UNIVERSITY OF EDUCATION, WINNEBA

IMPLICATIONS OF COP 26 FORTY-FIVE PERCENT REDUCTION IN CARBON EMISSIONS ON DISASTERS, ECONOMIC GROWTH AND MULTIDIMENSIONAL POVERTY

ACQUAH ISAIAH

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ACQUAH ISAIAH
202121362

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FEBUARY, 2023

DECLARATION

Student's Declaration

I, Francis Quayson, declare that this dissertation, with the exception of quotations and references contained in published works which have all been identified and acknowledged, is entirely my own original work, and it has not been submitted, either in part or whole, for another degree elsewhere.

Signature: ……………...…………

Date: ………………..………..…..

Supervisor's Declaration

I hereby declare that the preparation and presentation of this work was supervised in accordance with the guidelines for supervision of Dissertation as laid down by the University of Education, Winneba.

Name: Dr. Osman Adams (Principal Supervisor)

Signature: ……………………………

Date: ……………………..…………

Name: Dr. Raphael Ane Atanga (Co-Supervisor)

Signature: ……………………………

Date: ……………………..…………

DEDICATION

I dedicate this work to my dear families and friends who provided moral and financial support, encouraged, love and support me throughout this course.

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GLOSSARY

AFC	Africa Finance Corporation
AU	African Union
AFDB	African Development Bank
COP 26	Conferences of Parties 26
DBEIS	Department for Business, Energy and Industrial Strategy
ECOWAS	Economic Communities of West African States
LDC	Low Developing Countries
NGO	Non-Governmental Organization
NDC	Nationally Determined Contributions
IMF	International Monetary Fund
IPCC	Intergovernmental Panel on Climate Change
IRENA	International Renewable Energy Agency
SANBI	South African National Biodiversity Institute
SDG	Sustainable Development Goal
UN	United Nation
UNFCCC	United Nations Framework Conventionn on Climate Change
UNISDR	United Nations International Strategy for Disaster Reduction

ABSTRACT

The Conference of Party [COP] 26 proposed a forty-five percent (45%) reduction in carbon emissions by all countries before the year 2030. The measure is expected to reduce the world's temperature by 1.5^0C and disasters. However, there is no empirical study to ascertain the direct effect of the carbon reduction on disaster reduction. Also, the generic 45% carbon reduction measure does not consider the possible effect on economic growth and poverty especially in developing countries. Hence this study sought to assess the effect of the 45% reduction in carbon emission on disaster occurrences, economic growth and poverty across the various continents of the world. The study collected secondary data from several international institutions and adopted the exploratory and inferential spatial statistics techniques. Results indicated that disasters in Oceanic and Africa countries are more likely to reduce by 51% and 9.6% respectively given the 45% reduction in carbon emission. GDP growth rate is expected to decrease by 0.11% while monetary poverty will increase by 0.96% in Africa but the opposite will persist in Europe and America with reduction in carbon emission. The study concludes that, though the 45% reduction is more likely to reduce disasters, but with negative consequence on economic growth and poverty in developing countries as such the generic 45% should be reassessed based on countries level of development. Also, developed countries should support Africa and Oceania states with the needed climate funds to improve their resilience to climate change.

CHAPTER ONE

INTRODUCTION

1.1 Background to the Study

Global consumption of non-renewable energy sources has increased greenhouse gas by 50 billion tons between 2000 to 2019 (Zhou & Botzen, 2021). Moreover, climate experts have argued that since the industrial revolution (1750), carbon dioxide concentrations in the atmosphere have risen from about 280 parts per million (ppp) to 387ppp in 2021 (Xie et al., 2021). The countries with the highest carbon dioxide (CO_2) emissions include China (10,065 million tons), United States of America (5,416 million tons), and India (2,654 million tons) with least countries being Bhutan, Suriname Panama and Grenada (Nurgazina et al., 2022).

Greenhouse gases are responsible for the recent rise in the earth's surface temperature (Haddow et al., 2020). The rippling effect of climate change is the increase in disasters globally, with an estimated increase of more than 50% over the past 20 year (Baker et al., 2021). Climate change induced disasters have affected over 21.6 million people (Lohani et al., 2017). In addition, it creates a vicious circle of losses, poverty traps, and slows attempts to eradicate poverty (Trajkovic et al., 2017). Climate change is expected to push more than 100 million people into extreme poverty by 2030 (World Bank, 2020). Furthermore, climate change induced disasters caused an estimated $329 billion in damage to infrastructure between 2000 and 2018 (Uja, 2020).

Based on the effects of non-renewable energy, climate change, disasters and poverty, there has been a call by the Conference of Party (COP 26) to help in the complete switch to sustainable energy sources. The COP 26 builds a bridge between good intentions and measurable actions to lower carbon emissions, increase resilience and provide much-needed finance for climate actions (Onofrei et al., 2022). The parties are committed to more ambitious targets to reduce greenhouse gas emissions by 45% from 2022 to the year 2030 (Moosmann et al., 2021). It is projected that reduction in carbon emissions by 45% will help keep the rise in average global temperature below 2°C (Aftab et al., 2021).

Additionally, the specific targets for COP 26 are to encourage countries to submit more ambitious Nationally Determined Contributions (NDCs) under the Paris Agreement. Increase the level of support and finance for developing countries to help them adapt to the impacts of climate change and transition to low-carbon economies. And lastly, encourage countries to set a clear and robust long-term strategy to achieve net-zero greenhouse gas emissions by mid-century (2050), as well as to enhance transparency of countries' climate action and progress (United Nations Framework Conventionn on Climate Change [UNFCCC], 2021). In developing countries, it is evidenced that the process of climate change and disasters presents one of the greatest challenges to sustainable development and poverty reduction (Hasanov et al., 2021). Additionally, Bertussi et al. (2021) explained that, the process of disasters are extremely influenced by human activities, and other natural forces, thus, the 45% reduction in carbon emissions are not likely to reduce disasters without the improvement in the other variables like renewable energies, afforestation, access to sanitation, access to clean water etc.

The fragile industrial nature of most developing countries will suffer greatly with the reduction in carbon emission and can result in decline in economic growth and draw about 720 million people into extreme poverty (Elfaki et al., 2021). Largely because 0.6% increases in carbon emission stimulate a 1% increase in economic growth hence Africa is highly disadvantage (Alaganthiran & Anaba, 2022; Aftab et al.

(2021). Also, Azam et al. (2016) pointed out that, in Asia, the greater the economic growth, the greater its carbon emission and thus, any effort to decrease carbon emissions could lead to diminish in the economic growth in Asia (Sayre et al., 2019). These effects have implications on the achievement of the Sustainable Development Goals One, Two, and Eight which seek to eradicate extreme poverty and promote economic growth (Lohani et al., 2017).

Per the effects and problems associated with non-renewable energy, it is important to understand the implication of COP 26 targets on disasters, economic growth and poverty. This will help understand the challenges that will be faced by the developing countries in adopting these targets.

1.2 Statement of the Problem

The relationship between carbon emissions, climate change, and disasters in both developing and developed economies has been the subject of several theoretical and empirical research (Lee et al., 2021; Rakshit, 2021). This accounts for one of the reasons COP 26 advocated for 45% reduction in carbon emission to help reduce global temperature by 1.5°C by 2030. With the hope that it will help reduce occurrences of disasters (Alaganthiran & Anaba, 2022). However, no empirical study has been performed to estimate if the carbon reduction will have any significant impact on disaster reduction. Also, the relationship between carbon emission, climate change and disasters in most studies have overly concentrated on natural hazards such as climatological, geophysical, hydrological and meteorological hazards to the neglect of biological, technological. However, climate has been known to contribute to increasing pathological like COVID, Severe Acute Respiratory Syndrome (SARS), Human Immunodeficiency Virus (HIV), H5N1 while also stimulating technological disasters such as industrial accident and transport accident (Emergency event

Database [EM-DAT], 2020). Hence is imperative to understand the complete effect of carbon emissions on the totality of all disasters globally.

Furthermore, the call for 45% reduction in carbon emissions by countries is believed to be generically applied as its impact will have different effects on countries and continents (Haddow et al., 2020). Especially, countries in Africa which are emerging economies need fossil fuel to improve domestic economic growth and reduce poverty. Hence, 45% reduction is likely to significantly impact them than European countries. Rakshit (2021) believe that the 45% carbon reduction is a neo-colonial policy to under develop Africa and other emerging economies. Is important that empirical analysis is undertaken to ascertain the exact impact of the 45% reduction in carbon emission on economic growth and poverty at the country level (Uja, 2020). This can help COP adjust their generic 45% to find country specific reduction targets.

1.3 Purpose of the Study

The main purpose of this study was to assess the implications of the COP 26 forty-five percent [45%] reduction in carbon emissions on disasters, economic growth and poverty across the various continents.

1.4 Hypothesis

H_1: Climate disasters are more persistent in African countries than the Western countries

H_2: COP 26 target of 45% reduction in carbon emission by 2030 is not likely to reduce the number of disasters in African.

H_3: COP 26 target of 45% reduction in carbon emission by 2030 is more likely to increase economic growth in African countries than Americas and Europe.

H_4: COP 26 target of 45% reduction in carbon emission by 2030 is more likely to reduce multidimensional poverty in African countries than all other continents.

1.5 Significance of Study

Climate disasters are dynamic phenomenon that modifies through time and space due to increasing human activities leading to climate change and natural forces (Flores & Peralta, 2020). Therefore, understanding the trends, distribution, magnitude and frequency of climate disasters on each continent is of great importance. Besides, getting knowledge about the continent that is highly at risk of this type of disaster will make it very convenient for international bodies, planners, and policy makers to come out with a good policy to regulated it through time.

Disasters has become a global threats to environmental sustainability and are now trending in a direction of increasing frequency as the scope and dependence on technology expands (Cao et al., 2020; Haddow et al., 2020). However, assessing the effects of COP 26 target of 45% reduction in carbon emission by 2030 on disasters in Africa will enhance the knowledge of the number of disasters that are likely to occur in the near future thereby assisting the international bodies such as the United Nation (UN) and other policy makers to design tailored measures to curtail these occurrences.

Furthermore, assessing the effects of COP 26 target of 45% reduction in carbon emission by 2030 will assist the international bodies, governments and policy makers to know the implication of the 45% reduction in carbon emission on growth and poverty. Knowing to these effects on poverty levels will inform the developed countries to know the consequences of the rapid switch for renewable energy by the developing countries thereby relaxing the strong push for the adoption of the renewable energy.

1.6 Organization of Thesis

This research is in five separate but related chapters. Chapter One gives background information about the study. It covers introduction, statement of the problem, hypothesis and significance of study. The Chapter Two provides review of the related literature of the study whiles the Chapter Three discusses the study area and the methodology of the research. It deals with the description of the biophysical characteristics of the study areas, sources and methods in data collection, major approaches followed during analysis.

Also, the fourth chapter presents the findings of the study derived upon analysis of all available data and discusses the major findings of the study with reference to existing knowledge, and relates them to the objectives, and overall framework of the study. Finally, the Chapter Five presents the concluding remarks and implications of the major findings in addressing prevailing challenges and also presents issues for further research. In other words, this chapter presents the major findings, conclusion, recommendations and the limitation of the study.

CHAPTER TWO

LITERATURE REVIEW

2.0 Introduction

This chapter focuses on a review of relevant literature about carbon emissions, climate change, disasters and economic growth. The chapter deals with definitions and useful constructions for understanding the relationship between climate change, disaster, economic growth and poverty. In addition, it has the conceptual framework which provides the structure for understanding the relationship between carbon emission, disasters, economic growth and poverty.

2.1 Carbon Emission, Climate Change and COP 26

Carbon emissions and climate change are two of the most pressing environmental issues facing the world today. Recent research has shown that the Earth's average temperature has risen by about 1.1 degrees Celsius since the pre-industrial era (Chen et al., 2022). This warming has led to a variety of negative impacts on the environment, including rising sea levels, more severe storms, droughts, and heatwaves, as well as the extinction of many plant and animal species (Amin & Porna, 2012). Carbon emissions, primarily from the burning of fossil fuels, have been identified as a significant contributor to climate change (Djalante, 2019). Research by Islam et al. (2021) found that human activities are responsible for the majority of the warming that has occurred in recent decades. In order to mitigate the effects of climate change, it is necessary to reduce carbon emissions.

Numerous studies have explored potential strategies for reducing carbon emissions. One approach is to invest in renewable energy sources, such as solar and wind power, as shown by research from the (International Renewable Energy Agency [IRENA], 2019). Another approach is to implement carbon pricing mechanisms, such as a carbon tax or cap-and-trade system, as shown by research from the (International Monetary Fund [IMF], 2018). The COP is a key event in the global effort to address climate change. Several COPs has been organized to address climate change and its related issues. COP 1 was held in Berlin, Germany in 1995, and was the first meeting of the Parties (UNFCCC). COP 3 held in Kyoto, Japan in 1997, resulted in the adoption of the Kyoto Protocol. Similarly, COP15 (Copenhagen, Denmark in 2009) aimed to reach a new international agreement on climate change to succeed the Kyoto Protocol. Additionally, COP 21 which was held in Paris, France in 2015 resulted in the adoption of the Paris Agreement. COP 25 was held in Madrid, Spain in 2019, and aimed to finalize the rules for the implementation of the Paris Agreement, but ended without reaching an agreement on several key issues.

However, the COP 26 was the sixth conference of parties which aimed to accelerate the implementation of the Paris Agreement, which was adopted in 2015 with the goal of limiting global warming to well below 2 degrees Celsius (Nurgazina et al., 2022). Studies by the UNFCCC (2021) on climate change highlighted the importance of COP 26 in achieving the goals of the Paris Agreement and the need for ambitious and immediate action to reduce carbon emissions. The specific targets for COP 26 are to encourage countries to submit more ambitious. Increase the level of support and finance for developing countries and encourage countries to set a clear and robust long-term strategy to achieve net-zero greenhouse gas emissions by mid-century. Enhance transparency of countries' climate action and progress (UNFCCC, 2021). COP 26 was an opportunity for countries to come together and agree on ambitious targets and actions that will help meet this goal.

In preparation for COP 26, several countries announced new or strengthened climate targets, such as the European Union's goal to become climate-neutral by 2050 (Esen & Bayrak, 2017) and the United Kingdom's target to reduce carbon emissions by 68% by 2030 (Department for Business, Energy and Industrial Strategy [DBEIS], 2022). However, it is important to note that reducing carbon emissions and mitigating the impacts of climate change will require a coordinated global effort, as well as significant changes in the way we produce and consume energy, transport goods and people, and manage our land and forests.

2.2 Concept of Disaster

Disaster refers to the serious disruption of the functioning of a community or a society at any scale due to hazardous events interacting with conditions of exposure, vulnerability and capacity, leading to one or more of the following: human, material, economic and environmental losses and impacts (Lohani et al., 2017). It can also be defined as the extreme disruption of a community or society's functioning that results in widespread losses of people, property, money, or the environment that beyond the capacity of the affected community or society to recover using its own resources (Lohani et al., 2017). However, the coverage of a disaster can be immediate and localized, and are often prolonged and widespread, testing or exceeding the capacity of a society to cope using its own resources, and therefore requiring assistance from external sources (Soergel et al., 2021). That is, a disaster is defined as an incident that exceeds a community's ability to respond. Similarly its occurrence is dynamic and vary in extent, magnitude size and geographically with time and space (Wolff, 2021).

Disasters result from improper risk management (Lee et al., 2021). Disaster is also seen as a process leading to an occurrence that combines a people in a socially created state of vulnerability with a potentially destructive agent from the natural or technical domain (Wolff, 2021). Disasters reflect the varying levels of economic and social development and has the potency to cause all types of social, physical, spiritual, and economic damages (Lee et al., 2021). This study adopts the definition of disaster by EM-DAT (2020) as a serious disruption of the functioning of a community or a society, which causes widespread human, material, economic or environmental losses that exceed the ability of the affected community or society to cope using its own resources.

2.3 Characteristics of Disasters

The growing number of disasters is a result of the intricate interactions between physical and human systems (Haddow et al., 2020). Because of this, it is obvious that individuals are purposefully or unintentionally accountable for the outcomes of events that were formerly ascribed to forces beyond their control (Chen et al., 2021). Thus the numerous disasters arising from natural hazards would not have occurred or would have had a smaller impact on communities without being orchestrated by the actions human (Roe & Zavar, 2021). Disasters can be triggered by a variety of factors, including: natural hazards, human-induced hazards, climate change, poverty, social and economic factors among others (Roe & Zavar, 2021).

The duration of disasters are thought of in multiple ways (Djalante, 2019). It is the time span in which disaster events takes place. It includes the length of the disaster itself, which could range from seconds for an earthquake or explosion, to hours or days for a hurricane or blizzard, and even to weeks for a slowly advancing and receding flood (Twigg, 2018). It can also be viewed as the duration a disaster affects people and the time to recover (Djalante, 2019). Most often the duration of the disasters is dependent on the magnitude of the hazard as well as the vulnerability of elements at risk (Prasad & Francescutti, 2017).

Vulnerabilities to these disasters are predisposed by low socio-economic conditions of the communities, which significantly increase losses of life and livelihoods, property damage, and services (Majeed & Luni, 2019). Despite the absolute economic loss of disaster in Least Developed Countries (LDCs) is smaller than developed nations, fatalities are disproportionately higher in LDCs than in developed countries (Chaudhary & Piracha, 2021; Djalante, 2019).

Elements at risk to disasters are the various components of a community or society that are within the spatial extent of a disaster (Twigg, 2018). They include, people, buildings and infrastructure, environment, economic assets and cultural heritage etc. (Chaudhary & Piracha, 2021). Overall, disaster can affect all the components of a community and society, which can cause a ripple effect on the whole system (Majeed & Luni, 2019).

The damage caused by disasters ranges from a smaller to a larger scale. The large scale disasters requires national or international assistance when it affects a society, whereas, small-scale disasters affects local communities which require assistance beyond the affected community (Enia, 2020). Approximately 1.65 billion people have been affected by over 3000 occurrences of floods and storms in the past 20 years (Majeed & Luni, 2019).

Spatially, Asia is the most vulnerable continent to disasters, which has suffered about 38% of the major disasters of the world. Asia is home to 88 percent of disaster victims and 57 percent of fatalities worldwide (Doytch, 2020). The disasters that occur on the African continent account for 22% to 26% of the world's disasters.

2.4 Types and Causes of Disaster

Disasters are broadly divided into two main types comprising of natural and man-made (technological) based on the origin of the hazard (Sena & Michael, 2018). Furthermore, whereas natural disasters come from the action of natural forces (climate and geology) and are typically devastating in nature, man-made disasters are staged by human acts (Righi et al., 2021). Disasters has also been categorized according to several criteria which includes, affected sector/community; duration of the disaster; magnitude of the disaster (Sena & Michael, 2018). EM-DAT (2020) classification of disasters is based on the origin of the hazard thus, biological, climatological, geophysical, hydrological, meteorological and technological disasters (Espoir et al., 2022).

Biological disaster

A biological disaster results from the contact of humans with pathogens and poisonous materials (Lee et al., 2020). They are biologically transmitted processes or phenomena of organic origin that can cause loss of life and property, injury, disease, or other negative effects on one's health, as well as disruptions to services, social order, and the economy (Ishiwatari et al., 2020; Lee et al., 2020). EM-DAT (2020) classified biological disaster into epidemics (bacterial disease, parasitic disease and viral disease), insect infestation (grasshopper, locust), and animal accident (Gössling et al., 2020). Biological disasters can take the form of an epidemic that strikes a disproportionately large number of people in a population, community, or region at the same time, or a pandemic, such as Covid-19 and Influenza H1N1[Swine Flu] (Nundy et al., 2021).

Despite not occurring in stable populations, epidemic diseases have the capacity to spread, leading to frequent and severe outbreaks that are conveyed by tainted water or food, direct human-to-human contact, or by animal or insect vectors (Ishiwatari et al., 2020). Cholera, measles, dysentery, respiratory illnesses, malaria, and HIV are just a few examples of the epidemic diseases that frequently pose a threat to populations that have been forced to flee their homes (Bell et al., 2018).

Climatological disaster

Climatological disasters (climate induced disasters) are disasters that are triggered by long-lived, meso to macroscale phenomena, that is, ranging from intra-seasonal to multidecadal climate variability in a spectrum (Sena & Michael, 2018). The classification of climatological disasters by EM-DAT (2020) includes, extreme weather temperature (cold wave, heat wave, and severe winter conditions), drought, glacial lake outburst and wildfire).

It is well established from literature that human activity significantly contributes to climatological disasters, and that humans are increasingly accountable, directly or indirectly (Roe & Zavar, 2021). Human activities, like as urbanization, settlement patterns, landscape modification, and carbon dioxide emissions, among others, frequently increase both the likelihood and the consequences of climatological disasters (Haddow et al., 2020).

Geophysical disaster

Geophysical disasters refers an event or phenomenon that originates from the solid earth that has the potential to be harmful and cause environmental degradation, human or animal deaths, property damage, or economic or social disturbance (Kong et al., 2021). Geophysical disasters result from tectonic and seismic activity below the earth's surface (Sena & Michael, 2018). The events associated with this hazard according to EM-DAT (2020) classification scheme includes earthquakes (ground movement, and tsunami), volcanic activity (Ash fall, lava flow, and pyroclastic flow), and dry mass movement (avalanche, landslide, rock fall, and land subsidence).

Geophysical disaster risks are frequently influenced by geographic considerations, and processes and are unevenly distributed around the world (Doytch, 2020). India and China are widely known for these disasters, and the worst concentrations are located near the plate borders that span from the Eastern Mediterranean through the Middle East and Central Asia (Chaudhary & Piracha, 2021). The "Ring of Fire" is one of the region's best renowned for this type of activity and for causing geophysical disasters (Susilo et al., 2022).

Geophysical disasters account for more than 99 percent of the fatalities, negative consequences, and economic losses (Righi et al., 2021). As a more than 2.4 million people have died, leaving around 206 million people injured or homeless between 1900 and 2020 (Chaudhary & Piracha, 2021). The economic toll of these events for the noted period is estimated to be more than USD 1.3 trillion (Doytch, 2020).

Hydrological disasters

Hydrological disasters are associated with the occurrence, movement, and distribution of fresh and saltwater over or beneath the Earth's surface (Chaudhary & Piracha, 2021). They are caused by deviations in the regular water cycle and/or overflow of bodies of water caused by wind set-up (Espoir et al., 2022). The events created by this hazard include flood (coastal flood, flash flood, and riverine flood), and mass movement [avalanche, landslide, mudslide, rock fall, land subsidence] (Enia, 2020; EM-DAT, 2020)

Hydrological hazards and their impacts are associated with climate variability, demographic trends, land-cover change, and other causative factors and could be exacerbated by global climate change (Trajkovic et al., 2017). From 1900 to 2020, hydrological disasters claimed the lives of more than 7 million people worldwide (Chaudhary & Piracha, 2021). For the same period (1900-2020), more than 3.8 billion people were injured or displaced due to these disasters (Lohani et al., 2017). China is the most severely affected by hydrological hazards, losing more than 6.6 million people during the same period (Tasri et al., 2022). Additionally, more than 2 billion Chinese people was also rendered either homeless or jobless (Lohani et al., 2017).

The economic cost of these occurrences was estimated to be around 1.3 trillion dollars for the time under consideration, with China suffering the greatest economic losses, totalling more than 413 billion dollars (Chaudhary & Piracha, 2021). However, it is also shown in research that, while economic losses accounted for close to 40% of the total cost incurred globally, the social impact of hydrological catastrophes in terms of fatalities and persons affected over the time period in the Americas and Europe was quite low (Chaudhary & Piracha, 2021).

Meteorological disasters

Meteorological disasters are defined as short-lived or small- to meso-scale atmospheric processes that range in time from minutes to days and can be made worse by global climate change (Enia, 2020). This category of hazard includes convective storms or tornadoes, extra-tropical storms (occurring in the middle, from latitude 30 to 60), tropical storms (occurring up to 30 latitude), and fog (Enia, 2020; EM-DAT, 2020). Considering the number of fatalities, those affected, and the resulting economic losses per continent from 1900 to 2020, the Asia-Pacific area accounted for more than 50% of the occurrences and more than 90% of the social cost in terms of lives lost and people affected (Chaudhary & Piracha, 2021).

However, the Americas experienced the most of the economic losses, with the USA accounting for the lion's share of the loss. Similar to geophysical and hydrological disasters, America and Asia suffered roughly 60% of its occurrences with 90% of the human and economic losses (Haddow et al., 2020). The percentage of losses in the African and European continents was quite small (Loayza et al., 2012). Nevertheless, Europe experienced financial loss than Africa (Sena & Michael, 2018). Additionally, 1.4 million people worldwide died in calamities brought on by meteorological hazards globally (Haddow et al., 2020). The total economic damage caused by disasters in this category exceeded 2.1 trillion dollars, making it the most costly of the three types of disasters over time (Chaudhary & Piracha, 2021).

