CLIMATE CHANGE VULNERABILITIES IN SOUTH ASIA: PROSPECTS OF WATER, AGRICULTURE AND FOOD SECURITY

[1]DR. BIBI SAIRA, [2]DR. SIDRA NOUREEN,[3]DR. MUHAMMAD ABRAR AHMAD, [4]DR. IRAM NASEER, [5]DR. MUHAMMAD MUNIB KHALID

[1]Assistant Professor, School of Political Sciences Minhaj University Lahore
sairanouman.polsc@mul.edu.pk

[2]Assistant Professor, School of Sociology Minhaj University Lahore
sidranoreen.soc@mul.edu.pk

[3]Assistant Professor, Dept. of History and Arts, Division of Arts and Social Science, University of Education,
abrar.ahmad@ue.edu.pk

[4]Assistant Professor, Dept. of History and Pakistan Studies F. C College University
iramnaseer86@gmail.com

[5]Assistant Professor, School of Political Sciences Minhaj University Lahore
munibkhalid@mul.edu.pk

Abstract

South Asia is one of the most vulnerable regions to climate change. Climate change is a challenge for water availability and temperature which directly affect agriculture yields causing issues of food security in South Asia. The research study examines climate change effects such as a rise in temperature, glacial melt monsoon rainfall, floods and droughts on agriculture and food production in South Asia. The objective of the study is to observe the impacts of climate change on agriculture growth, food security, and water security in South Asian countries and to analyze how water shortage decreases agricultural growth products which can cause food security issues by adopting Green Theory.This research uses qualitative methods with a natural and descriptive approach and the emphasis is not on statistics but more on describing the actual and natural facts and events, and how the impacts can be minimized or avoided. The data is collected from literature by reviewing various information from reports of various UN agencies, the Food and Agriculture Organisation (FAO),the World Bank, the Asian Development Bank, the United Nations Framework Convention on Climate Change (UNFCCC), the Intergovernmental Panel on Climate Change (IPCC). The results show that climate change has caused water scarcity in South Asia, directly related to the decrease in agricultural products and food insecurity.Furthermore, the study reveals that an increase in temperature has affected the production of major crops like wheat, maize and rice. Similarly, rainfall, floods andmonsoon negatively impact agriculture, causing food insecurity in South Asia. The decrease in agricultural growth is predicted to cause food security issues directly affecting human security. Therefore, adaptation policies are required for sustainable agricultural growth, water security and to reduce vulnerability to climate change.

***Key Words**: Climate Change, South Asia, Water Scarcity, Agriculture, Food Security, Glacial melt, Food Insecurity*

INTRODUCTION

South Asia is the area most vulnerable to climatic changes (Alvi& Jamil, 2018). Climate change has an effect on land and water, which are crucial to agriculture and crop yields. Climate change is predicted to decrease the availability of water, while agricultural water demand will rise by 19% by 2050 (UN-Water 2013). More than 40% of the people in these countries depend on agriculture in some capacity, making it a significant source of employment (Kühn, 2019). Policymakers and experts are more concerned about how much food will be available for the increasing population in the future (Mughal and Fontan Sers, 2020).Major changes happening due to climate change include rising sea levels, famine, droughts, displacements, climate-induced migration, floods and threats to critical infrastructure. The Intergovernmental Panel on Climate Change (IPCC) reports found that

human activities have disturbed the climate severely affecting the ecosystems and livelihood of people (IPCC, 2014). Human activities such as CO2 emissions, use of oil and coal, Industrialization, increased urbanization, deforestation, and agriculture have affected climate change and caused global warming(IPCC, 2015). National Intelligence Council (2012) warned that there would be a 40% increase in demand for water and a 35% increase in food demand by 2030. Despite making the least contribution to climate change, the world's poorest countries suffer the most from it.The most critical issues in South Asia are the availability of fresh water, loss of Agricultural crops, floods, and rising of sea levels. Mirza (2011). These issues have been the cause of conflict at the interstate and intrastate levels.The conflict between India and Pakistan on the distribution of water is a sensitive issue of water insecurity. (Hanjra& Qureshi, 2010). Furthermore, frequent natural disaster food security, and access to clean water due to climate change is likely to increase will cause conflicts in South Asia and will be disastrous for South Asia (Khalid & Ahmed 2021).

