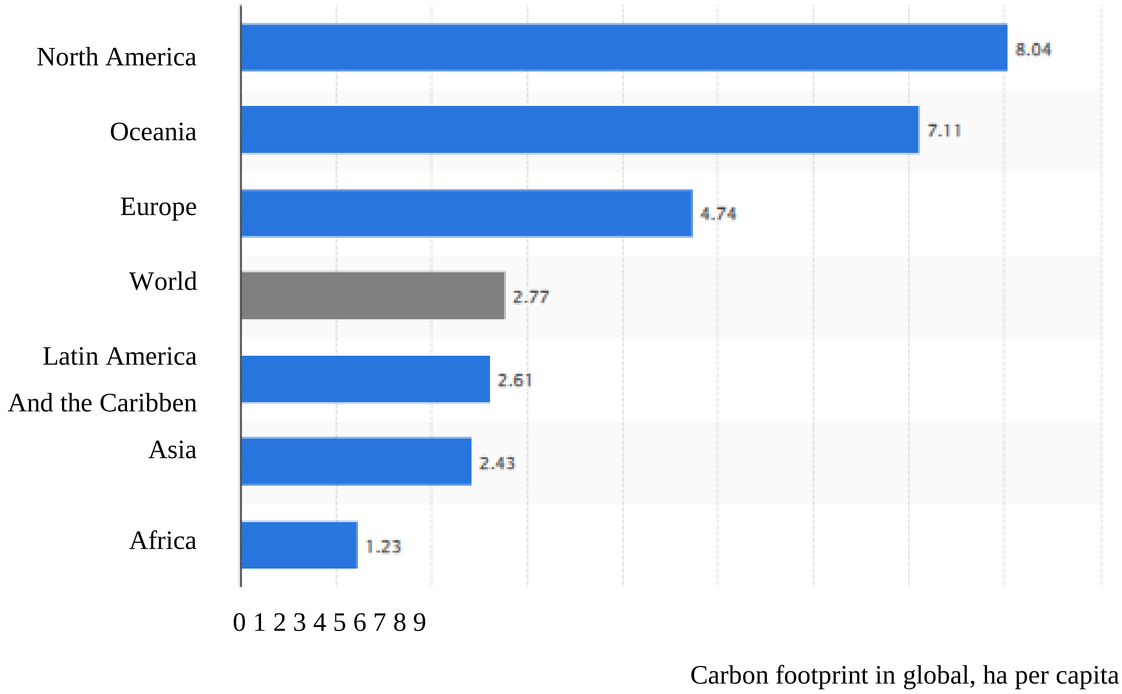


Figure 2. Global per capita ecological footprint, 2017.

Source: The data is based on the latest available statistics from Statista, 2024; European Commission, 2024.

As shown in Fig. 2, the average resident of North America had the largest ecological footprint – more than eight hectares per capita according to 2017 data. By comparison, the average person living in Africa had an ecological footprint of only 1.36 hectares. Oceania and Latin America are the only regions of the world where the estimated biocapacity has exceeded the ecological footprint. This includes the Caribbean. Africa occupies marginal indicators. Since 1970, the world has experienced a net global deficit (Statista, 2024).

It is worth noting that according to official data, global carbon dioxide emissions from fossil fuels and industry amounted to 37,15 billion metric tons in 2022. Experts believe that emissions will increase by an average of 1,1% in the future. It is worth mentioning that since 1990, global CO_2 emissions have increased by more than 60% (fig. 3).

China is the largest contributor to global greenhouse gas emissions, followed by the United States. Since 1990, CO_2 emissions in China have more than quadrupled. The spread of COVID-19 caused global CO_2 emissions to decrease by approximately 5.5% in 2020 (Statista, 2024).