Technological disaster

Technological disasters are the failure or breakdown of systems, equipment and engineering standards that harms people and the environment; structural collapses, such as bridges, mines and buildings (Chen et al., 2021). Technological disasters result from human activities, such as explosions, fires, the release of toxic chemicals or radioactive materials, bridge or building collapse, crashes, dam or levee failure, nuclear reactor accidents, breaks in water, gas, or sewer lines, deforestation, war, etc. (Roe & Zavar, 2021). According to EM-DAT (2020) classification scheme, technological disasters include, industrial accident (chemical spill, collapse, explosion, industrial fire, gas leak, oil spill, poisoning, and radiation), miscellaneous accident and transport accident (Air, Rail, Road, & Water).

Technological disasters are unpredictable, and is capable of spreading across geographical areas. They could be inevitable and tend to involve many more casualties than natural disasters of the same magnitude of energy release (Chen et al., 2021). Technological disasters are trending in a direction of increasing frequency as the scope and dependence on technology expands and are now occurring at a rate higher than in the past decades (Haddow et al., 2020; Loayza et al., 2012).

In comparison to natural disasters, technological disasters tend to be more frequent, devastating, and fatal as a result of the misuse or failure of engineered structures, technologies, manufacturing processes, and other aspects of modern life (Haddow et al., 2020). In addition, the growing incidences of technological disasters has resulted in economic losses, and has the capacity to exceed a country's capacity to reconstruct in a short time, leading to a cutback in national energy supply and consumption (Uja, 2020; Lee et al., 2021). Particularly in developing nations in Africa without sufficient safety regulations and disaster response capabilities (Ndiaya & Lv, 2018).

2.5 Economic Growth and Poverty

Economic growth and poverty are two closely related issues that have been studied extensively in the literature. According to the World Bank (2020) economic growth is the process by which a country's per capita income and employment opportunities increase over time. Statisticians conventionally measure such economic growth as the percent rate of increase in the real gross domestic product, or real GDP. Other scholars also look at measure such economic growth as an increase in GDP per capita rate (Stiglitz & Guzman, 2021). On the other hand, poverty refers to the inability to achieve a minimum level of well-being, as measured by the standard of living, access to basic needs such as food, shelter, and healthcare, and the ability to participate in the economic and social life of a country (World Bank, 2020). The World Bank (2020) however, measures poverty in terms of monetary poverty, education and basic infrastructure (access to electricity, access to clean water and sanitation)

Economic growth in Africa has been relatively slow, with poverty rates remaining high. A study by the African Developmet Bank [AFDB] (2021) found that lack of access to credit and financial services, poor infrastructure, and a lack of investment in human capital are major constraints on economic growth and poverty reduction in the region. Additionally, institutional factors such as corruption and poor governance have also been identified as barriers to economic growth and poverty reduction (Chen et al., 2022). According to the World Bank (2020) about 41% of the population in sub-Saharan Africa lived below the international poverty line of $1.90 per day in 2019. This is the highest poverty rate of any region in the world (Espoir et al., 2022).

In the Americas, economic growth has been relatively strong, and poverty rates have generally been low (Doytch, 2020). However, poverty and inequality remain significant issues in the United States, where the poverty rate is higher than in other developed countries, as shown by the research of the (Cao et al., 2020). Factors that have been identified as contributing to poverty in the Americas include lack of accessibility to affordable health care, inadequate social safety net programs, lack of access to credit and financial services, lack of investment in human capital, and institutional factors such as corruption and poor governance (David, 2020). About 4% of the population in Latin America and the Caribbean lived below the international poverty line of $1.90 per day in 2019 (World Bank, 2020). Moreover, the Cao et al. (2020) noted that, the poverty rate in the United States was 10.5% in 2020

In Asia, economic growth has been more robust, with many countries experiencing significant reductions in poverty. However, there are still wide disparities in economic growth and poverty across the continent, with some countries, such as Afghanistan, still facing high poverty rates (Stiglitz & Guzman, 2021). Factors that have been identified as contributing to economic growth and poverty reduction in Asia include investments in education, as shown by the research of World Bank (2020) the expansion of microfinance. About 8% of the population in East Asia and Pacific lived below the international poverty line of $1.90 per day in 2019. In South Asia, the poverty rate was about 14% (IMF, 2018).

Moreover, economic growth has been relatively strong, and poverty rates have generally been low in Europe (Doytch, 2020). However, the recent financial crisis has led to increased poverty and inequality in some countries, as shown by the research of (Esen & Bayrak, 2017). Policies aimed at promoting inclusive growth and reducing poverty, such as progressive taxation and social protection programs, have been shown to be effective in Europe (Stiglitz & Guzman, 2021). Poverty rate in Europe is relatively low, with about 2% of the population living below the international poverty line of $1.90 per day in 2019 (Mlodkowski, 2019).

Economic growth in Oceania has been relatively strong, with low poverty rates. However, there are still disparities in income and wealth distribution, as shown by the research of the (Soergel et al., 2021). Factors contributing to poverty in Oceania include a lack of affordable housing and inadequate social safety net programs (Sayre et al., 2019). However, factors that contribute to economic growth and poverty reduction vary across regions and countries. Therefore, it is crucial to understand the specific context of a country or region in order to design effective policies for economic growth and poverty reduction.

2.6 Factors Influencing Economic Growth and Poverty

2.6.1 Non-renewable energy emission

Recent empirical research has established a strong relationship between carbon emissions and economic progress. Aftab et al. (2021) claimed that between 1990 and 2015, an increase in carbon emissions of about 0.93 percent resulted in economic growth of 1% across 147 nations. Additionally, a study conducted on 26 countries in the European Union demonstrates an increase in carbon emissions of 0.6% increases economic growth by 1% (Alaganthiran & Anaba, 2022).

Additionally, a 1% rise in per capita income in China and India was followed by a 1.28 % rise in carbon emissions (Rakshit, 2021). Instead, economic expansion in Sub-Saharan African nations between 2002 and 2017 lowered carbon emissions; as a result, every increase of 1% in economic growth results in a decrease in carbon emissions of about 0.09 % (Osadume & Edih, 2021). In Nigeria, the relationship between carbon emissions along with factors from 1980 and 2010 showed a considerably negative relationship (Alaganthiran & Anaba, 2022).

Arguably, the effects of unchecked carbon emissions contributing to climate change have weakened the attempts to end poverty (Soergel et al., 2021). The Global South has been more severely affected by the negative economic effects of rising carbon emissions (high temperatures), which has increased inequality worldwide (Addae-korankye, 2019). Carbon emissions resulting to climate change is posting a serious risk to poverty reduction and threatens to undo decades of development efforts (Zhao et al., 2021). As we get closer to the zero-poverty goal, experts claim that if present carbon emissions patterns continue and are uncontrolled, up to 720 million people would fall back into extreme poverty as a result of climate change (Elfaki et al., 2021). The majority of the world's poorest people depend on agriculture and other subsistence activities to make a living (Hallegatte et al., 2020). Nevertheless, these people's ability to feed themselves and be able to support their families financially is challenged (crops and cattle are wiped out) because of their dependency on the weather (Islam et al., 2021). It is estimated that, by 2030, climate change could force more than 100 million people into extreme poverty (Susilo et al., 2022)

2.6.2 Renewable energy

To ensure sustainable development renewable energy is required as it ensures the availability of clean energy (Majeed & Luni, 2019). It is anticipated that from 2017-2050, the share of renewable energy in the whole energy sector will increase from 25% to 85% (Sasana & Ghozali, 2017). Numerous empirical studies have discovered that the use of renewable energy to support the electricity industry is accelerating economic growth rates (Majeed & Luni, 2019). For instance, Marinaş et al. (2018) found that adopting renewable energy accelerates GDP growth in the Central and East European economies. Also, El Zrelli et al., (2020) demonstrates that, from 1980 to 2019, the use of renewable energy had a beneficial impact on the economic performance of Mediterranean countries (Sasana & Ghozali, 2017).

Notwithstanding, billions of dollars invested in energy infrastructure are lost to disasters each year, causing significant social and economic disruptions (Lohani et al., 2017). The failure or collapse of the renewable energy infrastructure itself is capable of temporally crippling any economy (Uja, 2020). Disasters and their attendant impact on renewable energy production and consumption (Hasanov et al., 2021). Esen & Bayrak (2017) also suggested that the renewable energy expansion is negatively associated with economic expansion and however have no effect on economic growth or that its effect is so small that it can be ignored. Additionally, some scholars has argued that, fossil energy in developing countries is efficient and less costly as compare to the use of the renewable one which requires enormous costs to produce it (Sasana & Ghozali, 2017).

2.6.3 Industrialization

Industrialization has been viewed by many scholars as the engine for economic growth. Investment in industries has been attributed to several nations' success in catching up in economic development since 1870 (Ndiaya & Lv, 2018). It results in a growth in the amount and variety of manufactured items, which increases employment and raises citizens' standards of living (Anwar & Elfaki, 2021). Industrialization fosters economic progress by boosting productivity, creating jobs, encouraging innovation, and making the best use of resources (Elfaki et al., 2021). It affects technical advancement and innovation, advances learning and skill development, makes it possible to provide necessities, and spurs social change, all of which are important for human progress (David, 2020).

The assertion that there is a strong association between industrialization and economic growth has been supported by a number of empirical studies because the growth of manufacturing output and the growth of GDP are correlated (Ndiaya & Lv, 2018). In addition, industrialization is frequently seen as a more significant economic catalyst in developing nations than in industrialized economies in recent literature. Strong expansion in the manufacturing sector is one of the main forces behind sustainable development in emerging and least developed nations, since it significantly improves their economic and social well-being (David, 2020).

Industrialization has created new issues despite simplifying work and increasing productivity with new techniques and equipment (Anwar & Elfaki, 2021). As industrialization grows, resource depletion re-emerges and has a detrimental impact on the general welfare of the larger population (Chtouki & Raouf, 2021).

Industrialization also exacerbated the separation of labour and capital and widens the gap between the rich and poor (Buettner, 2021). Wider income disparity results from the tendency of those who own the means of production to amass excessive profits from their economic activity (Ming-yue et al., 2021).

2.6.4 Access to clean water

It is well acknowledged that water is essential for social progress and economic growth. Water is a vital component of sustainable growth and poverty alleviation (Majeed & Luni, 2019). It is a component of practically all forms of production, including household usage by healthy individuals in healthy ecosystems, industry, agriculture, and energy (Kauffman, 2019). Food and energy production depend on water, which is also a critical and frequently irreplaceable component in a variety of industrial value chains (Zhang et al., 2021). Half of the global workforce is employed in eight water and natural resource-dependent industries: agriculture, forestry, fisheries, energy, resource-intensive manufacturing, recycling, building and transport (Cao et al., 2020).

Access to clean, inexpensive, and reliable water supplies, improves living standards, boosts local economies, and creates more decent jobs and better social participation (Taheripour et al., 2020). Since water and jobs are intertwined on many levels, developing and managing water resources is crucial to creating wealth, reducing risk, and eradicating poverty (Rakshit, 2021). For instance, in Africa, small-scale water access initiative could generate estimated economic returns of roughly US$28.4 billion year, or nearly 5% of the continent's GDP (Zhang et al., 2021). These initiatives are also advantageous for the labor market. In the United States, every US$1 million invested in infrastructure for water delivery and treatment creates between 10 and 20 more jobs. The consequences of ignoring water issues might be catastrophic and incredibly expensive, with major negative effects on economies, lives, and communities (Zhang et al., 2021). Reduced access to clean water per person will drive up water's economic cost and, in a water-scarce environment, restrict the possibility of economic growth (Chen et al., 2022).

2.6.5 Access to sanitation

For positive outcomes in health, nutrition, education, and livelihoods as well as sustainable development, access to sanitation and hygiene is essential (Islam et al., 2021). According to economists, having access to good sanitation is essential for poor households to be able to save enough money to end their cycle of poverty (Aftab et al., 2021). Furthermore, improving access to sanitation is paramount to increasing the income of individuals and households living in poverty (WorldBank, 2017). People with better health and nutrition are able to operate more efficiently at work, school, and at home, increasing their earning potential (Islam et al., 2021).

Investment in appropriate sanitation generates returns on investment, jobs, and benefits the local economy as a whole (Aftab et al., 2021). According to empirical research, investing $1 in sanitation would result in a worldwide economic return of US$5.5 (Marinaş et al., 2018). According to estimates, achieving the Sustainable Development Goal (SDG) targets for water and sanitation alone would result in the yearly reduction of 443 million school days and 3.2 billion adult working days, raising worker productivity and long-term earning potential (Marinaş et al., 2018).

Poor sanitation is a leading cause of poverty in developing countries, primarily because unsatisfactory sanitation services to the poor increase their living costs, lower their income earning potential, damage their well-being and make life riskier (Twigg, 2018). Aside from these negative consequences on health, inadequate access to sanitation cost the world economy US$222.9 billion in 2015, up from US$182.5

billion in 2010 a jump of almost US$40 billion in just five years (Susilo et al., 2022). This amount represents an average of 0.9 percent of the countries' gross domestic product (GDP), a little decrease from 1 percent of GDP five years ago (Xie et al., 2021). Asia Pacific experiences the largest losses to regional GDP, amounting to 1.1 percent of GDP. India was by far the most affected on a worldwide scale in terms of overall costs, with US$106.7 billion in GDP lost in 2015, nearly half of all global losses and 5.2 percent of the country's GDP (Marinaş et al., 2018).

2.6.6 Political stability

Political stability is closely linked to economic growth because it is crucial to a nation's economic progress (Nur et al., 2020). Economic development are achieved through political stability (Anwar & Elfaki, 2021). According to economists, economic growth only occurs in stable environments and states with strong economies and stable governments experience faster growth than those with unstable economies (Dalyop, 2018). Political stability ensures an increase in both domestic and foreign investment because it protects citizens' fundamental rights, improves employment conditions, fosters national unity and culture, and provides access to basic infrastructure and services like electricity, water supply, and healthcare (Chtouki & Raouf, 2021). Alternatively, poor economic performance causes a collapse of governments and political upheaval (Bakaboukila & Hakizimana, 2021).

Economic growth is negatively impacted by an unstable political system, which poses a substantial danger to economic performance (Nomor & Iorember, 2017). Studies also show that political unrest is more common in developing countries and that this political unrest hinders economic development due to lack of strong political and economic institutions and because future economic conditions and policies are more unclear (Nur et al., 2020). Uncertainty brought on by a volatile political climate slows economic growth and discourages private investment (Nomor & Iorember, 2017). According to economics literature, in times of political unrest, investment expenditures that may foster economic growth are diverted from their goals and used instead for wasteful military purposes (Bakaboukila & Hakizimana, 2021).

Likewise, political unrest can break a nation's unity and integrity, thus, creating an unfavourable environment for investment and an unfavourable investment climate conditions results in a decline in the rate of economic growth (Abdillah & Dwi, 2020). Political violence, such as civil wars, military coups, and large-scale protests, has a negative impact on economic activity by upsetting market dynamics and labour relations, which has a direct negative impact on productivity (Ayessa & Hakizimana, 2021).

2.6.7 Afforestation

Forests have a significant impact on how economies evolve, supporting livelihoods, guiding economic transformation, and fostering sustainable growth (Xie et al., 2021). High levels of economic advantages from forests to individuals, businesses, and governments served as the first push for protective laws and regulations (Hu et al., 2021). Food and Agriculture Organization [FAO] (2021) estimate that, forest industries generated more than US$ 450 billion in national earnings in 2008, contributed up to 1% of the global GDP, and employed up to 0.4% of the world's work force formally (IMF, 2018). Additionally, forests produce chances for informal employment, provide additional sources of income and advantages for subsistence, and act as economic value reservoirs rural households (Hao et al., 2018).

Countries with rapidly declining forest resources had faster economic growth than those with better rates of forest conservation, because of its varieties of manufacturing materials that are essential for economic success (Elfaki et al., 2021). Thus, assuming that rapid socioeconomic growth is typically accompanied by the exploitation of forest resources (Hao et al., 2018). By offering an alternate source of tree products, afforestation is assisting in reducing the pressure on natural forests that has resulted from the rising demand for tree products (Nundy et al., 2021). As it supplies raw resources for human use without endangering nature, afforestation is a more practical approach (Elfaki et al., 2021). Besides, it transfers the advantages of trees and forests to arid places, promoting regional economic development (Cuaresma et al., 2017). Additionally, the process of afforestation entails various stages that call for a certain set of abilities, necessitating the hiring of various people (Hao et al., 2018). Numerous workers are needed to carry out the various chores, which include digging up the soil, planting seeds, watering plants, and collecting trees. The majority of those working in these sectors have previously been unemployed and are typically in poverty (Nundy et al., 2021).

2.7 Effects of Disaster on Economic Growth

Growth is a progressive phenomenon that develops over time as a result of a number of variables [natural, social, and technical] (Osadume & Edih, 2021). The intrinsically destructive and disruptive character of disasters causes significant economic losses, which frequently produce significant physical and economic harm and may imperil a nation's overall economic development temporarily or permanently (Loayza et al., 2012). They have negative economic and human effects that result in the loss of lives, property, and livelihoods. (Cavallo et al., 2021). Growth models have indicated that disasters have a detrimental impact on production. (Owusu-Sekyere et al., 2021). For firms, disasters damage a company's ability to produce goods by destroying tangible assets like buildings and equipment as well as human capital (Iizuka, 2020). These negative impacts can often be devastating to the businesses, forcing them to shut down. (Haddow et al., 2020).

Disasters brought on by climate change leads to an issue food scarcity, to which developing nations are particularly susceptible due to a lack of technology in these nations (Tasri et al., 2022). The socioeconomic situation of an area affects how much of an impact a disaster will cause. Thus, the poor countries suffer more from disasters than developed countries (Owusu-Sekyere et al., 2021). A country's productivity will drop after a disaster, which will have a negative impact on its ability to build its economy (Owusu-Sekyere et al., 2021). In fact, studies show that for every million people affected, flooding alone can lower GDP growth rate per capita by 0.005 percent (Tasri et al., 2022).

However, the initial impact of disasters can result in direct damages (human deaths, injuries, property losses, etc.), which can then cause indirect damages (of potential wages and capital) at the macro level in terms of inevitable production and/or agricultural output, affecting the nation's GDP over time (Owusu-Sekyere et al., 2021). The fiscal and trade balances of these nations suffer as a result of severe disasters, which also hinder economic growth in these regions and reduce GDP by an average of 1.8% (Hallegatte et al., 2020; Zhou & Botzen, 2021). More than 800 natural disaster incidents were officially recorded in 2018 and between 2017 and 2018, these catastrophes resulted in 21,501 fatalities and $523 billion in economic losses (Iizuka, 2020).

Recent studies have estimated the average annual damages from disasters triggered by climatological, hydrological, geophysical and meteorological hazards in 2002-2011 at US$103 billion, US$24 billion and US$52 billion, respectively (Sayre et al., 2019). According to growth models built on Schumpeter's creative destruction hypothesis, natural disasters have a beneficial impact on economic growth because they may spur more investment in the renovation and/or upgrading of already-existing physical capital due to the physical destruction they create (Sayre et al., 2019).

2.8 Effects of Disaster on Multidimensional Poverty

Increased poverty means increased disaster risk. To eradicate severe poverty, it is imperative to develop disaster resilience (Mahmoodi, 2017). As one of the primary causes of disaster, considering how it causes and worsens social and economic fragility, the growth in disaster conditions, which further impedes the advancement of sustainable development, has been considerably exacerbated by poverty (Trajkovic et al., 2017). Evidence suggests that, disasters can undo years of hard work toward development in both developing and industrialized nations, potentially pushing the poor and most vulnerable into even greater poverty (Zhao et al., 2021). Thus, by 2030, 325 million people could be living in poverty and being exposed to all types of natural disasters and climate extremes, especially in sub-Saharan Africa and South Asia (Susilo et al., 2022).

The impact of disasters on developing countries' aspirations for development is extremely troubling because the rising frequency of disasters has increased the vulnerability of many households and communities in affected areas, particularly in developing countries, which primarily worsens their economic woes and makes the process of recovery more challenging (Ndiaya & Lv, 2018). The UNISDR predicts that disaster-related damages would likely rise even further in the foreseeable future, with the poor suffering the most (Trajkovic et al., 2017). This does support the idea that poorer nations are more susceptible to the effects of disasters because they lack the institutional, financial, technological, and physical resources needed to respond.

Disasters result in poverty cycle, which draw back the efforts to eradicate poverty (Trajkovic et al., 2017). Poor individuals frequently lose their valuables during calamities, which is essential to their survival (Hallegatte et al., 2020). For instance, the primary source of income for many impoverished people is agriculture, but a drought or flood can instantly wipe out an entire year's worth of income (Righi et al., 2021). People in poverty are frequently compelled to utilize their already meagre assets to avert catastrophic losses, which deepens their poverty because they lack access to insurance and social protection (Lu et al., 2022). Therefore, poverty is both a cause and effect of disaster especially in the cases of drought being the risk most directly related to poverty. Storms, floods, and droughts have devastating effects on people and the economy, with the poor frequently bearing the brunt of these effects.

2.9 Theoretical Framework

The study is underpinned by the Risk Society Theory by Ulrich Beck (1999). The risk society theory, developed by sociologist Ulrich Beck in 1999, posits that modern industrial societies are increasingly characterized by the production and management of risks. According to Beck (1999), the increasing carbon emission and disasters (e.g., Covid-19) etc we see in society today are a direct result of this process of risk production. The theory argues that as industrial societies become more complex and interconnected, the risks associated with technological and environmental changes also increase (Kim & Sohn, 2018). This includes risks associated with climate change, nuclear power, genetically modified organisms, and other forms of technological development (Islam et al., 2021).

In the risk society, traditional forms of social organization and regulation are no longer able to effectively manage these risks, and new forms of governance and regulation are needed (Chen et al., 2022). Beck (1999) argues that this shift in the management of risks leads to a new form of politics, where experts and technocrats take on a more prominent role in shaping public policy and decision-making. The theory also emphasizes that risks are not evenly distributed across society, and that certain groups and individuals are more vulnerable to the impacts of these risks. This includes marginalized communities, low-income populations, and those living in areas prone to environmental disasters (Kim & Sohn, 2018).

To address the increasing carbon emission and disasters, the theory suggests that we need to shift from a paradigm of risk management to one of risk prevention (Loayza et al., 2012). This includes investing in renewable energy sources, implementing sustainable development practices, and promoting social and economic equity (Hasanov et al., 2021).

2.10 Conceptual Framework

To guide the study, a conceptual framework was developed from the three theories underpinning the study. Frameworks are critical in guiding the research process by describing notions and theories that explain why the research problem under investigation exists. The framework conceptualizes the implication the of COP 26 targets on disasters, economic growth and poverty.

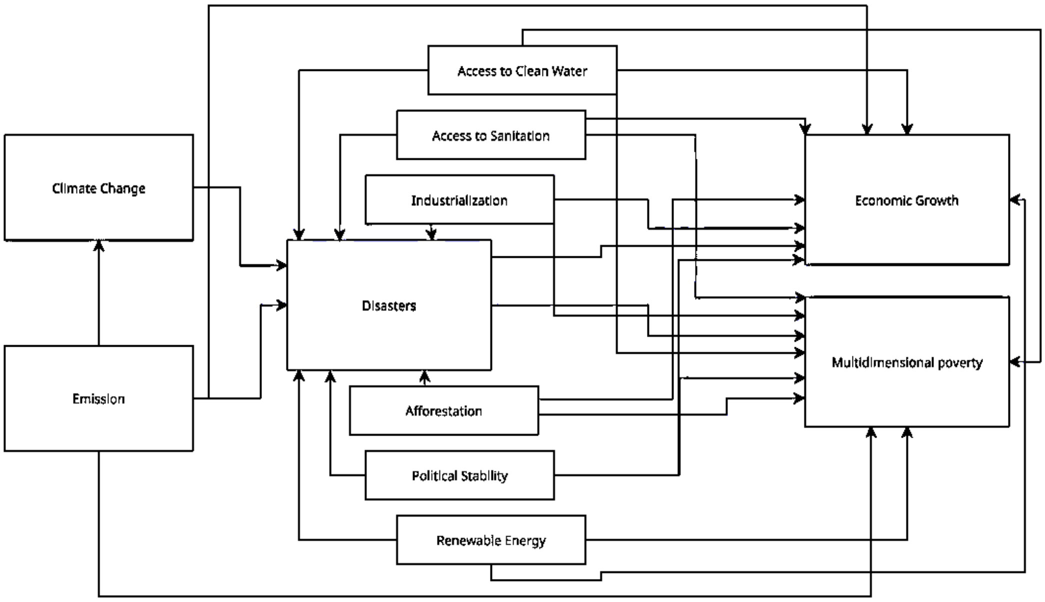

Figure 1: Relationship between carbon emission, disasters, economic growth and poverty

Source: Adopted and modified from Beck (1999)

From Figure 1, the increasing global consumption of non-renewable energy such as fossil fuel leads to an increase in carbon emission (Chaudhary & Piracha, 2021). Carbon emissions can impact both growth and poverty positively and negatively depending on the kind of policies put in place (Zhang et al., 2021). Carbon emissions thus, impact or have influence climate change (Flores & Peralta, 2020; Haddow et al., 2020).

