

REGIONAL INTEGRATION AND DETERMINE THE VULNERABILITY OF CLIMATE CHANGES IN AGRICULTURE AND FOOD SECURITY IN SOUTH-ASIA

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ABSTRACT

Continuous carbon emission and green house gas (GHG) creates vulnerable crisis of climate changes in South-Asia at present and ultimate consequence in near future on food security, forestry, human health, biodiversity and ecosystem. Rising temperature, solar radiation and precipitation have been a mammoth influential factor of deterioration of production of food items in the SAARC region not just that it also accelerate the poverty level and also create endanger of small farmers along with expansion of migration problems. Sea level rises craft salinity intrusion, having poor research infrastructure this region unable to develop eco-friendly organic product. Regional Adaptation and regional mitigation can expand horizon where proper regional collaboration and commitment and continuous research and information sharing reduce the sufferings of the people. Local government as well as the South-Asian body should focus on agro-base seed bank for the food security that might be the good options for ensure lightening and prosperous SARRC region.

Key words: carbon emission, GHG, climate changes, solar radiation, precipitation, SAARC, adaptation, mitigation, migration, organic product, local government

1. Introduction

Climate change is an issue that instigates the consequential issues for the deterioration of the status of living in the South-Asian region. South-Asia is the highly sensitive region of climate changes due to the increasing temperature that causes sea level rise and affects low lying coastal areas and deltas of the world. Already climate changes makes vulnerable crisis especially land corrosion, salinity intrusion and thrashing in biodiversity and for that reason food production has been deteriorating in this reason. In imminent future sea level rise will cause river bank erosion, salinity intrusion, flood, damage to infrastructures, crop failure, fisheries destruction, loss of biodiversity and so on. Adaptation and mitigation are two options that decelerate the vulnerable condition of the 200 million of people in this region. Agriculture is an inseparable part for the escalating of GDP of the South-Asian region and that contributes green house gas (GHG) also. For mitigation of GHG this region now concentrates on organic agriculture (OA) that is eco-friendly and also reduces carbon emission. For ex-termination of climate changes this region make a better collaboration for improve productivity of the crops, regional cooperation for knowledge generation and sharing on climate change, national and regional research for agro base product , water security and strengthen disaster management and promote Public private partnership (PPP) to resolve crisis that can ensure food security in the future.

2. Objective: The objective of this paper is illustrated here;

1. To determine the impact of climate changes in agriculture and food security in South-Asia.
2. To analyze the causes of climate changes and its effect on agriculture.
3. To understand climate changes and its impact on regional integration and bilateral relation among South-Asian countries.

3. Research Methodology: The study has been conducted mainly on the basis of literature survey and secondary information. Various seminar papers and summary of discussion in those seminars, taskforce reports of research organization, journals and some periodicals on climate change have been surveyed for the purpose of the study. Some environmental analyst and expertise person has also been interviewed for the purpose of accumulating facts and information.

4. Literature Review:

Regional integration is a process in which states enter into a regional agreement in order to enhance regional cooperation through regional institutions and rules. The objectives of the agreement could range from economic to political, although it has generally become a [political economy](#) initiative where commercial purposes are the means to achieve broader socio-political and security objectives (Hill, 2003). South Asia covers 3 percent of the world's land surface, contains 22 percent of the world's population, and shares 1 percent of the world's trade.

South Asia is home to almost 1.5 billion people with diverse geography. The region has been bestowed with rich biodiversity, mountains, glaciers, coasts, deserts and productive plans. However, South Asia is also vulnerable to all types of climate change impacts. It is projected that climate change will bring severe changes in livelihood patterns and lives of people in South Asia. The region will have to face a range of problems and vulnerabilities. Even Maldives, coastal parts of Sri Lanka, Bangladesh, Pakistan and India would be at the risk of extinction. Specific areas of concern for South Asia would be agriculture and food security, water resources, coastal sinking, loss of biodiversity and its impacts on regional security. However,

