Global Warming and Climate Change: The Role of CFCs and Links to Social Issues

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Abstract

Climate change and global warming represent unprecedented challenges to planetary systems and human well-being, primarily driven by anthropogenic greenhouse gas emissions since the Industrial Revolution. Chlorofluorocarbons (CFCs), once widely used for their stability and industrial versatility, occupy a critical position in this crisis. Beyond their well-documented role in stratospheric ozone depletion, CFCs act as highly potent greenhouse gases with long atmospheric lifetimes, contributing significantly to global warming. Despite the success of international measures such as the Montreal Protocol, the persistence of CFCs continues to affect climate processes, linking ozone loss with warming. Consequences include rising temperatures, sea-level rise, biodiversity decline, and intensified extreme events, accompanied by health burdens such as heat stress, respiratory disorders, and the spread of vector-borne diseases. Climate change magnifies social inequalities, disproportionately impacting low-income groups, women, children, and marginalized communities, who face greater exposure to disasters, displacement, and economic insecurity. This article underscores the interconnectedness of environmental degradation and

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Anu Books
Social Issues: Trends and Analysis
DOI: https://doi.org/10.31995/Book.AB348-O25.Chapter5
Plagiarism Report: 05%

social inequities, advocating for integrated, equity-oriented mitigation strategies. Demand-side reductions, sustainable consumption, gender equity, and inclusive policymaking are essential to address the dual legacy of CFCs and climate change, fostering resilience and securing a just, sustainable future.

Keywords

Climate change, Global warming, Chlorofluorocarbons (CFCs), Ozone depletion, social inequality, Environmental justice

Introduction

One of the biggest problems that threatens life as we know it is a consequence of human greed and is infamously known as Climate change and Global warming, which have altered Earth's atmospheric composition and energy balance. Global warming can be simply defined as the increase in Earth's average surface temperature due to the accumulation of greenhouse gases (GHGs), while climate change encompasses broader shifts in weather patterns, sea levels, and ecosystems. Since the transformative industrial revolution, which took the world by storm, anthropogenic emissions from fossil fuel combustion, deforestation, and industrial processes have accelerated these changes, leading to unprecedented temperature rises. The Intergovernmental Panel on Climate Change (IPCC) has confirmed that the rate of warming is faster now than at any point in the past millennium, with grave consequences on biodiversity, agriculture, and human societies**.**

Chlorofluorocarbons (CFCs) were synthetic compounds that transformed industries with their stability and non-toxic nature. They were ubiquitously used in refrigeration, aerosols, and foam production, and play a dual role in this crisis. Being innately inert, they can persist for decades and thereby deplete the stratospheric ozone layer, allowing harmful ultraviolet (UV) radiation to reach the Earth's surface. They also act as greenhouse gases, contributing to global warming **(Ko et al., 1993)**. While attempts like "The Montreal Protocol" of 1987 managed to remove CFCs to protect the ozone layer, their long atmospheric lifetimes mean lingering effects on climate (**MIT Climate Portal, 2023).**

Moreover, climate change is not just a threat to the planet but also to our human society as it exacerbates social inequalities, disproportionately affecting low-income populations, women, and marginalized communities through increased vulnerability to extreme weather, health risks, and economic disruptions **(Islam & Winkel, 2017).** This article explores the interwoven web of issues like global warming, the specific contributions of CFCs, and mostly how social life, which we feel is exempt from environmental issues, is not so isolated at all.

The imperativeness of the issue is highlighted by evidence from organizations like NASA, which documents unequivocal warming driven by human activities, including rising sea levels, shrinking ice sheets, and intensified extreme events (**NASA, 2024).** As temperatures rise, the poorest nations and communities bear the brunt, amplifying cycles of poverty and inequality (**Viveros-Uehara, 2023)**. By linking these environmental and social dimensions, this article aims to advocate for equitable policies that address both causes and consequences.

Understanding Global Warming and Climate Change

Global warming is fundamentally a byproduct of the enhanced greenhouse effect, where GHGs like carbon dioxide (CO2), methane (CH4), and nitrous oxide (N2O) trap heat in the atmosphere, preventing it from escaping into space (**United Nations, n.d.)**. Fossil fuel burning for electricity, heat, and transportation accounts for over 75% of GHG emissions, with deforestation and industrial processes contributing significantly (**United Nations, n.d.)**. Since the Industrial Revolution, CO2 levels have surged from about 280 parts per million (ppm) to over 420 ppm, leading to a 1.1°C increase in global average temperature above pre-industrial levels (**NASA, 2024)**.

The consequences are affecting several walks of life, be it environmental-centric, food production and quality of life. Hotter temperatures have intensified heat waves, droughts, and wildfires, while warmer oceans fuel more severe storms and hurricanes (United Nations, n.d.). Sea levels have risen by about 20 cm since 1900 due to thermal expansion and melting ice sheets, threatening coastal communities (**NASA, 2024**). Ecosystems suffer from biodiversity loss, with species extinction rates 1,000 times higher than natural backgrounds, driven by habitat shifts and extreme weather**.** Agricultural productivity declines as soils degrade and water resources dwindle, exacerbating food insecurity (**Rossati, 2017).**

The health impacts that are a consequence of climate change are dire, including increased mortality from heat-related illnesses, respiratory issues from air pollution, and the spread of vector-borne diseases like malaria and dengue as warmer climates expand mosquito habitats**.** For instance, a 2-3°C temperature rise could increase malaria risk by 3-5%, while floods heighten outbreaks of leptospirosis and cryptosporidiosis (**Rossati, 2017).** Mental health is also affected, with natural disasters linked to higher rates of anxiety, depression, and even civil conflicts**.**

Climate change is not uniform; it amplifies regional disparities. The Arctic warms twice as fast as the global average, leading to permafrost thaw and methane releases that further accelerate warming. CO2, which gets absorbed in the oceans, causes acidification, harms marine life, including coral reefs vital for fisheries**.** These changes feed back into the climate system, creating tipping points like Amazon dieback or ice sheet collapse, which could lock in irreversible warming.

