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Climate Change Mitigation and Adaptation in Nepal and South Asia: Challenges, Progress, and Recommendations

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Abstract: This study examines the challenges and status of climate change mitigation and adaptation in South Asian countries, with a specific focus on Nepal. The study employs a purposive sampling approach, selecting countries based on the engagement of researchers in those regions and performing a comprehensive literature review. The analysis of the gathered literature provided valuable insights into the challenges of climate change mitigation and adaptation in South Asian countries, particularly Nepal. The study highlights the significant impacts of climate change on sectors such as agriculture, infrastructure, and coastal regions. However, it also acknowledges the progress made through the implementation of climate change mitigation and adaptation measures. Despite the progress, challenges remain in effectively addressing climate change, with current measures falling short of the ambitious targets set by the Sustainable Development Goals (SDGs) and the Paris Agreement. To address these challenges, the study recommends strengthening regional collaboration and knowledge sharing, prioritizing the adoption of renewable energy technologies, investing in climate-resilient infrastructure, promoting sustainable agricultural practices, developing comprehensive policy frameworks, exploring innovative financing mechanisms, and enhancing capacity and awareness.

Keywords: Climate change adaptation, Environment, Mitigation measures, Nepal, Resilience building, South Asia

Conflicts of interest: None

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1. Introduction

Climate change, characterized by long-term alterations in temperature and weather patterns due to increasing greenhouse gases in the atmosphere, is primarily caused by human activities (UN, 1992). The excessive concentration of greenhouse gases such as CO₂ and Methane leads to global warming, resulting in significant changes in climate (Wigley & Raper, 2001). If greenhouse gas emissions are not effectively controlled, there is a high probability that global temperatures will rise between 1.7°C and 4.9°C by 2100 (Wigley & Raper, 2001). The impacts of climate change include rising sea levels, melting ice, increased frequency of natural disasters, and changes in biodiversity (IPCC, 2014a; IPCC, 2014b; Oo, & Thin, 2022).

Reducing greenhouse gas emissions presents a significant challenge due to society's heavy dependence on

activities that produce these gases, particularly through the excessive use of fossil fuels (Broecker, 1975). Developing and underdeveloped countries, including those in South Asia, are particularly vulnerable to the adverse effects of climate change (UNDP, 2019). The most vulnerable groups, such as low-income countries and marginalized populations, often lack support from local governments and organizations (UNDP, 2019). Additionally, limited political will and challenges in international cooperation hinder the implementation of climate change mitigation and adaptation measures (Masson-Delmotte, 2018).

Although nature-based solutions to climate change have gained attention, there is still a knowledge gap regarding their effectiveness, implementation, and their societal implications (Kabisch et al., 2016). The impacts of climate change disproportionately affect vulnerable populations and ecosystems due to poverty, inadequate resources, and increased exposure to environmental disasters (Mal et al.,

2018) causing deaths (Figure 1). Hydroclimatic shifts, such as floods and droughts, significantly impact water, sanitation, hygiene, and health in urban areas (Caretta et al., in press).

To address the global challenge of climate change, the Sustainable Development Goals (SDGs) have been established, with SDG 13 focusing on climate action (UN, 2015a; UNDP, 2015; FAO, 2016). However, the current efforts outlined in the Intended Nationally Determined Contributions (INDCs) are insufficient to limit global warming to below 2°C, and additional private sector participation and funding are crucial (CEPAL). Achieving SDG 13 and other related goals requires transformative measures in various sectors, including food systems (Campbell et al., 2018; Tandon et al., 2022).

In Nepal, climate change mitigation and adaptation initiatives have faced obstacles such as a lack of transparent and adaptable policies, technological barriers, and conflicts between multi-sectoral organizations (Regmi & Bhandari, 2013). However, the country has also made significant policy efforts, including the establishment of the National Adaptation Programme of Action (NAPA) and the Climate Change Policy (Ojha et al., 2016). Nepal aims to transition from being a least developed country to a developing country while balancing climate change and development efforts (GoN, 2019).