Frequent and intense extreme weather due to climate change is causing floods and droughts, a decrease in agricultural products, livestock and food supplies (Godde et al., 2021) Groundwater tables are depleting due to climate change making it hard for the population of South Asia to increase their crop yield. The population of South Asia is at hunger risk in this fragile environment. According to World Health Organization (WHO, 2020), South Asia is one of the most affected regions that is predicted to face malnutrition and food security due degradation of natural resources and high population growth vulnerable to climate change. In 2015 United Nations presented Sustainable Development Goals (SDGs) and SDG's goals 2 and 3 are food security and sustainable agriculture goals. SDG 2 is to "end hunger, achieve food security andimproved nutrition, and promote sustainable agriculture" (UNGA, 2015) and SDG 3 is to ensure good health and well-being for all. As SDGs are related to sustainable agriculture and food so achieving these goals means stable food security (Yan&Alvi, 2022).

METHODOLOGY

This research uses qualitative methods with a natural and descriptive approach and the emphasis is not on statistics but more on describing the actual and natural facts and events, and how the impacts can be minimized or avoided. The data is collected from literature by reviewing various information from reports of various UN agencies such as the Food and Agriculture Organisation (FAO), the World Bank, the Asian Development Bank, the United Nations Framework Convention on Climate Change (UNFCCC), the Intergovernmental Panel on Climate Change (IPCC). journals and documents, etc. The data is analysed by reviewing and interpreting data and making conclusions.

Conceptual Framework

This research is about the issues of agriculture, food security and water security due to climate change currently faced by developing nations of the world more specifically the South Asia countries. Human Security is the responsibility of the state which is facing not only societal and environmental challenges but also economic and political challenges. The objective of the study is to determine the effects of climate change on human security challenges such as agriculture, food security, water shortage and floods in South Asia.According to UNDP Human Security means security from disease, hunger and repression. United Nations Development Programme (UNDP 1994). Human security can be considered as political security, personal security, food security, environmental security, economic security and health security and there should be no threat at all levels.

However, Climate change has severely affected human security. Bushfire in Australia in 2019-2020 is the latest example of climate change, which caused destruction and life losses. Likewise, the massive 2010 floods in India and Pakistan and the 2022 floods in Pakistan caused loss of life and huge damage to crops is another example of explosive climate change. These floods caused water and food security as a challenge and threat for Pakistan and India and the international community. South Asia is a fertile land and most of its population is dependent on agriculture as a source of employment. South Asia has Mountain ranges of the Himalayas, Hindukush, and Karakorum huge storage of glaciers and snow melting water as a primary Source. However, climate change has caused increased glacial melting and unpredictable weather pattern.

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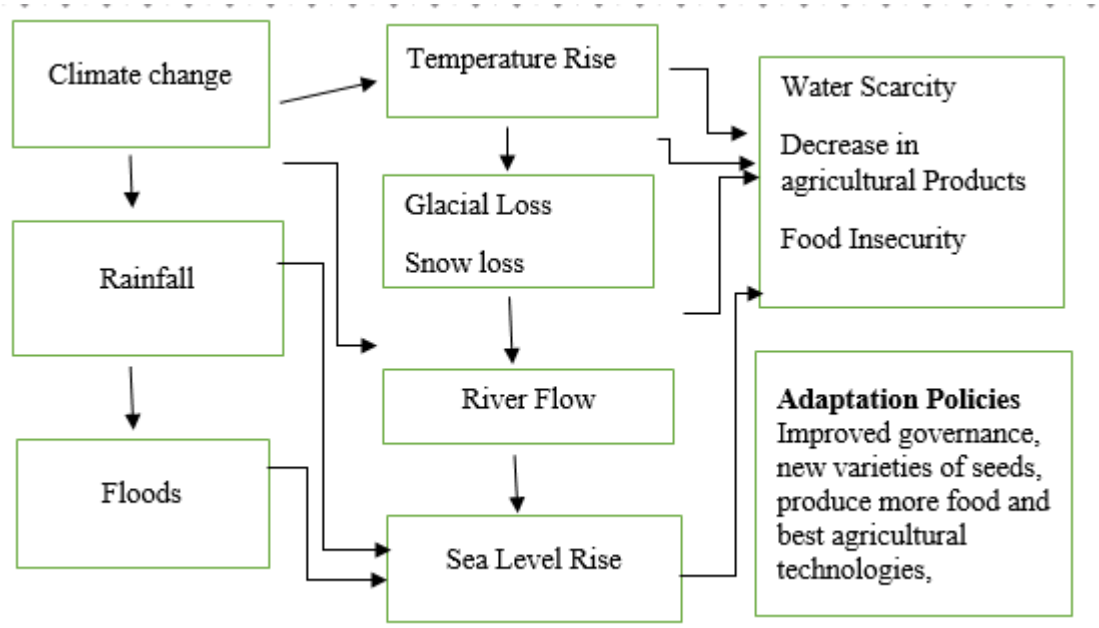