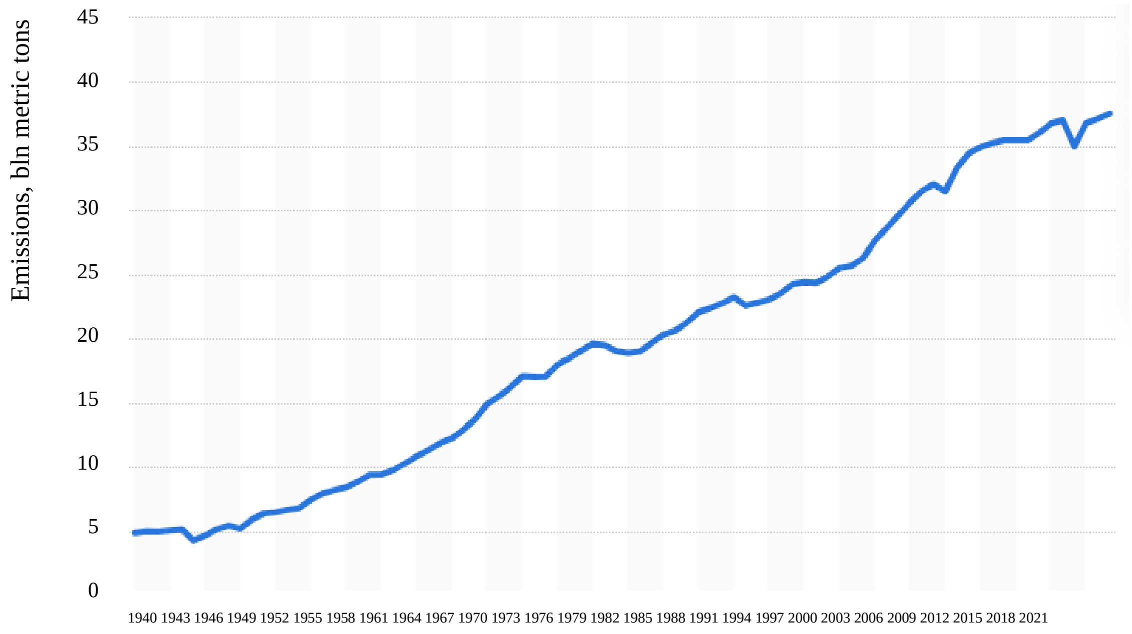


Figure 3. Annual carbon dioxide (CO_2) emissions worldwide, 1940-2021.

Source: The data is based on the latest available statistics from Statista, 2024; European Commission, 2023.

The volume of CO_2 emissions in Ukraine was analysed on the basis of official statistics. It is worth noting that emissions decreased by 15% compared to 2008. This is due to the consequences of the global economic crisis of 2008. During this time, the production of cement, ammonia and metal decreased significantly. In 2010-2013, the growth of CO_2 emissions was characterized by a general recovery of the economy. During this period, the consumption of solid fossil fuels in the energy sector increased. In 2014-2015, a sharp reduction in emissions was observed, caused by the decline of the economy due to the occupation of the Autonomous Republic of Crimea and the city of Sevastopol, as well as the beginning of hostilities in the Donetsk and Luhansk regions. In 2016-2019, fluctuations in CO_2 emissions were observed at the level of 337-362 million tons of CO_2-equivalent. This period is characterized by the beginning of the active implementation of the energy efficiency policy (the "Warm Credits" program is being implemented) and the gradual bringing of tariffs for electricity, hot water and heat to market values. However, in 2020, emissions fell by 11% compared to 2019 levels, because of COVID-19 pandemic and measures taken to combat the virus. In 2021, the recovery of the country's economy led to an increase in greenhouse gas emissions by 7.5% compared to 2020.

