Climate Change and Environmental Governance

Climate Change and Environmental Governance

By

Taiwo O. Ogunwale

Cambridge Scholars Publishing

Climate Change and Environmental Governance

By Taiwo O. Ogunwale

This book first published 2026

Cambridge Scholars Publishing

Lady Stephenson Library, Newcastle upon Tyne, NE6 2PA, UK

British Library Cataloguing in Publication Data
A catalogue record for this book is available from the British Library

ISBN: 978-1-0364-6719-7
ISBN (Ebook): 978-1-0364-6720-3

TABLE OF CONTENTS

MODULE 2: MONETARY OF CLIMATE CHANGE

MODULE 5: CHANGE IN CLIMATE AND BIODIVERSITY

LIST OF ILLUSTRATIONS

Module 1

Module 2

LIST OF TABLES

Module 3

PREFACE

There is widespread paucity of instructional materials in the higher education establishments of Nigeria. The accessible materials concerning the course on the Climate Change and Environmental Governance are not adequate to our ecological and socio-economic setting.

This book is prepared mainly for EMT students, and is arranged on the basis of the lesson plan of Climate Change and Environmental Governance in the curriculum of EMT students. However, the lecture note is supposed to be beneficial for almost all degree and diploma Environmental Science students in the University and in another place in the nation. Taking into consideration the dearth of instructional materials for the course- Climate Change and Environmental Governance, this book is proposed to be utilized as a reference for students.

This material is presented in eighteen chapters with five modules. Module one entails: the climate change science such as understanding the science of climate change, climate change models, climate change observations and predictions for the future, and critically review the global warming. Module two presents monetary of climate change like climate change and economic growth, climate economics through the influential neoclassical viewpoints, cost-benefit analysis and climate change impacts on different sectors, and economic challenges, ecological viewpoints, and sustainable growth**.** Module three is all about governance, policy, and institutions such as protocols, policy frameworks, and climate change, development, climate change, and policy alternatives, funding for climate change as well as the plans for addressing climate change. Module four covers impacts of climate change on human health, remedial methods, and environmental governance. Module five encompasses change in climate and biodiversity, changes in Climate and their consequences on biodiversity, and mitigation of climate change and preservation of biodiversity in the Nigerian context are presented.

Each chapter starts with preamble, desired learning objectives, by indicating what is expected from students on completion of the chapter. In addition, self-evaluation task after each important topics' discussions and at the end

of each chapter there are conclusion, recap, and short questions for revision pertinent to the basic issues of the respective chapter. In a nutshell, tutorial questions are set for exam preparation.

ACKNOWLEDGEMENTS

I am very indebted to the Managing Director of Cambridge Scholar Publishers Limited for his positive suggestion, encouragement, subsidy, and moral support. I also acknowledge efforts of the Editorial crew and all staff of Cambridge Scholar Publishers for editing and publishing this textbook.

I am incredibly grateful to the Chairman of the Governing Council of Lead City University in Ibadan for giving me the chance to mentor and instruct these students as well as for giving me the space to write this book.

I would also want to thank Dr. (Mrs.) Omonike Bakare, the Head of the Biological Sciences Department, and Dr. P. O. Ogungbile, the Head of the Environmental Management and Toxicology Unit, for fostering a culture of teamwork among the department's employees.

I express my deep appreciation to all my teachers who taught me at the various levels of my academic endeavors. They have all been so unique. I am specifically indebted to those who taught me at the tertiary level for granting to use their past questions.

Above all I thank Almighty God, the Author of knowledge, wisdom, and understanding with whom nothing is unattainable.

I value everybody that has added one way or the other to the successful culmination of this textbook. God will bless you all.

Thanks.

