

Climate Change Management

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Uday Chatterjee *Editors*

Climate Crisis, Social Responses and Sustainability

Socio-ecological Study on Global
Perspectives

 Springer

Climate Change Management

Series Editor

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*Dedicated to
Young Scholars in the Field of Atmospheric
Science, Climatology, Environmental
Science, Hazard and Disaster Management,
Geography, Social Science and Sustainability
Science and Policy Makers*

Foreword



The book *Climate Crisis, Social Responses and Sustainability: Socio-ecological Study on Global Perspectives*, edited by Uttam Mukhopadhyay, Subhasis Bhattacharya, Pradip Chouhan, Suman Paul, Indrajit Roy Chowdhury, and Uday Chatterjee, is an important source of knowledge and insight in light of the challenges posed by climate change, inequality, and environmental harm. This book aims to enhance our comprehension of the intricate relationship between human societies and the environment by working collaboratively.

The book is divided into four parts, each offering valuable insights into different aspects of the climate crisis. In Part I, readers are introduced to the primary themes and goals of the book, providing a thorough understanding of the social and ecological issues we face. Part II examines ecological perspectives on the climate crisis, including the impact of rapid urbanization on microclimates, the vulnerability to natural disasters, and the response of agricultural systems to climate change. By conducting thorough research and analyzing data, these chapters reveal the complex connections between human actions and the environment, emphasizing the importance of sustainable practices in environmental management and urban development. In Part III, the book delves into sociological perspectives, exploring how the

climate crisis intersects with social justice, health, and migration. These sections explore the psychological impact of climate anxiety and the socioeconomic effects of disease outbreaks. They highlight the significance of implementing comprehensive approaches that prioritize human welfare and fairness in combating climate change. Part IV of the volume scrutinizes sustainable initiatives that aim to address the climate crisis by considering the sustainable development goals (SDGs). These chapters provide practical tips for creating climate-resilient communities and supporting sustainable livelihoods by utilizing indigenous knowledge, community resilience, and new adaptation strategies. As I contemplate the extensive research presented in this volume, I am conscious of the significant obstacles we face in our shared endeavor to address the climate crisis. However, despite these challenges, there is cause for hope. The diversity of perspectives and innovative solutions showcased in this book demonstrate how people can remain resilient, imaginative, and united in the face of adversity.

I commend the editors and contributors for their committed efforts to enhance understanding and encourage discourse on this pressing issue. I sincerely hope that this updated compilation will motivate individuals to continue prioritizing sustainability, equity, and the well-being of our planet, as we strive to construct a fairer and more adaptable world for future generations.



March 2024

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Preface

Climate change is apprising deeply since the intervention of human involvement, and it creates several challenges and issues seeking the global crisis which have been assumed the reciprocal impact on society as well as on the ecology in the global perspective. Issue of climate change turns over the communities into more vulnerable and they are facing several disproportionate challenges in terms of extreme weather events such as extremity of flood, unprecedented impact on ecosystem and human well-being too, incidence of natural as well as anthropogenic disaster and several mountable effect such as climate crisis and agricultural responses, interlinking relation between climate change and urban environmental issues, most importantly several discussion seeking to incorporate in this proposed book about the transformation of ecological adaptation to climate crisis for sustainable development in connection with SDGs. Moreover, society and community are some of the underlying platforms which might be responded positively due to this climate crisis issue, it brings the impact on human health and well-being, several impacts must be highlighted on the mental as well as physical health, and it leads to food security issue due to inadaptability case of cropping pattern and diversification. Several studies highlighted the burning issues like social stress which leads to migration in the global perspective. Therefore, issues of climate crisis outbreak the poverty and drought as the human adaptability are not in a position to balance to resolve the environmental crisis, which leads to search alternative livelihood options to sustain in the society. Climate change also creates extreme phenomenon like outbreak of diseases which leads to occurrence of epidemic and pandemic diseases globally, crisis of climate also decline the patches of green space and it creates a reciprocal relationship with the changing phenomenon of climate change and ecosystem services. The report of Intergovernmental Panel on Climate Change (IPCC) has noted the fact that resolving the climate crisis issue that brings the principles of procedural and meaningful justice which leads to sustainable development outcomes, in this connection measures and policies should be expanded for the beneficiaries of the society as well as communities too. In addition to changeable phenomenon of climate crisis, addressing the climate resilience action plan and disaster risk reduction (DRR) statue must be implemented in connection with community participation, collaborative programs with

