

Carbon Emissions as Threats to Environmental Sustainability: Exploring Conventional and Technology-Based Remedies

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Abstract

Carbon emissions are serious threats to the environment. This study examines carbon emissions as threats to the achievable extent of environmental sustainability. It relies on closely related secondary data that are subjected to content analysis and thematic review. It is anchored on Kuznets' Environmental Kuznets Curve theory. The EKC holds that the effects of environmental degradation, such as those of gas emissions, greatly affect a society's socio-economic growth, health wellbeing and sustainable development. Leaning on the insights from EKC theory, the study argues that the adverse effects of carbon emissions continually threaten environmental sustainability, thereby limiting the supposed significant extent of its realization. Drawing evidence from extant studies, the paper shows that efficacious and strategic conventional and technology-based techniques can be leveraged for remedies to carbon emissions and the attendant effects. It concludes that carbon emissions are indeed threats to environmental sustainability, while AI and other cutting-edge technologies and strategic conventional measures can significantly mitigate the threats. The study charges stakeholders to combine conventional and technology-based techniques for remedies to carbon emissions and the attendant effects on humans and the nonhumans alike.

Keywords: Carbon Emissions, Threats, Environmental Sustainability, Conventional Remedies, Technology-Based Remedies.

Introduction

Carbon is a greenhouse gas. Its emission into the environment is done both directly and indirectly by individuals, groups and organizations. Dakwale and Ralegaonkar (2012) emphasize that carbon emissions are serious threats to the environment; noting that the generation of energy by fossil fuel contributes to carbon emissions. Generally, carbon footprint, which arises from the difference in heat trapping, poses threats to the environment and accounts for global warming. Carbon emissions include industrial pollutions, construction and mining activities, manufacture, food production, meat products, food, livestock, transportation, and household energy, residential electricity and space heating. Greenhouse gas emissions and wasted energy are caused by gas flaring (Rodrigues, 2022).

Gas flaring is a high temperature oxidation process, used to burn combustible components having volatile organic compounds (VOCs) piped to a remote location and burned in an open-air flame. Gas flaring increases atmospheric carbon emissions (McEwen & Johnson, 2012). It causes serious harms to the environment (Bodin, 2021; Okoye et al., 2022;

Ojjiagwo, 2017). The Policy and Legal Advocacy Centre [PLAC] (2004) has noted that an estimation of gas production and consumption across the globe between 1990 and 2025 showed a worrisome state of gas flaring and energy consumption among countries. It is found that over 100 billion cubic meters of natural gas are flared annually across the globe (PLAC, 2004). Given the foregoing, this study engages with carbon emissions, which it considers as threats to environmental sustainability, to provide remedies to the threats. In doing so, it will draw evidence from extant studies.

Statement of the Problem

The rate of carbon emissions in the US is currently very high. This raises concern and deserves a scholastic investigation. Also, the worrisome effects of carbon emissions on humans and the non-humans of the ecosystem ought to be given maximum attention and large volume of research. This investigation is an attempt in that direction. The study is motivated by the serious threats posed by carbon emissions to the environment.

The research is necessary in order to contribute to the growing literatures on carbon emissions and thereby increase awareness about carbon emissions and the attendant effects. More research into carbon emissions would make the larger population of the US and other parts of the globe realize that even food and other edible substances are sources of carbon emissions. The realization would lead to a significant decrease in carbon emissions across various settings, as the mentality of aligning carbon emissions to industrial settings alone ceases.

Purpose of Study

Stating categorically, the aim of the study is to examine carbon emissions as threats to environmental sustainability, with a view to identifying conventional and technology-based remedies to the risks posed by the emissions. It has three objectives. First, the study sets out to explore carbon emissions as threats to environmental sustainability. Next, it seeks to determine the extent to which carbon emissions threaten environmental sustainability. The third objective is to identify conventional and technology-based remedies to the risks posed by carbon emissions.