Moreover, the emphasizes has been placed on climate change as widely known to be the major cause of increasing disasters which have led to a surge more than 50% in the past decades (Cao et al., 2020). They are now occurring at a rate four times higher than disasters in 1950 and are trending in a direction of increasing frequency (Zhou & Botzen, 2021). Disasters also have impacts on both growth and poverty (Lee et al., 2021). Climate change also presents one of the greatest challenges impacts to renewable energy (Njoh, 2021). It affects it both positive and negatively. Renewable energy also affects growth and poverty both positive and negatively (Sasana & Ghozali, 2017). The cofounding variables such as afforestation, access to clean water, sanitation, industrialization, and political stability also have impact on both economic growth and poverty (Addae-korankye, 2019).

CHAPTER THREE

METHODOLOGY

3.0 Introduction

This chapter elaborates on the methodology employed in this study. The chapter looks at the philosophical and research design employed for this research. It also discusses the data employed and their sources, data processing techniques and analysis.

3.1 Research Philosophy and Design

The researcher's preferred approach is influenced by his or her philosophical outlook and educational background. Hence, positivism (objective world through quantitative approaches) and constructivism (subjective world through qualitative approaches) and the pragmatic (mixed methods researchers) persist in research (Creswell, 2018). This research adopts the positivism because the research sought to test the hypotheses and also measure a wide range of concepts (economic growth, poverty, disaster) over a short period of time. The explanatory research design was adopted for this study because it is generally considered as most suitable design for prediction and analysing of trends and patterns (Ishtiaq, 2019). Creswell (2018) highlighted that, descriptive research design provides detailed information about a particular phenomenon such as how often it occurs, how it is related to other variables, and how it has changed over time. This study adopted the descriptive research design because it aims at predicting, and analysing trends and patterns between climate change, disasters, economic growth and poverty.

3.2 Study area

The study area inncluded all the continents of the world Thus Africa, Americas (North and South) Asia, Europe and Oceania(Cleland, 2013).

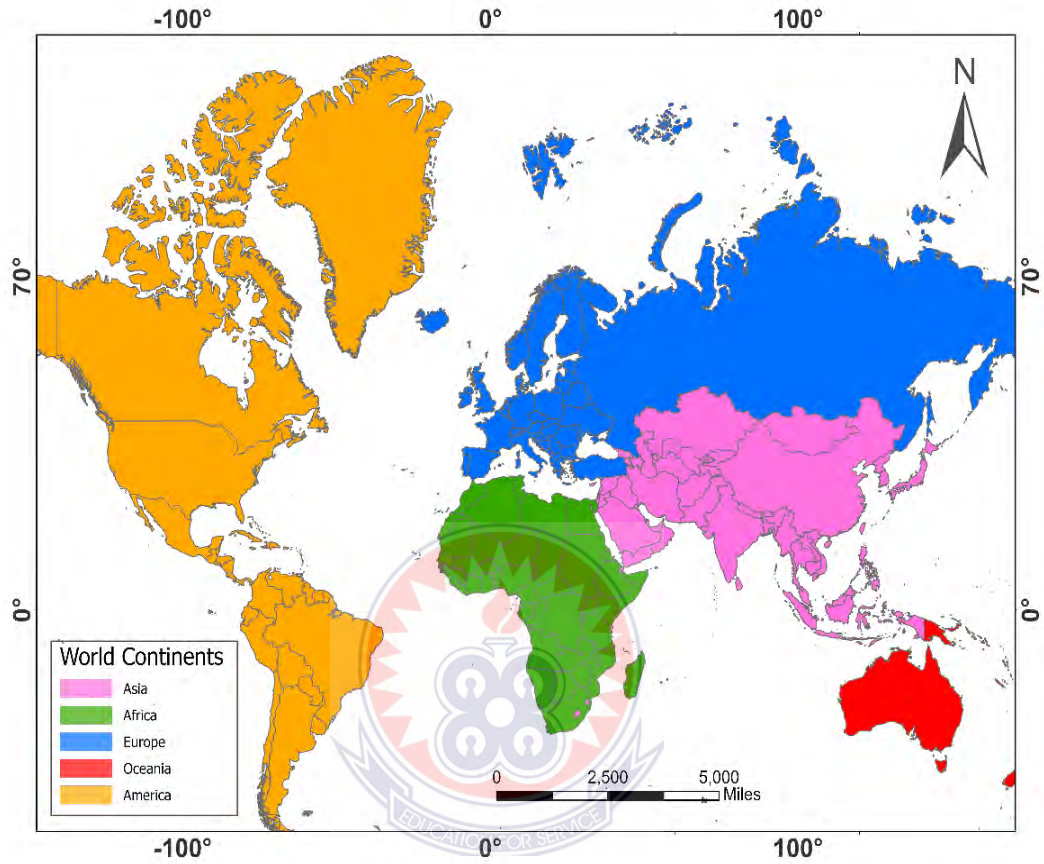

Figure 2: Map of the world

Source: Constructed by Acquah, 2023 with data from ICPAC GEOPORTAL website (https://bit.ly/3E1R33S)

Africa is the second-largest continent after Asia with a total area of about 30.2 million square kilometers. America has a total land area of about 42 million square kilometers. Moreover, Asia is the largest continent in the world with a total area of approximately 44.5 million square kilometers (David, 2020). Europe has a total area of 10.2 million square kilometers (David, 2020). Lastly, Oceania is the smallest continent with an area of approximately 8.5 million square kilometers (Sayre et al., 2019).

As of November 15, 2022 the world population according to the United Nations was estimated at 8 billion people with a growth rate of 2.1% (Buettner, 2021). About 3.97 billion representing 50.42% of the population are males whereas 3.905 billion representing 49.58% of the world population are females (Buettner, 2021). In January 2023, the population of Africa was 1.4 billion, nearly 18% of all people on Earth. Also, the Americas is made up of 1.02 billion people. Similarly, Asia has a population of about 4.7 billion. Moreover, the current population of Europe is about 748,789,218 million people. Notwithstanding, Oceania is made up of about 44,063,041 people (Buettner, 2021).

Disasters across the globe differ in terms of its type, magnitude and intensity (Twigg, 2018). Whereas Africa is the most vulnerable to climate-induced disasters such as drought and floods, the Americas are also vulnerable to hydrometeorological disasters such as hurricanes, storms and wildfires (Palanbek et al., 2022). The Asian and the Oceanian continents are also noted for geophysical and hydrological disasters that has account for the biggest fatalities and havocs (Tasri et al., 2022). Additionally, Europe has hydrological disasters being paramount on the continent.

Africa was the continent with the fastest GDP growth rate in 2013 at 5.6% annually and is anticipated to grow by an average of more than 6% annually in 2023. The African trade, industry, agriculture, and human resources make up the continent's economy (Espoir et al., 2022). Besides, the growth in the American continents was at 2.0 percent in 2022 and it's expected to slow of about 0.2 percent in 2023 and then rebound to 1.7 percent in 2024. However, after a strong rebound of 6.5 percent in 2021, growth in Asia was expected to moderate to 4.0 percent in 2022 and rise to 4.35 in 2023 (Hasanov et al., 2021). Moreover, the economic growth in Europe and

Oceania is forecast to progressively regain traction, averaging 1.6% and 1.5% in 2023 and 2024 respectively (Mlodkowski, 2019).

According to Susilo et al. (2022) most of the African countries typically fall towards the bottom of any list measuring small size economic activity such as income per capita despite a wealth of natural resources. In 2021, the poverty rate in the Americas was 11.6 percent with about 37.9 million people in poverty. According to the World Bank 2021 report, more than 320 million people in Asia live in extreme poverty. This mean that, hundreds of millions of people are living below the standard economic definition of poverty (Roe & Zavar, 2021). Other studies has also suggested that, an estimation of 21.7% of the population or about 95.4 million people are at risk of poverty or social exclusion in Europe (Lu et al., 2022). In Oceania, the percentage of the population living below the poverty line is relatively low at 26.9% of the total population.

3.3 Data Collection and Processing

The study collected data on climate, disasters, energy, economic growth (GDP growth rate and GDP per capita rate), poverty (monetary, education and basic infrastructure) and the other variables (afforestation, access to clean water, access to sanitation, industrialization, political stability and renewable energy). The carbon emission and the energy data from 2000 to 2020 were secured from Our World in Data (https://ourworldindata.org) database (Table 1).

Table 1: Datasets and sources

variables	Explanation	Source	Year span
Climate	CO_2 emission	Representative Concentration Pathway (http://www.iiasa.ac.at/web-apps/tnt/RcpD)	2000-2020
Disasters	Biological Climatological Geophysical Hydrological Meteorological Technological	EM-DAT, CRED/UCLouvain, Brussels, Belgium (www.emdat.be)	2000 - 2020
Economic Growth	GDP growth rate GDP per capita rate	World Bank (https://datacatalog.worldbank.org/)	2000-2020
Poverty	Monetary Education Basic infrastructure	World Bank (https://datacatalog.worldbank.org/)	2000-2020
Confounding variables	Afforestation Access to clean water Access to sanitation Industrialization Political stability Renewable energy	World Bank (https://datacatalog.worldbank.org/)	2000-2020

Source: Author's Construct, 2023

Also, the climate data was acquired from the Representative Concentration Pathway (RCP) website at http://www.iiasa.ac.at/web-apps/tnt/RcpD. Disaster data (2000-2020) was likewise acquired from EM-DAT, CRED/UCLouvain, Brussels, Belgium (www.emdat.be) database. Additionally, the economic growth and poverty data were also secured from the World Bank website https://datacatalog.worldbank.org/ (Table 1).

The databases for these datasets were selected due to their comprehensiveness, as they contain data on more than 90% of the countries in the world, and the year periods were selected due to the ten-year prognosis (2030). Also, the data was secured from the various sources such as the World Bank and the Organization for Economic

Cooperation and Development because of they adhere to the following data quality criteria: data relevance, applicability, adequacy, timeliness, quality, and coverage.

Nevertheless, there were some limits to the data because some countries lacked records and others had out-of-date records (Tampah-Naah et al., 2019). However, this was resolved using the K-nearest-neighbor (KNN) function which employs thespatial autofill method. The mean value of K (the number of nearest neighbors) is used to calculate K-nearest-neighbor (Arnesson & Lewenhagen, 2018). The value of K in this study was four, hence four neighboring nations were used to estimate the value of countries with no value. The theoretical underpinning of KNN is Tobler's first law of geography, which states that objects that are closer together are more connected in space and time and so more likely to have similar values (Osman et al., 2022). The KNN was chosen because to its dependability, simplicity, speed, and scalability in computing (Arnesson & Lewenhagen, 2018).

Additionally, the Microsoft Excel was used to process and filter the six main datasets (Climate, disaster, economic growth multidimensional poverty and confounding variables data). The sorting considered the variables and year gap for the study. Subsequently, the ArcGIS PRO 2.8.2 software was used to join the world shapefile with the datasets. The world country's layers were then projected to WGS 1984 World Mercator projected coordinate system using ArcGIS Pro 2.8.2. However, the shapefile for the world country's layers was acquired from ICPAC GEOPORTAL website at https://bit.ly/3E1R33S.

3.4 Data Analysis

In looking for a model that best explain the dependent variable within the dataset of this study an exploratory regression was run to evaluates all possible combinations and best fit of the input variables. The exploratory regression runs OLS on every possible combination of the candidate explanatory variables for models with at least the minimum number of explanatory variables. However, with the ten explanatory variables that were considered for the analysis, seven of the variables were listed as predicting variables. The selected variables include, afforestation, access to clean water, access to sanitation, industrialization, political stability and renewable energy. A spatial autocorrelation (Global Moran's I) tool was later run to assess independency of the models (Majeed et al., 2021).

The spatial analysis techniques adopted for this study were mean centre and trend analysis, incremental autocorrelation, standard distance ellipsoid, emerging hotspot analysis, exponential smoothing and random forest forecast and random forest-based classification and regression.

To achieve H1 (Climate disasters are more persistent in African countries than the Western countries), mean centre analysis was used to determine the average x-y coordinates of the disasters of the various countries. The mean centre's function is given as (Equation 1)

$$\overline{X} = \frac{\sum_{i=1}^{n} xi}{n} \text{ and } \overline{Y} = \frac{\sum_{i=1}^{n} yi}{n} \text{..................(Equation 1)}$$

where:

x_i and y_i as the coordinates for the features i and n as the number of features.

Also, the incremental spatial autocorrelation was used to test for the presence of spatial autocorrelation at a range of band distances (Esen & Bayrak, 2017). It was used to identify the farthest distance at which the types of disasters have a significant impact on each continent. For each distance increment, the method produces Global Moran's I, Expected I, variance, a z-score and a p- value (Majeed et al., 2021). The z-score peaks reflect distances at which a clustering process seems to be occurring. The higher the z-score, the stronger the clustering process at that distance (Loayza et al., 2012). The incremental spatial autocorrelation function is given as (Equation 2)

LISA = (Zi - Zbar) / (1 - Zbar)……………………………..(Equation 2)

Where:

LISA is the incremental spatial autocorrelation value for a given location i.

Zi is the observed variable value at location i.

Zbar is the mean variable value for all locations (Anselin, 1995).

Likewise, utilizing the standard deviational ellipse, the trend of disasters was evaluated in order to determine whether the distribution was elongated and had a certain orientation. Standard deviational ellipse (Equation 3) has the following function.

$$C = \frac{\sum_{i=1}^{n} \bar{X}i2 \sum_{i=1}^{n} \bar{X}i\bar{Y}i}{\sum_{i=1}^{n} \bar{X}i\bar{Y}i \sum_{i=1}^{n} \bar{Y}i2} \text{...(Equation 3)}$$

where:

x and y as coordinates of the features (i) $\bar{X}$ and $\bar{Y}$ as coordinates of the features.

Furthermore, the emerging hot spot analysis tool in ArcGIS Pro 2.8.2 software was used to identify emerging hotspots zones in the various types of disasters globally. The emerging hotspot analysis tool used each variable in the dataset to identify emerging hotspot trends and patterns. The tool detected new, increasing, decreasing, sporadic and other patterns within datasets. It takes space-time Net-CDF cube to conceptualize spatial relationship value to calculate Getis-Ord Gi* statistics (Iizuka, 2020). Moreover, to achieve the H2, H3 and H4 spatial prediction model with the help of a space-time cube was employed. Space-time bins were generated for both the disasters, economic growth and the poverty variables with an interval of one year each for the ten years period (2021-2030). In each bin defined a set of observations over one year period. A trend analysis for the bins across time were measured using the Mann-Kendall Statistics (Iizuka, 2020).

A random forest-based classification and regression was used to assess the factors influencing disasters, economic growth, and poverty. In the analysis, entropy served as the foundation for examining the relationship between two or more variables. Entropy-based calculations search for relationships that are structural rather than just linear, including exponential, quadratic, sinusoidal, and complicated relationships (Osman et al., 2022). The random forest-based classification and regression was used to find out if carbon emission is reduced by 45% or not plus the other variables, how disasters, economic growth and poverty will be by the year 2030. This was done using ArcGIS Pro 2.8.2. The tool created hundreds of trees called an ensemble of decision trees which was used to create a model for prediction (Soergel et al., 2021). Each decision tree is created using randomly generated portion of the original data (Cuaresma et al., 2017). A random forest is a classifier consisting of a collection of tree structured classifiers (Osman et al., 2022). Cuaresma et al. (2017) gave the function of Leo Braiman Random forest-based regression (Equation 4) as follows

$$\{h(x, \Theta_k), k=1, ...\} \quad \text{………………………………………….(Equation 4)}$$

Where:

$\{\Theta_k\}$ are independent identically distributed random vectors and each tree casts a unit vote for the most popular class at input x.

X is an input vector

N is the number of decision trees by using K regression of h (x, Θ_k) as the predictive results.

Afterwards, the results of the random classification and regression the were further analysed using the Stata 17.0. software. The mean of the statistical data that was generated by random forest-based were compared across continents using the paired t-test.

CHAPTER FOUR

RESULTS AND DISCUSSION

4.0 Introduction

This chapter focuses on the analysis of the results. The chapter is presented based on the hypothesis underpinning this study: persistence and disparities of disasters, effect of 45% reduction in carbon emission on disasters, economic growth and poverty.

4.1 Persistence and Disparities of Disasters

4.1.1 Mean centre of disasters

Spatial mean centre analysis at the global scale revealed that technological disasters (154) have the highest occurrence for the 21 years period of study with South Sudan as the mean centre (Table 2). However, meteorological and hydrological had mean values of 68 (Libya) and 60 (South Sudan) respectively. With biological disasters (4) the least occurred with a mean country as Sudan. Moreover, whereas, geophysical disasters (21) recorded the fourth highest disasters (Saudi Arabia), climatological disasters (12) recorded the fifth highest disaster with mean centre being Mali. Per continents, the study found that, Asia had the most of hydrological hazards with mean value of 108 from 2000 to 2020, with Bangladesh as the mean centre. Also, the Americas had the highest meteorological disasters of 125 with United States as a mean country. However, Africa climatological disasters average occurrence was 5 centred in DR. Congo (Table 2).

Table 2: Mean values of disasters per continents from 2000-2020

	All			**African**			**American**			**Asia**			**Europe**			**Oceania**		
Variables	MC	Mco	SD	MC	Mco	Sd	MC	Mco	SD	MC	Mco	SD	MC	Mco	SD	MC	Mco	SD
									Disaster									
Bio	4	Sudan	6.8	20	Central African Republic	10.3	4	Panama	1.9	14	India	6.9	3	Poland	1.3	3	Mauritius	1.3
Climate	12	Mali	5.6	5	DR Congo	2.2	26	Mexico	10.5	7	India	3.8	7	Poland	3.7	10	Papua New Guinea	4.9
Geophys	21	Saudi Arabia	9.8	5	Cameroon	1.4	8	Costa Rica	4.2	38	India	18.0	8	Germany	4.0	8	Australia	4.2
Hydro	60	South Sudan	28.3	29	DR Congo	14.5	42	Costa Rica	21.3	108	Bangladesh	50.6	23	Poland	11.8	17	Reunion	8.5
Meteo	68	Libya	26.8	12	DR Congo	6.0	125	United States	43.0	89	Myanmar	38.8	22	Germany	10.7	19	Seychelles	9.3
Tech	154	South Sudan	55.9	95	Central African Republic	44.9	54	Panama	25.8	280	China	105.5	62	Russia	25.1	5	Papua New Guinea	1.8

Source: Acquah, 2023

MC=Mean centre value, Mco=Mean centre country, SD=Standard deviation, Bio=Biological, Climate=Climatological, Geophys=Geophysical, Hydro=Hydrological, Meteo=Meteorological, Tech=Technological

4.1.2 Incremental spatial autocorrelation of disaster

The incremental spatial autocorrelation analysis on disasters at the global scale shows that all the disasters had one peak point. Geophysical disaster had the highest max peak at 6.99^{000}km with Moran's I=0.13, Z score=12.90 and p=0.00 (Appendix 1). Climatological disasters were the disaster type with the second highest max peak of 6.04^{000}km [Moran's I= 0.11, Z= 9.88, p=0.00] with the technological disasters having the least mean peak value of 5.09^{000}km.

Africa had hydrological disasters having the highest maximum peak at 2.74^{000}km [Moran's I=0.09, Z= 2.9, p=0.00] whiles, geophysical and technological disasters recorded no maximum peaks. Equally, Asia had hydrological disasters having the maximum peak at 4.43km^{000} [Moran's I=0.07, Z= 3.2, p=0.00] with the least being geophysical disaster with maximum peak value of 1.90^{000}km. In America, technological disaster had the highest maximum peak at 1.57^{000}km [Moran's I=0.17, Z= 2.6, p=0.01] with the rest of the disasters recording the same maximum peak of one (1). Europe had both bio and climate disasters having same max peak value of 1.47^{000}km and the least of 1.24^{000}km for meteorological disasters. There were no peak points for geophysical, hydrological and technological disasters for Europe. Oceania had only peak value for meteorological disasters with a maximum peak of 4.55^{000}km [Moran's I=0.10, Z=1.65, p=0.10] (Appendix 2).

4.1.3 Standard distance ellipsoid of disasters

Globally, the standard distance ellipsoid analysis of disaster (2000-2020) had a rotation between 84^0 to 94^0 affecting more than 198 countries (Table 3).

Table 3: Standard distance ellipsoid values of disaster from 2000-2020

	All				Africa				America				Asia				Europe				Oceania			
Variables	CX (Km^2)	CY (Km^2)	Rot	NC	CX (Km^2)	CY (Km^2)	Rot	NC	CX (Km^2)	CY (Km^2)	Rot	NC	CX (Km^2)	CY (Km^2)	Rot	NC	CX (Km^2)	CY (Km^2)	Rot	NC	CX (Km^2)	CY (Km^2)	Rot	NC
Bio	3.1	1.3	88.5	114	2.0	0.4	140.8	46	-8.7	0.8	126.1	28	9.0	2.6	96.0	43	2.3	6.8	70.5	43	7.4	-0.9	89.2	4
Climate	-0.3	2.0	92.2	198	2.5	-0.2	123.5	39	-11.0	2.3	140.2	47	9.2	2.9	90.3	48	2.1	6.5	70.4	44	0.1	-1.3	91.1	5
Geophys	4.5	2.4	90.7	184	1.3	0.6	120.6	37	-9.8	0.9	141.2	47	9.4	3.1	93.4	51	1.6	6.7	67.5	44	8.6	-1.2	89.4	4
hydro	3.9	1.9	90.7	161	2.2	0.3	125.4	31	-9.1	1.2	144.9	31	10.1	2.6	107.2	47	2.4	6.4	71.6	42	10.6	-1.3	92.6	5
Meteo	2.8	3.0	94.7	184	2.6	-0.3	144.4	26	-10.5	3.4	130.7	40	10.8	3.0	91.5	27	1.5	6.2	68.5	39	10.9	-1.8	90.6	7
Tech	4.0	2.2	84.5	128	2.0	0.5	140.0	32	-9.1	1.0	135.3	46	9.7	3.3	98.0	23	4.2	6.9	69.2	38	2.3	-1.2	89.8	4

Source: Acquah, 2023

CX=Centre X, CY=Centre Y, Rot=Rotation, NC=Number of Countries, Km^2=Kilometres Square, Bio=Biological, Climate=Climatological, Geophys=Geophysical, Hydro=hydrological, Meteo=Meteorological, Tech=Technological

Climatological disasters (198) were found to have the highest number of countries affected with the least disaster as biological (114) from 2000 to 2020. Africa had the highest number of countries that were affected by biological disasters (46). Meteorological (26) affected the least number of countries. In Asia, hydrological, climatological and geophysical disasters affected the most countries thus 47, 48 and 51, respectively. The Americas recorded most of number of countries being affected by meteorological disasters (40). Oceania recorded the least number of countries that was affected by all the disaster types (Table 3).

4.1.4 Emerging hotspot analysis of disaster

The emerging hotspot analysis on disaster indicated that, Central Africa Republic [HS=76, Z=3.81, p=0.00], Dr Congo [HS=71, Z=3.90, p=0.00] and Sudan [HS=67, Z=-3.27, p=0.00] were sporadic hotspot zones in terms of biological disasters (Figure 3). In the Americas, USA was identified to be persistent hotspot zone of climatological disasters while Paraguay was a sporadic hotspot zone.