UNIQUENESS

This book is easy to understand. It is an all-encompassing textbook as it outlines the materials needed to pass some levels of examinations. What makes this textbook very valuable and distinctive is the style of presentation of materials for easy recall and understanding. Each chapter starts with preamble, desired learning objectives, by indicating what is expected from students on completion of the chapter. Furthermore, at the end of each chapter there are conclusion, recap, and short questions for revision in line with the fundamental issues of the respective chapter. The syllabus for Climate Change and Environmental Governance is fairly covered. The book is highly recommended for all three tiers of education. It is also a useful tool for ecology and environmental science tutors. They will undoubtedly find this textbook essential to their studies towards achieving success in their diverse academic programmes

MODULE 1:

THE CLIMATE CHANGE SCIENCE

CHAPTER 1

UNDERSTANDING THE SCIENCE OF CLIMATE CHANGE

1.0 Preamble

Conventionally speaking, climate is the long-term average of meteorological parameters like temperature, cloud cover, and precipitation; changes in these parameters over several decades serve as a key indicator of climate change. Naturally, the climate varies. There have been other worldwide climate shifts throughout Earth's history that have been significantly larger than those that have occurred recently, according to the evidence. The earth was most likely significantly warmer than it is now for the majority of the last 500 million years. According to some estimates, average global temperatures have increased by as much as 1°C since the middle of the 1800s, and recent trends have shown increases of one to two tenths of a degree every decade (IPCC, 2001). The causes of these shifts and their implications for the future are the subject of much uncertainty and continuous scientific discussion. The IPCC's computer-run climate models attribute the majority of this trend's cause to rising atmospheric concentrations of greenhouse gases, primarily from the burning of fossil fuels.

1.1 Desired Learning Objectives (DLOs)

By the time this chapter is through, you should be able to:

- Recognize the historical background of climate change science;
- Identify the causes and impacts of climate change; and
- Know what steps can be taken to lower the amount of greenhouse gases in the atmosphere.

1.2 Main Text

1.2.1 Historical Background of Climate Change Science

It is useful to review the lengthy historical perspective that led to the current condition of climate change in order to gain a better understanding of the science behind it. This course begins with an explanation of the terms "climate change" and "global warming." It then uses a broad selection of examples to discuss how the climate has changed throughout human history.

The World Meteorological Organization (WMO) coined the phrase "climatic change" in 1966 to refer to any type of climatic fluctuation on timescales longer than ten years, regardless of the source. In the 1970s, as it became evident that human activity had the capacity to significantly modify the climate, the phrase "climate change" supplanted "climatic change" to emphasize anthropogenic causes. The UN Framework Convention on Climate Change (UNFCCC) and the Intergovernmental Panel on Climate Change (IPCC) both have climate change in their names. These days, the term "climate change" is used to refer to the issue as well as a technical explanation of the process.

Although the terms "climate change" and "global warming" are commonly used interchangeably, they have distinct meanings because a "warming" is simply one aspect of the Earth's wider climatic system that is subject to natural change. Scientists now know that a wide range of elements can contribute to long-term changes in the planet's climate thanks to empirical evidence from both Earth and space. Solar radiation levels, the Earth's orbit around the sun, volcanic activity, ocean currents, and even plate tectonics are a few examples of these variables. Warming and cooling periods are called glacials and inter-glacials, respectively; the latter are marked in part by massive ice sheets that radiate from the poles.

The Little Ice Age (A.D. 1270-1850) and the Medieval Warm Period (A.D. 1000-1270) are two recent times of change in human history. Contrary to popular belief, there has long been discourse among individuals about climate change. Weart (2007) points out that although the concept of climate change dates back to ancient times, our understanding of the topic has grown as research tools have advanced. Guy Stewart Callendar, a significant figure in the history of climate research, foresaw potential issues and stated that "even subtle changes in the Earth's orbit could make a difference." In fact, computer climate simulations in the 1970s confirmed Callendar's theory that carbon dioxide acts as a heat-trapping agent. Many were surprised to learn

that astronomical cycles had partially determined the time of the ice ages based on research of ancient climates. It seems that the climate was so finely tuned that nearly any slight disturbance may trigger a significant change (Weart, 2007). The Intergovernmental Panel on Climate Change, an organization composed of numerous scientists with expertise in climate studies, has been studying Earth's climate more lately. In recent years, the IPCC has published four assessments that examine the links between climate change and human activity. According to the most current report, "Climate Change 2007," the IPCC as a whole is 90% certain that greenhouse gas emissions from human activity directly cause global warming.

