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CLIMATE CHANGE SOURCES, IMPACTS, MITIGATION, AND ADAPTATIONS IN ASIA

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Abstract
Climate change is the greatest challenge to the stability of the world, with its disastrous effects being disproportionately felt among the developing economies of Asia. This review assesses the complex causes of climate change, its socio-economic impacts in Asia, and also identifies a severe imbalance in the vulnerability and adaptiveness of the region. Although Central Asia struggles with unprecedented cryospheric instability and South Asia is dealing with unpredictable monsoon cycles, the local response in the latter is frequently hindered by systemic implementation gaps in policies that are paper-based instead of action-oriented. Moreover, there is a lack of social science research in existing literature, which favors physical modeling and overlooks critical human aspects such as climate justice, gender-sensitive adaptation, and feminization of agriculture. This paper will argue that a radical shift toward a more practical and institutionalized approach to nature-based solutions and climate-smart agriculture is necessary in the Global South. As the review concludes, the unequal coping abilities, which are determined by economic status and technological access, serve to increase the gap between countries. In conclusion, to tackle the climate crisis issue in developing Asia, it is necessary to fill the gap between scientific modeling and local socio-political facts to achieve equitable resiliency, amidst the most vulnerable groups in the world.

INTRODUCTION

Climate change is the permanent alteration of the world's weather and temperature variations that result in reduced predictability of seasonal changes (Yousaf et al., 2025). At the global scale, these changes disrupt agricultural productivity, especially in agricultural regions, whose rainfall is no longer considered reliable. The Intergovernmental Panel on Climate Change (IPCC) has claimed that these impacts are disproportionately experienced in developing nations because of their particular geographical positions, economic dependence on natural resources, and their inability to support their infrastructure (Arif et al., 2025). Although industrialized countries have the institutional strength to buffer climate extremes, the developing nations, which contribute least to the global greenhouse gas emissions, bear the brunt of the climatic consequences because of limited adaptive capacity (Arif et al., 2025).

In the South, climate change is an immediate threat multiplier that intensifies the socio-economic vulnerabilities present. This has been characterized in Central Asia by cryospheric instability, where temperatures are elevating at a higher rate than the global average, causing the shrinking of glaciers and

unstable flows of rivers (Vakulchuk et al., 2023). The vulnerability of Southeast Asia is due to the fast urbanization of the coastline and the rise in sea level (Tun et al., 2025). In South Asia, and especially in Pakistan, there is a variation of extreme monsoon climate change. The area has experienced a mean temperature rise of 0.57 °C /year in temperature and 25 percent growth in precipitation, causing super floods and heat waves that surpass important limits of human and agricultural well-being (Habib-ur-Rahman et al., 2022). The causes of such changes in Asia are multifaceted; for example, in 2022, floods in Pakistan impacted 33 million people and cost the country an estimated US$15 billion, which is why such a combination of climatic extremities and economic vulnerability is catastrophic (Otto et al., 2023).

Energy production is one of the key drivers of climate change, and the development of Central Asia is largely dependent on fossil fuels (Vakulchuk et al., 2023; Yousaf et al., 2025). Emissions of Pakistan are also related to the generation of power (Vakulchuk et al., 2023; Yousaf et al., 2025). Moreover, agricultural activities are also a source of methane and nitrous oxide (Habib-ur-Rahman et al., 2022). These drivers lead to cascading effects: physical environmental deterioration, including the intrusion of saltwater in the Mekong Delta, and socio-economic crisis, including the eco-migration and the feminization of agriculture, as men migrate due to resource scarcity (Tun et al., 2025; Vakulchuk et al., 2023).

In spite of the proliferation of natural science literature, multiple gaps and holes in the literature persist. There exists a social science gap, and most of the research is greatly biased towards physical modeling instead of the socio-political impacts, in terms of poverty, gender, and climate justice (Vakulchuk et al., 2023). There exists an implementation gap, in which the policies are just paper-based and fail to come into action due to a lack of finances and failing governance. Literature treats Asia as a single unit and is unable to account for unsymmetrical adaptive capacities (Arif et al., 2025; Habib-ur-Rahman et al., 2022). The purpose of this review is to bring together these unequal socio-economic effects in developing Asia, with a particular focus on the gap in human-focused research and the institutional demands for successful strategies like nature-based solutions and climate-smart agriculture. Vulnerability of different countries to climate change varies as is shown in figure 01.