Theoretical Framework

The study is rooted in Kuznets' (1955) Environmental Kuznets Curve (EKC) theory. The theory is adopted because its postulations and ideals capture gas emissions, environmentalism and environmental sustainability. The EKC theory avers that there is an inverted U-shape relation between environmental degradation and gross domestic product (GDP) per capita, such that growth is reduced by the environmental impact of economic activity in the long run (Bodin, 2021; Chakravarty & Mandal, 2016). This central viewpoint of EKC makes it a suitable theory for this study. The major reason is that the theory recognizes and worries about the adverse effects of gas emissions, such as carbon

emissions. By taking cognizance of the effects of carbon emissions, as in other gas emissions, the theory aptly situates in and grounds or roots this study adequately.

The hazardous exposure of the environment to even all that can be avoided makes it possible for carbon emissions to pose serious threats to the environment. Gas emission, including carbon emissions, can be averted if the needful is done consistently. Averting the emissions implies averting the effects. Averting the effects means saving nature, humans and animals alike from hazards. Doing this entails sustainability. The ideals of EKC allow for environmental sustainability and align with the goals of environmental sustainability. It is observed that EKC holds that as the economy of a country grows, the rates of emissions therein increase until a maximum level is reached. As Bodin (2021) agrees, an insignificant growth in the economy of a nation breeds a significant growth in emissions, while a decrease in emissions follows an increase in Gross Domestic Product (GDP).

Studies, such as Ericsson (2022), Ostic et al. (2022), and Oganessian (2017), affirm the viability of EKC theory in discourses on gas emissions and economic growth. Ericsson (2022) and Oganessian (2017) indicate that EKC adequately explains the correlation between environmental trends and economic growth. Ostic et al. (2022) are of the view that there is a specific inverted U-shaped relationship between income and environmental pollution. EKC can be faulted for basing countries' economic breakthrough on the direction of the changes in the volume of environmental pollution emitted into the environment; and asserting that when a country reaches a certain level of development, it begins to import rather than produce pollution-intensive goods. This study argues that the theory is apt in looking at environmental concerns and carbon emissions. By capturing the adverse effects of carbon (gas) emissions on the environment and the economic implications of emissions, the theory suits the present study.

It warns against human misdeeds against Nature, which either cause or facilitate environmental pollutions to human and non-human species. Its postulations on economic implications or effects of gas emissions highlight the effects of emissions on the economic wellbeing of societies and individuals. EKC makes it obvious that a nation's economy is bound to be affected by gas emissions, if left uncontrolled. It is beneficial to consistently control gas emissions. Doing so averts the risks posed by gas emissions, such as carbon emissions. The benefits are not only economic but also health-concerned, developmental, and sustainability-driven. That is why the present study adopts EKC theory for theoretical insights to carbon emissions as threats to environmental sustainability. For this study, the strengths of the EKC theory include:

- i. EKC theory captures structural changes that are capable of bringing information-intensive industries and services to place.
- ii. It raises concerns about the grave implications of exploiting the environment mindlessly and without ethical considerations for the nonhumans.
- iii. The theory draws attention to the occurrence of avoidable higher expenditures on environmental sustainability efforts and programs.

- iv. Insights from EKC foster increased awareness about environment-friendliness and environmental sustainability.
- v. The economic implications of environmental exploitations by humans pose challenges to governance and legislative efforts, and the socio-economic wellbeing of individuals and their nations.
- vi. Enacting and enforcing environmental regulations allows for sustainability, as environmental degradation gets reduced significantly.

Carbon Emissions and Environmental Concerns

The concept of carbon emissions refers to a systematic channeling of gas to the knockout drum, right from where gas is directed to the flare stack (Ojijiagwo, 2017). The concept only refers particularly to the flaring of one particular— carbon. Atmospheric carbon emissions are increased by gas flaring, which cause serious hazards to the environment (McEwen & Johnson, 2012). Such hazards pose serious threats to environmental sustainability. Flared gas consists of several compositions, with Methane (CH₄) and Ethane having the highest mole fractions (McEwen & Johnson, 2012). Gas flaring is utilized to dispose unwanted gas or the gas not needed at the moment (Bjorndalen et al., 2005). This process, as Ojijiagwo (2017) rightly notes, can take place at oil wells, refineries or even in chemical plants.