Nepal has developed policies and frameworks under the United Nations Framework Convention on Climate Change (UNFCCC) to address climate-related risks and hazards. The National Climate Change Policy and National Framework of Local Adaptation Plan of Action (LAPA) have been endorsed by the Government of Nepal, aiming to improve livelihoods, promote low-carbon economic development, and enhance resilience through research and technology development. However, effective implementation of these policies remains a challenge (GoN, 2018).

This study explores the impacts of climate change in South Asian countries, with a particular focus on Nepal. By understanding the challenges faced in climate change mitigation and adaptation, valuable lessons can be drawn to improve future strategies and policies.

2. Materials and methods

In this study, a purposive sampling approach was employed to select South Asian countries based on the engagement of researchers in those regions. The researchers collaborated through a common platform facilitated by the Global Research Institute and Training Center (GRIT).

To gather relevant literature, online sources such as Google Scholar, Springer, Science Direct, CORE, ResearchGate, and Academia were accessed. Various keywords related to climate change adaptation and policies in specific countries were used for literature search, including "Climate Change Adaptation in Nepal," "Nepal National Climate Change Policy," "Climate Policy Pakistan," "Nepal SDGs target," "Bhutan Climate

Approaches," "Climate Approaches in Pakistan," "Climate Policy Afghanistan," "Climate Policy Sri Lanka," "Maldives Climate Adaptation Approaches," "Nepal Climate Change Policies," "Climate Policy in Nepal," "Climate Change Adaptation Bhutan," "India SDG target," and "Sustainable Development Goals."

The gathered online literature was then subjected to analysis to extract relevant information and insights related to the challenges of climate change mitigation and adaptation in South Asian countries, with a specific focus on Nepal. This methodology allowed for a comprehensive review of existing research, policies, and approaches related to climate change in the selected countries. By utilizing this approach, the study aimed to provide a comprehensive overview of the current status and challenges of climate change mitigation and adaptation in South Asia and derive lessons that can be applied to Nepal and other similar regions.

3. Results and discussion

3.1. Climate change issues in South Asia

According to the International Centre for Integrated Mountain Development (ICIMOD), Nepal is significantly impacted by climate change, particularly in the agriculture and hydropower sectors. The country's economy heavily relies on agriculture, and changes in temperature and precipitation patterns have resulted in crop failures and decreased yields. Nepal has implemented various climate change mitigation and adaptation programs, leading to several benefits. Notably, mountain communities have become more resilient to climate change impacts due to measures such as constructing climate-resilient infrastructure and promoting sustainable livelihoods. These initiatives have reduced the number of people affected by natural disasters by up to 30% (ICIMOD).

India has also implemented several climate change mitigation and adaptation programs, with renewable energy capacity being a notable benefit. The country has set a target to achieve 175 GW of renewable energy by 2022 and has made significant progress towards this goal. According to the Ministry of New and Renewable Energy, India's renewable energy capacity has increased by over 15 GW in the past year alone. This has not only reduced greenhouse gas emissions but has also lowered electricity costs and created employment opportunities in the renewable energy sector. India has developed policies such as the National Environment Policy, Prime Minister's Council on Climate Change, National Action Plan on Climate Change (NAPCC), Parliamentary Forum on Global Warming and Climate Change, Climate Change Action Programme (CCAP), and Indian Network for Climate Change Assessment (INCCA) to address climate change effects (Government of India, 2013). The NAPCC-2008 emphasizes adaptation through collaborations with developed nations and focuses on mitigation efforts that have co-benefits for development (J et al., 2010).

Bangladesh experiences the impact of climate change on its agriculture and coastal sectors. Being a low-lying country, rising sea levels have caused coastal erosion and saltwater intrusion, affecting agriculture and fishing. Increased frequency and intensity of floods and cyclones have also had devastating effects on infrastructure and the economy. Bangladesh is highly vulnerable to climate change due to its physical, social, and economic circumstances (Huq & Ayers, 2020). The country has implemented measures like constructing sea walls and planting mangroves to enhance the resilience of coastal communities against sea-level rise and coastal erosion. These initiatives have reduced the number of people affected by coastal floods by up to 50% (International Centre for Climate Change and Development).