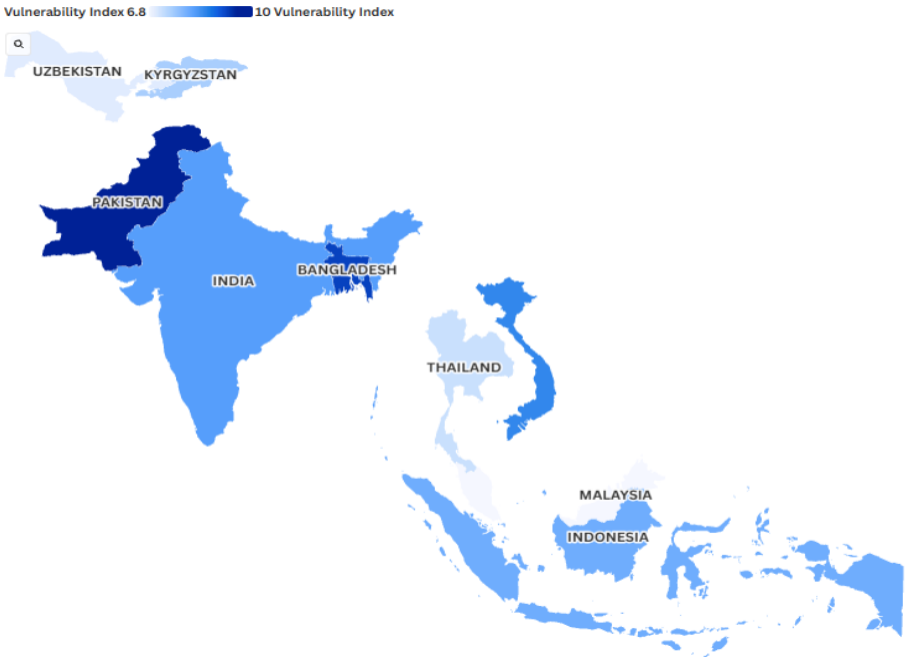

Figure 01: Spatial distribution of climate vulnerability in developing Asia

Major sources of climate change in Asia

The Earth's climate system has been experiencing continuous interactions of natural processes and human activities at different times and in different geographical regions. The climatic changes experienced in the last three centuries were the outcome of changes in the climate system (Kay et al., 2009). Earth's climate system has been undergoing natural changes in the course of history, and these changes are the outcome of the natural operations of the climate system, including the operations of volcanic eruptions, changes in solar radiation, and the operations of ocean-atmosphere circulation systems as the primary climatic forces. The natural forces of the Earth system are responsible for the natural occurrences of cooling, warming, drought, and changes in precipitation, even before the beginning of the development of industries. However, in the mid-18th century, a major change in the climate occurred. There was the industrial revolution, which brought about the combustion of fossil fuels, the establishment of industries, and the modification of the landscape. After this, the greenhouse gases accumulated. These greenhouse gases included carbon dioxide, methane, and nitrous oxide. Lastly, the greenhouse effect occurred, which brought about a change in the climate (Kwon et al., 2018). As a result, global warming emerged as a trend. The greenhouse effect is identified as the primary cause of climate change and affects many continents, including Asia.

Asia is home to some of the fastest-growing economies in the world, especially China and India, whose fast-paced industrialization and population growth have caused a drastic change in the atmospheric environment in the past few decades (Reyer et al., 2017). Fast-paced industrialization, urbanization, energy consumption, and infrastructure development have led to an increase in the emission of short-lived climate pollutants, especially black carbon (BC). This has resulted in East Asia and South Asia becoming hotspots in the global BC emission distribution (Ramanathan & Carmichael, 2008). The causes of climate change in developing Asia, both natural and anthropogenic factors, are given below, in order to understand the trend of the change in the climate in the past and the manner in which it should be addressed in the future (Change, 2001).

a) Natural Drivers of Climate Change

Natural causes, such as those present in the Earth's history, have been the driving force behind the changes to the Earth's climate, as shown in Figure 02. Although the effect is still present today, it is only responsible for the cyclical changes rather than the long-term changes that have been experienced (Fahey et al., 2017).

Volcanic eruptions are one of the major climate forcing events. When a major eruption happens, it releases large amounts of sulfate aerosol into the stratosphere. The sulfate aerosol has a major impact on Earth because it reflects some of the solar radiation that enters our atmosphere (Charlson & Wigley, 1994). As a result, some of this radiation is bounced back into space, causing a short-term reduction in global temperatures. Climate models that include volcanic forcing accurately simulate this phenomenon, proving its impact on our climate. But as you can expect, this sulfate aerosol will eventually fall to the Earth (Cole-Dai, 2010).