the panel will specifically look into agriculture and food security, and water. Numerous factors shape and drive the agricultural sector. Market fluctuations, changes in domestic and international agricultural policies (such as the form and extent of subsidies, incentives, tariffs, credit facilities, and insurance), management practices, terms of trade, the type and availability of technology and extension, land-use regulations and biophysical characteristics (availability of water resources, soil quality, carrying capacity, and pests and diseases) are among the set of primary influences. Climate change is expected to result in long-term water and other resource shortages, worsening soil conditions, drought and desertification, disease and pest outbreaks on crops and livestock, sea-level rise, and so on. Vulnerable areas are expected to experience losses in agricultural productivity, primarily due to reductions in crop yields (Rosenzweig and others 2002). Climate change on the agricultural sector has prompted concern over the magnitude of future global food production (Intergovernmental Panel on Climate Change (IPCC) 1996; Bindi and Olesen 2000). Early global estimates predict (without consideration of CO₂ fertilization effects or adaptation) a 20–30 percent reduction in grain production (Darwin and others 1995). Declines in aggregate production are anticipated in most of Africa and South and East Asia (for example, Western India, Bangladesh, and Thailand), with increments in countries such as Indonesia, Malaysia, Taiwan, and parts of India and China. Murdiyarso (2000) highlights that rice production in Asia may decline by 3.8 percent of production levels of 2000 (estimated at 430 metric tons) under likely future climate regimes. Seshu and Cady (1984) estimate a decrease in rice yield in India at the rate of 0.71 ton per hectare given an increase in minimum temperature from 18o C to 19o C. The authors also associate a decrease of 0.41 ton per hectare with a temperature increase from 22o C to 23o C. Similarly, Sinha and Swaminathan (1991) find that a 2o C increase in mean air temperature could decrease rice yield by about 0.75 ton per hectare in the high-yield areas and by about 0.06 ton per hectare in the low-yield coastal regions. Further, a 0.5o C increase in winter temperature would reduce wheat crop duration by seven days and reduce yield by 0.45 ton per hectare. Rao and Sinha (1994) estimate that wheat yields could decrease by 28–68 percent. Similarly, Aggarawal and Sinha (1993) show that in North India, a 1o C rise in mean temperature would have no significant effect on wheat yields, while a 2oC increase would reduce yields in most places. The main conclusion to emerge from those, besides early estimates of impacts, is that countries in the tropical zones (essentially South Asia) are the most vulnerable. More recently, Murdiyarso (2000) estimates the potential impact of climate change and variability on rice production in Asia, taking into account CO₂ effects, to be a decrease of 7.4 percent of rice potential per degree increase in temperature. Mirza and others (2003) examine the impact of climate change on river discharges in Bangladesh, including possible changes in the magnitude, extent, and depth of floods of the Ganges, Brahmaputra, and Meghna (GBM) rivers. Agricultural production will decrease manifold due to increased extent and incident of pest and disease attack, soil erosion, droughts, floods and loss in productivity. “It is predicted that there would be 2.5 to 10 per cent decrease in the yield of crops in 2020s and 5 to 30 per cent decrease in 2050s from the levels of 1990s in Asia” (IPCC 2007). According to the World Bank (2008), “Loss in productivity and production will impact food security in the region, which is already the most food insecure region with a population of 229 million people.”

Bangladesh lost about 0.5 million tonnes of rice annually as a result of floods that accounts for nearly 30% of the country's average annual food grain imports (Paul and Rashid 1993). In Bhutan, for instance upland crop production, practised close to the margins of viable production, can be highly sensitive to variations in climate. A temperature increase of 2 °C would shift the cultivating zone further into higher elevation. This means that crops that are sensitive to low temperatures can be introduced into higher elevations with this temperature rise. In the hot climate of Pakistan, cereal crops are already at the margin of stress. An increase of 2.5oC in average temperature would translate into much higher ambient temperatures in the wheat planting and growing stages. Higher temperatures are likely to result in decline in yields, mainly due to the

shortening of the crop life cycle especially the grain filling period. More recently, the National Communication (MoE 2003) highlighted that crops like wheat, cotton, mango, and sugarcane would be more sensitive to increase in temperatures compared to rice. Extreme events of rise in temperature and changes in rainfall patterns will have adverse impacts on agricultural production in Sri Lanka. The changed rainfall scenario suggests an increase in amplitude of rainfall extremes causing adverse environmental impacts. Climate scenarios produced by the CSIRO indicate that temperature changes are significant for Sri Lanka by the year 2070. So it is to be noted that regional commitment and collaboration can reduce the uppermost vulnerability in this region.

