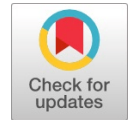


A Study of Greenhouse Gas Emissions in Afghanistan

Nasrin Faqiri, Ahmad Fawad Faqiri



Abstract: Afghanistan stands as one of the leading contributors to global greenhouse gas emissions, yet it remains one of the most susceptible nations to the adverse impacts of climate change. This vulnerability is underscored by recurrent episodes of droughts, floods, and landslides, exacerbated by the nation's exposure to natural disasters. However, the crux of this vulnerability lies not solely in exposure but also the heightened sensitivity of the Afghan populace to these calamities. In light of Afghanistan's poverty and relatively underdeveloped status, any immediate expectation of curtailing greenhouse gas emissions appears unrealistic and unjust. The nation faces a paradoxical challenge balancing burgeoning emissions, inevitable amid developmental strides, with safe-guarding the interests of the impoverished populace. The heart of this challenge lies in ensuring that the trajectory of rising emissions aligns with uplifting the socioeconomic status of the vulnerable. This research explores the intricate relationship between Afghanistan's greenhouse gas emissions, its developmental trajectory, and the population's vulnerability to climate change. By scrutinising these facets, it aims to uncover pathways that reconcile developmental needs with environmental consciousness, with a paramount focus on protecting the most marginalised against the dire consequences of climate change.

Keywords: Drought, Flood, Greenhouse Gases, Vulnerability.

I. INTRODUCTION

Afghanistan, amidst its complex socio-political landscape and economic challenges, stands as a noteworthy contributor to global greenhouse gas (GHG) emissions. Despite being among the top emitters, this nation finds itself uniquely vulnerable to the adverse impacts of climate change [1]. The interconnectedness between Afghanistan's emission patterns and its susceptibility to climatic events, such as droughts, floods, and landslides, highlights a critical nexus that warrants further investigation. This study aims to investigate the intricate relationship between Afghanistan's greenhouse gas emissions and its susceptibility to climate change-induced disasters. The vulnerability of the Afghan population to environmental hazards extends beyond mere exposure and is rooted in multifaceted dimensions that encompass socioeconomic, cultural, and political aspects. Understanding this interplay is pivotal in devising effective strategies to mitigate the detrimental effects on the country's

populace.

Greenhouse gas emissions have become a significant concern globally due to their contribution to climate change and its associated impacts. Understanding the sources and trends of greenhouse gas emissions in specific regions is crucial for developing effective mitigation strategies. This literature review aims to provide an overview of research findings related to greenhouse gas emissions in Afghanistan. Riahi et al. (2011) present the Representative Concentration Pathway (RCP) 8.5 scenario, which represents a high-emissions trajectory of greenhouse gases. This research finding suggests that Afghanistan's greenhouse gas emissions may follow a similar trajectory if appropriate mitigation measures are not implemented [2]. Riahi et al. (2017) provide an overview of the Shared Socioeconomic Pathways (SSPs) and their implications for greenhouse gas emissions. The study highlights the importance of considering socioeconomic factors in understanding and projecting future emissions. This research finding emphasizes the need to incorporate socioeconomic factors in analyzing greenhouse gas emissions in Afghanistan [3]. Mora et al. (2018) discuss the broad threat to humanity from cumulative climate hazards intensified by greenhouse gas emissions. The study emphasizes the need for urgent action to mitigate emissions and reduce the impacts of climate change. This research finding underscores the importance of addressing greenhouse gas emissions in Afghanistan to minimise the potential risks and hazards associated with climate change [4]. Stolaroff et al. (2018) analyse the energy use and life cycle greenhouse gas emissions of drones for commercial package delivery. The study highlights the potential environmental impacts of drone technology. This research finding suggests that assessing the emissions associated with emerging technologies, such as drones, can provide insights into the overall greenhouse gas emissions in Afghanistan [5]. Gillingham and Stock (2018) discuss the cost of reducing greenhouse gas emissions. The study highlights the economic implications of mitigation strategies. This research finding suggests that understanding the cost-effectiveness of mitigation measures can inform policy decisions in Afghanistan [6]. Sarkodie and Strezov (2019) examine the relationship between foreign direct investments, economic development, energy consumption, and greenhouse gas emissions in developing countries. The study highlights the importance of considering economic factors and energy consumption patterns when assessing greenhouse gas emissions in Afghanistan. This research finding suggests that economic development and energy consumption may be significant drivers of emissions in the country [7].