Solar radiation is the primary source of energy in the Earth's climate system. Solar variations happen in cycles of 11 years and even longer periods of 100 years. Solar variations were a factor in the changes in the Earth's climate in the pre-industrial era (Gray et al., 2010). However, scientific evidence proves that changes in solar irradiance in the past 100 years were relatively minor. Data collected from the sun does not reveal a trend of increasing solar output that could be the cause of the current global warming phenomenon. Solar variations are part of the Earth's climate system's natural variability (Solanki, 2002).

The greenhouse effect is a natural process that occurs in the atmosphere and is vital for life on Earth. Greenhouse gases, like carbon dioxide, trap heat and prevent it from escaping into space. They do this by absorbing infrared radiation, or heat, from the Earth's surface and then emitting it in all directions (Mohajan, 2017). If the greenhouse effect did not occur, the Earth's temperature would be about –6°C instead of the present 15°C. The problem facing modern civilization is not the greenhouse effect itself, but its intensification. In other words, the concentration of greenhouse gases in the atmosphere exceeds the natural concentration, and the greenhouse effect has been amplified. It is the enhanced greenhouse effect, and not the natural one,

which is the major cause of climate change (Hegerl et al., 2019).

b) Anthropogenic Drivers in Asia

Fossil fuel combustion and urbanization have led to an increase in greenhouse gases in the atmosphere, a primary driver of climate change in Asia, due to its fast-paced industrialization and urbanization.

The major human source of BC in Asia is the incomplete combustion of fossil fuels. The industrialization of China and India has been fueled by coal-based energy. Coal-fired power plants remain the major source of electricity in both countries. Industrial combustion processes in the steel industry, cement industry, petrochemical industry, and brick kilns are major sources of soot emissions (Inumaru et al., 2021). These industries are geographically located in the most industrialized areas, thereby contributing to regional hotspots of emissions. Transportation is another major source of BC emissions. Diesel vehicles, especially heavy-duty trucks and buses, are major sources of BC emissions due to the incomplete combustion of fuel (Liggio et al., 2012). Additionally, residential coal burning, still practiced in some rural and peri-urban areas, is a source of seasonal increases in BC emissions during the winter months. The atmospheric loading of BC remains considerable even though East China's control policies have reduced BC emissions in recent years. Due to rising energy consumption and population density, South Asia's BC emissions are rising. Accordingly, the primary source of elevated BC concentrations in Asia continues to be the burning of fossil fuels (Bond et al., 2013).

Biomass burning is a second important source of BC emissions in Asia. Agricultural residue burning is a common practice in northern India and selected regions of China, particularly in the pre-monsoon and post-harvest periods. Such burning activities cause a substantial increase in aerosol optical depth and contribute to serious regional air pollution events. Forest fires, whether natural or human-induced, lead to episodic but strong BC emissions (Keywood et al., 2013). Moreover, residential biofuel use, such as wood, charcoal, and agricultural residues for cooking and heating, is still a common practice in rural South Asia, resulting in continuous baseline emissions. Biomass burning activities cause a substantial increase in shortwave radiation absorption during the pre-monsoon season. High BC concentrations during the winter and pre-monsoon seasons enhance atmospheric heating rates and impact the monsoon onset intensity and timing. Such emissions not only impact regional atmospheric stability but also cause large-scale circulation changes due to energy budget perturbations (Samset, 2018).

Urbanization enhances BC emissions in a variety of complexly intertwined ways. Increased transportation infrastructure leads to more fossil fuel burning. The growth of industry drives up energy demand and emissions. Construction sectors are dominated by diesel engines and brick kilns, which are both major BC emitters (Wan & Kahn, 2013). The economic development of China and India during the past several decades has been accompanied by a rapid enhancement of aerosol emissions. Nevertheless, the emergence of new regional contrasts has led to the development of an aerosol dipole structure, with reduced aerosol concentrations in some regions of East China because of more stringent environmental policies and increasing emissions in India because of ongoing industrialization (Zhang & Wang, 2019).

c) Physical Mechanisms: The Role of Black Carbon in Altering Asian Climate

The dominant pathway through which BC influences climate is aerosol–radiation interaction (ARI). The atmospheric energy balance is significantly altered as a result of this process, which involves BC particles suspended in the atmosphere absorbing solar radiation (Sadiq et al., 2015).

Strong absorption of incoming solar radiation by black carbon results in significant atmospheric heating, especially in the lower troposphere. This heating improves atmospheric static stability and modifies the vertical temperature profile. The atmospheric column's net cooling is decreased by increased atmospheric warmth. A decrease in cooling necessitates a corresponding decrease in latent heat release, which results in less rainfall because precipitation is essentially limited by the atmospheric energy budget. Therefore, with large BC loading, precipitation suppression is mostly driven by thermodynamics (Persad et al., 2017).