Self-Evaluation Task 1

Give a thorough explanation of what is meant by "climate change."

1.3 Climate Change Causes

The positioning of continents, the activity of volcanoes, variations in solar radiation, and other external factors can all affect the climate. It may also shift due to anthropogenic (caused by humans) factors, such as extensive changes to the land surface and the atmospheric composition of greenhouse gases, or internal climate system influences, such as clouds and atmospheric composition.

The Earth's equilibrium temperature and climate are determined, in the widest sense, by the rate at which energy is received from the Sun and the rate at which it is lost to space. Through the use of winds, ocean currents, and other mechanisms, this energy is dispersed throughout the world and influences regional climates. "Forcing mechanisms" or "climate forcings" are variables that have the power to alter the climate. These include phenomena like fluctuations in the Earth's orbit, variations in solar radiation, variations in the albedo or reflectivity of the continents, atmosphere, and oceans, variations in the formation of mountains and continental drift, and variations in the concentrations of greenhouse gases.

Either internal processes or external forces may be the cause of climate change. Changes in the ocean's and atmosphere's energy distribution, such as adjustments to the thermohaline circulation, are frequently the result of internal, unforced processes. There are two types of external forcing mechanisms: natural (such as variations in solar output, the earth's orbit, and volcanic eruptions) and anthropogenic (such as increased emissions of greenhouse gases and dust).The climate system may respond quickly (as in

the case of an abrupt cooling brought on by flying volcanic ash reflecting sunlight) or slowly (as in the case of thermal expansion of warmed ocean water) depending on the nature of the initial forcing mechanism, whether internal or a mix of them (for example, the Arctic Ocean's abrupt loss of albedo due to melting sea ice, followed by the water's more slow thermal expansion). As a result, while the climate system is capable of sudden changes, it may take centuries or even longer for forcing processes to fully manifest their effects.

Anything or anything created by people is considered anthropogenic. Excessive greenhouse gas emissions are one item that may be anthropogenic. Environmental factors that are anthropogenic alterations brought about by human activities and that have an impact on the organic world. People affect the lives of animals and plants by changing their environments, rearranging nature to fit human wants. Both direct and indirect influences are possible greenhouse gas. Anthropogenic carbon dioxide emissions, or emissions caused by human activity, are mostly emitted by burning fossil fuels, primarily coal, oil, and natural gas. Deforestation, altered land use, soil erosion, and agriculture, including raising livestock, also contribute to the emissions.

1.3.1 Internal Variability

The earth's climate system is composed of five main components, as defined by scientists: the atmosphere, hydrosphere, cryosphere, lithosphere (which is limited to the surface soils, rocks, and sediments), and biosphere. "Climate variability" within the climate system is the outcome of natural fluctuations. Examples include variations in the circulations between the ocean and atmosphere and the kind and distribution of animals.

A. Variability between Ocean and Atmosphere

Together, the ocean and atmosphere have the capacity to produce internal climatic variability on their own, which can last for several years or even decades. The Pacific decadal oscillation, the Atlantic Multi-decadal Oscillation, and the El Niño–Southern Oscillation are a few instances of this kind of fluctuation. By shifting heat between the deep ocean and the atmosphere or by changing the distribution of clouds, water vapor, and sea ice, these fluctuations can have an impact on the earth's overall energy budget. Because of the ocean's extremely high thermal inertia and hundreds of times mass greater than that of the atmosphere, the oceanic components of these circulations can produce variability over centennial timescales. For

instance, changes to ocean circulation patterns, such as thermohaline circulation, are crucial for the global ocean's heat distribution. The Little Ice Age, which took place between 1600 and 1800, had an impact on ocean temperature, which is currently being adjusted at depth due to the lengthy durations of this circulation.