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Hertwich et al. (2019) review material efficiency strategies to reduce greenhouse gas emissions associated with buildings, vehicles, and electronics. The study emphasizes the importance of considering material efficiency in emission reduction efforts. This research finding suggests that adopting material efficiency strategies in Afghanistan's construction and transportation sectors can help reduce greenhouse gas emissions [8]. Lamb et al. (2021) provide a comprehensive review of trends and drivers of greenhouse gas emissions by sector from 1990 to 2018. The study identifies key industries that contribute to emissions, including energy, agriculture, and transportation. This research finding underscores the significance of sector-specific analysis in comprehending the sources of greenhouse gas emissions in Afghanistan [9]. Based on the reviewed research findings, there is a need for comprehensive and up-to-date data on greenhouse gas emissions and their vulnerability in Afghanistan.

The paper is organized around the theme of "Climate Change and Vulnerability to it in Afghanistan," where in it explores the greenhouse gas emissions and societal vulnerability in Afghanistan; Results and Discussion, where findings are presented and critically analyzed; and Conclusion, providing a comprehensive summary of the paper's key in sights and concluding remarks.

II. CLIMATE CHANGE AND VULNERABILITY TO IT IN AFGHANISTAN

This section provides a thorough analysis of greenhouse gas emissions in Afghanistan and their impact on temperature and precipitation patterns. It examines the consequences of climate change, including heightened vulnerability to droughts, floods, and associated risks. Moreover, it examines the social vulnerabilities in Afghan communities and highlights how climate change affects their structures and ability to adapt.

A. Emission of Greenhouse Gases

Afghanistan contributes approximately 0.05% of the global aggregate of greenhouse gas emissions. Over the past few decades, Afghanistan has witnessed a doubling of its greenhouse gas emissions since 1995. Comparative analysis depicted in Table 1 underscores that, except Tajikistan, Afghanistan's emissions register lower than those of all neighbouring countries [10].

Table I: Emission of Greenhouse Gases in Afghanistan and its Neighbours [10]

Country	Total GHG Emissions	Total GHG Percentage in the World
Tajikistan	22.83	0.04 %
Afghanistan	29.12	0.05 %
Turkmenistan	128.92	0.24 %
Uzbekistan	227.21	0.42 %
Pakistan	546.10	1.02 %
Iran	951.98	1.77 %
China	15684.63	29.16 %

In Afghanistan, greenhouse gas emissions differ greatly from global averages. While the energy and industrial sectors globally contribute nearly 60% of emissions, in Afghanistan, they account for only about 20%. Conversely, sectors such as agriculture, land use, and waste, which typically contribute

less than 20% of global emissions, collectively account for over half of Afghanistan's total emissions. This skewed distribution reflects the underdeveloped state of energy and industry in the country, as supported by the data in Figs. 1 and 2, which highlight the stark contrast between Afghanistan's emissions and global trends.