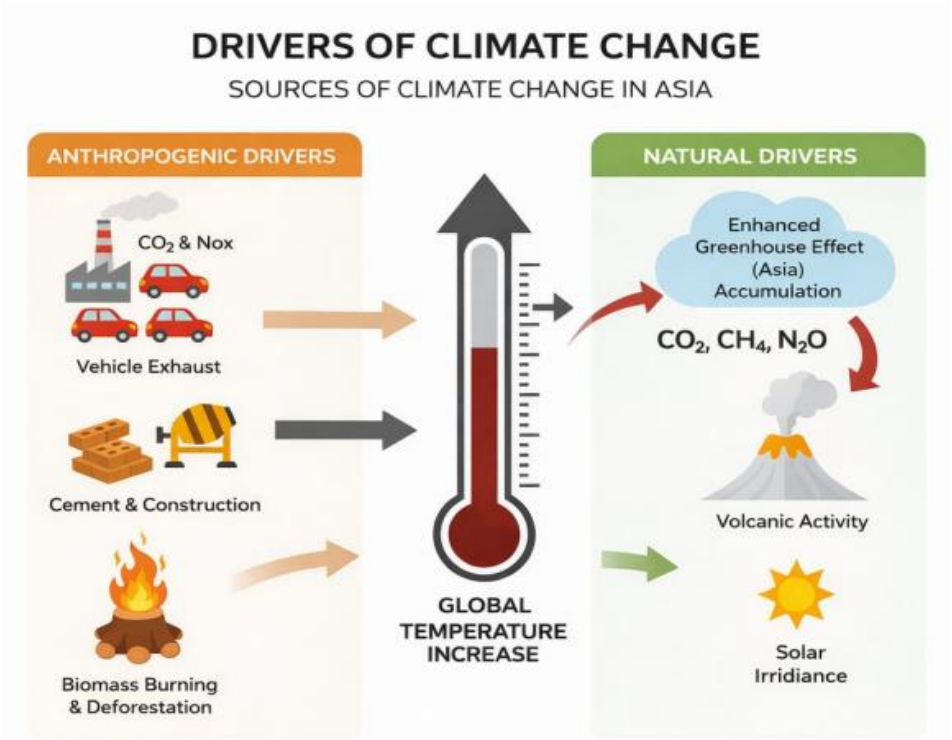

Figure 02. Sources of Climate Change in Asia

d) Black Carbon and Asian Monsoon Variability

Asian climate is characterized by large monsoon systems, such as the East Asian Summer Monsoon (EASM), South Asian Summer Monsoon (SASM), and East Asian Winter Monsoon (EAWM). BC emissions strongly impact these monsoons through local thermodynamic forcing and remote circulation patterns (Betzler et al., 2016).

BC emissions over East Asia lead to large-scale drying, with the largest reduction in precipitation over South China. While the diabetic cooling effect in the atmosphere weakens over the region due to shortwave absorption, dynamic circulation responses are spatially heterogeneous. In the case of northern China, dry-static-energy flux divergence offsets precipitation reduction. However, in South China, dynamic responses reinforce drying. This is why South China shows the largest reduction in rainfall. Seasonally, BC-induced atmospheric warming reduces the intensity of summer monsoons and changes the transport routes of moist air, causing continuous precipitation reduction in the region (Wang, 2004).

One of the world's most climate-vulnerable regions is developing Asia, whose agriculture and food security are particularly vulnerable to rising temperatures, glacial melt, monsoon variability, floods, droughts, and sea level rise (Alvi & Jamil, 2018; IPCC, 2022). These effects are exacerbated by human activities that have contributed to global warming, such as the use of fossil fuels, industrialization, urbanization, deforestation, agriculture, and CO_2 emissions, as shown in Figure 03 (IPCC, 2015).

According to temperature projections, under moderate emission scenarios, South Asia may see an increase of about 2°C by 2050 (IPCC, 2022). By the end of the century, warming might surpass 4°C under higher emission pathways, with dire economic and environmental repercussions. Particularly at risk is the Himalayan region, known as the "Water Tower of Asia." The Brahmaputra and the Indus are two major river systems that rely significantly on snow and glacier melt. Short-term flood risks and long-term water scarcity are both increased by the acceleration of glacial retreat, which jeopardizes long-term water availability (IPCC, 2022).

If global warming continues, sea levels are expected to rise dramatically. A 4°C increase in temperature could result in a significant rise in sea level, raising the risks for low-lying coastal areas in developing Asia (IPCC, 2021).