River Flow River

The aim of the research is to determine the human security risks due to climate change in South Asia. The aim of the study is also to determine the threats that climate change poses to the security of agriculture, water, and food. The study aims to find the impact on crop yields considering weather trends, temperature and production of major crops in South Asia and what challenges will South Asia face in the future due to climate change. Qualitative research methodology has been adopted to critically examine and analyse the latest situation of the climate-agriculture-water-food security nexus. The data is obtained from the articles more specifically from reports of those international organisations that are working on climate change. Reports of the United Nations, Food and Agriculture Organisation (FAO) World Bank, Asian Development Bank, United Nations Framework Convention on Climate Change (UNFCCC), Intergovernmental Panel on Climate Change (IPCC), World Economic Forum and government documents are used for research analysis. The arguments are built on the basis of the data available and the fact in these reports. The findings of the research are significant to explain and manage the challenges of food and water security posed by climate change in South Asia.

Theoretical Framework

Climate change affects the whole ecosystem as well as present and future generations of humans who are not to be blamed for it. To address the impact of climate change, it is essential to consider the moral and ethical values connected with it and to adopt a practical approach to associatepeople to ensure a better future for everyone.The climate change approach from a green theory perspective can be reinterpreted in terms of its longstanding ecological implications. The green theory approach inspires the nation to consider how our policies, decisions and actions will impact the climate for future generations. We may reinterpret challenges like climate change in terms of long-term ecological values and in this regard, green theory can play a decisive role. According to the green theory of the environment, collective human behaviour directly causes climate change (Barry, 2014). In particular, this has produced arbitrary political systems (states) with historically anthropocentric economic practices that have abused nature for their own short-term gain. According to the green theory, this technical deadlock needs a modification in human values and conduct, which creates an opening for political innovation or possibly a fundamental shift in world politics (Carter, 2002). Therefore, nations must consider moral and ethical considerations while policy making and implementation as these choices will directly impact the future of the whole world (Symons & Karlsson, 2015). Considering the green theory and adopting

ethical and moral approaches nations can protect the environment and secure the rights of generations to come. The green theory promotes social and environmental service as Derek Wall, a British green proponent highlighted four main pillars that well define green politics. These pillars are Ecological Wisdom, Grassroot Democracy, Social Wisdom, Social Justice and Nonviolence which make the foundation of green politics and can be helpful to attain just and sustainable world.

Temperature, Glacial Loss, River Flow and Sea-level Rise

A warming trend has started in South Asia and world temperature is expected to increase by 4°C while South Asia's temperature will increase by 3°C to 6°C by 2100 (Kumar et al., 2010). Moonson pattern changes are expected to be more challenging for the population of South Asia as it depends on runoff rivers and precipitation as freshwater sources. According to Schewe and Levermann (2012), global warming has caused a change in monsoon rainfall patterns can result in major drought in South Asia. In the past century, 80 percent of the moisture is receding supplied by summer monsoon to Himalayan Glaciers. Indus and Brahmaputra are most vulnerable to snowmelt and glacier melt due to climate change (Bajracharya et al 2015).In coming decades there is projected to be a considerable drop in the flow of these rivers in summer and late spring as there is a shift of high winter with the increase in 2°C warming which can be extreme as 4°C (Diffenbaugh, Scherer&Ashfaq 2013). Glacial ice loss, snowmelt and precipitation changes can lead to a considerable change in the extreme flow of downstream. Gain et al (2011) for instance predict the Brahmaputra may rarely face low flow in the future.Nevertheless, the rise in flow would cause high flood risks with the rise of sea level, which would cause alarming impacts on Bangladesh specifically and South Asian other regions. The Sea-level is projected to rise by 0.65m with an increase of 4°C causing local and international risks (World Bank 2014).