The Role of Chlorofluorocarbons (CFCs)

CFCs, synthetic compounds introduced in the 1930s, were hailed for their stability but later revealed as environmental hazards. They deplete stratospheric ozone by releasing chlorine atoms that catalyse ozone destruction, but they also trap infrared radiation, contributing to global warming (**Ko et al., 1993**). CFCs absorb heat in spectral windows not covered by CO2 or water vapour, making them exceptionally potent GHGs, with global warming potentials (GWPs) ranging from 4,750 to 14,400 over 100 years (**MIT Climate Portal, 2023).**

Despite low concentrations—about four parts per billion—CFCs contribute around 16% of the warming effect from CO2 emissions (MIT Climate Portal, 2023). Specific compounds like CFC-11 and CFC-12 account for 10% of CO2's warming impact, with lifetimes of 55-140 years ensuring persistent effects post-phaseout (**MIT Climate Portal, 2023)**. Projections indicate that under substitution scenarios, halocarbons like CFCs and their alternatives (HCFCs, HFCs) could contribute 4-10% of total greenhouse warming by 2100, with uncontrolled growth doubling this share (**Ko et al., 1993).**

The Montreal Protocol has curbed CFC emissions, aiding ozone recovery and mitigating climate impacts by reducing equivalent CO2 emissions. However, unexplained increases in some CFCs raise concerns, potentially from illegal production or bank releases during natural hazards. CFCs' dual role links ozone depletion to climate, as reduced ozone allows more UV radiation, altering atmospheric circulation and amplifying warming in polar regions.

Interactions Between Ozone Depletion and Climate Change

Ozone depletion and climate change interact synergistically, with CFCs at the nexus. Stratospheric ozone loss increases UV-B radiation, affecting ecosystems and human health, while GHGs influence ozone dynamics. The Antarctic ozone hole, exacerbated by CFCs, has led to higher UV indices, causing photodamage to plants and animals. Climate change modifies these effects; warming reduces snow cover, increasing UV exposure in polar regions**.**

Stratospheric cooling from greenhouse gases is reported, which can enhance ozone depletion in the Arctic, leading to events like the 2020 depletion that influenced Eurasian weather patterns. Ozone depletion drives Southern Hemisphere climate shifts, such as altered precipitation and sea ice loss, explaining over 50% of subtropical changes. In aquatic systems, increased UV from depletion affects phytoplankton, but climate-driven runoff shields pathogens, potentially increasing disease risks.

Terrestrial impacts involve UV-induced plant stress, compounded by extreme events like wildfires, reducing biodiversity. Biogeochemical cycles are altered, with UV photo degradation releasing GHGs from litter, amplifying warming (Neale et al., 2022). The Montreal Protocol's success in reducing ODS has averted additional warming, but high GHG scenarios could increase future UV in the Arctic (**Neale et al., 2022).**

Social Issues and Inequalities

Climate change deepens social inequalities through a vicious cycle where initial disparities increase exposure, susceptibility, and recovery challenges for disadvantaged groups. Low-income populations, often in hazard-prone areas like floodplains, face higher risks due to poor housing and limited resources **(Islam & Winkel, 2017).** Economic inequality worsens health outcomes, with half the world's population lacking resilient health care, leading to higher morbidity from climate hazards.

Marginalized groups, including women, children, and ethnic minorities, suffer disproportionately; for example, Hurricane Otis in Mexico highlighted gaps in health services for 323,000 children (**Viveros-Uehara, 2023**). Climate impacts increase poverty and displacement, with 23.1 million people displaced annually by weather events. In developing countries, this exacerbates migration and conflicts**.**

Elitists have always thrived on consumption and drive emissions through consumption, apathetic towards those who bear costs, increasing global inequality. Studies show climate impacts widen income gaps, disproportionately affecting the disparities globally. (**Islam & Winkel, 2017**). Health injustices arise from inadequate adaptation, with calls for human rights-based approaches to ensure equitable access (**Viveros-Uehara, 2023**).

Mitigation Strategies and Social Aspects

Mitigation must integrate social dimensions, focusing on demand-side reductions like efficient energy use and lifestyle shifts, which can cut emissions by 40-70% by 2050. Behavioural changes, nudged by policies and norms, empower communities, with gender equity enhancing outcomes. Indigenous leadership and social movements drive equitable transitions, addressing energy, poverty ..

Conclusion

Addressing the pandemic of global warming that is rotting away at the very heart of the planet requires tackling the legacy of CFCs', as well as undoing the damage incurred by our forefathers, and changing our mindset and belief systems, through inclusive policies. Integrated action can break vicious cycles, fostering resilience and justice.

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