Coastal flooding, erosion, and saline water intrusion into inland agricultural areas are all consequences of rising sea levels. Both agriculture and coastal populations are at serious risk from saltwater penetration, which deteriorates soil quality and interferes with crop production. IPCC (2021).

Freshwater from glaciers and snowmelt is essential for growing Asia, especially in the Himalayan region. Due to climate change, the river basins of the Indus and Brahmaputra are extremely susceptible to variations in snowmelt and glacial melt (Bajracharya et al., 2015). According to studies, summer and late spring river flows will significantly decrease with a 2°C increase in temperature and possibly a 4°C increase in extreme warming (Diffenbaugh, Scherer, & Ashfaq, 2013).

Changes in glacial ice, snowmelt, and precipitation patterns are expected to alter extreme river flows downstream. For example, Gain et al. (2011) predict that the Brahmaputra River may occasionally experience very low flows in the future. Conversely, increased flow during other periods could raise flood risks, especially when combined with rising sea levels, posing alarming impacts for Bangladesh and other South Asian regions (Gain et al., 2011).

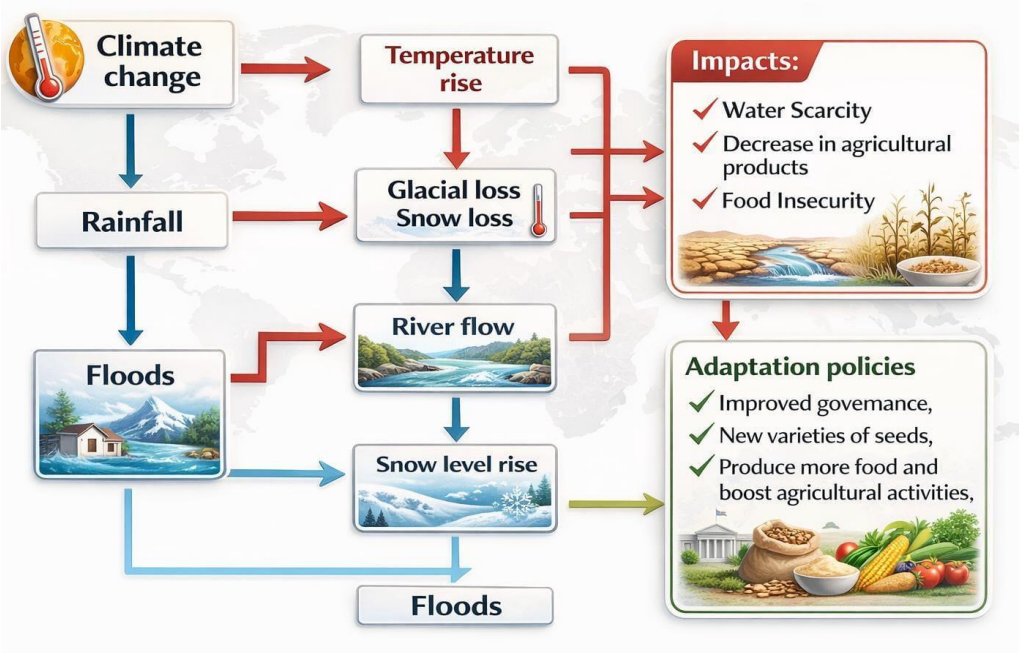

Figure 03. Impact and adaptation policies of climate change in Asia

Agriculture and Food Security

In developing Asia, agriculture is heavily reliant on consistent monsoon rainfall patterns. It is anticipated that climate change will increase rainfall variability and exacerbate flood events. Flood risks could be further increased by modifications to river peak flows and monsoon timing. (WMO, 2023; World Meteorological Organization).

Regular droughts and floods lower agricultural production and crop yields, which increases unemployment and poverty in rural areas. Food insecurity rises as a direct result of decreased agricultural productivity brought on by rising temperatures and changed precipitation patterns. Prices may increase as the region's food supply diminishes, exacerbating hunger, poverty, and malnutrition (FAO, 2021).

Freshwater supplies are under threat from climate change due to glacier depletion, unpredictable rainfall, and protracted droughts. The lack of water

for home and agricultural purposes could exacerbate the socioeconomic situation in developing Asia.
Conflicts over shared water resources between and within states are just one example of the wider human security issues that can result from food and water insecurity. Regional instability may be exacerbated by such forces (IPCC, 2022).