Table 4: Emerging hotspot analysis on disaster from 2000-2020

Variables	Country	PoH	z-score	p-value	% Sig HS
Biological disasters	Sudan	Sporadic Hot Spot	-3.27	0.00	67
	DR Congo	Sporadic Hot Spot	-3.90	0.00	71
	Central African Republic	Sporadic Hot Spot	-3.81	0.00	76
Climatological disasters	USA	Persistent Hot Spot	-1.51	0.13	90
	Paraguay	Sporadic Hot Spot	-1.48	0.14	14
	Indonesia	Sporadic Hot Spot	0.33	0.74	43
	Philippines	Sporadic Hot Spot	0.74	0.46	29
Hydrological disasters	Peru	Sporadic Hot Spot	0.48	0.63	19
	Bolivia	Sporadic Hot Spot	0.36	0.72	19
Geophysical disasters	Mongolia	Diminishing Hot Spot	-1.99	0.05	100
	Vietnam	Sporadic Hot Spot	0.27	0.78	19
	Cambodia	Sporadic Hot Spot	0.27	0.78	19
	Malaysia	Sporadic Hot Spot	0.30	0.76	19
	Paraguay	Sporadic Hot Spot	0.46	0.65	19
	Cameroon	Sporadic Hot Spot	1.60	0.11	14
	Congo	Sporadic Hot Spot	1.30	0.19	14
	Central African Republic	Sporadic Hot Spot	0.33	0.97	14
	Chad	Sporadic Hot Spot	0.57	0.57	14
	Sudan	Sporadic Hot Spot	1.48	0.14	14
	Uganda	Sporadic Hot Spot	0.48	0.63	14
	Rwanda	Sporadic Hot Spot	0.76	0.45	14
	Burundi	Sporadic Hot Spot	0.76	0.45	14
	Tanzania	Sporadic Hot Spot	0.73	0.47	14
	Kenya	Sporadic Hot Spot	0.88	0.38	19
	Ethiopia	Sporadic Hot Spot	1.72	0.08	14
	Djibouti	Sporadic Hot Spot	1.36	0.17	14
	Oman	Sporadic Hot Spot	1.21	0.23	14
	Sri Lanka	Sporadic Hot Spot	0.00	1.00	71
	India	Sporadic Hot Spot	1.18	0.24	81
	Pakistan	Sporadic Hot Spot	0.48	0.63	43
	Afghanistan	Sporadic Hot Spot	0.54	0.59	38
	Tajikistan	Sporadic Hot Spot	0.45	0.65	81
	Kyrgyzstan	Sporadic Hot Spot	0.39	0.69	81
	Nepal	Sporadic Hot Spot	0.67	0.51	86
	Vietnam	Sporadic Hot Spot	0.88	0.38	57
	Cambodia	Sporadic Hot Spot	0.88	0.38	57
	Indonesia	Sporadic Hot Spot	1.09	0.28	48
	Malaysia	Sporadic Hot Spot	0.88	0.38	48
	Somalia	Sporadic Hot Spot	1.27	0.20	14
	Philippines	Sporadic Hot Spot	0.21	0.83	38
	Brazil	New Hot Spot	0.67	0.50	5
	Gabon	New Hot Spot	0.97	0.33	5
	Angola	New Hot Spot	0.33	0.74	5
	Botswana	New Hot Spot	0.85	0.40	5
	Zambia	New Hot Spot	1.06	0.29	5
	Zimbabwe	New Hot Spot	0.39	0.69	5

	Malawi	New Hot Spot	0.54	0.59	5
	Mozambique	New Hot Spot	0.54	0.59	5
	Comoros	New Hot Spot	0.76	0.45	5
	Mayotte	New Hot Spot	0.18	0.86	5
	Mongolia	Persistent Hot Spot	0.00	1.00	95
	Bhutan	Persistent Hot Spot	-0.33	0.74	95
	Bangladesh	Persistent Hot Spot	0.00	1.00	95
	Myanmar				
	Taiwan	Persistent Hot Spot	-0.21	0.83	90
Meteorological disasters	North Korea	Sporadic Hot Spot	1.28	0.20	19
	Japan	Sporadic Hot Spot	0.00	1.00	43
	Myanmar	Sporadic Hot Spot	1.00	0.32	33
	USA	Sporadic Hot Spot	0.48	0.63	62
	Bangladesh	Persistent Hot Spot	0.61	0.54	100
	Bhutan	Persistent Hot Spot	0.36	0.72	90
	Laos	Persistent Hot Spot	0.24	0.81	95
	Mongolia	Persistent Hot Spot	-0.39	0.69	90
	-	Historical Hot Spot	0.82	0.41	95
Technological disasters					

% Sig HS=Percentage of Significant Hotspot, PoH=Pattern of Hotspot

Source: Acquah, 2023

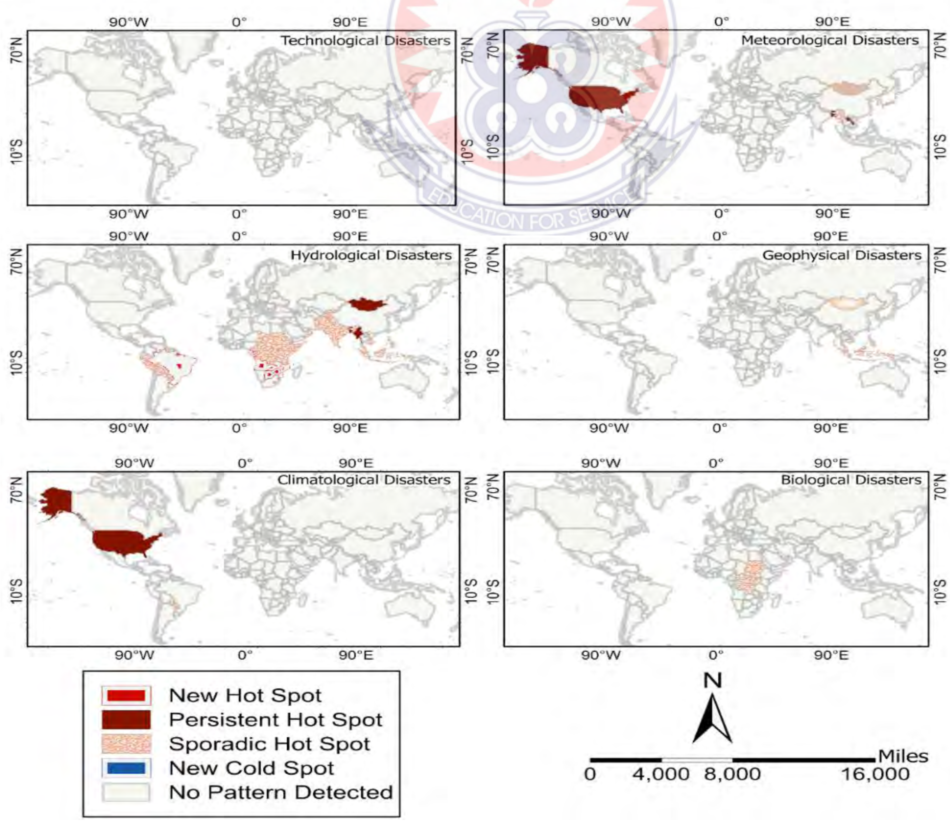

Figure 3: Emerging hotspot analysis on disaster from 2000-2020

Source: Acquah, 2023

For geophysical disasters Vietnam, Cambodia, Malaysia, Indonesia and the Philippines were identified as sporadic Hotspot zones (Table 4). Also, from Table 4, hydrological disasters were the disaster type that had the highest number of countries emerging as hotspot zones. Further, Mongolia was a diminishing hotspot zone [HS=100, Z=-1.99, p=0.05].

A total number of 29 countries emerged as sporadic hotspot zones while 12 countries were new hotspot zones. Mongolia, Bhutan, Bangladesh and Myanmar were the countries emerging as persistent hotspot zones for hydrological disasters. With regards to meteorological disasters, Taiwan, North Korea, Japan and Myanmar were sporadic hotspot zones. In addition, USA, Bangladesh, Bhutan and Laos Republic also emerged as persistent hotspot zones with Mongolia being noted as historical hotspot zone. On the other hand, technological hazards, didn't record any emerging hotspot zones.

However, for Africa 22 countries emerged as hotspot zones for hydrological and 2 countries for biological disasters. The Americas also had 2 countries emerging as hotspot zones for climatological and 5 countries for hydrological disasters, and 1 country each for geophysical and meteorological disasters. While in Asia, 6 countries were identified as hotspot zones for geophysical disaster, 18 countries for hydrological and 8 countries for meteorological disasters. Europe had no country emerging as hotspot zone for biological, climatological, geophysical, meteorological and technological disasters except Glorioso Islands and Mayotte as hydrological disasters hotspot. Oceania had no country emerging as hotspot zone for all the disasters (Figure 3).

4.1.5 Disasters forecast from 2021 to 2030

An exponential smoothing forecast analysis was performed to predict disaster from 2021 to 2030 (Disaster Trend [DTR]). Results indicated that globally, hydrological disasters were the highest likely to occur from 2021 to 2030. Cumulatively, about 1982 of hydrological disaster types are expected to occur within this 10 years period. The disaster with the least possible occurrence was biological disasters with the total of 91 disasters (Table 5). Per continent, hydrological disasters (76) were still the persistent disaster in Africa whereas geophysical disasters (1) had the least likelihood of occurrence.

Cumulatively, the Americas had both meteorological and hydrological disasters recording the highest likelihood of occurring (2021-2030) with a total of 354 and 323 respectively. Asia had the highest number of hydrological disasters with about 786 disasters likely to occur. Meteorological disasters (466) were the second most likely disaster while with geophysical disasters (133) being the least likely to occur disasters. In Europe, meteorological disasters had the highest likelihood of occurrence with each year recording about 21 disasters. The disaster with the least possible of occurrence in Europe was climatological with estimated 9 disasters. Equally, Oceania also had meteorological disasters (6) recording the highest likelihood of occurrence with biological disaster recoding no event (Table 5).

Table 5: Disasters forecast from 2021 to 2030

	All				Africa				America				Asia				Europe				Oceania			
	Min	**Max**	**Sum**	**Sd**	**Min**	**Max**	**Sum**	**Sd**	**M**	**Max**	**Sum**	**Sd**	**Min**	**Max**	**Sum**	**Sd**	**Min**	**Max**	**Sum**	**Sd**	**Min**	**Max**	**Sum**	**Sd**
Technological Disaster																								
2021	1	10	143	1.3	1	10	52	1.7	1	4	25	0.9	1	10	50	1.7	0	7	15	1.1	0	0	1	0.1
2022	1	10	135	1.2	1	10	51	1.6	1	4	24	0.9	1	9	47	1.7	0	6	13	0.9	0	0	1	0.1
2023	1	10	127	1.2	1	10	53	1.7	0	4	23	0.9	1	9	40	1.6	0	3	10	0.6	0	0	1	0.1
2024	1	10	119	1.2	1	10	46	1.6	0	4	22	0.9	1	9	38	1.7	0	5	12	0.8	0	0	1	0.1
2025	0	10	109	1.3	1	10	46	1.7	0	4	21	0.9	1	8	30	1.8	0	5	11	0.8	0	0	1	0.1
2026	0	10	101	1.3	1	10	41	1.6	0	4	20	0.9	1	8	27	2.0	0	6	13	1.0	0	0	1	0.1
2027	0	10	100	1.4	1	10	43	1.7	0	4	20	0.9	1	8	26	2.2	0	5	11	0.9	0	0	1	0.1
2028	0	10	87	1.5	1	10	37	1.6	0	4	18	1.0	0	7	23	2.5	0	2	8	0.6	0	0	1	0.1
2029	0	10	84	1.6	1	10	39	1.8	0	4	18	1.0	0	7	17	2.8	0	4	10	0.8	0	0	1	0.1
2030	0	10	79	1.7	1	10	37	1.6	0	4	17	1.0	0	7	15	3.1	0	4	10	0.8	0	0	1	0.1
Meteorological Disaster																								
2021	0	16	116	1.4	0	2	9	0.3	1	16	35	2.2	1	9	46	1.9	1	3	21	0.7	0	1	6	0.3
2022	0	14	118	1.4	0	2	9	0.3	1	14	34	2.0	1	10	49	2.2	1	3	21	0.7	0	1	6	0.3
2023	0	15	115	1.4	0	2	10	0.4	1	15	35	2.1	1	9	46	2.0	1	3	21	0.7	0	1	6	0.3
2024	0	16	115	1.4	0	2	10	0.4	1	16	36	2.2	1	9	44	1.9	1	3	21	0.7	0	1	6	0.3
2025	0	15	115	1.4	0	2	10	0.4	1	15	35	2.1	1	9	46	2.0	1	3	21	0.7	0	1	6	0.3

Min=Minimum, Max=Maximum, Sum=Sum, SD=Standard deviation

Table 5 Cont'd

2026	0	15	120	1.5	0	2	10	0.4	1	15	35	2.1	1	10	49	2.2	1	3	21	0.7	0	1	6	0.3
2027	0	16	117	1.5	0	2	10	0.4	1	16	36	2.3	1	9	46	2.0	1	3	21	0.7	0	1	6	0.3
2028	0	15	115	1.4	0	2	10	0.4	1	15	35	2.1	1	9	44	1.9	1	3	21	0.7	0	1	6	0.3
2029	0	16	117	1.4	0	2	11	0.4	1	16	36	2.2	1	9	46	2.0	1	3	21	0.7	0	1	6	0.3
2030	0	16	122	1.6	0	2	11	0.5	1	16	37	2.3	1	11	50	2.3	1	3	21	0.7	0	1	6	0.3
Hydrological Disaster																								
2021	1	12	183	1.4	1	7	54	1.2	1	4	33	1.0	2	12	75	2.4	0	2	17	0.5	0	2	4	0.4
2022	1	12	193	1.6	1	8	58	1.4	1	4	35	1.1	2	12	79	2.7	0	2	16	0.5	0	2	4	0.5
2023	1	12	189	1.5	1	10	59	1.7	1	4	32	1.0	2	12	76	2.5	0	2	16	0.5	0	2	4	0.5
2024	1	13	196	1.7	1	12	62	1.9	1	4	32	1.0	2	13	79	2.7	0	2	18	0.6	0	2	4	0.5
2025	1	14	197	1.7	1	14	64	2.1	1	4	34	1.1	2	13	77	2.5	0	2	18	0.6	0	2	4	0.5
2026	1	16	199	1.8	1	16	67	2.3	1	4	31	1.0	2	13	80	2.8	0	2	16	0.6	0	2	5	0.5
2027	1	18	206	1.9	1	18	76	2.7	1	4	31	1.0	2	13	78	2.5	0	2	16	0.6	0	2	5	0.5
2028	1	20	206	2.0	1	20	71	2.8	1	4	34	1.1	2	13	81	2.8	0	2	16	0.6	0	2	5	0.5
2029	1	21	206	2.0	1	21	74	3.1	1	4	31	1.0	2	13	79	2.6	0	2	18	0.6	0	2	5	0.5
2030	1	23	209	2.1	1	23	75	3.3	1	4	30	1.0	2	13	82	2.8	0	2	17	0.6	0	2	5	0.5

											Geophysical Disaster													
2021	0	4	26	0.4	0	0	1	0.1	0	1	5	0.2	0	4	15	0.7	0	2	3	0.3	0	1	2	0.2
2022	0	4	26	0.4	0	0	1	0.1	0	1	5	0.2	0	4	14	0.7	0	2	3	0.3	0	1	2	0.2

Min=Minimum, Max=Maximum, Sum=Sum, SD=Standard deviation

Table 5 Cont'd

2023	0	4	26	0.4	0	0	1	0.1	0	1	5	0.2	0	4	14	0.7	0	2	4	0.3	0	1	2	0.2
2024	0	4	25	0.4	0	0	1	0.1	0	1	5	0.2	0	4	14	0.7	0	2	4	0.3	0	1	2	0.2
2025	0	4	25	0.4	0	0	1	0.1	0	1	5	0.2	0	4	14	0.7	0	2	4	0.3	0	1	2	0.2
2026	0	4	25	0.4	0	0	1	0.1	0	1	5	0.2	0	4	13	0.7	0	2	4	0.3	0	1	2	0.2
2027	0	4	24	0.4	0	0	1	0.1	0	1	5	0.2	0	4	13	0.7	0	2	4	0.3	0	1	2	0.2
2028	0	4	24	0.4	0	0	1	0.1	0	1	5	0.2	0	4	12	0.7	0	2	4	0.3	0	1	2	0.2
2029	0	4	24	0.4	0	0	1	0.1	0	1	5	0.2	0	4	12	0.7	0	2	4	0.3	0	1	2	0.2
2030	0	4	23	0.4	0	0	1	0.1	0	1	5	0.2	0	4	12	0.7	0	2	4	0.3	0	1	2	0.2
											Climatological Disaster													
2021	0	2	18	0.2	0	1	6	0.1	0	2	6	0.3	0	1	3	0.2	0	1	1	0.1	0	1	1	0.2
2022	0	2	18	0.2	0	1	6	0.1	0	2	6	0.3	0	1	3	0.2	0	1	1	0.1	0	1	1	0.2
2023	0	2	18	0.2	0	1	6	0.1	0	2	6	0.3	0	1	3	0.2	0	1	1	0.1	0	1	1	0.2
2024	0	2	18	0.2	0	1	6	0.2	0	2	6	0.3	0	1	3	0.2	0	1	1	0.1	0	1	1	0.2
2025	0	2	17	0.2	0	1	6	0.2	0	2	6	0.3	0	1	3	0.2	0	1	1	0.1	0	1	1	0.2
2026	0	2	17	0.2	0	1	6	0.2	0	2	6	0.3	0	1	3	0.2	0	1	1	0.2	0	1	1	0.2
2027	0	2	17	0.2	0	1	6	0.2	0	2	6	0.3	0	1	3	0.2	0	1	1	0.2	0	1	1	0.2
2028	0	2	17	0.2	0	1	6	0.2	0	2	6	0.3	0	1	3	0.2	0	1	1	0.2	0	1	1	0.2
2029	0	2	17	0.2	0	1	6	0.2	0	2	6	0.3	0	1	3	0.2	0	1	1	0.2	0	1	1	0.2
2030	0	2	17	0.2	0	1	7	0.2	0	2	6	0.3	0	1	4	0.2	0	1	0	0.2	0	1	1	0.2

Min=Minimum, Max=Maximum, Sum=Sum, SD=Standard deviation

Table 5 Cont'd

											Biological Disaster													
2021	0	3	15	0.3	0	3	11	0.4	0	1	3	0.1	0	2	2	0.3	0	0	1	0.1	0	0	0	0.1
2022	0	3	16	0.3	0	3	11	0.5	0	1	3	0.1	0	3	3	0.5	0	0	1	0.1	0	0	0	0.0
2023	0	3	10	0.3	0	3	6	0.5	0	1	3	0.1	0	2	2	0.4	0	0	1	0.1	0	0	0	0.0
2024	0	3	9	0.3	0	3	5	0.5	0	1	3	0.1	0	3	3	0.5	0	0	1	0.1	0	0	0	0.0
2025	0	3	9	0.3	0	3	6	0.4	0	1	3	0.1	0	2	2	0.5	0	0	2	0.1	0	0	0	0.0
2026	0	3	10	0.3	0	3	6	0.4	0	1	3	0.2	0	3	3	0.6	0	0	2	0.1	0	0	0	0.0
2027	0	3	9	0.3	0	3	6	0.5	0	1	3	0.2	0	2	2	0.5	0	0	2	0.1	0	0	0	0.0
2028	0	3	5	0.4	0	3	1	0.6	0	1	3	0.2	0	3	3	0.6	0	0	2	0.1	0	0	0	0.0
2029	0	3	3	0.4	0	0	0	0	0	1	3	0.2	0	3	2	0.6	0	0	2	0.1	0	0	0	0.0
2030	0	3	5	0.4	0	3	1	0.5	0	1	3	0.2	0	3	3	0.7	0	0	2	0.1	0	0	0	0.0

Min=Minimum, Max=Maximum, Sum=Sum, SD=Standard deviation

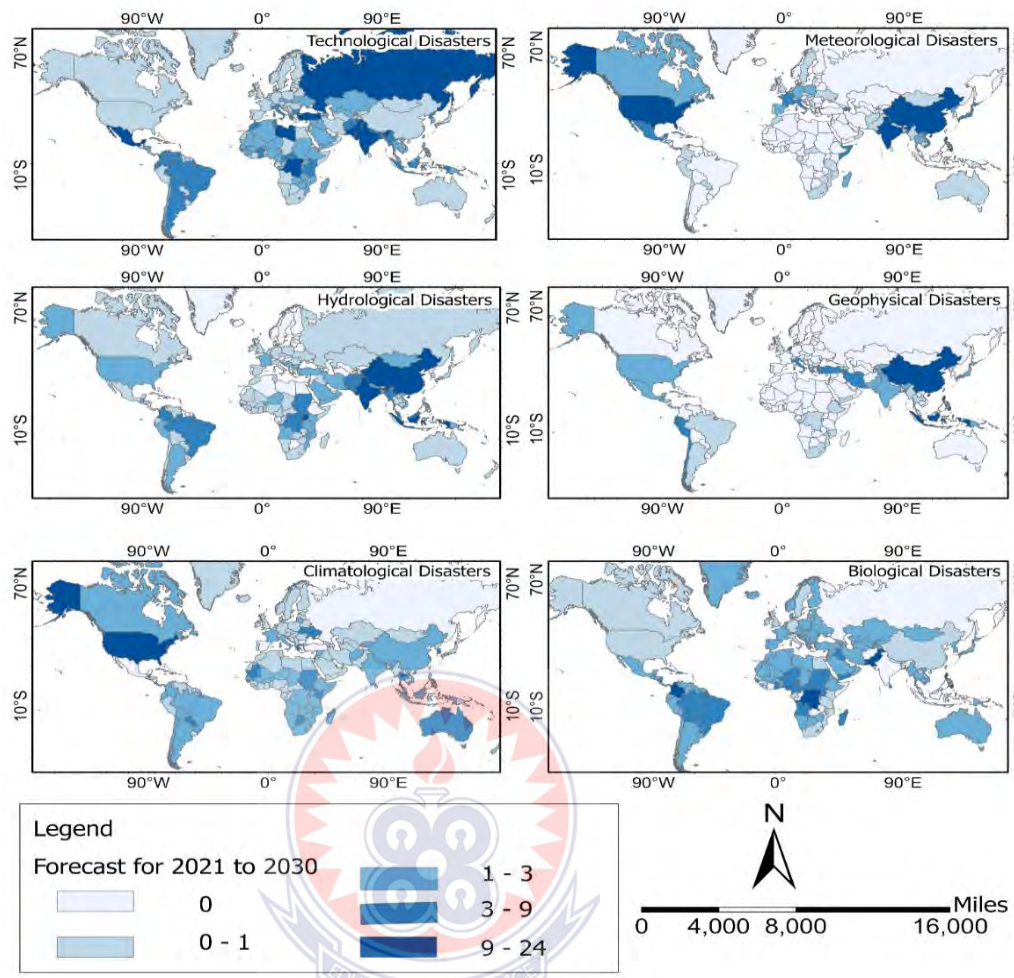

Figure 4: Disasters forecast from 2021 to 2030

Source: Acquah, 2023

4.2 Effect of 45% Reduction in Carbon Emission on Disasters

The study sought to assess the effect of the proposed 45% reduction in carbon emissions on disasters through five different scenarios. Firstly, the normal disaster trend (DTR) as presented in Table 5., disaster scenario one (DS1) dealt with the effects of no reduction in carbon emissions on disasters. Disaster scenario two (DS2) looked at effects of no reduction in carbon emissions, plus confounding variables on disasters. The disaster scenario three (DS3) focused on the effects of reduction in carbon emission (45%) on disasters while disaster scenario four (DS4) focused on the effects of reduction in carbon emission (45%) plus the confounding variables.

4.2.1 Disaster scenario one (DS1): Effects of no reduction in carbon emissions on disasters

The result from the forest-based classification and regression analysis on carbon emission if nothing is done (DS1), (if carbon emission is not reduced by 45%) showed various levels of influence on the disaster types. DS1 produced training R^2 with the least value of 0.66 and a p-value of 0.00. The validation R^2 range from 0.03 to 0.52 (Table 6). Biological disasters (R^2 =0.79, p=0.00) had the highest training prediction from the model while meteorological disasters had the least (R^2=0.66, p=0.03) (Appendix 3). Moreover, about 502 disasters are expected to occur in 2030 with regard to this scenario. Africa is expected to record 131, for America (117), Asia (215), Europe (99), and 24 in Oceania.

4.2.2 Disaster scenario two (DS2): Effects of no reduction in carbon emissions plus confounding variables on disasters

With regards to no reduction in carbon emission plus the other variables, the forest-based classification and regression result found carbon emission to have the highest influence on all the disaster types. The influence/importance of carbon emission on climatological and meteorological disasters were about 55%, and 40% respectively. The influence of carbon emission on biological and geophysical disasters was 40% and 30% respectively. Geophysical disasters had 17% influence from political stability, while climatological, technological, hydrological and meteorological had an influence range from 11% to 16%. Beside the model statistics, the result generated a training R^2 ranging from 0.83 to 0.89 and a p-value of 0.00. The validation R^2 range from 0.06 to 0.35 (Appendix 4). Cumulatively, about 562 of disasters are likely to occur in 2030 given scenario two. About 136 disasters are expected to occur in Africa, 113 in America, 213 in Asia, 111 in Europe and 23 occurrences in Oceania.

4.2.3 Disaster scenario three (DS3): Effects of reduction in carbon emission [45%] on disasters

The study also sought to assess the effect of 45% reduction in carbon emission on disasters in 2030. The results indicated that, geophysical and hydrological disasters had the highest influence from carbon emission (R^2 =0.80, p=0.00). On the other hand, meteorological disasters had the least influence from carbon emission with a training prediction R^2=0.60, p=0.00 and a validation prediction R^2=0.61, and a p=0.00 (Appendix 5). However, as a result of the 45% reduction, about 430 of disasters are expected to occur in 2030. Approximately, 108 disasters are expected in Africa, 96 in America, 153 in Asia, 95 in Europe and 22 in Oceania.

4.2.4 Disaster scenario four (DS4): Effects of reduction in carbon emission (45%) plus the plus confounding variables on disasters

With regards to assessing the effect of 45% reduction in carbon emission plus confounding variables (renewable energy, clean water, sanitation, political stability and afforestation), the result indicated a significant change in the level of importance of carbon emission. The influence/importance of carbon emission ranged from 34% to 59% with meteorological disasters (59%) affected the most. Notwithstanding, geophysical disasters (34%) were found to have the least influence from carbon emission. Additionally renewable energy had the highest influence on biological disasters (22%) whereas, climatological disasters had the least influence (2%).

However, geophysical disasters (12%) had the highest influence from clean water. Political stability also had the highest influence climatological disasters (28%). Hydrological disasters had the highest (15%) influence from afforestation. The training R^2 were within the range of 0.83 to 0.90 with a p-value 0.00, and a validation R^2 ranging from 0.14 to 0.67 (Appendix 6). Generally, approximately 490 disasters are predicted to occur in 2030 if the other cofounding variables are added to the 45% reduction. On continental front, the expected disasters in 2030 are 124 for Africa, 101 for America, 159 for Asia, 122 for Europe and 24 occurrences in Oceania.