Water-Related Climate Change Impacts

Hydrological Cycles such as glacial loss, snow melting, the decline in snowfall, extreme rainfall, river flow change sea level rise and droughts pose potential threats in South Asia. The monsoon's timely arrival and its regularity are very important for food production in this region. The Brahmaputra, Ganges and Indus Basins supply water to the population of 750 million fifths of the world's total population (Bajracharya et al 2015). An increase of fewer snow years and a climate shift of high winters and low summer runoff would likely increase freshwater availability and flood risks.The flooding includes inland river floods, extreme precipitation, glacial lake eruptions, landslides, and coastal river floods combined with the impacts of sea-level rise (Mirza 2010). The main flooding cause is precipitation and Pakistan experienced severe floods in 2010 (Webster et al., 2011). and 2022. Flood risk has grown since 1980 due to economic and population growth in low-lying areas and coastal regions in South Asia. According to UNISDR (2011),the floods of 2010 have effects on 45 million people which is about 65% of the world's population. Similarly. due to global warming, people are more prone to increase river flooding (Arnell and Gosling 2013). By 2100, the population of South Asia is predicted to dispose to floods due to the rise of 4°C.According to Arnell and Gosling (2013), the population's vulnerability to river floods rises sharply as global warming continues. In a 4°C future, approximately twice as many people are anticipated to be in danger of flooding globally in 2100 as opposed to a 2°C scenario, and by the 2050s, increases in the risk of flooding are especially significant for South Asia.

People living near coastal lines are vulnerable to floods, wetlands loss, livelihoods and infrastructure loss due to climate change and the rise of sea level along with human activities such as irrigation barrages, water diversions, upstream dams and water withdrawals (World Bank 2010). The population of Bangladesh is densely populated near the sea level and most vulnerable to floods as it happens every three to five years. These floods happen to occur frequently affecting the agriculture of South Asia. According to the estimates of Mirza (2011), there is a 29% increase in flooding with a 2.5°C increase in temperature.According to Vinke et al (2017), Pakistan is expected to have an increased risk of drought, while the Southern region of India is expected to face increased wetness. With the 3-4°C temperature increase by the end of the 21st century, Pakistan, Afghanistan and Northwest India would face severe drought.

Water security is dependent on an increase in population growth, economic and agricultural activities, increased precipitation, glacial water loss, snow melting and variations of seasonal changes in South Asia. Studies in South Asia find that the region is at high risk of waterstress (Fung, Lopez& New 2011) With a low capacity of water storage, resultantly increases the vulnerability of water flow fluctuation and precipitation patterns. Climate change worsens the situation of agricultural production(Sadoff& Muller 2009). Global warming affects river runoff in the Himalayas region of South Asia projected by Fung et al. (2011) and this runoff increases in monsoon seasons causing severe floods and a decrease in the dry season causing warming. An increase of 2.7°C can cause an increase in runoff by 20% and a 4.7°C increase is expected to cause a 50% increase. By 2080 the availability of per capita water in South Asia will decrease by 10% in Nepal and Pakistan and for India it will be between 30%-50%. According to Rockström et al. (2009) by 2050 2°C warming the water and food demand is likely to exceed the water availability of rainwater and underground water by 150% in India thus depending on blue water for agriculture production. Similarly, water availability for agriculture in Pakistan and Nepal will be below 1300m per capita annually which will cause an alarming situation for a balanced diet.

Agriculture-related climate change impacts on South Asia

In South Asia agriculture is extremely vulnerable to threats posed by climate change. By 2050 the rise in temperature projected by IPCC is 0.88-3.16°C and by 2080 1.56–5.44 °C (IPCC 2007a). Therefore, a rise in temperature and rainfall patterns is not only expected to shift monsoon and winter crop seasons but the suitability of crop cultivation and the possibility of an increase in pests and diseases can affect crop production and food sustainability. The rise in temperature and CO2 uncertain rainfall patterns can disrupt Monsoon Crop yield but the magnitude of disruption of winter crop yield can be huge. For instance, Pakistan's maize production periods have shifted to 4.6 days earlier in spring and 3 days per decade delayed in autumn (Abbas et al. 2017). Frequent extreme weathers disrupt crop yield severely in India due to the frequency and duration of floods and drought, pests and diseases, decreased duration of winter and decreased winter rainfall (Ravi 2008)