In the field of environmentalism, environment consists of animals, plants, mountains, rivers, valleys and other creatures inhabiting the ecosystem. These existential phenomena are threatened by human beings, when relate or interact harmfully with them. Human misdeeds against the environment cause ecological problems that face both humans and the nonhumans alike. On the other hand, when humans resort to all that is right or good concerning the environment, they proffer solutions to environmental or ecological problems. In this context, all that is good is all that is of common good to humans and the environment. Ericsson's (2022) study explores methane emissions and economic growth through the lens of N-shaped Environmental Kuznets Curve theory. It expresses worries over the challenging problems of climate change confronting the earth's population in contemporary time, emphasizing that the emission of greenhouse gases is a major cause of global warming. This poses serious threats to humans, non-humans and Nature. The study submits that the consequences of the emission is why high level of attention is paid to "carbon dioxide emissions and its impact on the environment" (Ericsson, 2022, p. iii).

As such, a study of this kind is imperative. There is the dire need for more research studies on carbon emissions so as to find lasting solutions to the matters arising from carbon and other gas emissions. It is to that end that the present study attempts to provide conventional and technology-based remedies to the threats posed by carbon emissions to environmental sustainability. Leaning on Environmental Kuznets Curve (EKC) theory, Bodin's (2021) study examines gas emissions and issues of economic growth in relation to environmental degradation in Austria, Portugal and Sweden. It establishes a strong positive sloped curve in Portugal, but the opposite obtained in Austria and Sweden, showing a

graphic curve resembling the EKC. Although it engages with salient environmental issues, the Bodin's study does not specifically concern itself with environmental sustainability. Also, unlike the present study, it does not focus on providing conventional and technologies remedies to the threats of environmental sustainability. The noted thematic concerns left out by Bodin's study are taken up by the present study. Thus, the present study makes unique contribution to knowledge in various regards. It also contributes to the attempts made at combating ugly environmental trends and the threats to environmental sustainability. Its attempts or provided remedies have the potential of enhancing and increasing environmental sustainability, as its goals are realized rather foiled by such threats. The threats posed by carbon and other gas emissions can be broadly categorized into environmental, developmental, technological, political and socio-economical factors. This study avers that the threats posed by carbon emissions to environmental sustainability adversely affect technological, socio-economic and politic systems of society. They also hamper development in these and other spheres.

Ethical considerations of environmental matters ground the field of environmentalism, which is broader than environmental ethics and not confined to ethics and philosophy alone. For this study, environmental ethics is the base of environmental sustainability. Issues of environmental ethics, as Zimmerman (2004) has rightly pointed out, are borne out of the differences in the experiences, perspectives and approaches of philosophers and other scholars engaged in environmentalism. The ground differences are cultural, regional and continental. The above assertion is affirmed by Zimmerman (2004), who notes that "continental philosophy shapes environmental philosophy and accounts for the variances in the conception of environmental issues, the treatment of the environment and the scholastic approaches to environmentalism" (Zimmerman, 2004, p. 3). According to Zimmerman (2004), "the experience and the conception of nature, shared by descendants of colonists, differ from the experience and the conception of nature shared by European contemporaries" (p. 4). He emphasizes that the noted "factors make the differences in the views and approaches of American, Australian, New Zealand and French environmental philosophers" (Zimmerman, 2004, p. 4). The implication of the foregoing is that the problems rooting exclusive environmental ethics are borne out of the differences in the experiences, perspectives and approaches of philosophers and other scholars engaged in environmentalism (Zimmerman, 2004).

The implication of the foregoing is that the problems rooting exclusive environmental ethics are borne out of the differences in the experiences, perspectives and approaches of philosophers and other scholars engaged in environmentalism. Environmental ethics questions human interactions or relations with the environment. The questions concern the harms human beings cause the environment while relating with and exploiting it. Akpulu (2021) describes environmental ethics as the critical philosophic interrogation of human interaction with and use of the environment, based on morality, ethics and law. Akpulu (2021) expresses the thought that through the lens of environmental ethics, one realizes

that the wrongs meted out on the environment by human beings warrant punishment for violating moral codes, ethical principles and laws that apply. Again, environmental concerns are ethical concerns. These include the threats or dangers posed by carbon emissions.