4.2.5 Differences between the disaster scenarios

The study also sought to compare the results from the various scenarios on a continental basis (Table 6; Figure 5).

Table 6: Pairwise t-test analysis on continental differences of disasters

Biological	**DTR**			**DS1**			**DS2**			**DS3**			**DS4**		
	Mean	t	P	Mean	t	P	Mean	t	p	Mean	t	P	Mean	t	P
AF	5	1.11	0.26	13	6.02	0.00	17	12.74	0.00	13	7.02	0.00	15	12.32	0.00
AM	3			3			3			3			3		
AF	5	-0.61	0.54	13	2.61	0.01	17	7.67	0.00	13	6.28	0.00	15	4.03	0.00
AS	7			7			6			4			6		
AF	5	3.20	0.00	13	-2.28	0.02	17	-3.90	0.00	13	-4.02	0.00	15	-6.13	0.00
EU	4			24			29			35			41		
AF	5	-0.27	0.78	13	3.62	0.00	17	6.87	0.00	13	4.96	0.00	15	8.21	0.00
OC	1			1			1			1			1		
Climatological															
AF	7	-0.48	0.63	6	-0.66	0.51	7	0.01	0.98	6	0.53	0.59	7	0.93	0.35
AM	7			8			7			5			6		
AF	7	0.66	0.51	6	0.03	0.97	7	2.41	0.01	6	2.57	0.01	7	3.19	0.00
AS	5			5			6			4			4		
AF	7	1.81	0.07	6	2.01	0.05	7	6.55	0.00	6	3.24	0.00	7	9.61	0.00
EU	3			3			3			2			2		
AF	7	0.05	0.95	6	1.04	0.31	7	2.56	0.01	6	0.40	0.68	7	1.38	0.18
OC	2			2			2			2			2		
Geophysical															
AF	3	-1.95	0.05	4	-2.11	0.03	3	-4.21	0.00	3	-2.91	0.00	3	-4.83	0.00
AM	5			6			6			5			5		
AF	3	-2.61	0.01	4	-4.33	0.00	3	-5.65	0.00	3	-2.29	0.02	3	-7.27	0.00
AS	16			15			15			8			11		
AF	3	0.06	0.94	4	0.69	0.48	3	-2.12	0.03	3	-1.48	0.14	3	-2.22	0.03
EU	3			2			3			3			4		
AF	3	-0.79	0.43	4	-3.14	0.00	3	-3.76	0.00	3	-2.17	0.04	3	-7.04	0.00
OC	3			3			2			3			4		

AF=Africa, AM=Americas, AS=Asia, EU=Europe, OC=Oceania, DTR=Disaster Trend, DS1=Disaster Scenario One, DS2=Disaster Scenario Two DS3=Disaster Scenario Three, DS4=Disaster Scenario Four

Table 6 Cont'd

Hydrological															
AF	51			41			43			37			44		
AM	4			40			34			29			33		
AF	51	-1.48	0.14	41	-3.38	0.00	43	-4.51	0.00	37	-2.09	0.04	44	-4.32	0.00
AS	75			77			72			56			60		
AF	51	2.18	0.03	41	0.98	0.33	43	0.91	0.36	37	3.35	0.00	44	1.56	0.12
EU	22			26			30			17			28		
AF	51	1.83	0.08	41	2.40	0.02	43	3.90	0.00	37	3.08	0.00	44	4.38	0.00
OC	9			9			9			7			7		
Meteorological															
AF	11	-1.80	0.07	9	-2.79	0.00	12	-4.83	0.00	11	-2.21	0.03	11	-5.51	0.00
AM	13			32			34			30			29		
AF	11	-2.74	0.00	9	-4.51	0.00	12	-6.64	0.00	11	-4.78	0.00	11	-7.93	0.00
AS	45			42			46			32			39		
AF	11	-2.44	0.01	9	-4.31	0.00	12	-7.07	0.00	11	-3.71	0.00	11	-9.31	0.00
EU	21			22			22			21			24		
AF	11	-2.22	0.03	9	-1.78	0.09	12	-0.70	0.49	11	-2.71	0.01	11	-3.21	0.00
OC	6			6			5			6			6		
Technological															
AF	60	1.67	0.10	58	2.66	0.01	54	3.04	0.00	38	1.58	0.11	44	3.32	0.00
AM	31			28			29			24			25		
AF	60	-0.46	0.64	58	-0.87	0.38	54	-1.62	0.11	38	-1.85	0.06	44	-0.88	0.38
AS	67			69			68			49			39		
AF	60	1.95	0.05	58	2.65	0.01	54	2.65	0.01	38	1.81	0.07	44	2.88	0.00
EU	21			22			24			17			23		
AF	60	2.05	0.05	58	3.57	0.00	54	3.47	0.00	38	4.38	0.00	44	7.25	0.00
OC	3			3			4			3			4		

Source: Acquah, 2023

AF=Africa, AM=Americas, AS=Asia, EU=Europe, OC=Oceania, DTR=Disaster Trend, DS1=Disaster Scenario One, DS2=Disaster Scenario Two, DS3=Disaster Scenario Three, DS4=Disaster Scenario Four

From Table 6 the paired t-test analysis found statistically significant difference between biological disaster in Africa and America (DS1 [t=6.02, p=0.00], DS2 [t=12.74, p=0.00], DS3 [t=7.02, p=0.00] and DS4 [t=12.32, p=0.00]).

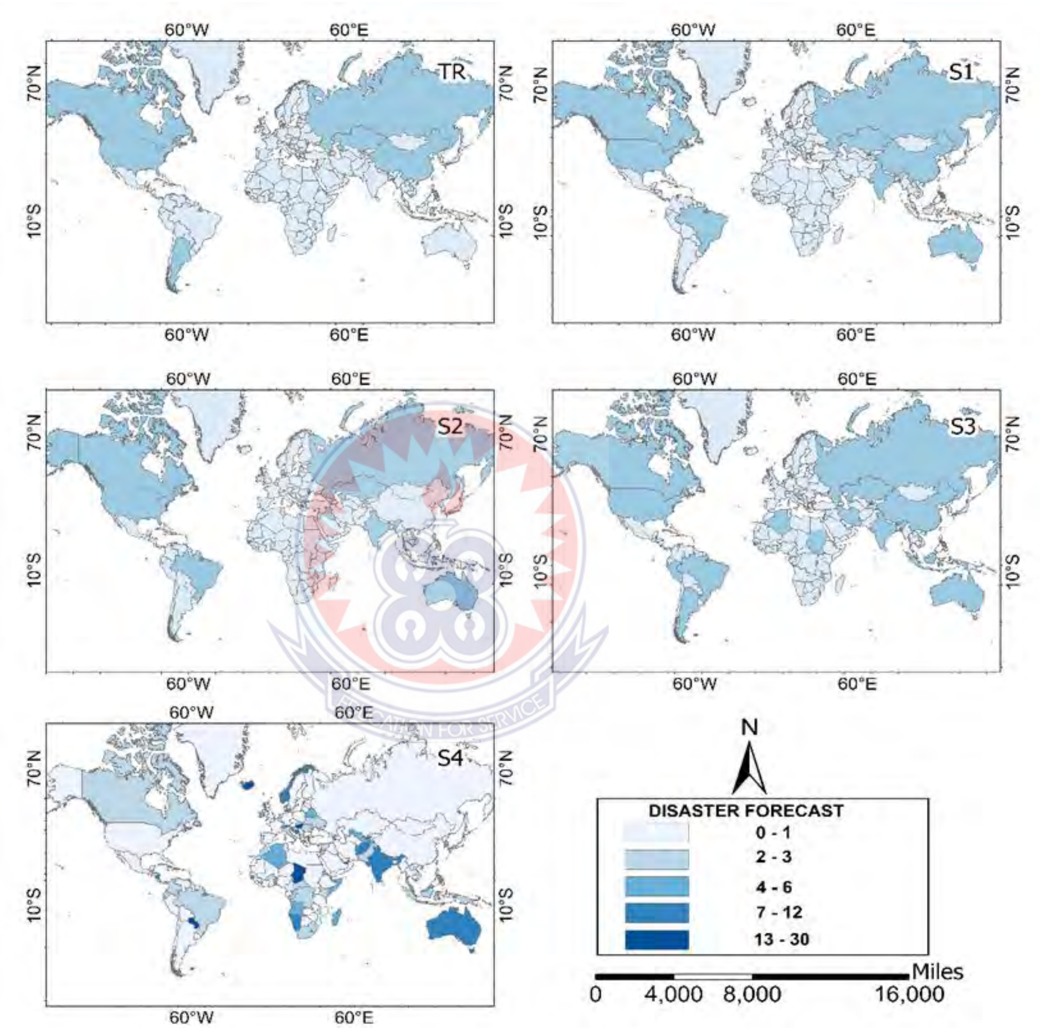

Figure 5: Differences between the effects of carbon emission on disasters on disasters

Source: Acquah, 2023

Africa is expected to record higher biological disaster than America. Similarly, the result also indicated a statistically significant difference between predicted biological disasters in Africa and Europe in all the scenarios (DTR [t=3.20, p=0.00], DS1 [t=-0.28, p=0.02], DS2 [t=-3.90, p=0.00], DS3 [t=-4.02, p=0.00] and DS4 [t=-6.13, p=0.00]).

Also, there was statistically significant higher climatological disasters in Africa than America. The models indicated that with geophysical disasters Asia will record high events than Africa. Hydrological disasters are expected to be significantly higher in Africa than Europe while Africa will have less meteorological disaster compared with America. Asia is expected to record more technological disasters than Africa, but Africa will have more also than Europe and Oceania (Table 6).

4.3 Effect of 45% Reduction in Carbon Emission on Economic Growth

The study sought to assess the effect of 45% reduction in carbon emissions on economic growth through five different scenarios. The first was economic trend (ETR) which looked at the normal forecast trend in economic growth (GDP per capita rate and GDP growth rate). Economic scenario one (ES1) deals with the effects of no reduction in carbon emissions on economic growth. Economic scenario two (ES2) also looked at effects of no reduction in carbon emissions, plus the confounding variables on economic growth. The economic scenario three (ES3) focused on the effects of reduction in carbon emission (45%) on economic growth. The economic scenario four (ES4) studied the effects of reduction in carbon emission (45%), plus the confounding variables on economic growth. The study further compares the statistical differences between the economic growth scenarios and among continents.

4.3.1 Economic growth trend (ETR) from 2021 to 2030

A random forest-based forecast was used to assess the effect COP 26 target of 45% reduction in carbon emission by 2030 on economic growth. The random forest-based forecast predicted GDP per capita rate to have a mean (M) of 3.6% and a maximum of 36.9%, globally by the year 2030. GDP growth rate also had a mean of 1%, and a max of 10% within the same 10 years period (2021-2030) [Table 7]. In Africa, the random forest-based forecast predicted GDP per capita rate to have an average of 2.67%, and a maximum of 9.8% in 2030. In terms of GDP growth rate, the result predicted an average increment of 0.96% and a maximum of 1.0%. The GDP per capita rate in America, was reported to have a mean of 0.55%, and a maximum increment of 5.0%. Also, GDP growth rate, per the random forest-based forecast had a mean of 1.22% and a maximum of 6.0% in 2030.

Moreover, the GDP per capita rate in Asia was predicted to have a mean of 0.72% and a maximum of 6.0% by the year 2030 with GDP growth rate also recording a mean of 1.38% and maximum of 7.0%. In Europe GDP per capita rate was projected at a mean of 0.61% and a maximum of 6.0% while GDP growth rate had a mean of 2.27% and a maximum of 8%. However, in Oceania predicted GDP per capita rate to have an average of 0.16% and a maximum growth of 2.0% while an average of 1.0% and a maximum of 5.0% is expected for GDP growth rate also recorded in 2030 (Table 7).

Table 7: Economic growth trend (TR) from 2021 to 2030

Growth	Lower Forecast			Middle Forecast			Upper Forecast			Forecast RMSE			Validation RMSE		
	Mean	Max	Sum	Mean	Max	Sum	Mean	Max	Sum	Mean	Max	Sum	Mean	Max	Sum
ALL															
GDP/CAP	-44	0	-11097	3.6	36.9	89.28	1	7	159	2	15	432	4	29	933
GDP	-45	0	-11267	1	10	35.6	38	343	9553	2	15	438	4	30	955
AFRICA															
GDP/CAP	24..58	96	1352	2.67	9.8	14.78	30.18	100	1660	0.09	1	5	0.54	2	29
GDP	-46.99	0	-2584	0.96	1.0	5.3	47.16	343	2594	1.92	15	106	4.19	23	230
AMERICA															
GDP/CAP	-32.77	0	-1507	0.55	5	25	27.24	85	1253	1.43	6	66	2.91	10	134
GDP	-31.92	0	-1468	1.22	6	56	29.24	89	1345	1.46	6	67	3.15	12	145
ASIA															
GDP/CAP	-52.73	0	-2689	0.72	6	37	39.51	147	2015	4.70	9	103	4.70	21	240
GDP	-57.59	0	-2937	1.38	7	70	43.94	174	2241	2.07	10	106	4.73	19	241
EUROPE															
GDP/CAP	-50.11	0	-2054	0.61	6	25	36.71	214	1505	1.87	9	76	4.25	29	174
GDP	-53.44	0	-2,191	2.27	8	93	39.61	222	1624	1.89	10	77	4.22	30	172
OCEANIA															
GDP/CAP	-34.27	0	-685	0.16	2	3	27.04	92	541	1.58	5	32	3.22	10	64
GDP	-37.35	0	-747	1.07	5	21	30.31	88	606	1.61	5	32	3.16	10	63

Source: Acquah, 2023

4.3.2 Economic scenario one (ES1): Effects of no reduction in carbon emissions on economic growth

The random forest-based forecast result used to assess the effects of carbon emission, if nothing is done (not reduced by 45%) had an influence of 100% on both GDP per capita rate and GDP growth rate. The result generated a highest training R^2 ranging from 0.27 to 0.76 and a validation R^2 also ranging from of 0.03 to 0.65 for GDP per capita rate. In terms of GDP growth rate, the training R^2 for carbon emission ranged from 0.32 to 0.76 and a validation R^2 of 0.15 to 0.76 (Appendix 7). GDP per capita rate is expected to increase by 0.63% in 2030 if carbon emissions are not reduced. Similarly, GDP growth rate is also expected to increase by 1.14% to no reduction in carbon emission.

4.3.3 Economic scenario two (ES2): Effects of no reduction in carbon emissions plus confounding variables on economic growth

Furthermore, from the forest-based classification and regression analysis performed to assess the influence of no reduction in carbon emission plus the confounding variables on GDP per capita rate indicated that, globally, carbon emission had the fourth highest influence (24%) on GDP per capita rate. Per continents, the result found carbon emission (27%) to have the highest influence on GDP per capita rate in Africa. America had the least influence of carbon emission on GDP per capita rate. Further, political stability (27%) had the highest influence on GDP per capita rate in Asia and Europe. Industrialization had an influence on GDP per capita rate in America by 34%. Moreover, regarding GDP growth rate, the influence of carbon emission ranges from 11% and 19% for

Europe and Oceania respectively. In Africa, political stability (30%) had higher influence on GDP growth rate than carbon emission (18%). Globally, about 0.64% increase in GDP per capita rate and 1.64% is GDP growth rate expected when the confounding variables are added to the no reduction in carbon emission (Appendix 8).

4.3.4 Economic scenario three (ES3): Effects of reduction in carbon emission (45%) on economic growth

The forest-based classification and regression analysis on carbon emission if halved by 45% revealed that, GDP per capita rate had the highest training R^2 of 0.83 and a p=0.00 with a validation R^2 of 0.10 whiles, the least training R^2 was 0.31, p=0.00 and a validation R^2 of 0.10. In addition, the result also generated a training R^2 with the least value of 0.23, p=0.04 and the highest value of 0.78, p=0.00 for GDP per capita rate and R^2 range of 0.10 and 0.94 for GDP growth rate (Appendix 9). The expected GDP per capita rate and GDP growth rate for 2030 are 1.43 and 0.69 respectively.

4.3.5 Economic scenario four (ES4): Effects of reduction in carbon emission (45%) plus the confounding variables on economic growth

The model statistics on the reduction in carbon emission (45%) plus the confounding variables revealed that, GDP per capita rate in Africa and Europe had the highest influence (28% and 30% respectively) from carbon emissions, whereas the Americas (30%) and the Asia (27%) had the highest influence from industrialization. Also, Africa and Europe had the least influence from renewable energy (2%). Interestingly, renewable energy and political stability is expected to influence GDP per capita rate in Oceania by 12% and 35% respectively. The GDP per capita rate relationships with carbon emission halved by 45% plus the cofounding variables produce a training prediction R^2 ranging from 0.80 to 0.92 and a p-value of 0.00, and a validation R^2 also ranging from 0.04 to 0.39.

Additionally, with regards to GDP growth rate, the result indicated that carbon emission had an influence level ranging from 10% to 17%. Europe (30%) was the continent with the highest influence from carbon emission while for Africa political stability (32%) affected GDP growth rate the most. Globally, about 1.8% of the GDP growth is expected in 2030 if carbon emission halved by 45% plus the cofounding variables. The R^2 for training the data was within the range of 0.88 to 0.92 with a p-value 0.00, and a validation R^2 ranging from 0.04 to 0.80 (Appendix 10). Notwithstanding, the influence of all the variables on GDP growth rate per continent were not significant at a p-value greater than 0.05.

4.3.6 Differences between the economic scenarios

Regarding the assessment of the effects of 45% reduction in carbon emission, the study further compares the statistical differences between the economic growth scenarios and among continents. The paired t-test analysis on effects of reduction in carbon emission on GDP per capita rate found no statistical differences between all the scenarios in Africa. On the other hand, the paired t-test result found a statistically significant differences between ES1 and ES3 [t=-3.18, p=0.00] in America. Correspondingly, the result also found a statistically significant differences (t=-3.18, p=0.00) between ES3 [m=0.52] and ES4 [m=0.33].

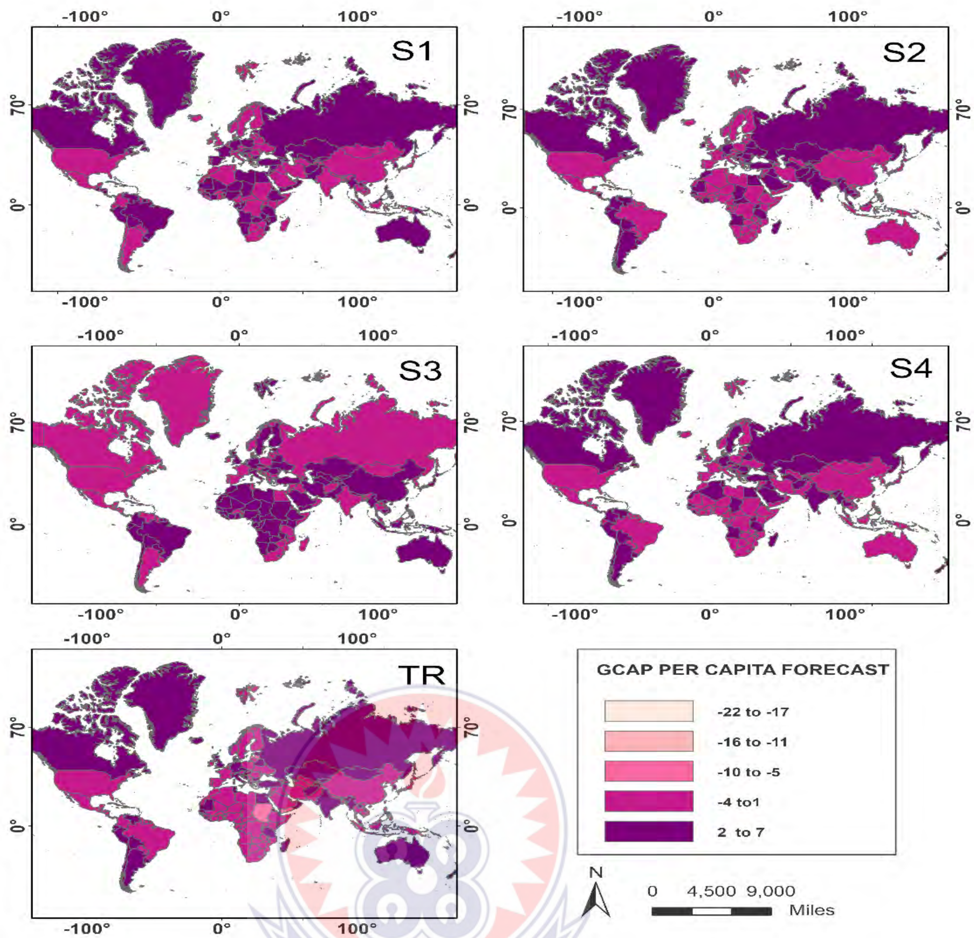

Figure 6: Differences between the effects of carbon emission on GDP per capita rate in 2030

Source: Acquah, 2023

Asian continent was found to have statistically higher (t=1.93, p=0.05) GDP per capita rate for ES1 [m=0.94] than ES3 [M=0.53]. The paired t-test analysis found has a statistically significant differences (t=-2.10, p=0.04) between ES2 [m=-0.22] and ES3 [m=-0.15] in Oceania with respect to GDP per capita rate (Appendix 11).

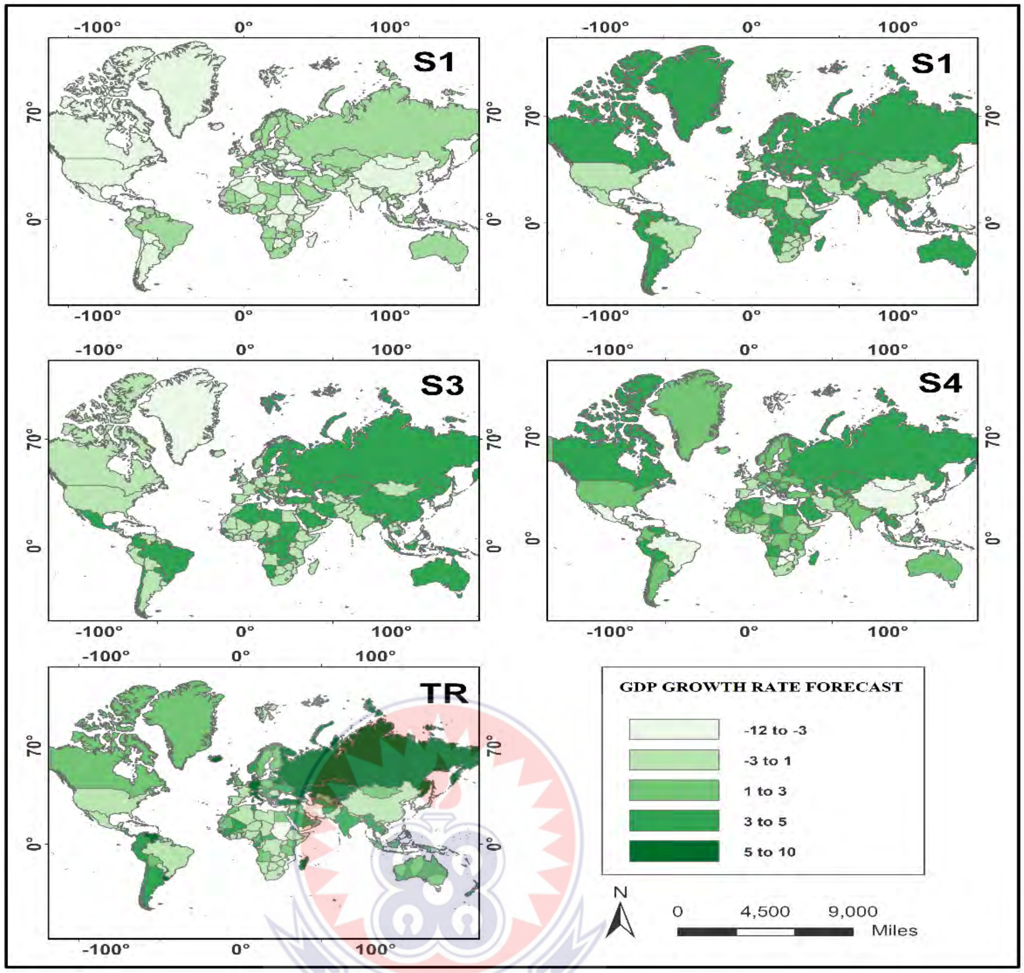

Figure 7: Differences between the effects of carbon emission on GDP in 2030
Source: Acquah, 2023

Moreover, regarding the GDP growth rate the paired t-test result found a statistically significant difference between Africa and America in ES3 [AF=0.66, AM=1.48, t=-2.86, p=0.00]. The result also found lower GDP growth rate for Africa than Europe for ES2 [AF=1.12, EU=2.55, t=-5.32, p=0.00], ES3 [AF=1.36, EU=2.19, t=-3.14, p=0.00] and ES4 [AF=1.33, EU=2.21) t=-3.46, p=0.00]. Malaysia (-3.8) was predicted from the model to record the least GDP per capita rate growth in 2030 whereas Papua New Guinea is expected to record the highest GDP growth (Figure 6 and 7).