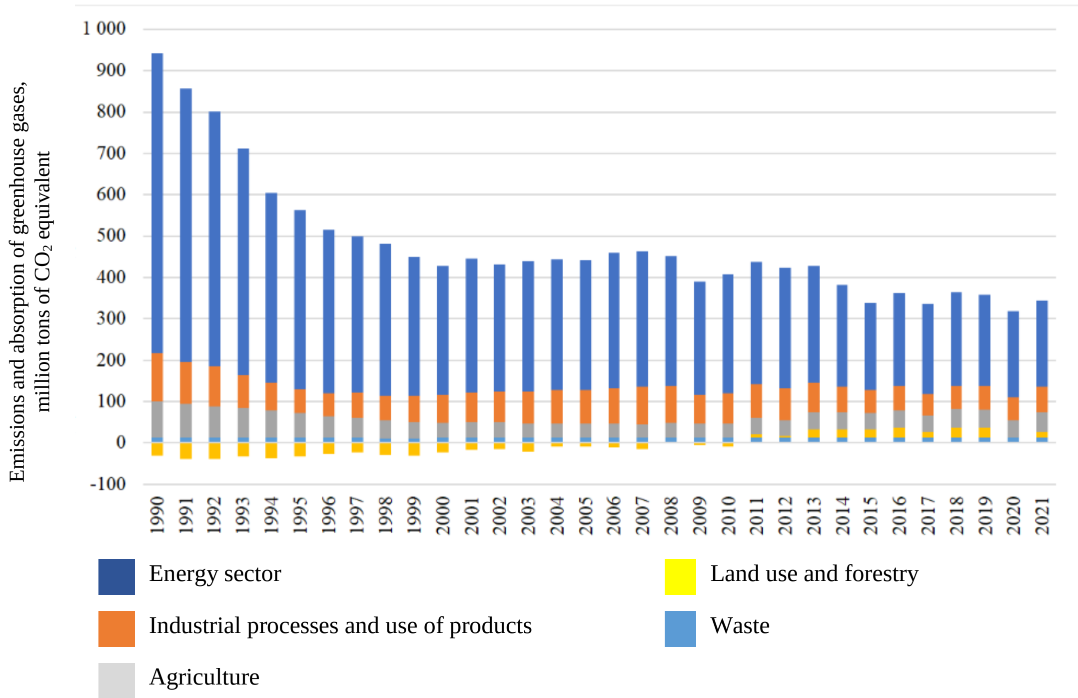
Table 2.
Emissions and absorption of CO_2 in 1990-2021 in Ukraine, tys. tons

Sphere of the national economy	Years					Deviation of data 2021 to 1990 (+; -)	Growth rate (decrease) of emissions in 2021 to the base year 1990, %
	1990	2015	2017	2019	2021		
1	2	3	4	5	6	7	8
Energy sector	725,3	210,8	217,8	219,2	209,7	-515,6	-71,1
Industrial processes and use of products	118,2	56,4	51,8	57,6	61,5	-56,7	-48,0
Agriculture	86,8	39,4	40,9	44,8	47,0	39,8	-45,9
Land use and forestry	31,4	19,7	13,4	23,3	14,2	-17,2	-145,3
Waste	12,4	12,6	12,7	12,6	12,2	-0,2	-2,3
Total	911,4	33,9	336,7	357,5	344,6	-566,8	-62,2

Source: The data is based on the latest available statistics from Povidomlennia pro opryliudnennia 2022; Statista, 2024; European Commission, 2024.

According to the data of the Ministry of Environment, in 2021, GHG emissions in the "Energy" sector amounted to 209.74 million tons of CO_2-equivalent, or approximately 64% of all GHG emissions in Ukraine. During the entire period of 1990-2021, these emissions decreased by 71,1% compared to the base level. In the Industrial Processes and Product Use sector, GHG emissions increased by 9,8 % in 2021 compared to 2020. This growth occurred in all key categories: "Manufacturing of mineral products", "Metallurgy" and "Chemical industry". The main factor behind this increase in GHG emissions is the recovery process of Ukraine's economy after quarantine restrictions in 2020. At the same time, GHG emissions in the sector in 2021 decreased significantly (by 48 %) compared to the base year of 1990, which is associated with a decrease in industrial production in the metallurgical industry by 50% and the chemical industry by 43% (Povidomlennia pro opryliudnennia, 2022; Ministry of Ecology, 2024).

The author in this article did a comparative analysis on carbon footprint and ecological footprint with data for different countries (tab. 2). In United States greenhouse gas emissions (CO_2) amount to approximately 5 billion metric tons per year, primarily due to the use of coal and oil in energy production and transportation. China is the world's largest emitter of greenhouse gases – CO_2 emissions exceed 10 billion metric tons per year, a result of intensive industrial activity and growing energy consumption. Sweden has one of the lowest carbon footprints per capita in the world. The carbon footprint per capita in Sweden is approximately 4 tons per year, thanks to high levels of renewable energy use and energy-efficient technologies. The United States have one of the highest carbon footprints per capita in the world. The carbon footprint per capita in the United States can reach up to 16 tons per year due to high energy consumption and reliance on coal and oil (Statista, 2024).