To address and prevent environmental concerns, ethics is applied to environmentalism. Interestingly, environmental sustainability is an integral part of environmental ethics and environmentalism. Doing so entails ethical principles being applied to dealings concerning the environment. Næss (1973, 1999 & 2001) identifies seven 'platform principles' that ought to be followed in human versus non-human relations in the ecosystem. These are:

- Intrinsic value and biocentric equality
- Non-violence and non-interference
- Deep questioning and self-realisation
- Ecocentrism and rejection of anthropocentrism
- Diversity and decentralisation
- Spontaneous experience and ecological perception
- Environmental activism and policy.

Technology-Based Remedies to Carbon Emissions

The point of emphasis here is that artificial intelligence (AI) and other cutting-edge technologies can be leveraged for tangible remedies to the risks of environmental sustainability. The others include smart technologies, applications, digital media, and algorithms of different kinds. The focus here is on AI technologies. That is, the study avers that AI technologies can be leveraged for remedies to carbon emissions. AI is proven by many studies to be revolutionizing different spheres with innovations. Such studies include Ali et al. (2022), Baduge et al. (2022), George et al. (2022), Onifade and Alola (2022), Talluri et al. (2022), Thuraka (2022 & 2021), Bidhendi and Azizi (2021), Bodin (2021), Srivastava (2021), Van et al. (2020), and Jarrahi (2018).

AI technologies, which can be leveraged for remedies to risks of environmental sustainability, include deep learning (DL), natural language processing (NLP), machine learning (ML), internet of things, computer vision (CV), digital image analysis (DIA), reinforcement learning (RL), expert systems (ES), robotics, and AI algorithms & hardware accelerators (Pasupuleti, 2022; Pasupuleti & Inyang, 2022). Each of the technologies of AI has distinct techniques, as typified in the following table:

Table 1: Some AI technologies and their peculiar techniques

AI technologies	Techniques
Machine Learning	Supervised Learning
	Unsupervised learning
	Reinforced learning
Deep Learning	Image and speech recognition

	Generative adversarial networks Healthcare diagnostics
Natural Language Processing	Chatbots Virtual assistants Sentiment analysis Machine translation
Computer Vision	Facial recognition Autonomous Vehicles Medical imaging
Robotics	Industrial automation Service robots Exploration
Expert Systems	Medical diagnostics Financial services Manufacturing
AI in Cybersecurity	Anomaly detection Automated threat response Phishing detection
AI Applications (AI in Personalization)	Recommendation systems Targeted advertising Content curation

Source: Author, 2022

The AI techniques listed in the Table 1 can be leveraged for remedies to the threats to environmental sustainability. There are studies that lend credence to the position that AI technologies can proffer remedies to the threats to environmental sustainability. Several examples can suffice. Bidhendi and Azizi (2021) indicate that as technological innovations, AI is known for innovations, discoveries, inventions and huge contributory role to growth and development in various spheres. Regona et al. (2022) and Wang (2019) share the viewpoint that decision-making processes, rationality in the human mind, and stimulation of learning and teaching are some of the major functions and benefits of AI technologies. AI technologies, such as Machine Learning, Deep Learning and Digital Image Analysis, can provide remedies to the threats of environmental sustainability through cost-effectiveness (George et al., 2022; Wusu et al., 2022; Bidhendi & Azizi, 2021; Xu et al., 2021). Also, with digital image analysis and canny edge detector, among others, maximal monitoring of safety can obtain at a significant extent (Baduge et al., 2022; Seo et al., 2015). Thus, AI and smart technologies can be leveraged for remedies to the threats posed by carbon emissions to environmental sustainability. AI technologies have been contributing significantly to environmental sustainability in the following ways.

- Speeding up human efforts at addressing environmental sustainability risks
- Making the conservation of the environment easy and largely seamless
- Increasing efficiency and optimization of resource management
- Enhancing and increasing predictions that improve biodiversity and environmental sustainability
- Offering more vibrant, result-oriented and technology-based solutions to climate change issues
- Devising efficient strategies and management techniques capable of achieving environmental sustainability
- Through predictive analytics, AI provides advanced monitoring and analysis of environmental impact.