In Bhutan, changes in temperature and precipitation patterns have led to crop failures and reduced yields, impacting the country's economy heavily reliant on agriculture. Natural disasters like floods and landslides, exacerbated by climate change, have further damaged infrastructure and the economy (Kibria, Pavel, Miah, & Islam, 2022). Bhutan has swiftly established national legislation and policies to address climate change challenges, including the National Adaptation Programme for Action (NAPA) in 2006 (Uddin et al., 2007). Bhutan's NAPA was later amended in 2012 to focus on urgent projects and activities for adapting to and reducing climate change risks (UNDP: Climate Change Adaptation, 2013). The 11th Five Year Development Plan (2013-2018) and Climate Change Policy (2020) aim to address climate challenges, achieve carbon-neutral development, mitigate climate change, and promote effective execution and cooperation among stakeholders (Royal Government of Bhutan, 2020). Bhutan has made significant progress in reducing carbon emissions through the promotion of renewable energy and sustainable forestry practices, already achieving a 72% reduction in carbon emissions and striving to be carbon-neutral by 2020.

Pakistan's agriculture sector is highly vulnerable to climate change, necessitating a focus on adaptation measures to mitigate its impacts. The country has implemented measures like constructing dams and promoting water-efficient irrigation practices to enhance water availability for agriculture and reduce the risk of water scarcity. These initiatives have increased crop productivity by up to 20% (Pakistan Agriculture Research Council). Pakistan's Ministry of Climate Change has initiated several mitigation and adaptation strategies, including the National Climate Change Policy of 2012 and the Nationally Determined Contribution (NDC) clarification to the Paris Agreement. The National Climate Change Policy aims to ensure that development in Pakistan occurs without negatively impacting the climate and prioritizes economically and socially vulnerable sectors (Government of Pakistan, 2021).

In Afghanistan, changes in temperature and precipitation patterns have led to crop failures and reduced yields, affecting food security. The increasing frequency and intensity of floods and droughts, driven by climate change, have further damaged infrastructure and the

economy. Afghanistan has developed a National Adaptation Programme of Action (NAPA) to outline its goals and needs related to climate change. This program has been implemented across various government sectors and stakeholders (World Food Programme & United Nations Environment Programme, n.d.). The country has also pledged to pursue Low Emission Development (LED) to reduce greenhouse gas emissions during the 2015 Paris Climate Conference (COP21). Afghanistan, being impacted by both conflict and climate change, faces significant challenges in services like water, land, and urbanization (Přivara & Přívarová, 2019).

The Maldives, with its dispersed topography and low-lying islands, is particularly susceptible to the effects of climate change. The country established the Climate Change Policy Framework in 2015 to address escalating climate change and strengthen other climate-related policies (Ministry of Environment and Energy, 2015). Measures such as constructing sea walls and promoting sustainable tourism have been implemented to reduce the risk of damage from storms and flooding. These efforts have helped decrease the number of people affected by coastal floods by up to 40% (Maldives Ministry of Environment and Energy).

Sri Lanka experiences crop failures and reduced yields in agriculture due to changes in temperature and precipitation patterns. The coastal sector is also at risk from sea-level rise and increased coastal erosion, endangering low-lying areas and coastal communities. Sri Lanka aims to reduce greenhouse gas emissions as per the Paris Agreement but prioritizes restoration of communities and ecosystems as a developing nation (Secretariat, 2016). The National Climate Change Adaptation Strategy (NCCAS) focuses on reducing climate change impacts on food security while protecting biodiversity. The continuously updated NAPA addresses the current climate change situation in Sri Lanka. The Conservation Action Plan of 1999 aims to preserve high biodiversity in land severely threatened by climate change (Zoysa & Inoue, 2014).