Table 8: Pairwise t-test analysis on continental differences on economic growth

GDP/CAP	ETR			ES1			ES2			ES3			ES4		
	Mean	t	P	Mean	t	P	Mean	t	p	Mean	t	P	Mean	t	P
AF	0.34	-0.38	0.69	0.90	1.69	0.09	0.65	1.34	0.18	0.78	-9.12	0.00	0.62	1.36	0.17
AM	0.54			0.33			0.38			3.90			0.33		
AF	0.43	-0.55	0.58	0.93	1.03	0.30	0.68	-1.51	0.13	0.87	1.28	0.20	0.67	0.63	0.52
AS	0.72			0.64			0.94			0.53			0.56		
AF	0.63	0.03	0.97	0.98	0.91	0.36	0.72	0.09	0.92	0.75	1.06	0.29	0.64	-0.26	0.79
EU	0.60			0.58			0.70			0.32			0.71		
AF	0.24	0.18	0.85	0.95	2.21	0.03	0.57	3.99	0.00	0.63	1.55	0.13	0.51	2.74	0.01
OC	0.15			0.06			-0.22			0.15			-0.07		
GDP															
AF	0.93	-0.44	0.65	1.28	0.33	0.74	1.11	-0.84	0.40	0.66	-2.86	0.00	1.33	0.44	0.65
AM	1.19			1.19			1.30			1.48			1.23		
AF	0.99	-0.64	0.52	1.28	0.42	0.67	1.15	-1.08	0.28	1.46	1.41	0.16	1.37	0.92	0.36
AS	1.38			1.17			1.42			1.12			1.16		
AF	1.11	-1.63	0.10	1.33	-1.91	0.06	1.12	-5.32	0.00	1.36	-3.14	0.00	1.33	-3.46	0.00
EU	2.30			2.16			2.55			2.19			2.21		
AF	1.18	-0.19	0.84	1.25	0.57	0.57	1.01	0.48	0.63	1.17	0.83	0.41	1.28	0.84	0.40
OC	1.28			1.11			0.90			0.98			1.08		

Source: Acquah, 2023

AF=Africa, AM=Americas, AS=Asia, EU=Europe, OC=Oceania, ETR=Economic Trend, ES1= Economic Scenario One, ES2= Economic Scenario Two, ES3= Economic Scenario Three, ES4= Economic Scenario Four

Likewise, Greenland (-4.7%) is expected to have the least GDP growth in 2030. However, Libya (4.18%) is also expected to record the highest GDP growth in Africa (Figure7).

4.4 Effect of 45% Reduction in Carbon Emission on Multidimensional Poverty

The hypothesis tried to assess the effect of 45% reduction in carbon emissions on multidimensional poverty (monetary [PM], education [PE], basic infrastructure [PI]) through five different scenarios. The trend (PMTR, PETR, PITR) looked at the normal forecast trend in poverty. Scenario one (PMS1, PES1, PIS1) dealt with the effects of no reduction in carbon emissions on poverty. Scenario two (PMS2, PES2, PIS2) also looked at effects of no reduction in carbon emissions, plus the other variables on poverty. The scenario three (PMS3, PES3, PIS3) focuses on the effects of reduction in carbon emission (45%) on poverty. The scenario four (PMS4, PES4, PIS4) also emphasizes on the effects of reduction in carbon emission (45%), plus the other variables on poverty. The study further compares the statistical differences between the poverty scenarios and among continents.

4.4.1 Multidimensional poverty trend analysis 2021 to 2030

The random forest-based forecast generated three levels of forecast lower, middle and upper. Results from the middle forecast indicated that global average PMTR is expected to be 9.0% by the year 2030 (Table 9). PETR expected at 81.0% and PITR at 65%.

Table 9: Poverty forecast from 2021 to 2030

Model statistics	Lower Forecast (%)		Middle Forecast (%)		Upper Forecast		Forecast RMSE		Validation RMSE	
	Mean	Max	Mean	Max	Mean	Max	Mean	Max	Mean	Max
					All					
PM	-79	0	9	69	58	75	5	87	17	227
PE	-3	92	81	100	77	100	3	11	9	27
PI	-14	99	65	100	68	100	4	14	10	66
					AFRICA					
PM	-100	93	11	70	76	97	7	88	24	227
PE	4	78	81	100	76	100	3	10	8	22
PI	-24	99	61	100	68	100	4	14	10	54
					AMERICA					
PM	-93	0	11	68	54	78	5	22	17	75
PE	-9	79	87	100	75	100	3	11	9	27
PI	-30	94	89	100	69	72	4	10	11	50
					ASIA					
PM	-59	0	6	49	48	75	4	23	14	68
PE	-14	68	83	98	79	90	3	10	9	21
PI	-18	99	66	99	68	100	4	13	10	66
					EUROPE					
PM	-77	0	8	48	51	99	4	8	14	49
PE	5	89	94	100	80	100	3	8	8	22
PI	8	98	93	100	63	100	3	12	8	29
					OCEANIA					
PM	-70	-2	7	36	52	63	4	12	15	65
PE	0	52	83	95	78	100	3	10	9	23
PI	13	91	66	97	59	100	3	8	7	44

Source: Field work df=47

PM=Poverty Monetary, PE=Poverty Education, PI=Poverty Basic Infrastructure

In Africa PMTR is expected to average around 11.0%, PETR (81%) and PITR (61%). Asia (6%) is expected to have less PMTR compared with Europe (8%) and Americas (7%). But Europe will have better PETR (94%) and PITR (93%) than all the other continents.

4.4.2 Multidimensional scenario one: effects of no reduction in carbon emissions on poverty

The study sought to assess the level of influence of carbon emission on poverty in 2030. The forest-based forecast on the effects of carbon emission if not reduce revealed a 100% influence of carbon emission on monetary poverty (PMS1). Globally, the result of PMS1generated a training R^2 of 0.66 and validation R^2 of 0.22. Also, with regards to PES1, the result had a training R^2 ranging from 0.55 to 0.86 and a validation R^2 also ranging from 0.03 to 0.74 with PIS1 having R^2= 0.67 and validation R^2 =0.12. The continent which will have high PMS1 was Asia, with PES1 and PIS1 being Africa (Appendix 13).

4.4.3 Multidimensional scenario two: Effects of no reduction in carbon emissions plus the other variables on poverty

Analysis for PMS2 indicated that that political stability had the highest on America (27%) and Africa (20%) (Appendix 14). Effect of carbon emission on PM was high for Europe (31%) and Asia (29%) than Africa (18%) and America (18%). PM in Oceania is expected to be mainly influenced by sanitation (38%) than carbon emission (7%). In terms of PES2, the influence of carbon emission was 33% with Europe (45%) and Asia (41%). But in Africa carbon emission influence was 24% while access to clean water was 27%. The influence of carbon emission on P1S2 was below 11% for most continents.

4.4.4 Multidimensional scenario three: Effects of reduction in carbon emission 45% on poverty

Moreover, assessing the effects of carbon emission, if halved by 45% (reduced by 45%) on monetary poverty (PMS3) the forest-based classification and regression obtained a training R^2 ranging from 0.46 to 0.88 and a non-significant validation R^2 ranging from 0.0 to 0.29 with a p-value above 0.05. Besides, the training R^2 for educational poverty also ranged from 0.50 up to 0.83. 0.50 up to 0.83 with Asia having the highest training prediction R^2 (0.83). The validation R^2 were between 0.01 and 0.70. With respects to poverty in basic infrastructures the model indicated a training R^2 value ranging from 0.48 to 0.79 with a validation R^2 also ranging from 0.01 and 0.51 (Appendix 15).

4.4.5 Multidimensional scenario four: Effects of reduction in carbon emission 45% plus the other variables on poverty

Globally, with regards to the effects of carbon emission if halved by 45% plus the confounding variables, carbon emission (17%) had the third highest influence (Appendix 16). Sanitation (19%) was identified to have the highest influence on monetary poverty than carbon emission (17%) in Africa but in America (28%), Asia (23%) and Europe (29%) its effect was high. Political stability (36%) was found to have the highest influence on monetary poverty in Oceania. Carbon emission had over 30% influence on access to education across all continents. Lastly, influence of carbon emission on access to infrastructure was low ranging from Asia (7%) and Europe (12%).

4.4.6 Differences between the multidimensional poverty scenarios

A pair t-test was used to assessed significant differences between the results generated for all the scenarios on multidimensional poverty. The paired t-test analysis indicated a statistically significant difference ($t=-3.43$, $p=0.00$) between PMS1 [m=8.03] and PMS2 [m=9.49] (Table 10). Similar relationship was established between Africa and Europe for PMS2 and PMS4 (Table 10). In Africa countries like Mali and Mauritania were persistent of having higher PM, in Europe (Sweden, Lithuania and Bulgaria) and Asia (India, Mongolia, Saudi Arabia and Thailand) (Figure 8).

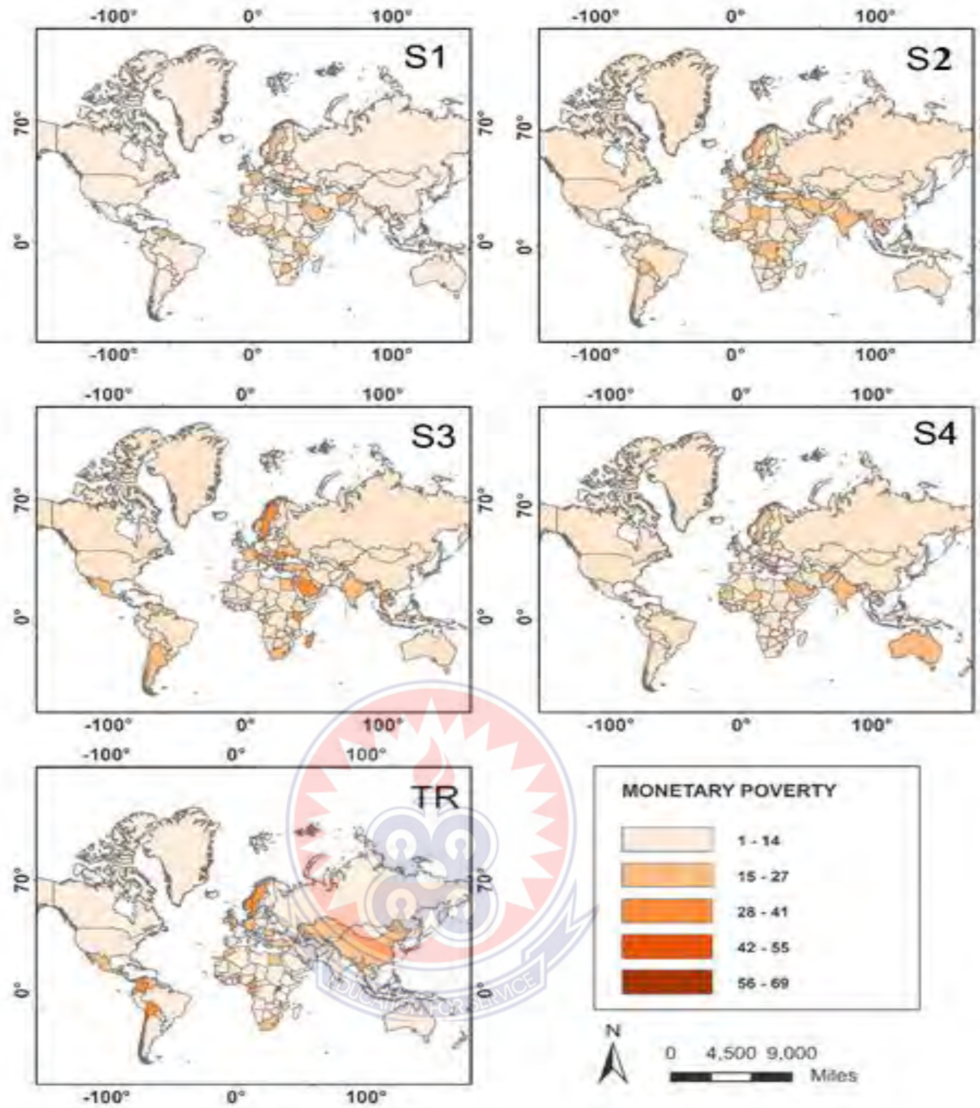

Figure 8: Differences between the effects of carbon emission on monetary poverty in 2030

Source: Acquah, 2023

Result of PMS4 [m=9.49] was significantly higher (t=-2.32, p=0.02) than results from PMS3 [m=8.44] (Appendix 18). However, at the continent level there were no significant differences in the results for PM. For PE there was PES3 [M=81.68] results were higher compared with PES2 S2 [M=78.09]. At the country level most countries were likely to gain in access to education (80%-100%) even with reduction in carbon emission (Figure 9).

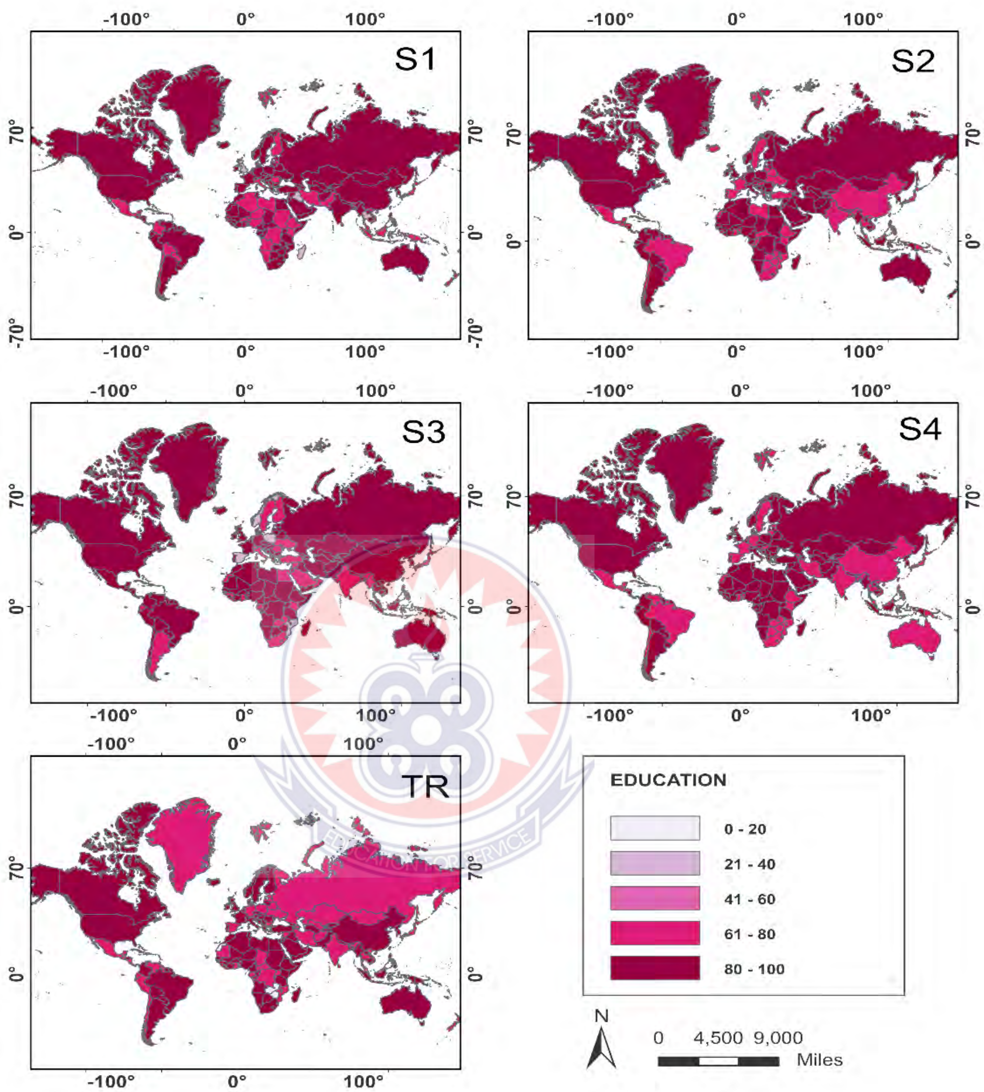

Figure 9: Differences between the effects of carbon emission on educational in 2030
Source: Acquah, 2023

Table 10: Pairwise t-test analysis on continental differences on poverty

Monetary	PTR			PS1			PS2			PS3			PS4		
	Mean	t	P	Mean	t	P	Mean	t	p	Mean	t	P	Mean	t	P
AF	10.36	-0.14	0.88	11.07	-0.60	0.54	10.79	0.35	0.72	12.00	0.59	0.55	11.51	4.53	0.00
AM	10.77			12.10			10.45			11.08			8.04		
AF	11.46	-10.98	0.00	11.01	-21.03	0.00	11.16	-14.29	0.00	11.77	-25.49	0.00	11.83	-15.25	0.00
AS	6.59			5.55			9.14			15.93			19.04		
AF	10.07	0.74	0.46	11.03	1.96	0.05	10.48	1.02	0.31	12.25	3.38	0.00	11.21	2.72	0.00
EU	8.47			8.43			9.65			7.72			9.15		
AF	10.60	1.02	0.31	11.09	2.12	0.04	10.48	3.85	0.00	10.61	2.57	0.01	12.21	3.30	0.00
OC	7.32			7.61			9.65			6.54			7.48		
Education															
AF	84.27	2.18	0.03	79.72	1.69	0.09	78.92	2.41	0.01	82.09	3.85	0.00	84.27	5.12	0.00
AM	77.17			75.33			73.58			73.15			71.51		
AF	84.23	0.63	0.52	79.65	-1.72	0.09	79.20	-2.03	0.04	82.34	0.76	0.45	84.23	1.71	0.09
AS	82.84			83.46			82.10			80.96			81.51		
AF	84.49	0.37	0.70	79.19	-0.70	0.48	78.63	-1.68	0.09	81.95	0.35	0.72	84.49	1.32	0.19
EU	83.74			80.91			81.09			81.24			82.53		
AF	82.60	0.04	0.96	80.92	-0.45	0.65	78.62	-0.81	0.42	82.06	0.49	0.62	82.60	0.60	0.55
OC	82.45			82.22			80.58			80.98			81.00		
Basic Infrastructure															
AF	62.71	0.86	0.39	61.89	0.04	0.96	55.50	0.99	0.32	58.79	0.11	0.90	55.85	1.48	0.14
AM	57.20			61.69			51.21			58.25			49.53		
AF	63.56	-0.40	0.68	61.89	-0.66	0.50	56.14	-1.21	0.23	60.47	-3.22	0.00	56.31	-1.16	0.25
AS	65.89			64.57			61.41			71.93			61.04		
AF	60.28	-1.92	0.06	61.96	-2.97	0.00	53.38	-3.11	0.00	58.80	-3.43	0.00	53.86	-2.67	0.01
EU	73.48			72.35			66.83			70.97			65.35		
AF	59.41	-0.74	0.46	62.53	-0.63	0.53	52.13	-2.75	0.01	59.72	-0.52	0.60	52.59	-1.67	0.11
OC	66.03			66.24			68.07			63.27			63.69		

Source: Acquah, 2023

AF=Africa, AM=Americas, AS=Asia, EU=Europe, OC=Oceania, ETR=Poverty Trend, ES1= Poverty Scenario One, ES2= Poverty Scenario Two, ES3= Poverty Scenario Three, ES4= Poverty Scenario Four

PIS3 results were higher than PIS2 but at the country level PIS3 results for USA will drop between 1-32% but addition of the confounding variables will improve access to basic infrastructure.

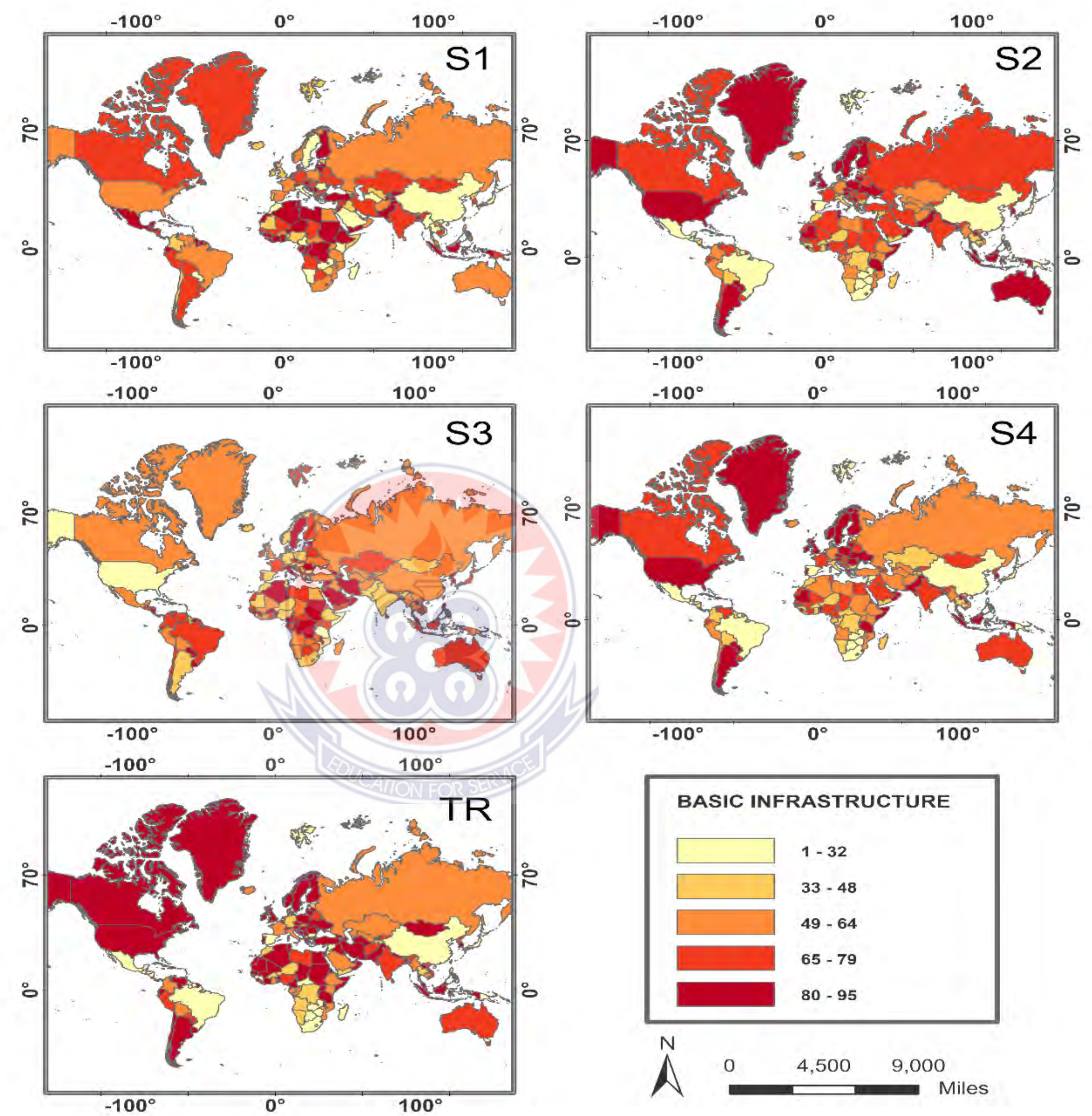

Figure 10: Differences between the effects of carbon emission on basic infrastructural in 2030

Source: Acquah, 2023

But for PIS4 countries like Brazil and China, and most Southern African countries will have lower access to basic infrastructure (Figure 10). PIS1 results for Europe [72.35%] were statistically significant higher [t=-2.97, p=0.00] than

Africa [61.96%]. Countries which will not be affected most in Europe by the 45% reduction in carbon emission were Romania and Bulgaria and in Africa were Somalia, Tanzania and Mozambique (Figure 10).

4.5 Discussion of Results

4.5.1 Persistence and disparities of disasters

The Hypothesis H_1 of the study sought to assess the persistency and disparities of climate disasters from 2000 to 2020. Climatological disasters were the fourth highest disaster (2000-2020) with mean centre being Mali. Africa had the least climatological disasters with DR. Congo identified as mean centre country. This result is contrary to the study by Bari and Dessus (2022) who found Africa as the most vulnerable continent to climate induced natural disasters such as droughts and floods. USA was a persistent hotspot zone while Paraguay was a sporadic hotspot zone. This findings concur with that of Atwii et al. (2022) who established that countries in Asia and Americas are emerging as hotspot zone for climatological disasters. According to Khattri (2021) extreme weather events in the United States and Paraguay, are becoming more frequent and more severe because of frequent occurrences of hurricanes and drought. However, the number of persons to be affected in Africa and America is estimated to be very high around 140 million people climate disasters will induce water stress, crop failure and sea level rise.

Taalas (2022) evidenced that, the surges of disasters will continue until the latter half of the twenty-first century if carbon emissions are not checked which hold true for Africa. As the scenarios indicated that 45% reduction in carbon emission will reduce disaster by 9.6% (33 disasters). This holds true for the risk theory by Becks (1999) who suggests that in addressing these surges of disasters, we need to shift from a paradigm of risk management to one of risk prevention (Loayza et al., 2012). This includes investing in renewable energy sources, implementing sustainable development practices, and promoting social and economic equity (Hasanov et al., 2021).