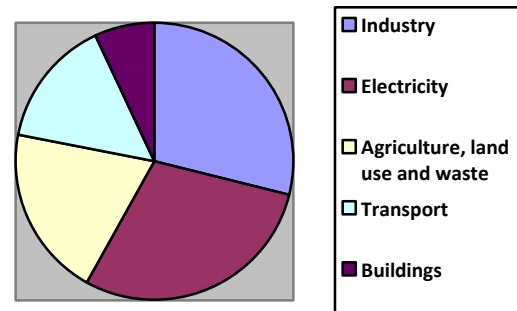


Fig. 1. Global Greenhouse Gas Emissions by Sector in 2022 [10]

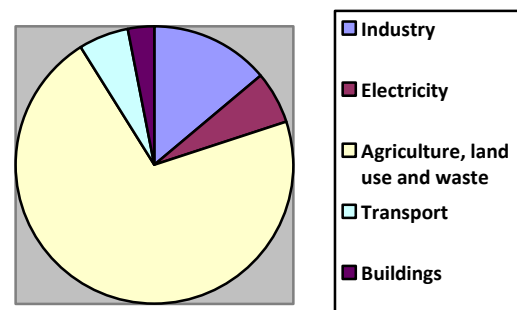


Fig. 2. Afghanistan Greenhouse Gas Emissions by Sector in 2022 [10]

As per the findings outlined by the Afghanistan National Environmental Protection Agency, projections indicate a significant increase in greenhouse gas emissions within Afghanistan. It is estimated that the total volume of greenhouse gas emissions is expected to surpass 50 million metric tons of carbon dioxide equivalent by 2030. This projection is visually represented in Fig. 3.

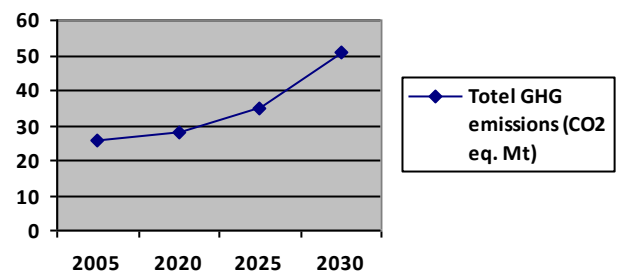


Fig. 3. Total GHG Emission

a. GHG Impact on Temperature in Afghanistan

In Afghanistan, there has been a discernible upward trend in average temperatures, as highlighted by the INC report, indicating an annual increase of 0.6°C since 1960, equivalent to 0.13°C per decade.

Projections for the future indicate a sustained trajectory of rising temperatures, with estimates forecasting an escalation ranging between 1.4 °C and 4 °C by the 2060s and a more pronounced increase spanning 2.0 °C to 6.2 °C by the 2090s. The Intended Nationally Determined Contribution (INDC) report delineates potential temperature scenarios, as illustrated in Fig. 4. An 'optimistic' outlook anticipates a 1.5°C rise by 2050 and an approximate 2.5°C increase by 2100. Conversely, a 'pessimistic' scenario portends a sharper ascent, projecting a 3°C temperature hike by 2050, culminating in a potentially alarming surge of up to 7°C by the close of the 21st century [11][12].

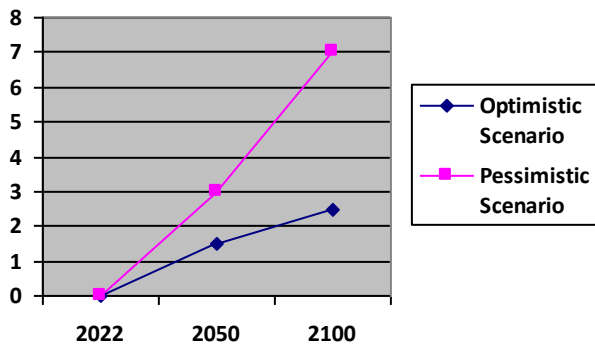


Fig. 4. Temperature Increases Projection by 2100 in Afghanistan

b. GHG Impact on Rainfall in Afghanistan

Since 1960, Afghanistan has experienced a marginal decline in average rainfall, registering a reduction of approximately 5.0 mm per month or 2% per decade. Recent assessments, notably by the Afghanistan National Environmental Protection Agency, corroborate this trend, particularly noting a slight decrease in spring rainfall. Additionally, Savij et al. (2009) have forecasted a diverse spectrum of rainfall variations spanning from a potential decline of -31% to an increase of +28% by the year 2090, projecting an annual average change ranging between -5% and -8%. However, it is crucial to recognise that Afghanistan's intricate topographical landscape signifies that localised responses to precipitation alterations are likely to vary significantly. Consequently, numerous regions may exhibit distinct patterns deviating from broader regional changes in rainfall dynamics [13].