Climate change has increased the temperature and patterns of rainfall andthe relation between crop yields and water availability in the soil during the crop growing season has decreased. It indicates that during the growing season, the no or low availability of soil water and high heat stresses is damaging crop production (Porter and Semenov 2005). If these challenges remain and are not addressed then the rise in temperature will have determinantal effects on agriculture in South Asia (Lal 2011). Thus, countries need adaptive capacities to increase their crop productivity (Aryal et al. 2018a). Himalaya and Hindukush regions of India Pakistan Nepal and India are the most vulnerable parts to climate change due to their high dependency on agriculture for their living. These parts of South Asia have poor infrastructure, low productivity and limited global market access. (Rasul et al. 2019). The climate change impacts wheat, maize and rice in South Asian Countries and the production of these agricultural products has decreased due to precipitation variability and change in temperature.

There is a crop decrease of 5% in wheat, 6-8% in rice and 10-30% in maize (Aryal et al 2019). 57% of Bhutan's population is dependent on agriculture even though mountain topography has constrained farming. Bhutan is experiencing a loss in crop yield due to erratic rainfall, floods, landslides, hailstorms, windstorms, drought and diseases and pests (Chhogyel& Kumar 2018). The groundwater in India is depleting and can reduce crop production by half due to global warming and other climate changes. The rainfall in the monsoon period is decreased by 19% causing the reduction of agricultural production by 18% (Kumar et al. 2004).

The Rise in temperature has a negative impact on rice and wheat production in South Asia due to the rise in dryness level. With the projected 2°C increase in temperature and a 7% precipitation rate decrease, the agricultural revenue is predicted to decrease by 8.4%. Similarly, a 1°C increase in temperature is expected to decrease by 6-9% wheat production. Likewise, in Sri Lanka, a 0.5°C temperature rise will decrease rice production by 6%. Shahid (2011) suggests that rice production is expected to decrease by 8% and wheat by 3.2% in Bangladesh by 2050.

Impact of Climate Change on Food Security in South Asia

South Asian countries are the most populated countries having a population of 1.86 billion. The UN estimates a 25% increase in population by 2030and by 2030 there will be a further 10% increase in Population (Uhlenbrook& Connor,2019). Due to climate change, there is a water shortage that has decreased agricultural product yields and caused food security issues. The challenges to meet the food demands of the population of South Asia is a daunting task because of climate change. Studying food security is very important for the countries of South Asia as 30% of the world population facing food insecurity is the inhabitant of this region (WEF, 2011).

According to the World Bank estimates 702 million people in the region are living in extreme poverty and the malnourished population number is even higher with 786 million and 425 million living in Asia (FAO, 2022). Climate change will intensify the food security issue creating water shortages, extreme weather conditions and rainfall patterns during monsoon. The Food and Agriculture Organisation (FAO,2017) report highlighted four food insecurity indicators. These are "Food Availability, Food Access, Food Utilization and Food stability".

Food Availability

Climate change will negatively affect the quality and quantity of food availability. Major crops production has decreased which is directly affected by the rise in temperature. Therefore, crop yield decrease and its quality will be more alarming in the future. It can be the cause of severe conflict as countries can make negative strategies to take control of scarce food resources.

Food Access

The increase in Population has increased food demand and climate change's negative effect on the production and quality of crops is expected to disturb the balance between demand and supply and will decrease food access. The imbalance between increased demand and decrease food supply will consequently increase major crop prices. Hence South Asia will need to spend more on food security which is already a poverty-ridden region. Thus, climate change will negatively affect food access

Food Utilization

The rising population and decreased agricultural yields have caused a shortage of food in South Asia. Thus, causes a reduction in food availability and food access resultantly facing low nutritional value due to less calorie intake because of food scarcity and diverse diet patterns.

Food Stability

Climate change has increased the extreme weather intensity and frequency which is going to make it hard to manage to meet food production targets. Moreover, food availability is negatively affected due to variable precipitation and drought. Furthermore, uncertain weather changes have made projecting the correct crop yield difficult. Increased population growth and uncertain food supply will disturb food supply stability.