the administration, meaningful innovations, and technical assistance to resolve the climatic crisis must be judgmental discussion in the present-day context. In connection to implement the mitigating plan, long-term impact assessment with sustainable solutions touching the SDGs is more relevant to discussion which would create the backbone of the proposed theme of the book. Therefore, this kind of comprehensive theme has not been discussed yet, which is more meaningful to bring the policy measures with community outlook.

Climate crisis leads to several socio-ecological issues which need to be discussed with some empirical case studies from the contextual global evidences. Climatic crisis generates several social responses which are associated with mitigating issues in addition to sustainable development goals. Under these circumstances, several loopholes interlinked with climatic crisis need to be exposed in the present-day context. The books cover climate change holistically, including global and regional scales, ecosystems, agriculture, energy, and sustainability. This book also addresses the variety of challenges associated with climate change, along with possible solutions. Climate Change, Community Response and Resilience focuses on recent climate change research to help researchers and graduate students in natural resource management, ecological vulnerability, landscape ecology, social engineering, environmental science and management, and sustainability get up to speed on the science of climate change so far and establish a baseline for how to effectively move into the future. This book explores the effects of climate extremes as well as disaster risk reduction measures. This book also assesses climate change policies and initiatives, as well as provides insights from independent assessments of the major international organizations that promote climate action in developing nations. It will appeal to students and instructors at both undergraduate and graduate levels, especially in programs that promote multi-disciplinary and trans-disciplinary study of contemporary complex issues

Additionally, this book aims to provide an interdisciplinary understanding of the issues mainly from the lenses of geography, economics, and sociology as well as environmental studies too. Given the focus of this study, it is believed that an approach that harmonizes the cognitive domain from different discipline is appropriated. A combination of chapters using qualitative as well as quantitative methods also made this book exclusive from others. We believe that this edited volume will surely contribute the knowledge domain with some relevant chapters' discussion in the contemporary time and lead to reduce the gap of knowledge.

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Part I
Introduction

Chapter 1

Climate Crisis Impact on Ecosystem Services and Human Well-Being



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Abstract Ecosystem services encompass a broad spectrum of benefits to human society, making a substantial contribution to human well-being. Any disturbances in the ecosystem directly affect the services they offer, thus impacting human welfare and endangering the essential requirements for human survival. Therefore, comprehending how climate change affects these services and human society is of paramount importance in addressing the issue. The potential negative outcomes of climate change can lead to substantial global socio-economic and environmental issues. This chapter, therefore, explores the global implications of climate change on ecosystem services and human welfare. A thorough review of existing research will improve our comprehension of the complex relationship between ecosystem services, climate change, and their influence on human well-being. This knowledge will equip decision-makers with essential insights for devising critical measures to mitigate the potential threats.

Introduction

Climate change constitutes an omnipresent and burgeoning worldwide peril to the integrity of biodiversity and the stability of ecosystems (Weiskopf et al. 2020). Human actions, largely due to the emission of greenhouse gases, have unquestionably led to global warming, raising global surface temperatures by 1.1 °C above pre-industrial