Adaptation Strategies in Asian Countries

Adaptation strategies for climate change in Asia in multi scaler process ranging from the ecosystem – community level initiatives to localized household responses.

a) Ecosystem and sector-based adaptations

Across South Asian countries, the adaptation strategies for climate change that are operating in the community report that ecosystem-based adaptation is widely promoted, including forest conservation, afforestation and reforestation programs, watershed and river basin management, protection and restoration of wetlands and coastal mangroves, and sustainable land-use planning to reduce flood and erosion risks. In agriculture, adaptation measures include the promotion of climate-resilient crop varieties, crop diversification, changes in planting calendars, improved irrigation efficiency, rainwater harvesting, soil moisture conservation techniques, and integrated pest management to cope with rising temperatures and variable rainfall. Water-related adaptation includes the development and rehabilitation of the reservoirs, small dams, and ponds, groundwater recharge, an efficient irrigation system, and the development of better drinking-water supply infrastructure in the drought-affected areas. Some of the strategies to reduce the occurrence of climate-related disasters are ensuring strong early warning mechanisms against floods, cyclones, heat waves, and landslides; climate-resistant housing and infrastructure; community-based disaster preparedness and relocation or planned retreat in highly vulnerable regions near the coastline and floodplains. Climate-sensitive disease surveillance, heat-health action, sanitation, and provision of clean water during extreme events are some of the adaptations in the health sector. The institutional and governance activities include the establishment of national adaptation plans, mainstreaming climate adaptation in development planning, strengthening local governmental capacity, facilitating community involvement, increasing climate information services, and strengthening and intensifying regional and international cooperation to obtain finance, transfer technologies, and establish capacities (Gassner et al., 2019).

b) Rural and Livelihood Resilience

South Asian rural empirical studies indicate that there are short-term coping and long-term adaptation strategies used by households to deal with climate-related risks like droughts, floods, heat stress, and crop failure. Some of the common adaptations in agriculture are related to changing to more climate-resistant varieties of crops, changing the cropping calendar, implementing mixed cropping systems, enhancing irrigation techniques, and implementing soil and water erosion control to ensure agricultural productivity in the changing climatic conditions. Other livelihood strategies used by households include income diversification, seasonal migration, non-farm livelihood activities, and relying on remittances to contain income shocks elicited by the climate. At the community level, collective efforts, including community-based management of resources, community-driven disaster preparedness, and community-based water management, are part of resilience. However, the research highlights constraints to adaptation, including limited access to financial resources, insufficient infrastructure, low levels of education, weak official support, and unequal access to information and knowledge. Strengthening rural infrastructure, improving access to climate services, providing targeted financial and technical support, and enhancing institutional coordination are identified as key strategies to improve long-term adaptive capacity and reduce vulnerability among smallholder farmers (Adhikari et al., 2015).

c) Farmers Adaptation Strategies in South Asia and East Asia

Farmers adopt various adaptation strategies to minimize the effects of those risks on their livelihoods. Changes in farming practices are the most common adaptation strategy among farmers in Nepal and Kenya, whereas past savings and borrowing are common adaptation strategies in Bangladesh, India,

and Ethiopia, as shown in Table 1. Unlike farmers in the other countries in this study, many in Bangladesh received government assistance. Various factors determine the choices of climate change adaptation strategies by farmers in South Asia and East Asia. Gender plays an important role, particularly in the limited adaptive capacity of female-headed households. Male-headed households are more likely to seek employment and change agricultural practices, while female-headed households prefer to reduce consumption and rely on savings and borrowings. Therefore, enhancing gender equity, especially women's access to off-farm jobs, can help them to better adapt to climate risks. Likewise, older farmers rely more on reducing consumption, rather than taking additional jobs, to adapt to climatic risks. This may be due to their health problems, suggesting the critical need for additional government support to older farmers, irrespective of their gender. (Aryal et al., 2021)

Household assets index, farmland, and livestock holdings also influence the farm household's choice of adaptation strategy. Households with large farms mostly change farming practices to adapt to climatic risks. Those with more livestock rely on savings and borrowing as an adaptation strategy because livestock acts as an insurance mechanism for them. Households with higher education rely mostly on additional jobs and seek government and non-governmental organization help. Similarly, farmers with training in farming and climate-related issues change farming practices and take additional jobs as adaptations to climate change risk (Aryal et al., 2021).

The Challenges and Barriers of Climate Change for Developing Asia

Asia's developing nations are among the most at risk from climate change. The region faces significant environmental, social, and economic challenges in effectively addressing climate change, even though it contributes to global economic growth (IPCC, 2022).

A. The Challenges of Climate Change for Asia's Development

Asia's developing nations are confronted with some of the most serious and intricate problems caused by climate change. These nations are particularly vulnerable because of their fast urbanization, poverty, and reliance on climate-sensitive industries like agriculture, as shown in Figure 04 (World Bank, 2022).