In addition to the above identified ways through which AI and smart technologies can offer remedies to environmental sustainability, some other scholars' viewpoints are presented hereafter for scholarly evidence and justification of the claims of the present study.

Table 2: Some technology-based remedies

Remedy functions	Citations
Prediction	Bidhendi and Azizi (2021) Srivastava (2021)
Detection	
Safety	
Efficient management of risks Ensure safety	George et al. (2022) Yigitcanlar et al. (2020) Jarrahi (2018)
Fostering and ensuring compliance management	George et al. (2022) Yigitcanlar et al. (2020)
Efficient planning	
Increased performance	
Efficient operations	Thuraka (2022)
Cost reduction	
Effective planning	
Optimizing performance	

Source: Author, 2022

Since environmental sustainability is capital intensive, leveraging AI techniques for cost-effectiveness is imperative. The functions played by AI technologies and other contemporary technologies are what constitute their remedies to different problems needing their interventions. They are the benefits of these sets of technological innovations. These are the cores of what they do, for which the advocacy for their adoption has remained a continual trend. For this study, the functions of the AI technologies that solve problems are remedies to such problems. In this case, they are remedies to the threats posed by carbon emissions as well as other gas emissions to environmental sustainability. In addition, the following table contains central ideas of some related studies that affirm

the place of AI in proffering advanced solutions to environmental concerns and environmental sustainability:

Table 3: Findings of related studies on AI in environmental sustainability

S/N	Authors & Year	Findings
1	Bulama and Shirivastata (2022) George et al. (2022) Thakkar and Lohiya (2021)	AI technologies help greatly in tackling risks to humans and the environment.
2	Koyuncu et al. (2021)	AI has the capacity to address the risks of environmental sustainability in the 21st century.
3	Onifade and Alola (2022) Yigitcanlar et al. (2020)	As AI and smart technologies provide massive data sets, carbon emissions as well as other gas emissions can be addressed significantly, thereby impacting environmental sustainability.

Source: Author, 2022

As evident in the Table 3, there are extant studies that lend credence to the claims of the present study about AI technologies with their distinct techniques being capable of serving as remedies to the threats to environmental sustainability. Although the studies engage with carbon and other greenhouse emissions and environmental concerns, they do not categorically consider carbon emissions as threats to the supposed extent of environmental sustainability realization. Also, they do not combine conventional and technology-based techniques as remedies to the threats to environmental sustainability. They consider or propose either of the two broad sets of remedies. The present takes a different dimension from all that, thereby filling in the uncovered thematic concerns. It portrays carbon emissions as threats to environmental sustainability and projects the combination of conventional and technology-based techniques for remedies to the threats and environmental concerns.

Conventional Remedies to Carbon Emissions

There are different conventional measures for tackling carbon emissions as well as other gas emissions in society. Several of those considered to be popular and comprehensively efficacious will be identified here, with some scholarly citations for backup. Accordingly, Banuri and Opschoor (2007) argue that policy measures, deploying renewable energy technologies and imbibing integrative strategies for de-carbonization would foster significant economic development in Kyoto and beyond, as climate stabilization and changed attitude towards the environment would obtain commonly. Also, institutional funding of environmental and public investment programs by governments of all nations

would serve as viable remedies to environmental issues and the constraints to environmental sustainability.

Furthermore, there is no doubt that research, waste control and operational legislations are effective conventional means of tackling carbon emissions. These conventional measures can proffer lasting solutions to the threats confronting environmental sustainability. Tvaronavičienė (2021) examines the effects of climate change on environmental sustainability and identifies some adaptation strategies with which environmental issues and the constraints to environmental sustainability can be tackled significantly. Industrial pollution, land degradation, and natural disasters are identified as causes of global warming. Effective resource management and integrated strategies capable of eliminating carbon footprint can help tackle climate change and allow for environmental sustainability. More so, favorable personal domestic habits and acts can serve as practical conventional remedies to the threats or constraints to environmental sustainability. These include avoidance of food wastage, lessening meat quantities in meals, controlled consumption of energy, patterns of energy consumption, and buying as well as using less of products and wares having high carbon footprints.