B. Forcing at Random

Regarding climate, one could argue that the weather is arbitrary. There is an energy imbalance and the oceans may absorb more heat if there are few clouds in a given year. This signal is 'stored' in the ocean and manifests as variability on time scales longer than the initial weather disturbances because of climate inertia.

1.3.2 Mechanisms of External Forcing

A. Greenhouse Gases

According to scientific consensus, climate change "is largely irreversible" and "that the climate is changing and that these changes are in large part caused by human activities". Climate scientists usually classify greenhouse gases emitted from volcanoes as external, but greenhouse gases released by the biosphere are commonly considered as a feedback or internal climate process. By absorbing infrared light, greenhouse gases like CO_2, methane, and nitrous oxide warm the climate system. Human activity's primary source of emissions is the burning of fossil fuels, which is followed by the production of cement and aerosols, which are atmospheric particles. A number of other causes are also involved, such as deforestation, land usage, ozone depletion, and animal husbandry (ruminant animals like cattle create methane).

B. The Volcanoes

Another component of the extended carbon cycle is volcanoes. They offset the uptake by sedimentary rocks and other geological carbon dioxide sinks by releasing carbon dioxide from the Earth's crust and mantle over very long (geological) time periods. According to US Geological Survey estimates, present human activities produce 100–300 times the amount of carbon dioxide emitted by volcanoes, meaning that volcanic emissions are substantially lower. Super eruptions, the most recent of which was the Toba eruption in Indonesia 74,000 years ago, may not release as much annually as human activity does.

C. Variations in Orbit

The seasonal distribution of sunlight reaching the Earth's surface and its global dispersion are influenced by minute fluctuations in Earth's motion. The annual average sunshine in a given place doesn't vary much, but the distribution's seasonal and geographic fluctuations can be quite significant. Variations in Earth's eccentricity, shifts in the tilt angle of the axis of rotation, and precession of the axis are the three categories of kinematic change.

D. Solar Power Output

The Earth's climate system primarily receives its energy input from the Sun. Other sources include heat from radioactive compound decay, tidal energy from the Moon, and geothermal energy from the Earth's core. It is well established that fluctuations in solar intensity, both short- and long-term, impact the global climate.

E. The Theory of Plate Tectonics

The movement of tectonic plates creates topography and reconfigures land and water areas around the planet over millions of years. Climate and atmosphere-ocean circulation patterns may be impacted, both locally and globally. The geography of the oceans is determined by the positions of the continents, which in turn affects the patterns of ocean circulation. The positions of the seas have a significant impact on the global climate because they regulate the movement of heat and moisture around the planet. Another significant factor is continent size. The seas' ability to stabilize temperature means that annual temperature changes are typically smaller along the shore than they are inland. As a result, a larger supercontinent than multiple smaller continents or islands will have a greater area with a strongly seasonal climate.

Self-Evaluation Task 2

Name four causes of climate change and explain them.

1.4 The Impact of Climate Change

We are just starting to learn how ecosystems and human systems including agriculture, coastal communities, transportation, and healthcare infrastructure will be impacted by climate change. Even within a particular region, there will be winners and losers from the effects of climate change, but overall, it

is anticipated that the losses would greatly exceed the gains. It will be harder for natural and human systems to adjust without negative consequences the faster and larger the changes in climate. Regrettably, the areas least able to adapt are frequently those that would be most negatively impacted. Millions of people would be forced to relocate if sea levels rise by roughly 40 inches (1 meter), with Bangladesh, one of the world's poorest countries, predicted to lose 17.5% of its land. Similar risks of increasing floods and susceptibility to storm surges may affect a number of islands in the Indian and South Pacific oceans. Freshwater supplies, vegetation, and animals will probably be at danger due to coastal flooding. Local agriculture and tourism may face serious obstacles.