The Intended Nationally Determined Contribution (INDC) does not indicate an overall global decline in rainfall but rather delineates alterations in precipitation patterns, notably observable in the northcentral and eastern highlands. The INDC anticipates a potential reduction of 5-10% in spring rainfall, offset by augmented precipitation during the fall and winter seasons. Nevertheless, the projected decrease in spring rainfall poses a substantial concern, particularly for the cultivation of the llama crop. This apprehension is further compounded by the concurrent rise in water evaporation rates due to increasing temperatures, which exacerbates the potential agricultural challenges associated with decreased spring precipitation.

c. GHG Impact on Droughts and Floods in Afghanistan

Drought, an adverse consequence of climate change predominantly observed in arid and semi-arid regions

worldwide, manifests uniquely in Afghanistan. Here, the occurrence of drought takes the form of recurrent local droughts that occur every three to five years, distinct from the countrywide drought cycles that recur at longer intervals of approximately 20 to 30 years. These different patterns of drought occurrence delineate the contextualized nature of aridity challenges faced by Afghanistan, shaping the frequency and scale of the resultant environmental and socioeconomic impacts within the region [14].

Drawing upon drought disaster data, the predominant occurrences spanning the years 1999–2001 and 2007/08 emerge as the most frequently documented events, occasionally extended to 1999–2002 and 2007–2010. Additionally, more localised drought incidences have been noted, including those in 1969, 1971–73, and 2006, contributing to the compendium of drought episodes within Afghanistan's historical record [15].

Afghanistan experiences periodic flash floods, primarily prevalent between February and June, with exceptions noted in the Kabul River region, where monsoon rainfall typically occurs in August and September. Areas unaffected by monsoon rains witness heavy rainfall and snow at the year's onset, leading to significant floods. River inundations during snowmelt periods are a recurring phenomenon, typically observed in June and July [16][17]. Approximately half of Afghanistan's population faces the threat of flooding, with an estimated 15% categorized as being at high risk of such events.

B. Social Vulnerability

Afghanistan's susceptibility to the impacts of greenhouse gases is evident across multiple domains. This vulnerability is apparent in several dimensions, notably in the realm of water resource accessibility, diminished agricultural yields, decreased livestock numbers, patterns of migration, constraints in obtaining potable water, conflicts arising from land access, increased indebtedness, compromised health outcomes, and challenges to educational access. These aspects collectively illustrate the intricate and wide-ranging ways in which Afghanistan's societal fabric is affected by and grapples with the ramifications of greenhouse gas-induced changes.

a. Fundamental Impacts of Unexpected Climate Events on Human Lives, and Strategies for Coping and Survival

In 2008, according to reports from the USDA Foreign Agricultural Service and the Ministry of Agriculture, Irrigation, and Livestock (MAIL) in 2009, insufficient rainfall and below-average snowfall resulted in a 40 to 55% decrease in wheat production in the country. Compared to the data from 2007, a normal year, the impact of the drought was significantly greater in dry land (a 58% decrease) than in irrigated land (a 16% decrease).

According to the 2004 FAO/WFP report on Afghanistan, the 2001 drought in Kandahar caused a 40% drop in wheat production compared to normal years, and fruit orchards decreased by 50-75%.

In 2004, water scarcity contributed to a 37% decline in wheat production. This scarcity also resulted in a 68% decrease in llama production and a 38% reduction in water-dependent agricultural products.