As constraints or threats, they thwart the attainment of environmental sustainability at the ideal or supposed extent. Getting rid of them implies paving way for significant realization of environmental sustainability. One of the other conventional remedies to the threats is to perform life-cycle analysis. This is to check for the degree of carbon footprint and assess the extent of the effects of carbon emissions on human life. Balanced environmental, social, and economic considerations and integrating different pragmatic and sustainable interventions can provide tangible remedies to carbon emissions and the attendant effects. It follows that remedies to the threats must be sustainable. It is only by being so that the attendant effects of carbon emissions can be reduced and prevented concurrently. Remedies to environmental concerns and threats to environmental sustainability have to be made strategic, pragmatic, result-oriented, productive, integrative and sustainable. Remedies can also be got through:

- Stakeholder, institutional, group and personal collaborations
- Policy reviews and enactments for legislative and political supports
- Capacity building.

Constraints to AI Adoption

In spite of the commonly affirmed huge benefits of AI, its adoption is still currently low or insignificant. Various factors account for the backdrop. These include issues of ethical and competent governance of AI, bad leadership, quality (assurance), bias, human-AI collaboration, fairness, data availability, and privacy. There are also the challenges posed by high costs of AI technologies, maintenance constraints, attitudinal factors like preference, perception, and resistance to innovations, lack of technical-know-how, and over reliance on conventional means.

Another set of adoption constraints comprises lack of or insufficient resources, environmental and socio-cultural factors, legislative and political embargoes, and lack of political will to adopt or proclaim AI adoption and fund the adoption processes and the needed AI technologies. More so, the increasing threats to cyberspace also lower the adoption of AI and other innovative technologies. These include invasion of privacy and personal data, impersonation, unethical use of AI and knowledge inhibition arising from excessive use of AI.

Contribution and Novelty

The significance of this study cannot be overemphasized. This is in view of its thematic preoccupations. The study engages with carbon emissions in relation to environmental sustainability. It investigates the extent to which carbon emissions threaten environmental sustainability. The investigation has drawn attention to some of the concerns left unattended to erstwhile. It makes valuable scholastic contributions to addressing environmental concerns that adversely affect or deter environmental sustainability. By approaching the concerns distinctly, the study is novel. It increases the current growing volume of studies on carbon emissions. Unlike previous studies, it portrays carbon emissions as threats to environmental sustainability. And, it makes a case for integrative remedies to the threats. This entail combining both conventional and technological techniques.

Although there are legions of studies on carbon emissions and environmental sustainability, only a few treat the two concerns in combination and comprehensively. Besides, even those that treat the two as such do not propose the combination of conventional and technology-based remedies to the risks posed by carbon emissions. As the study engages with its chosen thematic concerns, deserving scholastic attention is raised to them. The awareness level about these concerns gets increased too. The study establishes the extent to which carbon emissions threaten environmental sustainability to be high. By determining the extent to which carbon emissions threaten environmental sustainability, stakeholders become more poised to proffering tangible solutions to the issues of carbon emissions. Thus, the study is novel, contributive and timely.

Conclusion

With reflection on the adopted theory and the scholarly evidence from some previous studies, the study has demonstrated that carbon emissions are threats to environmental sustainability, because its realization is hampered by the dreadful effects on humans, the nonhumans, and phenomena alike. The threats posed by carbon emissions to environmental sustainability obtain at a high extent. The identified conventional and technology-based remedies to the risks posed by carbon emissions are proven viable by the adopted theoretical framework and most of the secondary data relied on. They are proven to be viable measures for mitigating the threats to environmental sustainability.

By mitigating the threats, significant realization of environmental sustainability obtains. The study concludes that although the supposed or ideal extent of environmental

sustainability realization is threatened by carbon emissions, the identified measures can serve as remedies to the threats and increase the extent of realization. The concerned stakeholders are charged to combine result-oriented and problem-solving measures, which constitute conventional and technology-based techniques, for remedies to carbon emissions and the attendant effects.

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