The United States and many other developed nations are likewise under danger. Rich countries are more likely to use research and technology to predict, reduce, and prepare for the effects of climate change, including challenges to agriculture and sea level rise. Revision of building rules in coastal areas or the creation of new agricultural technologies are examples of adaptations. The rich world will have to help the poor countries become better equipped to handle the problems of climate change adaptation.

Human health will probably be impacted by climate change in the future. Heat stress, elevated air pollution, and food shortages brought on by drought or other agricultural stressors are some possible effects. Additionally, the transmission of infectious diseases might be impacted by climate change. The lifecycles of many disease pathogens and carriers can be influenced by temperature, precipitation, and humidity, which can change the timing and severity of disease outbreaks. For instance, some research suggests that because of the expansion of mosquito habitat and range, global temperature change may cause a significant rise in the transmission of malaria.

Self-Evaluation Task 3

Determine any effects that climate change may have nearby.

1.5 Actions that can be Taken to Lower the Amount of Greenhouse Gases in the Atmosphere

Even if there are still unresolved issues, there is currently enough scientific evidence on climate change to support action to lower greenhouse gas concentrations in the atmosphere. The effects of current quantities of greenhouse gases on climate change are expected to last well beyond the 21st century and may even accelerate because carbon dioxide and certain

other gases have the ability to linger in the atmosphere for decades, centuries, or longer. In the future, stabilizing their atmospheric abundances and dealing with increasingly severe repercussions will be considerably more difficult if net greenhouse gas emissions are not significantly reduced.

Governments have shown they are capable of cooperating to lessen or even reverse the detrimental effects of human activity on the environment. The successful global initiative to phase out the use of chlorofluorocarbons (CFCs) in aerosols and refrigerants, which were destroying the ozone layer protecting Earth, is a prime example. There isn't a single solution available right now to stop global warming in the future. Policy Implications of Greenhouse Warming, published in 1992, discovered that a variety of potentially affordable technology solutions exist to aid in the stabilization of greenhouse gas concentrations. Decisions made on a personal, governmental, and global level may have an effect. A few examples include cutting back on driving, controlling emissions, and exchanging energy-related technologies.

1.6 Conclusion

We can conclude from this unit that the average weather over extended periods of time is referred to as the climate. In addition to intricate interactions between the air, water, land, ice, and living things, variations in solar energy also have an impact on the climate. The climate has evolved with the earth over billions of years. The greenhouse effect is one aspect of the planet's climate. The earth's surface and lower atmosphere are warmer as a result of this impact than they otherwise would be.

1.7 Recap

This section has covered a thorough overview of the science behind climate change, including its sources, impacts, historical evolution, and strategies for lowering greenhouse gas emissions.

1.8 Short Questions for Revision

1. What factors contribute to the changing global climate?

2. Describe the different consequences of climate change.

3. What steps can we take to cut back on greenhouse gas emissions?

CHAPTER 2

CLIMATE CHANGE MODELS

2.0 Preamble

Understanding the natural phenomena that shape the climate and forecasting the results of their interactions and changes are the goals of climate change models. Modeling climate change necessitates some simplifications since these interactions function across various space-scales and have varying reaction timeframes. While deep ocean systems have timescales of several hundred years, and those associated with ice sheets can reach thousands of years, air processes, for instance, have timescales of hours or a few days. As a result, the range of time periods taken into consideration and the number of distinct processes incorporated determine the variety of climate models. The constraints of computational resources necessitate a trade-off amongst these features. Since models are created with certain goals in mind, they ought to be assessed according to those criteria. The basic processes of a precise process that may be obscured by the intricacy of an elaborate model can frequently be explained by a fundamental model.

2.1 Desired Learning Objectives (DLOs)

After completing this chapter, the students ought to be capable of:

(i) The idea of feedback in all its forms and its significance in examining and modeling climate;
(ii) The processes through which climate varies over extended and shorter time periods;
(iii) The contribution of forcing agents, either natural or man-made;
(iv) The primary models created to model climate, its historical variations, and its anticipated future changes.