Source: The data is based on the latest available statistics from Povidomlennia pro opryliudnennia, 2022; Statista, 2024; European Commission, 2024; Ministry of Ecology, 2024.

Australia has one of the largest ecological footprints per capita in the world. The ecological footprint per capita in Australia reaches up to 8 hectares per year, mainly due to extensive land use for agricultural purposes and high levels of greenhouse gas emissions. Netherlands has a relatively small ecological footprint per capita. The ecological footprint per capita in the Netherlands is approximately 3 hectares per year, thanks to high levels of energy efficiency and waste management.

Table 3.

Comparative analysis on carbon footprint and ecological footprint data for different countries

Country	Carbon Footprint (tons CO_2/capita)	Ecological Footprint (global hectares/capita)	Population (millions)	Renewable Energy Usage (%)	GDP per Capita (USD)	Human Development Index (HDI)
United States	16	8	331	11	62,606	0,926
China	8	6	1441	26	10,262	0,758
Sweden	4	7	10	54	54,947	0,937
Australia	17	8	25	17	55,060	0,944
Netherlands	10	5	17	11	52,331	0,944

Source: The data is based on the latest available statistics from Statista, 2024; European Commission, 2024; Le Quéré et al., 2018; Wackernagel, Rees, 1996; Curran, 2013; Galli et al., 2012; Peters, Hertwich, 2008; Lenzen et al., 2012; Yakymchuk, Baran-Zgłobicka, 2023.

This table provides a comparative analysis of carbon footprint and ecological footprint data for different countries. Human Development Index (HDI) ranges from 0 to 1, where higher values indicate higher levels of human development. The United States has the highest carbon footprint per capita at 16 tons CO_2, indicating a significant contribution to global greenhouse gas emissions. Sweden exhibits the lowest carbon footprint among the listed countries, reflecting its commitment to sustainability and low-carbon policies. Australia and the United

States have the highest ecological footprints, suggesting high levels of resource consumption and environmental impact per capita. Sweden, despite its low carbon footprint, has a relatively high ecological footprint, possibly due to its large land area per capita and high consumption patterns.

China stands out with the largest population among the listed countries, significantly higher than the others. Sweden has the smallest population, which may contribute to its comparatively lower environmental impact. Sweden leads in renewable energy usage, with 54% of its energy derived from renewable sources, reflecting its commitment to clean energy transition. China also shows a significant percentage of renewable energy usage, indicating efforts to reduce dependence on fossil fuels.

The United States and Australia exhibit higher GDP per capita compared to Sweden and the Netherlands, indicating greater economic output per person. Despite China's large population, its GDP per capita is relatively lower, suggesting disparities in economic development within the country. Sweden and the Netherlands have the highest HDI values among the listed countries, indicating high levels of human development in terms of education, health, and income. While China has made significant progress in human development, its HDI value is lower compared to the other countries in the table. Overall, the analysis highlights the complex interplay between environmental impact, economic performance, and human development across different countries. It underscores the importance of sustainable development strategies to balance economic growth with environmental conservation and human well-being.

Greenhouse gas emissions, primarily carbon dioxide (CO_2), methane (CH_4), and nitrous oxide (N_2O), are major drivers of climate change, exacerbating global warming and its associated impacts. The combustion of fossil fuels for energy production, industrial processes, transportation, and deforestation releases vast quantities of greenhouse gases into the atmosphere, leading to the enhanced greenhouse effect. The consequences of climate change include rising temperatures, melting polar ice caps, sea-level rise, altered weather patterns, extreme weather events, and disruptions to ecosystems and agriculture. The relationship between ecological footprint and greenhouse gas emissions is complex and intertwined, with each exacerbating the impacts of the other. Increased resource consumption, driven by a larger ecological footprint, leads to higher emissions of greenhouse gases, further intensifying climate change. Conversely, climate change-induced disruptions, such as droughts, floods, and habitat loss, can amplify resource scarcity and environmental degradation, exacerbating humanity's ecological footprint.