Extreme weather events like heatwaves, cyclones, droughts, and floods are common and severe in developing Asian nations. For instance, destructive floods and typhoons frequently strike Bangladesh and the Philippines, causing damage to houses, infrastructure, and agricultural areas. In addition to endangering human life, these catastrophes often disrupt local economies and limit the potential for long-term growth (IPCC, 2022). Millions of people who live in low-lying areas are at greater risk because coastal zones are particularly susceptible to storm surges and rising sea levels.

Climate change significantly affects agriculture and water availability**.** Altered rainfall patterns, droughts, and rising temperatures reduce crop productivity, particularly in countries that rely heavily on rain-fed farming. This threatens food security and increases the risk of malnutrition. Freshwater availability is also compromised, affecting both domestic consumption and irrigation for agriculture, further intensifying socio-economic challenges (ADB, 2021).

Rising temperatures and climate extremes contribute to health-related challenges. Increased prevalence of vector-borne diseases such as dengue and malaria, heat stress, and waterborne illnesses affects vulnerable populations, including children, the elderly, and the urban poor. For example, in South and Southeast Asia, outbreaks of dengue have been linked to warmer temperatures and higher rainfall variability (UNEP, 2023).

Long-term economic effects of climate disasters include decreased agricultural output, trade disruption, and infrastructure destruction. Numerous nations in the area depend on industries that are susceptible to climate change, including tourism, fishing, and agriculture. High population density, informal urban settlements, and gender inequality are examples of social vulnerabilities that further impair adaptation ability, putting underprivileged populations at greater risk (World Bank, 2022).

Table 01: Adaptation and Mitigation Strategies in Asian countries

Region	Adaptation Strategies	Outcome	References
Nepal	Climate-resilient infrastructure. Local Adaptation Plans of Action (LAPAs) at village/community levels.	Reduced the number of people affected by natural disasters by up to 30% in targeted areas (ICIMOD)	(Giri et al., 2023)
India	Urban planning for climate resilience. Integrated solar & renewables.	Enhanced renewable energy share helps reduce fossil fuel reliance.	(Giri et al., 2023)
Pakistan	Strengthening institutional capacity. Water & disaster management planning.	Although policies exist, the region is still facing increased flood & disaster intensity. Climate change increased rainfall intensity by 10–15% in recent monsoon events.	(Idris, 2024)
South Asia	Multiple adaptation projects: water security, food systems, agriculture resilience.	Vulnerability persists due to socio-economic constraints.	(Mall, Srivastava et al. 2019)
ASEAN region	Efforts to build adaptive capacity to climate disasters.	Environmental performance lags global averages; gaps between member countries' performance	(Ding & Beh, 2022)

Developing Asian nations are especially susceptible to the effects of climate change since a substantial portion of their economy relies on industries that are sensitive to it, such as agriculture and fishing. Climate change hinders economic growth, raises the cost of catastrophe recovery, and reduces productivity (Akram, 2012; IPCC, 2021). According to research, particularly in poorer countries with less capacity for adaptation, the losses in gross domestic product in Asian economies could be significantly more than the global average under extreme warming scenarios (Akram, 2012; IPCC, 2021).

Heat stress and infrastructure vulnerability are increased when rapid urbanization and climate change coexist. Due to the urban heat island effect, South Asian metropolitan areas experience more intense heatwaves, which raise health risks and overwhelm the infrastructure systems that were not built for harsh weather (World Bank, 2023).

Due to disparities in institutional capacity, access to technology, and economic standing, developing Asian nations vary greatly in their abilities to deal with climate change. While some countries struggle with scarce resources and governance deficits, making them even more vulnerable, others are better positioned to adapt through investments and policy frameworks (Nature, 2025).