Death by Climate-Related Disaster

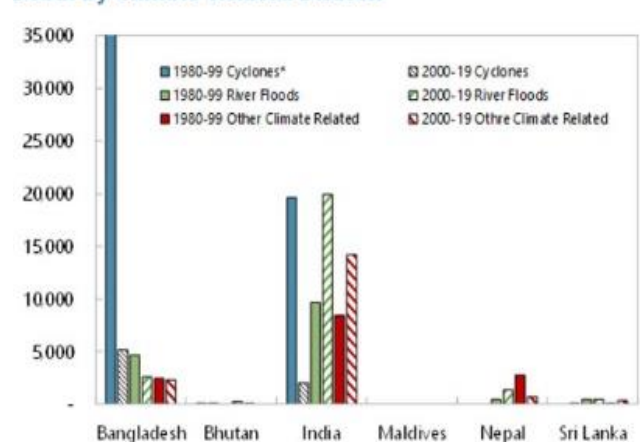


Figure 1: Death by Climate-Related Disaster

3.2. SDGs goals related target and also specific targets set by different Asian countries

The Sustainable Development Goals (SDGs) Report 2022 highlights the need for action on climate change and the inadequacy of current efforts to address the issue (UN, 2022). SDG Number 13 specifically focuses on climate action, calling for urgent measures to reduce climate change impacts and limit global warming to 1.5°C above pre-industrial levels, as stated in the Paris Agreement. The goal includes targets to reduce greenhouse gas emissions by 43% by 2030 and achieve net-zero emissions by 2050 (IPCC, UN, 2022).

In Nepal, SDG 13 aims to implement climate change adaptation measures in 750 communities and 120 village councils by 2030. The country also seeks to reduce ozone-depleting substance consumption by one-third, halve carbon dioxide emissions from transportation, industrial, and commercial sectors, establish climate-smart farming in 500 units, and develop climate-smart villages (GoN, 2017).

India's National Action Plan on Climate Change (NAPCC) emphasizes the importance of enhancing adaptive capacity to climate disasters (UN, SDG INDIA INDEX, 2018). The plan includes eight core missions addressing various aspects of climate change, such as sustainable habitats, enhanced energy efficiency, sustainable water management, sustaining the Himalayan ecosystem, promoting green practices, sustainable agriculture, and strategic knowledge on climate change. These missions rely on comprehensive strategies and the use of advanced technology to address climate change challenges.

According to the SDG Report 2022 for Bangladesh, the country has made significant progress in achieving its SDG targets and is actively working to sustain and track progress (Sustainable Development Report, 2022). Given the country's vulnerability to various natural disasters, including earthquakes, tornadoes, floods, and cyclones, Bangladesh has implemented measures to mitigate these risks, such as the development of the Bangladesh Climate Change Strategy and Action Plan (BCCSAP) and collaboration with international partners like the Green Climate Fund (GCF) to implement projects related to clean cooking, coastal community resilience, and climate-resilient infrastructure.

Bhutan's progress in achieving SDG target 13 has been challenging, with the country's current strategies for climate action operating at less than 50% resilience (Sustainable Development Reports, 2022). The indicators show a decline in CO₂ emissions from burning fossil fuels and cement production but an increase in CO₂ emissions from imports. The status of CO₂ emissions from fossil fuel exports remains undetermined.

Sri Lanka has achieved its SDG target 13 and is currently maintaining or tracking CO₂ emissions from fossil fuels, including those from imports. The country is committed to remaining neutral regarding CO₂ emissions from fossil fuel exports (Sustainable Development

Reports, 2022). Sri Lanka has implemented training programs and projects funded by the United Nations Development Programme (UNDP) to raise awareness about climate change, improve climate/weather information, and promote climate-smart agriculture among local communities and stakeholders.

Pakistan has also achieved SDG target 13 and is working to maintain or track CO₂ emissions from fossil fuels, including those from imports, while remaining neutral on CO₂ emissions from fossil fuel exports (Sustainable Development Report, 2022). The country has prioritized SDG goals, with target 13 falling under its third priority for action.

In summary, the SDGs emphasize the urgency of taking action on climate change, but current efforts are insufficient to address the issue effectively. Various Asian countries, including Nepal, India, Bangladesh, Bhutan, Sri Lanka, and Pakistan, have developed policies and implemented measures to mitigate and adapt to climate change. These include community-level adaptation, reducing emissions, enhancing energy efficiency, sustainable water management, promoting green practices, and fostering climate-smart agriculture. However, challenges remain, and continuous efforts are needed to achieve the ambitious targets set by the SDGs and effectively address the impacts of climate change.