This is climatological and meteorological disasters were largely dependent on carbon emission. As confirmed by Xie et al., (2021), Lopez and Troncoso (2020) and Roe and Zavar (2021) that recent increase in the frequency of severe climate-meteorological and hydrometeorological disaster occurrences globally is mostly due to global warming brought on by carbon emissions, hence needs to be reduced. But on the flip side, Africa is more likely to record the higher number of biological and technological in 2030. The increase in biological and technological disasters in Africa could partly be attributed to climate change (Xie et al., 2021). The result goes back to confirm the risk society theory of Beck (1999) who explains that , the increasing carbon emission and disasters we see in our society today are the direct result of this process of risk production (Kim & Sohn, 2018)

4.5.2 Economic growth forecast from 2021 to 2030

Africa had the highest growth rate projection with Oceania having the least growth rate in 2030, the World Economics estimates Africa's share of Global GDP to be 6.6% (Nundy et al., 2021). While GDP per capita rate in the poorest economies will be more than quadruple over the 2011 to 2060 period, it will only double in the richest economies (Nundy et al., 2021). Faster growth in low-income and emerging countries will reduce the wide gaps in living standards seen today with advanced countries, though large cross-country differences will persist (Doytch, 2020). Moreover, assessing the effects of 45% reduction in carbon emission plus the cofounding variables on growth, the result indicated that, economic growth in Africa is more likely to be affected. However, America and Europe is expected to have the least influence from carbon emission in 2030. Aftab et al. (2021) stated that, an increase of carbon emission levels by approximately 0.6% increases economic growth by 1% and thus reduction in carbon emission is more likely to disadvantage growth.

Comparing the differences in economic growth on continental bases given the scenarios, the paired t-test analysis indicated that, with the reduction in carbon emissions by the stipulated 45% as pushed by the COP 26, growth in Africa will be worse off if carbon emissions are cut by 45% in addition to the expenses on the confounding variables. Except Algeria, Angola, Burundi, Chad, Egypt, Eritrea, Gambia, Guinea-Bissau, Malawi, Senegal, and Tunisia, the rest of the African countries will record negative growth if carbon emissions are reduced. Espoir et al., (2022) found that, the environmental policies specifically designed to reduce carbon emissions in Africa as a whole may significantly impact production and to deter economic growth. Hence Africa can be exempted or the reduction of 45% can be reduced based on country economic growth.

Moreover, a reduction in carbon emission has more likelihood of affecting growth in Asia leaving almost all the countries in the Asian and the Oceanian continent recording a negative growth. Afghanistan, Tajikistan, Myanmar, Thailand, as well as Australia are the countries that will be much affected. This findings confirms the study done by Rakshit, (2021). Rakshit (2021) found out that in Asia, for every 1% increase in carbon emissions leads to an increase in the growth rate of 1.28% and hence a reduction in carbon emission will lead to a decrease in economic growth.

Growth in the Americas and Europe will still increase marginally even to the stipulated reduction in carbon emission together with the expenses on the improvement in the other variables. This increase must probably be as a result of proper measures such as improvement in technologies and the use of alternative energy that has been put in place by the Americas and the European countries. This thus explains the reasons behind the push for renewable energy and the reduction in carbon emission by the European countries (European Commission, 2022).

4.5.3 Multidimensional poverty forecast from 2021 to 2030

Poverty is a multidimensional problem that goes beyond economics to include, social, political, and cultural issues. Many countries have been considered to be at risk of monetary poverty, whiles others are noted for risk of poverty in education and basic infrastructure (Esen & Bayrak, 2017). The forecast result found Africa to record the highest poverty rate with the slow developing countries most likely to experience a rate of 70.0%. According to the baseline scenario by Chtouki & Raouf, (2021), with the continuation of these poverty trends: sub-Saharan Africa's poverty rate is expected to increase further to 24 percent by 2030, representing 300 million people.

Interestingly, Asia expected to have the least poverty rate with the average country in Asia recording a rate of 6.0. This must probably be as a result of high investment in advance technologies, industrialization and rapid economic growth on the continent over recent decades (Islam et al., 2021). In contrast, poverty in America, Europe and Oceania were expected to be high in 2030. This high poverty rate may be as a result of high spending of the countries on the American and the European continents coupled with increasing climate change, a switch to renewable energy and disasters (Iizuka, 2020).

Assessing the effects of emission plus the confounding variables on poverty, the findings indicated that, carbon emission had the second highest influence on monetary poverty in 2030. Africa had the second highest influence from the 45% reduction in carbon emission on poverty. The increased frequency and intensity of extreme weather events like wildfires and droughts brought on by carbon emission threatens lives in the front-line communities, and jeopardizing food sources and livelihoods. All these effects increase the likelihood of more conflict, hunger and poverty (Alaganthiran & Anaba, 2022). Poverty in Asia and Europe had the highest influence from carbon emission in 2030. Available studies indicate a strong negative correlation between poverty and social expenditures in the Asian and the European countries indicating that the country's at-risk-of-poverty rate tends to erode with increasing social expenditure (Miežiene & Krutuliene, 2019).

The paired t-test analysis revealed that reduction in carbon emission together with the spending on the improvement in the other variables, is more likely to worsen poverty level in Africa and Asia with Asia receiving the greatest impact. Studies have argued that reduction in carbon emission together with spending on the other variables will leads to a decline in growth thereby drawing up to 720 million people back into extreme poverty just as we approach the zero-poverty goal (Ndiaya & Lv, 2018). Moreover, Alaganthiran and Anaba (2022) noted that, the greater economic growth in Africa and Asia is dependent on the greater carbon emission produced and hence, a reduction in carbon emission will lead to an increase in poverty.

CHAPTER FIVE

SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

5.0 Introduction

This chapter entails a summary of the introductory chapter, the methodology and the major findings emanated from the study. Specifically, this chapter seeks to summarize issues brought to bare regarding the effects of COP 26 45% reduction in carbon emission on disasters, economic growth and poverty. It also includes limitations of the study and areas for further studies. In addition, the chapter goes further to give recommendations aimed at addressing the adverse effects associated with the COP 26 targets of 45% reduction in carbon emission.

5.1 Summary

The relationship between carbon emissions, climate change, and disasters in both developing and developed economies has been well researched. However, no empirical study has been performed to estimate the effects of COP 26 measure of 45% reduction in carbon emission on disasters, economic growth and poverty. The study assessed the implication of COP 26 targets on disasters, economic growth and poverty. The hypotheses of the study were; climate disasters are more persistent in African countries than the Western countries; COP 26 target of 45 percent reduction in emission by 2030 is not likely to reduce the number of disasters in African; COP 26 target of 45% reduction in carbon emission by 2030 is more likely to increase economic growth in African countries than Americas and Europe and COP 26 target of 45% reduction in carbon emission by 2030 is more likely to reduce multidimensional poverty in African countries than all other continents. The study was underpinned by the risk society theory which served as a useful theoretical framework foundation in explaning the relationships and similarities between and among variables in the study.

The study adopted a positivism research philosophy with a descriptive research design because it involves assessing or collecting data in order to test hypothesis or answer questions. The research was conducted using secondary data.

The datasets that were employed to conduct the study were climate, disasters, carbon emission, economic growth (GDP growth rate and GDP per capita rate), poverty indices (Monetary, education and basic infrastructure) and the other variables were sourced from Representative Concentration Pathway (RCP) (http://www.iiasa.ac.at/web-apps/tnt/RcpD), World Bank (https://datacatalog.worldbank.org/), EM-DAT, CRED/UCLouvain, Brussels, Belgium (www.emdat.be), and Our World in Data (https://datacatalog.worldbank.org/).

In achieving hypothesis one of the study, the mean centre and trend analysis, incremental autocorrelation, standard distance ellipsoid, emerging hotspot analysis, and the exponential smoothing forest forecast were used. Additionally, the forest-based forecast and the forest-based classification and regression were used to achieved hypotheses two, three and four. Also, the paired t-test analysis was used to compare the effect of carbon emission on growth and poverty in 2030 (H3 and H4).

5.2 Key Findings of the Study

The key findings from the study are as follows: the first hypothesis was climate disasters are more persistent in African countries than the Western countries. The following key findings were discovered in achieving this hypothesis:

- Africa had the least climatological disasters (2000-2020) with Congo identified as the mean centre country.
- USA [Sig HS=90, Z=1.51, p=0.13] and Paraguay [Sig HS=14, Z=-1.48, p=0.14] are emerging as hotspot zone for climatological disasters.

The second hypothesis was COP 26 target of 45% reduction in carbon emission by 2030 is not likely to reduce the number of disasters in African. The study revealed the following:

- The 45% reduction in carbon emission will reduce climatological and meteorological disasters in Africa by 2030 compared with other continents.
- The 45% reduction will not influence biological and technological disasters which is expected to be increase in Africa

The third hypothesis was: COP 26 target of 45% reduction in carbon emission by 2030 is more likely to increase economic growth in African countries than the Western countries. The study revealed the following:

- The forecast results predicted Africa to have the highest economic growth rate projection in 2030 if 45% reduction in carbon emissions are not implemented but will fall drastically with the reduction.

- Reduction in carbon emission will lead to negative growth rate in Asia especially Afghanistan, Tajikistan, Myanmar, and Thailand. Economic growth rate in the Americas and Europe will still increase marginally even to the stipulated reduction in carbon emission together with the expenses on the improvement in the other variables.

The fourth hypothesis was to model and forecast the effect COP 26 target of 45% reduction in carbon emission by 2030 on poverty. The study revealed the following:

- The 45% reduction in carbon emission had the highest negative influence on poverty in Asia and Europe in 2030.
- Political stability had the highest influence on poverty in Africa rather than the 45% reduction in carbon emission.

5.3 Conclusion

The study draws the following conclusions from the key findings.

1. Climatological disasters were the least disaster types in Africa but more persistent in the Americas.
2. COP 26 target of 45% reduction in carbon emission by 2030 is more likely to reduce hydrological and meteorological disasters in Africa in 2030 but not biological and technological.
3. Also, the study concludes that, the COP 26 target of 45% reduction in carbon emission by 2030 is more likely to decrease economic growth in Africa and Asia but not America and Europe.

4. The 45% reduction in carbon emission by 2030 will further increase poverty rate in Africa but not like the effect of political instability.

5.4 Recommendation

In relation to the conclusions, the following recommendations are being made:

1. Continental development agencies such as IMF, World Bank, UN, UNISDR and disaster agencies should intensify disaster interventions against climate change. For Africa, attention should be also given to biological and technological disasters while for the America focus should be on climatological disasters.
2. The rate of 45% reduction in carbon effect on disaster is much welcomed but there has to be monitoring by IPCC, UN and COP to ensure all countries comply as countries.
3. Climate pledges of allocating climate fund to African, Oceanic and South East Asian countries should be implemented by COP 26 members to help support them from the effect of the 45% carbon emission on economic growth and poverty.
4. For Africa is important that improving political stability on the continent has impact on poverty. UN, AU and ECOWAS can help mediate among warring parties within most countries on the continent.

5.5 Limitation and Areas for Further Studies

Data of some countries were devoid of records on the variables and some not being produced. To resolve the data gap problems, the researcher approximated scores for countries using spatial fill, and machine learning algorithms as approaches adopted by this work which are statistically sound and acceptable. Moreover, obtaining climate data was a challenge and hence the framework could not measure the impact of climate change on it. Studies could be done if data on climate are obtained to measure the effect of climate change on disaster, economic growth and poverty. Further studies can be done to model the impact of disasters on economic growth and poverty.

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APPENDIX

Appendix 1: Categories of a statistically significant hot and cold spot

Hot Spot Categories	Definition
No Pattern Detected	Does not fall into any of the hot or cold spot patterns.
New Hot Spot	A location that is a statistically significant hot spot for most recent time only.
Consecutive Hot Spot	A location with a single uninterrupted run of statistically significant hot spot bins in the final time-step intervals.
Persistent Hot Spot	A location that has been a statistically significant hot spot for 90 percent of the time-step intervals with no discernible trend in the intensity of clustering over time.
Diminishing Hot Spot	A location that has been a statistically significant hot spot for 90 percent of the time-step intervals, including the final time step.
Sporadic Hot Spot	A location that is an on-again then off-again hot spot.
Historical Hot Spot	The most recent time period is not hot, but at least 90 percent of the time-step intervals have been statistically significant hot spots.

Appendix 1 Cont'd

New Cold Spot	A location that is a statistically significant cold spot for the final time step and has never been a statistically significant cold spot before
Consecutive Cold Spot	A location with a single uninterrupted run of at least two statistically significant cold spot bins in the final time-step intervals.
Persistent Cold Spot	A location that has been a statistically significant cold spot for 90 percent of the time-step intervals with no discernible trend in the intensity of clustering of counts over time.
Diminishing Cold Spot	A location that has been a statistically significant cold spot for 90 percent of the time-step intervals, including the final time step.
Sporadic Cold Spot	A statistically significant cold spot for the final time-step interval with a history of also being an on-again and off-again cold spot.
Historical Cold Spot	The most recent time period is not cold, but at least 90 percent of the time-step intervals have been statistically significant cold spots.

Source: Esri website https://bit.ly/3rTENer

Appendix 2: Incremental spatial autocorrelation of disasters from 2000-2020

Variables	Bio	Climate	Geophys	Hydro	Meteo	Tech
			All			
No. Peaks	-	1	1	1	1	1
Max peak (Km^2)	-	6.04	6.99	5.56	5.56	5.09
Moran's I	-	0.11	0.13	0.20	0.14	0.09
z-score	-	9.88	12.90	13.93	10.80	6.92
p-value	-	0.00	0.00	0.00	0.00	0.00
			African			
No. Peaks	-	1	-	2	1	-
Max peak (Km^2)	-	2.80	-	2.74	2.80	-
Moran's I	-	0.20	-	0.09	0.06	-
z-score	-	5.87	-	2.97	2.24	-
p-value	-	0.00	-	0.00	0.02	-
			American			
No. Peaks	1	1	1	1	-	2
Max peak (Km)	1.57	2.72	1.00	1.00	-	1.57
Moran's I	0.33	0.01	0.57	0.18	-	0.17
z-score	4.50	1.88	5.88	2.17	-	2.62
p-value	0.00	0.06	0.00	0.03	-	0.01
			Asia			
No. Peaks	-	1	1	1	2	-
Max peak (Km)	-	3.59	1.90	4.43	4.01	-
Moran's I	-	0.08	0.18	0.07	0.14	-
z-score	-	3.23	2.60	3.20	4.97	-

Appendix 2 Cont'd

p-value	-	0.00	0.01	0.00	0.00	-
			Europe			
No. Peaks	1	1	-	-	1	-
Max peak (Km)	1.47	1.47	-	-	1.24	-
Moran's I	0.04	0.15	-	-	0.14	-
z-score	1.71	2.78	-	-	1.81	-
p-value	0.09	0.01	-	-	0.07	-
			Oceania			
No. Peaks	-	-	-	-	1	-
Max peak (Km)	-	-	-	-	4.55	-
Moran's I	-	-	-	-	0.10	-
z-score	-	-	-	-	1.65	-
p-value	-	-	-	-	0.10	-

Source: Acquah, 2023

Bio=Biological, Climate=Climatological, Geophys=Geophysical, Hydro=Hydrological and Meteo=Meteorological, Tech=Technological

Appendix 3: Model statistics on carbon emission, if nothing is done

Model Statistics	Bio	Climate	Geophys	hydro	Meteo	Tech	Composite
Number of Trees	100	100	100	100	100	100	100
MSE	0.15	0.04	0.20	2.10	1.58	2.41	25.06
Variable importance%							
Carbon Emissions	100	100	100	100	100	100	100
Training							
R-Squared	0.79	0.73	0.70	0.78	0.66	0.76	0.76
p-value	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Standard Error	0.02	0.02	0.02	0.02	0.03	0.02	0.02
Validation							
R-Squared	0.34	0.47	0.003	0.52	0.003	0.31	0.12
p-value	0.00	0.00	0.792	0.00	0.812	0.00	0.08
Standard Error	0.22	0.32	0.24	0.15	0.04	0.13	0.136

Source: Acquah, 2023

Bio=Biological, Climate=Climatological, Geophys=Geophysical, Hydro=hydrological, Meteo=Meteorological, Tech=Technological

Appendix 4: Model statistics on carbon emission, if nothing is done plus the other variables

Model Statistics	**Bio**	**Climate**	**Geophys**	**Hydro**	**Meteo**	**Tech**	**Composite**
Number of Trees	100	100	100	100	100	100	100
MSE	0.14	0.04	0.14	1.66	1.71	2.13	14.48
Variable importance%							
Carbon emissions	40	55	50	45	55	53	14
Renewable Energy	30	2	7	9	10	6	40
Clean Water	7	7	10	11	7	9	10
Sanitation	4	10	5	7	7	7	8
Political Stability	10	11	17	13	13	16	16
Afforestation	9	14	11	14	9	10	11
Training							
R-Squared	0.89	0.88	0.83	0.87	0.85	0.88	0.90
p-value	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Standard Error	0.013	0.01	0.02	0.02	0.01	0.02	0.01
Validation							
R-Squared	0.006	0.082	0.06	0.35	0.20	0.24	0.42
p-value	0.71	0.17	0.228	0.00	0.02	0.01	0.00
Standard Error	0.13	0.16	0.022	0.18	0.20	0.21	0.09

Source: Acquah, 2023

Bio=Biological, Climate=Climatological, Geophys=Geophysical, Hydro=hydrological, Meteo=Meteorological, Tech=Technological

Appendix 5: Model statistics of the effects of carbon emission, if halved by 45% on disasters

Model Statistics	Bio	Climate	Geophys	Hydro	Meteo	Tech	Composite
Number of Trees	100	100	100	100	100	100	100
MSE	0.14	0.02	0.19	1.65	0.86	2.40	14.07
Variable importance%							
Carbon emissions	100	100	100	100	100	100	100
Training							
R-Squared	0.76	0.76	0.80	0.80	0.60	0.74	0.76
p-value	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Standard Error	0.02	0.03	0.02	0.02	0.03	0.02	0.02
Validation							
R-Squared	0.50	0.73	0.04	0.11	0.61	0.39	0.75
p-value	0.00	0.00	0.66	0.11	0.00	0.00	0.00
Standard Error	0.07	0.03	0.44	0.08	0.30	0.13	0.08

Source: Acquah, 2023

Bio=Biological, Climate=Climatological, Geophys=Geophysical, Hydro=hydrological, Meteo=Meteorological, Tech=Technological

Appendix 6: Model statistics on carbon emission, if halved by 45% plus the cofounding variables

Model Statistics	Bio	Climate	Geophys	Hydro	Meteo	Tech	Composite
Number of Trees	100	100	100	100	100	100	100
MSE	0.12	0.03	0.10	1.57	1.78	2.05	10.55
Variable importance%							
Carbon emissions	39	58	34	44	59	56	12
Renewable Energy	22	2	8	6	7	5	41
Clean Water	10	9	12	11	6	8	13
Sanitation	5	9	9	8	9	6	6
Political Stability	12	10	28	15	11	12	15
Afforestation	11	12	10	15	8	13	12
Training							
R-Squared	0.86	0.90	0.88	0.86	0.83	0.88	0.90
p-value	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Standard Error	0.01	0.01	0.01	0.02	0.02	0.02	0.01
Validation							
R-Squared	0.49	0.11	0.14	0.66	0.15	0.27	0.67
p-value	0.00	0.11	0.07	0.00	0.06	0.01	0.00
Standard Error	0.12	0.10	0.03	0.03	0.38	0.18	0.05

Source: Acquah, 2023

Bio=Biological, Climate=Climatological, Geophys=Geophysical, Hydro=hydrological, Meteo=Meteorological, Tech=Technological

Appendix 7: Model statistics on carbon emission, if nothing is done

	GDP/CAP						GDP GROWTH RATE					
Model Statistics	ALL	AFRICA	AMERICA	ASIA	EUROPE	OCEANIA	ALL	AFRICA	AMERICA	ASIA	EUROPE	OCEANIA
Number of Trees	100	100	100	100	100	100	100	100	100	100	100	100
MSE	8.74	7.47	7.58	8.62	15.57	5.86	5.92	7.20	7.30	5.17	25.48	4.31
Variable importance%												
Carbon emissions	100	100	100	100	100	100	100	100	100	100	100	100
Training												
R-Squared	0.70	0.74	0.75	0.75	0.76	0.27	0.66	0.69	0.76	0.78	0.62	0.32
p-value	0.00	0.00	0.00	0.00	0.00	0.02	0.00	0.00	0.00	0.00	0.00	0.02
Standard Error	0.22	0.04	0.05	0.04	0.04	0.06	0.02	0.05	0.05	0.04	0.05	0.08
Validation												
R-Squared	0.15	0.03	0.44	0.20	0.65	0.21	0.10	0.76	0.20	0.15	0.57	0.20
p-value	0.05	0.80	0.35	0.84	0.19	0.35	0.13	0.05	0.55	0.53	0.24	0.67
Standard Error	0.93	0.16	0.28	0.40	0.13	0.28	0.05	0.24	0.74	0.34	0.93	0.79

Source: Acquah, 2023

Appendix 8: Model statistics on carbon emission, if nothing is done plus the cofounding variables

	GDP/CAP						GDP GROWTH RATE					
Model Statistics	ALL	AFRICA	AMERICA	ASIA	EUROPE	OCEANIA	ALL	AFRICA	AMERICA	ASIA	EUROPE	OCEANIA
Number of Trees	100	100	100	100	100	100	100	100	100	100	100	100
MSE	8.30	8.09	4.65	3.95	27.53	3.90	6.30	9.81	4.10	4.85	5.43	3.81
Variable importance%												
Carbon emissions	15	27	13	14	26	21	12	18	15	12	11	19
Renewable Energy	3	3	3	3	3	9	4	2	7	7	4	5
Industrialization	18	12	34	12	8	12	23	15	20	23	16	17
Clean Water	12	13	9	12	20	8	18	10	11	16	20	12
Sanitation	6	4	5	14	4	8	7	5	7	6	7	14
Political Stability	24	18	15	27	27	31	19	30	22	20	29	21
Afforestation	22	22	21	19	11	11	17	20	18	16	13	11
Training												
R-Squared	0.86	0.92	0.89	0.91	0.83	0.85	0.90	0.92	0.89	0.92	0.91	0.90
p-value	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Standard Error	0.01	0.023	0.03	0.03	0.03	0.05	0.01	0.02	0.04	0.03	0.04	0.05
Validation												
R-Squared	0.10	0.27	0.62	0.08	0.39	0.45	0.38	0.36	0.08	0.08	0.99	0.18
p-value	0.12	0.26	0.21	0.65	0.38	0.31	0.00	0.28	0.72	0.04	0.01	0.62

Standard Error	0.11	0.12	0.13	0.07	0.18	0.16	0.05	0.48	0.23	0.30	0.01	0.23

Source: Acquah, 2023

Appendix 9: Model statistics on carbon emission, if halved by 45% (growth)

Model Statistics	GDP/CAP						GDP GROWTH RATE					
	ALL	AFRICA	AMERICA	ASIA	EUROPE	OCEANIA	ALL	AFRICA	AMERICA	ASIA	EUROPE	OCEANIA
Number of Trees	100	100	100	100	100	100	100	100	100	100	100	100
MSE	9.17	6.97	34..86	6.74	28.06	4.58	9.42	12.21	6.90	8.99	18.05	7.52
Variable importance%												
Carbon emissions	100	100	100	100	100	100	100	100	100	100	100	100
Training												
R-Squared	0.68	0.68	0.83	0.74	0.66	0.31	0.68	0.78	0.73	0.74	0.75	0.23
p-value	0.00	0.00	0.00	0.00	0.00	0.02	0.00	0.00	0.00	0.00	0.00	0.04
Standard Error	0.02	0.05	0.03	0.04	0.05	0.09	0.02	0.04	0.05	0.04	0.04	0.08
Validation												
R-Squared	0.10	0.55	0.10	0.02	0.10	0.10	0.10	0.94	0.52	0.82	0.33	0.10
p-value	0.91	0.15	0.91	0.82	0.67	0.81	0.83	0.21	0.28	0.03	0.42	0.28
Standard Error	0.12	0.21	2.09	0.58	0.61	0.89	0.16	1.62	0.24	0.42	0.20	0.24

Source: Acquah, 2023

Appendix 10: Model statistics on carbon emission, if halved by 45% plus the confounding variables (growth)

	GDP/CAP						GDP GROWTH RATE					
Model Statistics	ALL	AFRICA	AMERICA	ASIA	EUROPE	OCEANIA	ALL	AFRICA	AMERICA	ASIA	EUROPE	OCEANIA
Number of Trees	100	100	100	100	100	100	100	100	100	100	100	100
MSE	9.07	8.12	5.30	5.12	20.85	4.45	7.02	10.07	4.26	6.07	14.73	4.51
Variable importance%												
Carbon emissions	16	28	16	9	30	8	9	16	10	16	17	12
Renewable Energy	3	2	5	4	2	12	3	1	4	8	3	8
Industrialization	18	14	30	27	10	9	23	15	27	20	15	25
Clean Water	12	12	7	15	26	14	21	9	11	13	17	17
Sanitation	6	5	5	12	3	5	5	6	5	5	3	10
Political Stability	22	16	15	16	15	35	21	32	27	21	31	17
Afforestation	22	24	23	18	14	18	17	21	17	18	14	12
Training												
R-Squared	0.85	0.92	0.90	0.91	0.80	0.90	0.92	0.91	0.90	0.92	0.88	0.90
p-value	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Standard Error	0.01	0.02	0.03	0.03	0.04	0.04	0.01	0.02	0.04	0.03	0.03	0.05
Validation												
R-Squared	0.10	0.37	0.20	0.04	0.05	0.39	0.17	0.32	0.80	0.30	0.04	0.79
p-value	0.12	0.26	0.95	0.74	0.78	0.85	0.04	0.33	0.11	0.34	0.79	0.11
Standard Error	0.15	0.40	0.09	0.07	0.45	0.08	0.12	0.41	0.04	0.15	0.03	0.02