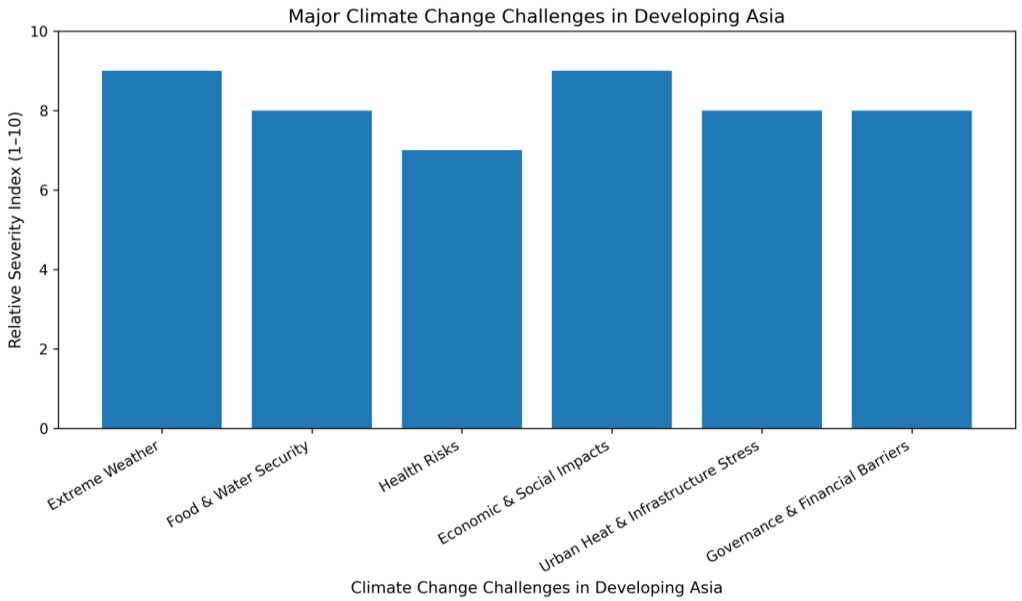

Figure 04. Major climate change challenges in developing Asia

B. Barriers of Climate Change for Developing Asia

For developing nations throughout Asia, climate change presents significant challenges. Despite the region's extreme susceptibility to the effects of climate change, a number of significant barriers prevent it from effectively responding (UNEP, 2023). Investment in climate adaptation and mitigation initiatives is constrained by a lack of funding. Developing nations frequently lack the funds to invest in renewable energy sources or construct infrastructure that is climate-resilient. International climate finance is available, but it is limited, complicated, and even challenging to access, which slows down crucial projects (ADB, 2021).

Effective climate action is hampered by weak governance frameworks. The effectiveness of climate programs is diminished by problems like incoherent policies, overlapping institutional functions, corruption, and insufficient enforcement. Effective mitigation and adaptation require robust institutions and well-defined policy frameworks (IPCC, 2022).

One of the main obstacles is technological restrictions. Modern clean energy systems, sophisticated monitoring instruments, and climate data necessary for efficient planning and execution are frequently unavailable in developing Asian nations. Although the Paris Agreement's technology transfer program attempts to close these gaps, results are inconsistent and gradual (UNEP, 2023). Instability in climate policies is undermined by political unpredictability and frequent changes in leadership. Short-term-focused governments frequently divert funds from permanent climate goals, which weakens policy continuity and delays projects. Investor trust is lowered, and the adoption of sustainable solutions is slowed by such uncertainty (Yusuf & Francisco, 2009).

Critical insights

One of the most significant critical observations is the asymmetry of adaptive capacity, in which literature tends to treat Asia as a unitary entity, ignoring the various socio-political and economic realities that determine the capacity of the nations to adapt to climatic extremes (Arif et al., 2025; Habib-ur-Rahman et al., 2022). In addition, the social science gap makes it evident that modern climate studies are skewed heavily towards physical models and tend to underrepresent the human aspect of poverty, gender inequality, and climate justice (Vakulchuk et al., 2023). The implementation gap also reveals a systemic deficit in terms of having sound national adaptation

plans, which are not implemented because of a lack of governance capacity and mobilization of financial resources (Habib-ur-Rahman et al., 2022). In Pakistan, although a national policy of climate change exists, in practice, the systemic weaknesses often prevent reaching the most vulnerable populations, as the infrastructure improvements will not be effective since the policy exists on paper, but not in practice. In the context of these cascading crises, including the "feminization of agriculture" and forced eco-migration, we overlook the fact that climate change is not just an environmental issue in the Global South but a threat multiplier for pre-existing socio-economic vulnerabilities (Vakulchuk et al., 2023; Tun et al., 2025).

Conclusion

To address the existing gaps, policymakers need to make nature-based solutions and climate-smart agriculture a high-priority area under the national development agendas, designed to have a dual benefit of mitigation and rural resilience. Financial models should be redesigned in a way that can make international climate finance easier to access, especially in localized disaster risk reduction and infrastructure development. In addition, it is also important that gender-sensitive policies be reinforced to ensure that the female-headed households are given specific attention that would guarantee equitable access to the off-farm jobs and the climate services. To sum up, although developing Asia is at the center of the climate crisis, the most pressing obstacle is still the shift of the paper-based policies into actual and humanistic policies. Long-term sustainability must involve a radical change towards integrated governing, regional knowledge sharing, and a willingness to confront the socio-economic inequalities that already characterize climate susceptibility in the region.

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