4. Discussion

Despite numerous challenges, many countries are actively addressing climate change and transitioning towards more sustainable practices. China has made significant progress in renewable energy, with solar capacity increasing from less than 1 GW to 131 GW between 2010 and 2017 (Li & Huang, 2020). The country has implemented a pilot Emission Trading System (ETS) to control air pollution, resulting in a reduction in haze concentration and SO₂ emissions (Yan et al., 2020). China is also implementing national environmental quality standards and taking strict actions against non-compliant facilities to adapt to climate change impacts (Provisions et al., 2014).

The United States, through the Environmental Protection Agency (USEPA), has set fuel efficiency standards, established the Clean Power Plan to reduce greenhouse gas emissions from power plants, and regulated industrial emissions (Hecht & Fiksel, 2015). The country has committed to reducing domestic emissions by 70% by 2030 compared to 2005 levels (Reyes et al., 2021). The USA is also adapting to climate change impacts through resilient infrastructure, protection of water and food rights, addressing knowledge gaps, and effective monitoring and evaluation systems (Reyes et al., 2021) (USDA, 2022).

India has set targets to reduce emission intensity, become carbon neutral by 2070, source 50% of electricity from renewable sources, and promote biofuels (Bioenergy, 2021). Policies such as the Electricity Act of 2003, Central Motor Vehicle Rule 1989, and National Policy on

Biofuels 2018 have been implemented to support these goals (Ministry of New and Renewable Energy, 2011) (Ministry of Road Transport and Highways, 1989) (The Electricity Act, 2003).

Brazil has committed to reducing emissions and has implemented the Carbon Farming Initiative to incentivize emission reductions in agriculture (Carbon Market Institute, 2017). Australia has established the National Climate Change Adaptation Research Facility to study soil health and develop analytical methodologies (Barlow et al., 2013). Japan has promoted renewable energy through feed-in tariffs and improved flood control infrastructure and agricultural practices (METI, 2017) (METI, 2018). South Africa has implemented the Renewable Independent Power Producer Programme (REIPPP) and carbon tax to promote renewable energy and has developed a National Climate Change Adaptation Strategy (Eberhard et al., 2014).

Mitigating the impacts of climate change can be achieved through various strategies. Transitioning to renewable energy sources, improving energy efficiency, implementing carbon capture and storage technologies, and promoting afforestation and reforestation are effective measures (IPCC, IEA, Global CCS Institute, UN-FAO). Adaptation strategies are also crucial in reducing vulnerability to climate change impacts, such as sea-level rise, natural disasters, and water scarcity. These strategies are context-specific and often require a combination of approaches.

The countries in South Asia, including Nepal, India, Bangladesh, Bhutan, Pakistan, Afghanistan, the Maldives, and Sri Lanka, are experiencing significant impacts from climate change. They have implemented various mitigation and adaptation programs, including resilient infrastructure, sustainable livelihoods, renewable energy investments, water management strategies, legislation and policies, and adaptation initiatives. These efforts have led to multiple benefits, such as increased resilience, reduced emissions, lower energy costs, improved water availability, enhanced agricultural productivity, and decreased vulnerability to disasters.

Despite the global recognition of the importance of climate action, current efforts are deemed inadequate to effectively address the issue. SDG Number 13 specifically focuses on climate action and sets targets for reducing greenhouse gas emissions and limiting global warming to 1.5°C above pre-industrial levels, in line with the Paris Agreement (IPCC, UN, 2022).

In Nepal, efforts are underway to implement climate change adaptation measures in numerous communities and village councils by 2030, as outlined in SDG 13. The country aims to reduce ozone-depleting substance consumption, carbon dioxide emissions from various sectors, and promote climate-smart farming and villages (GoN, 2017). India's National Action Plan on Climate Change (NAPCC) emphasizes the importance of enhancing adaptive capacity to climate disasters through comprehensive strategies and advanced technology.