Source: Acquah, 2023

Appendix 11: Pairwise t-test analysis on GDP/CAP

GDP/CAP	ALL			AFRICA			AMERICA			ASIA			EUROPE			OCEANIA		
	Mean	t	P	Mean	t	p	Mean	t	p	Mean	t	P	Mean	t	p	Mean	t	p
Tr	0.63	0.01	0.98	0.40	-1.71	0.09	0.54	0.74	0.46	0.72	0.28	0.78	0.60	0.03	0.97	0.15	0.25	0.80
S1	0.63			0.92			0.33			0.64			0.58			0.06		
Tr	0.63	-0.00	0.99	0.40	-0.99	0.33	0.54	0.60	0.55	0.72	-0.93	0.36	0.60	3.45	0.85	0.15	1.40	0.17
S2	0.64			0.64			0.38			0.94			0.70			-0.22		
Tr	0.63	-0.27	0.78	0.40	-1.41	0.16	0.54	-3.18	0.30	0.72	0.52	0.60	0.60	0.43	0.66	0.15	0.01	0.98
S3	0.68			0.84			0.52			0.53			0.32			0.15		
Tr	0.63	0.24	0.80	0.40	-0.96	0.34	0.54	0.67	0.50	0.72	0.64	0.52	0.60	-0.20	0.83	0.15	0.78	0.44
S4	0.59			0.64			0.33			0.56			0.71			-0.07		
S1	0.63	-0.03	0.97	0.92	1.78	0.08	0.33	-0.22	0.83	0.64	-1.92	0.06	0.58	-0.39	0.69	0.06	1.93	0.06
S2	0.64			0.64			0.38			0.94			0.70			-0.22		
S1	0.63	-0.46	0.64	0.92	0.47	0.64	0.33	-3.18	0.00	0.64	0.42	0.68	0.58	0.95	0.34	0.06	-0.98	0.33
S3	0.68			0.84			0.52			0.53			0.32			0.15		
S1	0.63	0.34	0.72	0.92	1.79	0.07	0.33	0.01	0.99	0.64	0.40	0.69	0.58	-0.43	0.66	0.06	0.85	0.40
S4	0.59			0.64			0.33			0.56			0.71			-0.07		
S2	0.63	-0.49	0.62	0.64	-1.31	0.18	0.38	-3.18	0.00	0.94	1.93	0.05	0.70	1.15	0.25	-0.22	-2.10	0.04
S3	0.68			0.84			0.52			0.53			0.32			0.15		
S2	0.64	1.49	0.13	0.64	-0.02	0.98	0.38	0.67	0.51	0.94	3.61	0.00	0.70	-0.13	0.89	-0.22	-2.35	0.02
S4	0.59			0.64			0.33			0.56			0.71			-0.07		
S3	0.68	0.91	0.35	0.84	1.40	0.17	0.52	3.18	0.00	0.53	-0.14	0.89	0.32	-1.45	0.15	0.15	1.11	0.27
S4	0.59			0.64			0.33			0.56			0.71			-0.07		

Source: Acquah, 2023

Tr=Trend (Predicted Growth), S1=Scenario one (Predicted Growth with no reduction in carbon emission), S2=Scenario two (Predicted Growth with no reduction in carbon emission plus the other variables), S3=Scenario three (Predicted Growth with reduction in carbon emission by), S4=Scenario four (Predicted Growth with reduction in carbon emission by 45% plus the other variables

Appendix 12: Pairwise t-test analysis on GDP growth rate

GDP GROWTH RATE	ALL			AFRICA			AMERICA			ASIA			EUROPE			OCEANIA		
	Mean	t	P	Mean	t	P	Mean	t	p	Mean	t	P	Mean	t	P	Mean	t	p
Tr	1.42	1.47	0.14	0.94	-0.75	0.46	1.19	-0.01	0.99	1.38	0.63	0.52	2.30	0.30	0.76	1.28	0.37	0.70
S1	1.14			1.23			1.19			1.17			2.16			1.11		
Tr	1.42	1.47	0.14	0.94	-0.64	0.53	1.19	-0.36	0.72	1.38	-0.17	0.86	2.30	-0.55	0.58	1.28	1.10	0.28
S2	1.14			1.12			1.30			1.42			2.55			0.90		
Tr	1.42	0.66	0.50	0.94	-1.19	0.24	1.19	1.46	0.15	1.38	0.67	0.50	2.30	0.22	0.82	1.28	0.63	0.53
S3	1.29			1.42			0.66			1.12			2.19			0.98		
Tr	1.42	-2.47	0.01	0.94	-1.38	0.17	1.19	-0.14	0.89	1.38	0.86	0.38	2.30	0.20	0.83	1.28	0.60	0.55
S4	1.80			1.34			1.23			1.16			2.21			1.08		
S1	1.14	-4.21	0.00	1.23	0.60	0.55	1.19	-0.48	0.64	1.17	-1.04	0.29	2.16	-1.10	0.27	1.11	1.32	0.20
S2	1.63			1.12			1.30			1.42			2.55			0.90		
S1	1.14	-1.31	0.18	1.23	-0.82	0.42	1.19	1.20	0.05	1.17	0.16	0.86	2.16	-0.09	0.92	1.11	1.18	0.25
S3	1.29			1.42			0.66			1.12			2.19			0.98		
S1	1.14	-5.44	0.00	1.23	-0.53	0.60	1.19	-0.18	0.86	1.17	0.03	0.97	2.16	-0.14	0.88	1.11	0.15	0.87
S4	1.80			1.34			1.23			1.16			2.21			1.08		
S2	1.63	3.09	0.00	1.12	-1.44	0.16	1.30	2.37	0.02	1.42	1.22	0.22	2.55	1.57	0.12	0.90	-0.44	0.65
S3	1.29			1.42			0.66			1.12			2.19			0.98		
S2	1.29	-5.14	0.00	1.12	-3.27	0.00	1.30	0.72	0.47	1.42	5.38	0.00	2.55	2.51	0.01	0.90	-1.80	0.08
S4	1.80			1.34			1.23			1.16			2.21			1.08		
S3	1.29	-4.56	0.00	1.42	0.38	0.71	0.66	-2.17	0.03	1.12	-0.16	0.86	2.19	-0.08	0.93	0.98	-0.42	0.67
S4	1.80			1.34			1.23			1.16			2.21			1.08		

Source: Acquah, 2023

T r= Trend (Predicted Growth), S1 = Scenario one (Predicted Growth with no reduction in carbon emission), S2 = Scenario two (Predicted Growth with no reduction in carbon emission plus the other variables), S3 = Scenario three (Predicted Growth with reduction in carbon emission by), S4 = Scenario four (Predicted Growth with reduction in carbon emission by 45% plus the other variables)

Appendix 13: Model statistics on carbon emission, if nothing is done on poverty

Model Statistics	MONETARY						EDUCATION						BASIC INFRASTRUCTURE					
	ALL	AFR	AME	ASI	EUR	OCE	ALL	AFR	AME	ASI	EUR	OCE	ALL	AFR	AME	ASI	EUR	OCE
Number of Trees	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100
MSE	163.0	252.9	322.0	128.8	177.7	144.9	388.3	518.0	760.5	421.9	472.5	158.5	1313.5	1219.4	1070.7	1055.6	1072.9	1377.1
Variable importance%																		
Carbon emissions	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100
Training																		
R-Squared	0.66	0.74	0.75	0.80	0.62	0.43	0.76	0.86	0.66	0.85	0.55	0.70	0.67	0.71	0.79	0.84	0.70	0.31
p-value	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01
Standard Error	0.22	0.04	0.04	0.04	0.06	0.08	0.01	0.02	0.05	0.03	0.06	0.07	0.02	0.04	0.05	0.0	0.05	0.10
Validation																		
R-Squared	0.05	0.26	0.18	0.05	0.02	0.21	0.03	0.27	0.74	0.03	0.03	0.20	0.12	0.12	0.04	0.33	0.36	0.16
p-value	0.74	0.38	0.58	0.70	0.87	0.35	0.78	0.36	0.13	0.92	0.82	0.67	0.09	0.56	0.78	0.30	0.39	0.67

Standard Error	0.72	0.09	0.23	0.31	0.86	0.28	0.38	0.01	0.71	0.22	0.15	0.72	0.09	0.98	0.45	0.18	0.16	0.89

Source: Acquah, 2023

AFR=Africa, AME=Americas, ASI=Asia, EUR=Europe, OCE=Oceania

Appendix 14: Model statistics on carbon emission, if nothing is done plus the confounding variables on poverty

Model Statistics	MONETARY						EDUCATION						BASIC INFRASTRUCTURE					
	ALL	AFR	AME	ASI	EUR	OCE	ALL	AFR	AME	ASI	EUR	OCE	ALL	AFR	AME	ASI	EUR	OCE
Number of Trees	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100
MSE	183.8	229.5	318.1	127.3	166.3	66.2	291.5	552.0	716.5	332.4	355.0	149.3	235.5	504.0	503.2	298.0	373.6	640.7
Variable importance%																		
Carbon emissions	17	18	18	29	31	7	33	24	29	43	45	6	4	9	8	7	11	13
Renewable Energy	6	14	2	3	5	2	5	3	2	5	15	2	2	2	3	2	4	5
Industrialization	13	8	19	8	9	2	10	10	8	8	6	17	7	17	10	6	4	6
Clean Water	16	14	12	10	17	13	12	27	13	14	12	16	34	32	32	33	45	21
Sanitation	14	14	5	12	6	38	11	6	16	4	5	13	9	12	6	9	10	8
Political Stability	20	20	27	18	17	31	17	19	17	13	8	29	16	11	14	10	15	17
Afforestation	13	12	17	21	16	8	13	11	14	14	9	18	28	16	26	33	12	29
Training R-Squared	0.89	0.93	0.89	0.85	0.87	0.96	0.76	0.71	0.76	0.64	0.77	0.84	0.86	0.91	0.95	0.95	0.94	0.93
p-value	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Standard Error	0.01	0.02	0.02	0.02	0.02	0.02	0.01	0.03	0.03	0.04	0.03	0.05	0.01	0.03	0.02	0.02	0.03	0.04

Validation																		
R-Squared	0.04	0.23	0.38	0.16	0.01	0.47	0.04	0.40	0.00	0.14	0.59	0.44	0.10	0.50	0.25	0.26	0.42	0.55
p-value	0.28	0.42	0.38	0.50	0.97	0.21	0.31	0.25	0.99	0.53	0.23	0.31	0.12	0.18	0.50	0.36	0.35	0.21
Standard Error	0.06	0.32	0.22	0.56	0.88	0.17	0.06	0.34	0.71	0.42	0.12	0.20	0.11	0.20	0.43	0.24	0.47	0.17

Source: Acquah, 2023

AFR=Africa, AME=Americas, ASI=Asia, EUR=Europe, OCE=Oceania

Appendix 15: Model statistics on carbon emission, if halved by 45% (poverty)

Model Statistics	MONETARY						EDUCATION						BASIC INFRASTRUCTURE					
	ALL	AFR	AME	ASI	EUR	OCE	ALL	AFR	AME	ASI	EUR	OCE	ALL	AFR	AME	ASI	EUR	OCE
Number of Trees	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100
MSE	190.3	294.8	344.7	102.2	174.5	134.5	316.1	793.7	830.7	439.9	479.4	157.3	1224.7	1179.0	1365.9	1447.7	795.2	1214.3
Variable importance%																		
Carbon emissions	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100
Training																		
R-Squared	0.64	0.76	0.66	0.88	0.62	0.46	0.71	0.70	0.62	0.83	0.50	0.72	0.66	0.74	0.77	0.79	0.68	0.48
p-value	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Standard Error	0.02	0.04	0.05	0.03	0.05	0.07	0.02	0.04	0.05	0.03	0.05	0.08	0.02	0.04	0.04	0.03	0.05	0.09
Validation																		
R-Squared	0.06	0.29	0.04	0.03	0.21	0.12	0.06	0.58	0.70	0.01	0.02	0.10	0.02	0.01	0.04	0.51	0.37	0.20

p-value	0.71	0.34	0.93	0.75	0.53	0.71	0.24	0.13	0.18	0.96	0.86	0.91	0.82	0.86	0.93	0.17	0.39	0.81
Standard Error	0.10	0.42	1.26	0.21	1.60	0.69	0.04	0.58	0.25	0.27	1.68	0.89	0.14	0.15	0.24	0.14	0.01	0.79

Source: Acquah, 2023

AFR=Africa, AME=Americas, ASI=Asia, EUR=Europe, OCE=Oceania

Appendix 16: Model statistics on carbon emission, if halved by 45% plus the confounding variables (poverty)

Model Statistics	MONETARY						EDUCATION						BASIC INFRASTRUCTURE					
	ALL	AFR	AME	ASI	EUR	OCE	ALL	AFR	AME	ASI	EUR	OCE	ALL	AFR	AME	ASI	EUR	OCE
Number of Trees	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100
MSE	162.4	290.8	189.0	112.3	147.9	109.4	321.7	521.3	720.4	293.3	365.2	125.3	250.3	486.3	620.9	345.8	355.5	567.7
Variable importance%																		
Carbon emissions	17	15	28	23	29	9	31	20	32	34	25	9	5	8	12	7	9	8
Renewable Energy	7	16	1	4	5	2	9	1	2	9	25	2	2	3	2	2	5	9
Industrialization	13	12	16	7	11	3	11	9	11	11	7	21	7	23	15	6	4	5
Clean Water	18	10	14	13	19	14	14	31	12	16	15	5	38	28	26	28	42	22
Sanitation	10	19	9	19	7	25	9	7	18	5	4	17	7	9	8	7	8	13
Political Stability	20	15	15	20	14	36	15	18	13	10	8	34	15	12	9	13	16	20
Afforestation	15	13	18	13	15	9	16	15	12	15	16	12	26	16	28	38	17	24
Training																		
R-Squared	0.91	0.89	0.89	0.86	0.86	0.94	0.71	0.75	0.79	0.61	0.83	0.86	0.95	0.94	0.90	0.95	0.94	0.91
p-value	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Standard Error	0.01	0.02	0.03	0.02	0.02	0.03	0.01	0.03	0.03	0.04	0.02	0.06	0.01	0.02	0.03	0.02	0.03	0.05
Validation																		
R-Squared	0.08	0.63	0.84	0.70	0.24	0.41	0.03	0.29	0.80	0.30	0.37	0.29	0.83	0.29	0.20	0.80	0.84	0.29
p-value	0.12	0.10	0.08	0.04	0.50	0.65	0.38	0.34	0.10	0.33	0.38	0.55	0.00	0.35	0.95	0.04	0.08	0.65
Standard Error	0.15	0.11	0.03	0.13	0.12	0.09	0.05	0.92	0.09	0.34	0.12	0.08	0.07	0.30	0.09	0.18	0.12	0.09

Source: Acquah, 2023

AFR=Africa, AME=Americas, ASI=Asia, EUR=Europe, OCE=Oceania

Appendix 17: Pairwise t-test analysis on monetary poverty

MONETARY POVERTY	ALL			AFRICA			AMERICA			ASIA			EUROPE			OCEANIA		
	Mean	t	P	Mean	t	p	Mean	t	p	Mean	t	P	Mean	t	p	Mean	t	p
Tr	8.91	1.10	0.27	11.26	0.27	0.78	10.77	-0.71	0.47	65.89	0.27	0.78	8.47	0.02	0.97	7.32	-0.13	0.89
S1	8.03			10.75			12.10			64.57			8.43			7.61		
Tr	8.91	-1.36	0.17	11.26	0.16	0.86	10.77	0.17	0.85	65.89	2.53	0.01	8.47	-0.83	0.40	7.32	0.68	0.49
S2	9.94			10.97			10.45			61.41			9.65			5.98		
Tr	8.91	0.56	0.57	11.26	-0.23	0.81	10.77	-0.12	0.89	65.89	-1.17	0.24	8.47	0.44	0.65	7.32	0.35	0.72
S3	8.44			11.71			11.08			71.93			7.72			6.54		
Tr	8.91	-0.76	0.44	11.26	-0.18	0.85	10.77	1.34	0.18	65.89	2.41	0.01	8.47	-0.48	0.63	7.32	-0.09	0.92
S4	9.49			11.60			8.04			61.04			9.15			7.48		
S1	8.03	-4.28	0.00	10.75	-0.25	0.79	12.10	1.59	0.11	64.57	0.80	0.42	8.43	-1.71	0.09	7.61	1.46	0.15
S2	9.945			10.97			10.45			61.41			9.65			5.98		
S1	8.03	-0.71	0.47	10.75	-0.91	0.36	12.10	0.66	0.50	64.57	-2.06	0.04	8.43	0.78	0.43	7.61	1.80	0.08
S3	8.44			11.71			11.08			71.93			7.72			6.54		
S1	8.03	-3.43	0.00	10.75	-0.90	0.37	12.10	3.53	0.00	64.57	0.91	0.36	8.43	-0.89	0.37	7.61	0.11	0.90
S4	9.49			11.60			8.04			61.04			9.15			7.48		
S2	9.94	3.11	0.00	10.97	-0.74	0.45	10.45	-0.48	0.63	61.41	-2.47	0.01	9.65	2.44	0.01	5.98	-0.53	0.59
S3	8.44			11.71			11.08			71.93			7.72			6.54		
S2	9.94	2.59	0.01	10.97	-2.33	0.02	10.45	4.13	0.00	61.41	0.66	0.51	9.65	1.44	0.15	5.98	-2.73	0.01
S4	9.49			11.60			8.04			61.04			9.15			7.48		
S3	8.44	-2.32	0.02	11.71	0.10	0.91	11.08	2.67	0.01	71.93	2.65	0.01	7.72	-1.93	0.05	6.54	-0.98	0.33

Source: Acquah, 2023

Tr= Trend (Predicted Growth), S1 = Scenario one (Predicted monetary poverty with no reduction in carbon emission), S2 = Scenario two (Predicted monetary poverty with no reduction in carbon emission plus the other variables), S3 = Scenario three (Predicted monetary poverty with reduction in carbon emission by), S4 = Scenario four (Predicted monetary poverty with reduction in carbon emission by 45% plus the other variables)

Appendix 18: Pairwise t-test analysis on educational poverty

EDUCATION	ALL			AFRICA			AMERICA			ASIA			EUROPE			OCEANIA		
	Mean	t	P	Mean	t	p	Mean	t	p	Mean	t	P	Mean	t	p	Mean	t	p
Tr	81.36	0.25	0.80	81.21	0.44	0.65	77.17	0.52	0.59	82.84	-0.26	0.78	83.74	1.48	0.14	82.45	0.13	0.89
S1	81.07			79.84			75.33			83.46			80.91			82.22		
Tr	81.36	1.37	0.17	81.21	1.38	0.17	77.17	1.11	0.27	82.84	0.43	0.66	83.74	1.92	0.06	82.45	1.26	0.22
S2	80.08			78.09			73.58			82.10			81.09			80.58		
Tr	81.36	0.21	0.83	81.21	-0.19	0.84	77.17	1.25	0.21	82.84	0.76	0.44	83.74	1.26	0.21	82.45	0.58	0.56
S3	81.11			81.68			73.15			80.96			81.24			80.98		
Tr	81.36	1.35	0.17	81.21	1.00	0.31	77.17	1.89	0.06	82.84	0.73	0.46	83.74	0.81	0.42	82.45	0.94	0.35
S4	80.07			78.88			71.51			81.51			82.53			81.00		
S1	81.07	1.59	0.11	79.84	0.92	0.35	75.33	1.07	0.28	83.46	0.94	0.34	80.91	-0.17	0.86	82.22	1.38	0.18
S2	80.08			78.09			73.58			82.10			81.09			80.58		
S1	81.07	-0.04	0.96	79.84	-0.87	0.38	75.33	1.07	0.28	83.46	2.08	0.04	80.91	-0.29	0.77	82.22	0.92	0.36
S3	81.11			81.68			73.15			80.96			81.24			80.98		
S1	81.07	1.53	0.12	79.84	0.43	0.66	75.33	1.92	0.06	83.46	1.30	0.19	80.91	-1.08	0.28	82.22	1.19	0.24
S4	80.07			78.88			71.51			81.51			82.53			81.00		
S2	80.08	-1.60	0.10	78.09	-2.30	0.02	73.58	0.21	0.83	82.10	0.65	0.51	81.09	-0.16	0.87	80.58	-0.19	0.84
S3	81.11			81.68			73.15			80.96			81.24			80.98		
S2	80.08	0.02	0.97	78.09	-1.32	0.19	73.58	2.04	0.04	82.10	1.74	0.08	81.09	-2.20	0.03	80.58	-0.98	0.33
S4	80.07			78.88			71.51			81.51			82.53			81.00		
S3	81.11	1.67	0.09	81.68	1.73	0.08	73.15	0.89	0.37	80.96	-0.32	0.74	81.24	-1.08	0.28	80.98	-0.00	0.99
S4	80.07			78.88			71.51			81.51			82.53			81.00		

Source: Acquah, 2023

Tr= Trend (Predicted education), S1 = Scenario one (Predicted education with no reduction in carbon emission), S2 = Scenario two (Predicted education with no reduction in carbon emission plus the other variables), S3 = Scenario three (Predicted education with reduction in carbon emission by), S4 = Scenario four (Predicted education with reduction in carbon emission by 45% plus the other variables)

Appendix 19: Pairwise t-test analysis on basic infrastructural poverty

BASIC INFRAS	ALL			AFRICA			AMERICA			ASIA			EUROPE			OCEANIA		
	Mean	t	P	Mean	t	p	Mean	t	p	Mean	t	P	Mean	t	p	Mean	t	p
Tr	64.80	0.36	0.71	60.71	-0.05	0.95	57.20	-0.88	0.37	65.89	0.27	0.78	73.48	0.29	0.77	66.03	-0.03	0.97
S1	63.99			60.97			61.69			64.57			72.35			66.24		
Tr	64.80	2.99	0.00	60.71	2.66	0.01	57.20	1.53	0.13	65.89	2.53	0.01	73.48	2.44	0.01	66.03	-0.59	0.56
S2	59.42			54.15			51.21			61.41			66.83			68.07		
Tr	64.80	-0.16	0.86	60.71	-0.00	0.99	57.20	-0.17	0.86	65.89	-1.17	0.24	73.48	0.60	0.54	66.03	0.41	0.67
S3	65.18			60.74			58.25			71.93			70.97			63.27		
Tr	64.80	3.62	0.00	60.71	2.53	0.01	57.20	1.93	0.05	65.89	2.41	0.01	73.48	2.88	0.00	66.03	0.72	0.47
S4	58.24			54.50			49.53			61.04			65.35			63.69		
S1	63.99	2.61	0.00	60.97	1.96	0.05	61.69	2.58	0.01	64.57	0.80	0.42	72.35	1.83	0.07	66.24	-0.55	0.58
S2	59.42			54.15			51.21			61.41			66.83			68.07		
S1	63.99	-0.78	0.43	60.97	0.06	0.95	61.69	1.18	0.24	64.57	-2.06	0.04	72.35	0.70	0.48	66.24	1.41	0.17
S3	65.18			60.74			58.25			71.93			70.97			63.27		
S1	63.99	3.22	0.00	60.97	1.80	0.07	61.69	3.31	0.00	64.57	0.91	0.36	72.35	2.35	0.02	66.24	0.63	0.53
S4	58.24			54.50			49.53			61.04			65.35			63.69		
S2	59.42	-2.97	0.003	54.15	-1.70	0.09	51.21	-1.36	0.17	61.41	-2.47	0.01	66.83	-1.40	0.16	68.07	1.19	0.24
S3	65.18			60.74			58.25			71.93			70.97			63.27		
S2	59.42	6.21	0.00	54.15	-0.61	0.54	51.21	1.13	0.26	61.41	0.66	0.51	66.83	2.32	0.02	68.07	2.98	0.00
S4	58.24			54.50			49.53			61.04			65.35			63.69		
S3	65.18	3.54	0.00	60.74	1.56	0.12	58.25	1.76	0.08	71.93	2.65	0.01	70.97	2.00	0.05	63.27	-0.08	0.92
S4	58.24			54.50			49.53			61.04			65.35			63.69		

Source: Acquah, 2023

Tr=Trend (Predicted basic infrastructure), S1=Scenario one (Predicted basic infrastructure with no reduction in carbon emission), S2=Scenario two (Predicted basic infrastructure with no reduction in carbon emission plus the other variables), S3=Scenario three (Predicted basic infrastructure with reduction in carbon emission by 45%), S4=Scenario four (Predicted basic infrastructure with reduction in carbon emission by 45% plus the other variables.