As the 2003 report by the Food and Agriculture Organisation (FAO) indicates, nomadic communities predominantly subsist on a livestock-based economy. These communities faced significant adversity during the severe drought that spanned from 1998 to 2002, as well as the subsequent water scarcity in 2004. The consequences of these environmental challenges were substantial, resulting in a loss of livestock ranging from 50 to 75% among nomadic groups.

The occurrence of drought amplifies the likelihood of temporary migration among affected populations. Simultaneously, the absence of dedicated studies examining the correlation between unforeseen climatic occurrences and migration complicates the assessment of the precise influence exerted by environmental pressures and unexpected climatic events on driving migration decisions.

During the 2011 water scarcity crisis, a substantial proportion of Afghan households (37%) encountered unexpected challenges in accessing potable water, primarily due to inadequate water accessibility. This contrasted starkly with the 18% average incidence rate observed in 2007.

In regions characterised by irrigated lands, the scarcity of water resources, often attributed to hydrological drought, exacerbates conflicts over the distribution and management of water bodies, such as canals and rivers, among communities situated upstream and downstream. Moreover, this scarcity occasionally exacerbates pre-existing tensions and animosities rooted in ethnic or political differences.

Afghan families turned to borrowing after selling assets during the 1998–2002 drought, resulting in high indebtedness for 60% of surveyed families by the end of the period. Risk practices like credit-based instruments worsened inequality, acting as exploitative tools [11].

Food insecurity in families can prompt parents to send their children to work, resulting in temporary absences from school. Parents often sacrifice their meals to support their families, risking their health as they bear the primary economic burden. The impact of these challenges due to climate pressures remains difficult to quantify.

III. RESULTS AND DISCUSSION

Afghanistan's vulnerability to climate change-induced risks has been starkly evident through our investigation. Analysis of historical climate data revealed an alarming trend of rising temperatures, with an annual increase of 0.6°C and a decade-wise rise of 0.13°C since 1960, far surpassing global averages. Concurrently, a notable reduction in average rainfall of approximately 5.0 mm per month, or 2% per decade, since 1960, exacerbates the risk of prolonged droughts, significantly impacting agriculture and water resources. The frequency and severity of extreme weather events, such as droughts occurring every 20 to 30 years and flash floods predominantly between February and June, highlight Afghanistan's susceptibility. River floods during June and July further compound the challenges, posing substantial risks to infrastructure, livelihoods, and public safety. Addressing these vulnerabilities requires urgent action, encompassing measures to mitigate greenhouse gas

emissions, enhance adaptive capacities, and implement resilient strategies.

Efforts to mitigate emissions, given Afghanistan's doubling of greenhouse gas emissions since 1995, are critical. Transitioning to renewable energy sources and sustainable development practices is imperative. Additionally, investments in infrastructure development, early warning systems, and empowering vulnerable communities through adaptive strategies are vital steps toward bolstering resilience. International cooperation and support remain essential in helping Afghanistan respond to climate change.

IV. CONCLUSIONS

In summary, the study on greenhouse gas emissions in Afghanistan highlights the country's vulnerability to climate change, characterised by rising temperatures, declining rainfall, and frequent extreme weather events. Afghanistan faces a critical juncture where mitigating greenhouse gas emissions is essential, yet challenging due to developmental needs and socioeconomic constraints. Urgent measures are necessary, focusing on transitioning to renewable energy sources, sustainable development practices, and bolstering adaptive capacities. Empowering vulnerable communities through infrastructure investments, early warning systems, and adaptive strategies is crucial. International cooperation is indispensable, necessitating collaborative efforts in technology transfer, capacity building, and financial aid to fortify Afghanistan's resilience. Addressing this conundrum requires a delicate balance between emission reduction and sustainable development to secure a more resilient and sustainable future for Afghanistan amidst the impacts of a changing climate.

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Availability of Data and Materials	Not relevant.
Authors Contributions	All authors have equal participation in this article.

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