SDGs underscore the urgency of addressing climate change, but current efforts fall short of effectively

mitigating its impacts. The Asian countries, including Nepal, India, Bangladesh, Bhutan, Sri Lanka, and Pakistan, have taken significant steps to mitigate and adapt to climate change. However, challenges persist, and sustained efforts are necessary to achieve the ambitious targets outlined in the SDGs and effectively tackle the impacts of climate change. Bangladesh has made significant progress in achieving its SDG targets, with a focus on mitigating the risks of natural disasters and promoting climate-resilient infrastructure (Sustainable Development Report, 2022). The country has implemented the Bangladesh Climate Change Strategy and Action Plan (BCCSAP) and collaborates with international partners like the Green Climate Fund (GCF) to implement projects related to clean cooking and coastal community resilience. Bhutan's progress in achieving SDG target 13 has been challenging, with indicators showing a decline in CO₂ emissions from fossil fuels but an increase in emissions from imports (Sustainable Development Reports, 2022). Sri Lanka has achieved its SDG target 13 and is actively working on maintaining or tracking CO₂ emissions from fossil fuels, while promoting climate-smart agriculture and raising awareness through training programs and UNDP-funded projects (Sustainable Development Reports, 2022). Pakistan has also achieved SDG target 13 and focuses on tracking CO₂ emissions from fossil fuels, including imports, while prioritizing SDG goals as part of its action plan (Sustainable Development Report, 2022).

Although progress has been made, challenges persist. Continued collaboration, funding, and capacity-building are necessary to effectively address the complex and interconnected issues related to climate change in the region. These countries are committed to achieving their climate goals while balancing economic and social development, aligning with international agreements such as the Paris Agreement.

5. Conclusion

There is significant impacts of climate change on various sectors, including agriculture, infrastructure, and coastal regions. However, it is evident that efforts have been made to implement climate change mitigation and adaptation measures, resulting in several benefits and progress. Nepal has successfully implemented climate change programs, leading to increased resilience in mountain communities and a reduction in the number of people affected by natural disasters. The success can be attributed to initiatives such as constructing climate-resilient infrastructure and promoting sustainable livelihoods. Bangladesh, being highly vulnerable to natural disasters and coastal erosion, has implemented measures such as constructing sea walls and planting mangroves to enhance the resilience of coastal communities. These efforts have resulted in a significant reduction in the number of people affected by coastal floods. Bhutan has swiftly established national legislation and policies, including the National Adaptation

Programme for Action and the Climate Change Policy, to address climate change challenges. Pakistan has focused on adaptation measures to mitigate the impacts of climate change on its agriculture sector. Initiatives such as constructing dams and promoting water-efficient irrigation practices have increased crop productivity and reduced the risk of water scarcity. Similarly, other countries, including India, Afghanistan, the Maldives, and Sri Lanka, have also implemented measures to address climate change impacts in various sectors. These initiatives range from establishing national adaptation programs to developing policies that prioritize climate change mitigation and ecosystem restoration. The ecosystem services have upgraded the livelihoods of local people, decreased energy demand, increased forest coverage, and helped decrease greenhouse emissions in South Asian countries (Giri, Poudel, Khanal, Pandey, Paudel, & Khanal, 2022). Despite the progress made, it is important to acknowledge that challenges persist in effectively addressing climate change. The current efforts are still insufficient to meet the ambitious targets set by the Sustainable Development Goals (SDGs) and the Paris Agreement. Continuous and collaborative efforts are needed to scale up and accelerate climate change mitigation and adaptation measures.

South Asian countries can greatly benefit from sharing experiences and best practices in climate change mitigation and adaptation. Strengthening regional collaboration and knowledge sharing platforms will facilitate the exchange of ideas, technologies, and strategies, enabling countries to learn from each other's successes and challenges. Additionally, governments should prioritize the development and implementation of policies and incentives that encourage the widespread adoption of renewable energy technologies. Governments should prioritize the design and construction of infrastructure that can withstand extreme weather events and rising sea levels, thereby reducing vulnerabilities and ensuring the long-term resilience of critical systems. Similarly, promoting sustainable agricultural practices, such as climate-smart farming techniques and water-efficient irrigation, can enhance agricultural productivity and build resilience in the face of climate change. Furthermore, South Asian countries should explore innovative financing mechanisms, including public-private partnerships and accessing international climate funds, to mobilize the necessary financial resources for climate change initiatives. Providing training, technical support, and raising awareness about climate change impacts and adaptation strategies will empower individuals and organizations to contribute actively to climate change mitigation and adaptation efforts. By prioritizing these points, South Asian countries can strengthen their resilience to climate change and contribute to global efforts towards a sustainable and climate-resilient future.

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