As discussed earlier climate change is expected to cause a decrease in food production andSouth Asia is the most vulnerable region for food security due to the decrease of growth of crop yield with the rise in temperature. Similarly, per capita calorie is also expected to decline along with the increased proportion of malnourished children by seven million in South Asia. By 2030 food pricing is expected to rise due to agricultural production shocks. In this low productivity scenario, the non-agricultural urban and rural population will severelybe affected by high prices of food and one-third population of Bangladesh is facing poverty along with India, Sri Lanka and Pakistan. The impact of global warming on food has negatively impacted food production which has a direct effect on malnutrition and undernourishment resulting in poor health and increased death rates. In South Asia 31percent of children below five years of age are underweight and 62% are facing child stunting and it can increase by 29% by 2050. Food shortage is predicted to happen in South Asia due to the decrease in agricultural products. According to the study of Springmann et al. (2016), by 2050 more than 500,000 deaths will occur in South Asia and Southeast Asia due to food shortagesand changes in diet as people will eat less water-intensive vegetables and fruits and less red meat that will lead to critical diseases like cancer and heart attack. Therefore, adaptation

policies for water availability, agriculture and food security are inevitable, as the temperature is rising due to climate change causing waterlogging and heat stresses.

Climate change adaptation Policies in South Asia

To overcome the negative impact of climate change on agriculture and food security the countries of South Asia need to formulate effective adaptation policies. Adaptation policies mean adjusting to the natural and human systems for actual and projected climate change that can minimize the harmful intensity and can change it into an opportunity. Agricultural and food security adaptation involves both technological and nontechnological solutions. For instance, South Asia needs improved governance, new varieties of seeds, produce more food, and best agricultural technologies, insurance, markets, risk sharing or reducing risk and social networking. Other adaptation options are improved cropland management, multiple cropping, including new crops, changing crop sequence, increase food productivity, integrated crop-livestock system, soil erosion prevention and reversal. With these adaptation policies, South Asia will be able to minimize the risk of food insecurity and will increase agriculture production with a variety.

Water harvesting (collecting rainwater) an old method used in many areas of South Asia is a potential method for irrigation across seasons. Water management can also minimize groundwater as well as runoff water. Similarly, the adaptation of micro-irrigation sprinkles and drip water can also save water. Sustainable intensification like water use efficiency, pest management, improved nutrients and soil fertility can overcome food insecurity. The cultivation of trees with agricultural crops on the same land can reduce the risk of floods and droughts. Combining grass and shrubs called silvopastoral systems for forestry and livestock grazing can also reduce land degradation water runoff and improve soil fertility (Aryal et al. 2020). This will not only provide rural farmers to double their income, one from fruit, flower, timber and medicine-producing trees and the other from their crop production thus causing food security.

CONCLUSION

Climate change is predicted to affect South Asia as an increase in temperature, glacial melting and snow melting, heat waves, monsoon rains, floods, drought and rise of sea level. Indus and Brahmaputra are most vulnerable to snowmelt and glacier melt due to climate change. The Sea-level is projected to rise by 0.65m with an increase of 4°C causing local and international risks.The results show that there is a rise of 2°C temperature by 2050 causing major threats to the development of South Asia. Agriculture is also affected by climate change causing major challenges to food security as South Asia is dependent on regular rainfall patterns for agriculture. Climate change is predicted to intensify the flood problems. The monsoon rains are becoming more variable and river peak flow timing may change and cause floods. Sea level is rising causing major threats to agriculture and population as saline water can penetrate inland disrupting food crops. Similarly, frequent floods and droughts will also damage food crop yields which can create unemployment making a huge population of South Asia vulnerable to malnutrition and starvation. The rise of temperature and precipitation patterns cause floods directly affecting the decrease in agricultural products and causing food security issues. Food insecurity would increase the prices of food in South Asia which would cause malnourishment, hunger and poverty. South Asia is predicted to face human security issues because the impacts of climate change. Water scarcity for agriculture, depletion of fresh water and food security can worsen the situation in South Asia. Furthermore, countries in South Asia can face inter-state and intra-state conflicts because of water scarcity and food security which can be the cause of regional instability.Therefore, Countries of South Asia should adopt short and long-term adaptation policies for food and water security to avoid food and water security and to mitigate the negative impacts of climate change. To implement these policies and avoid the impacts of climate change, countries of South Asia should develop and strengthen institutions at the state and regional levels. The formulation and implementation of policies for climate change can be helpful to overcome water scarcity and food insecurity and to increase agricultural growth in South Asia.

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