5. Conclusions

In this study, the author summarized the main points presented in the article, proved the essential importance of estimation of influence of carbon dioxide emissions in world economy. The main results are:

1. The footprint of carbon dioxide emissions permeates every aspect of our interconnected world, necessitating urgent and comprehensive efforts to mitigate its impacts. By acknowledging the multifaceted nature of the carbon dioxide dilemma and embracing sustainable solutions, we can chart a course towards a more resilient and equitable future for generations to come. The analysis highlights the complex interplay between environmental impact, economic performance, and human development across different countries. It underscores the importance of sustainable development strategies to balance economic growth with environmental conservation and human well-being.
2. The data illustrates significant disparities in environmental impact among the different countries. The United States and Australia exhibit higher carbon and ecological footprints, indicating greater resource consumption and emissions per capita. In contrast, Sweden demonstrates lower environmental impact, attributed to its sustainable practices and renewable energy usage. Also the data underscores the importance of renewable energy transition in mitigating environmental impact. Sweden leads in renewable energy usage, reflecting a commitment to clean energy policies. Other countries, including China, also demonstrate significant progress in renewable energy adoption, indicating a shift towards more sustainable energy sources.
3. Higher GDP per capita does not necessarily correlate with lower environmental impact. While the United States and Australia exhibit higher economic output, they also demonstrate higher environmental footprints. Conversely, countries like Sweden and the Netherlands achieve relatively lower environmental impact despite slightly lower GDP per capita, suggesting a decoupling of economic growth from resource consumption. Countries with higher levels of human development, as measured by the Human Development Index (HDI), tend to exhibit lower environmental impact and greater sustainability efforts. Sweden and the Netherlands, with high HDI values, lead in environmental sustainability, emphasizing the importance of integrating social, economic, and environmental policies for holistic development.
4. The analysis highlights the need for coordinated efforts at the national and international levels to address environmental challenges while promoting sustainable development. It emphasizes the importance of adopting cleaner technologies, reducing resource consumption, and fostering inclusive growth to ensure a more sustainable and resilient future for all.

5. Since 1970, the world has experienced a net global deficit. It is worth mentioning that since 1990, global CO_2 emissions have increased by more than 60%. Global carbon dioxide emissions from fossil fuels and industry amounted to 37,15 billion metric tons in 2022. The average resident of North America had the largest ecological footprint – more than eight hectares per capita according to 2017 data. By comparison, the average person living in Africa had an ecological footprint of only 1,36 hectares. Oceania and Latin America are the only regions of the world where the estimated biocapacity has exceeded the ecological footprint. Experts believe that emissions will increase by an average of 1,1% in the future. China is the largest contributor to global greenhouse gas emissions, followed by the United States. Since 1990, CO_2 emissions in China have more than quadrupled. The spread of COVID-19 caused global CO_2 emissions to decrease by approximately 5.5% in 2020.
6. The volume of CO_2 emissions in Ukraine was analysed on the basis of official statistics. Emissions decreased by 15% compared to 2008. This is due to the consequences of the global economic crisis of 2008. During this time, the production of cement, ammonia and metal decreased significantly. In 2010-2013, the growth of CO_2 emissions was characterized by a general recovery of the economy. In 2014-2015, a sharp reduction in emissions was observed, caused by the decline of the economy due to the occupation of the Autonomous Republic of Crimea and the city of Sevastopol, as well as the beginning of hostilities in the Donetsk and Luhansk regions. In 2016-2019, fluctuations in CO_2 emissions were observed at the level of 337-362 million tons of CO_2-equivalent. This period is characterized by the beginning of the active implementation of the energy efficiency policy and the gradual bringing of tariffs for electricity, hot water and heat to market values. However, in 2020, emissions fell by 11% compared to 2019 levels, because of COVID-19 pandemic and measures taken to combat the virus. In 2021, the recovery of the country’s economy led to an increase in greenhouse gas emissions by 7,5% compared to 2020.
7. The degradation of the environment represents one of the most pressing challenges of the 21st century, with far-reaching consequences for ecological integrity, human well-being, and socio-economic stability. Addressing this multifaceted issue requires a holistic approach that considers the interconnectedness of ecological footprint and greenhouse gas emissions. By adopting sustainable practices, reducing carbon emissions, conserving natural resources, promoting renewable energy, and fostering international cooperation, we can mitigate environmental degradation and pave the way towards a more resilient and sustainable future for our planet.

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