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levels between 2011 and 2020. The global emission of greenhouse gases has consistently increased from 2010 to 2019, with variations in past and present contributions originating from unsustainable energy practices, changes in land use, lifestyle decisions, consumption, and production patterns across different regions, both internationally and within nations, and at the individual scale (IPCC 2023). Ecosystem Services (ESs) refer to the direct and indirect advantages provided by ecosystems for human well-being and survival. Ecosystem valuation is an approach used to ascribe a financial value to an ecosystem and its vital goods and services, often referred to as Ecosystem Service Value (ESV) (Sannigrahi et al. 2019). Costanza et al. (1997) assessed the present economic worth of 17 ecosystem services across 16 biomes, drawing upon existing research findings and a limited number of original calculations. The estimated total value of the entire biosphere, much of which exists beyond conventional market transactions, falls in a range of US\$16–54 trillion annually, with an approximate average of US\$33 trillion per year. It's important to note that this estimate is a conservative baseline, given the inherent uncertainties involved. To put this in perspective, the global gross national product is approximately US\$18 trillion per year. The cumulative impacts of human-induced climate change, along with other human-related pressures like changes in land use, the spread of invasive species, and the growing global population, will lead to unprecedented consequences for human well-being (Whitmee et al. 2015).

Ecosystem management endeavours aimed at optimizing the yield of a single ecosystem service frequently lead to significant reductions in the delivery of other ecosystem services (Bennett et al. 2009). An inadvertent outcome of human cultivation and alteration of ecosystems has been unanticipated or adverse decreases in various other services provided by ecosystems. Globally, this phenomenon has led to an increase in specific services like food and timber production while simultaneously observing a reduction in the majority of other services, including flood control, preservation of genetic resources, and pollination (Millennium Ecosystem Assessment 2005). A comprehensive global assessment of these transformations has disclosed that more than 60% of the services or societal advantages furnished by biotic systems have been eroded due to human actions, with the most substantial depletion occurring within the last half century (Millennium Ecosystem Assessment 2005). Hua et al. (2021) conducted a research study in the Tibetan Plateau of China, wherein they examined the responsiveness of ecosystem services to historical climate variations and projected the possible impact of a global crisis on future ecosystem service vulnerability. Their specific objectives included the assessment of spatial patterns and long-term tendencies in primary ecosystem services, the quantification of how susceptible these services are to climate fluctuations, and an investigation into how ecosystem services may be affected across various prospective climate scenarios. Ecosystem services have the capacity to support both mitigation and adaptation initiatives by extending their contribution (Locatelli 2016). Each year, terrestrial ecosystems capture about 3 billion metric tons of atmospheric carbon through net growth, constituting 30% of human-induced CO₂ emissions (Canadell and Raupach 2008). Effectively governed ecosystems can assist societies in adjusting to present climate risks and forthcoming climate shifts by furnishing a variety of ecosystem services

(Pramova et al. 2012), local climate regulation in agriculture and cities, the preservation of coastal regions through land stabilization and the absorption and dissipation of wave energy, the protection of watersheds through groundwater recharge, and preventing soil erosion (Locatelli 2016).

Climate change is amplifying the intensity of global disasters and extreme climate conditions, exerting particularly disastrous impacts on developing nations and communities with limited resources. Immediate consequences, such as gradual environmental shifts, elevated temperatures, and natural catastrophes, are expected to give rise to subsequent effects, including social and economic pressures, population displacement, and conflicts (Weissbecker 2011). Climate change primarily affects human well-being by disturbing the ecosystem services furnished by nature. The migration of mosquitoes due to global warming poses a health hazard in numerous nations. Malaria, the most widespread mosquito-borne illness, has been a long-standing threat to nearly 50% of the global population, resulting in over 200 million documented cases in 2014 (WHO 2016). Norman Myers, a scholar from Oxford University, provided estimates for the long-term displacement of people directly attributable to climate change. According to him, with the onset of global warming, up to 200 million individuals may experience the adverse effects of disruptions in monsoon systems and other rainfall patterns, prolonged and severe droughts, as well as rising sea levels leading to coastal inundation (Myers 2005). The economic consequences of the climate crisis are multifaceted and wide-ranging. When the global average temperature increases by 2.5 °C, the economic well-being of an average individual would be akin to a decrease in income of about 1.3%, as suggested by the average of 11 impact assessments for this 2.5 °C warming scenario (Tol 2018). These challenges will result in the disturbance of physical, biological, economic, and environmental aspects of global society, consequently affecting human well-being. Existing research demonstrates a significant gap in the literature regarding the comprehensive integration of ecosystem services and climate change, and the multifaceted connections between these vital systems.

This chapter addresses the impact of the climate crisis in a more comprehensive and integrated way. The primary objective of this chapter to deepen understanding of the complex interplay between ecosystem services and climate change, specifically analysing the consequences of this interaction for human well-being. It recognizes the significance of the interconnectedness of ecosystem services and societal welfare. In order to achieve effective solutions, it is imperative to possess a comprehensive understanding of the interconnections and interdependencies among various elements. By considering the association between the ecosystem and human beings, the chapter presents an innovative and collaborative strategy to address the complexities presented by the global climate crisis. The chapter aims to study the distinct ramifications of the climate crisis on human wellbeing. Overall, the chapter's novelty stems from its all-encompassing, interconnected, and multi-faceted approach, which acknowledges the interdependencies among ecosystems, human welfare, and the consequences of climate change and promotes sustainable development. It also delivers a case study of ecosystem services assessment in a Himalayan watershed using the InVEST-SDR model.

Climate Change

Climate change refers to enduring transformations in temperature regimes and meteorological patterns. These alterations may manifest as inherent responses to variations in solar irradiance or consequential volcanic outbursts. Nevertheless, since the 1800s, anthropogenic activities have assumed the paramount role in instigating climate change, mainly originating from the burning of fossil fuels, specifically coal, oil, and natural gas (United Nations 2023). It is commonly recognized that human-induced climate change is poised to inflict deleterious consequences upon numerous individuals, particularly those who are socioeconomically marginalized. Specifically, it is anticipated to culminate in inundations, heightened thermal discomfort, nutritional instability, arid conditions, and augmented susceptibility to maladies transmitted through water and vectors (Caney 2015). Human-induced emissions of greenhouse gases (GHGs) and other radiative forcing agents have resulted in a global average temperature increase of approximately 1.2 °C (Fig. 1.1) by the year 2020 (World Meteorological Organization 2020). The Arctic region is presently experiencing warming in its oceanic and terrestrial aspects, along with an increased frequency of extreme heat events. Similarly, the Antarctic Peninsula and specific regions of West Antarctica have demonstrated significant warming patterns. Forecasts suggest that the Arctic, Antarctic Peninsula, West Antarctica, and certain parts of East Antarctica are anticipated to undergo continued warming at a rate surpassing the global average (IPCC 2021). To mitigate the repercussions stemming from additional warming (IPCC 2019), the signatories of the Paris Agreement reached a consensus to constrain the rise in global temperatures to a level significantly lower than 2 °C, with a dedicated commitment to endeavour towards limiting it to 1.5 °C. To facilitate this goal, a periodic global stocktake process has been established to evaluate the requisite reductions in emissions at intervals of five years (Terhaar et al. 2022).

Climate change represents the quintessential exemplar of externalities on a global scale (Tol 2009). The quantifiable and monetizable consequences of climate change encompass its effects on agriculture, forestry, water resources, coastal areas, energy utilization, air quality, and human well-being (Tol 2008). Air quality exhibits a significant dependence on meteorological conditions, rendering it sensitive to the influence of climate change. Studies employing General Circulation Models (GCMs) in conjunction with Chemical Transport Models (CTMs) indicate that climate change is poised to impact particulate matter (PM) concentrations in regions characterized by pollution by an estimated range of 0.1–1 $\mu\text{g m}^{-3}$ in the forthcoming decades. Furthermore, the escalating prevalence of wildfires, attributed to climate change, has the capability to emerge as a progressively important source of PM pollution (Jacob and Winner 2009). The study conducted by Marshall and Randhir (2008) reveals that the watershed's hydrological dynamics, including water patterns and fluxes, were observed to undergo notable shifts due to the effects of snowmelt and evaporation. Climate scenarios have brought about alterations in watershed processes that have substantial implications for both the volume and characteristics of water over the study duration. These alterations manifest as reduced annual stream flow, heightened