5. Climate Change:

Today, global warming is a major and controversial issue all over the world. It affects many aspects of life; agriculture, plant and animal biodiversity, environment and socio-economic well being. Global warming occurs because of heat-entrapment in the atmosphere by greenhouse gases (GHG). Global warming causes climate change. Since agricultural crops are greatly affected by climate patterns; the agro-ecological sustainability of crops will be affected. A study by the Indian Agricultural Research Institute (IARI) found that a temperature increase by about 20C will reduce grain yields in some regions. The three major greenhouse gases are carbon dioxide (CO₂), methane (CH₄) and nitrous oxide (N₂O).

The greenhouse effect occurs when the concentration of greenhouse gases ranges from about 190-280 parts per million (ppm). The problem only arises if there is imbalance between greenhouse gas production and gas sequestration. CO₂ gas makes the biggest contribution to global warming, being about 56%, while CH₄ contributes 18% and N₂O about 6%. Data from the Intergovernmental Panel on Climate Change revealed that the concentration of CO₂ gas increased from 280 ppm to 379 ppm/year, and is still increasing at the rate of 1.9 ppm/year. If this continues without any prevention efforts, the Earth's surface temperature is expected to rise between 1.8 up to 2.90C in 2100.

The increasing temperature up to 30C will destroy biodiversity which affects both food production and water conservation. It may also lead to increased pest and disease infestations. South Asia is acknowledged as a tropical agriculture region and is thus very vulnerable to the impacts. Paddy is the main crop in this region and its cultivation is dependent on irrigated and rain-fed systems, making it highly susceptible to climate patterns. Any deterioration of paddy production through the impact of climate change will result in serious problems in South East Asian countries in the longer term.

Box: Kyoto protocol and its framework for reducing carbon emission

The Kyoto protocol is an international agreement linked to the United Nations framework Convention on Climate Change. The major feature of the Kyoto protocol is that it sets binding targets for 37 industrialized countries and the European community for reducing greenhouse gas (GHG) emission. 30% of total carbon emissions are controlled but rest of 70% causes the vulnerable situation. USA, China, India and other economic develop countries should taken necessary steps to diminish carbon emission. The adaptation fund is established to finance adaptation projects and programmes in developing countries for assistance. At the end of 2012 a new international framework needs to have been negotiated and ratified that can deliver the stringent emission reduction the IPCC has clearly indicated are needed.

5.1 South Asia and its economy: The growth rate of this region (SAR) has improved dramatically since the 1980's. The economic cycle of this is control by the agriculture. Most of the people especially poor people in rural area largely depend on agriculture. In recent years this sector deteriorating due to the climate changes that increases poverty, unemployment especially coastal area and also hunger problem.

Table 1: GDP and percentage (%) of Agriculture in South-Asia from 1971 to 2010

Country	GDP Growth				Agriculture			
	1971-1980	1981-1990	1991-2000	2001-2010	1971-1980	1981-1990	1991-2000	2001-2010
Bangladesh	1.9	4.6	4.8	5	0.5	2.7	2.9	2.3
Bhutan		7.8	6.1	6		4.9	3.2	2.8
India	3.4	5.5	6	6.5	2.1	3.7	3	2.5
Nepal	2.5	4.3	4.4	4.1	0.8	3.8	2.5	2.1
Pakistan	4.9	6.6	3.7	3.1	2.6	4.9	4.4	3.5
SriLanka	4.3	4.3	5.3	5.7	2.6	2.7	1.9	1.6

Source: World Bank, 2010

Poverty is an inseparable hindrance for accomplishing a substantial development in South-Asia. South-Asia has lots of potentiality, but it has been deteriorating due to the diseases like poverty. Purchasing Power Parity (PPP) adjusted \$1.25 a day measure of poverty the World Bank (WB) estimates South Asia's headcount poverty rate at 40.4 per cent for 2010. This is the second highest rate after Sub-Saharan Africa (50.9 per cent).

Table: 2 Poverty level of the world

Region	% in \$1.25 a day poverty	Population (millions).	Pop. in \$1 a day poverty (millions)
East Asia and Pacific	16.8	1,884	316
Latin America and the Caribbean	8.2	550	45
South Asia	40.4	1,476	596
Sub-Saharan Africa	50.9	763	388
Total Developing countries	28.8	4673	1,345
Europe and Central Asia	0.04	473	17
Middle East and North Africa	0.04	305	11
Total		5,451	1,372

Source: See World Bank PovcalNet "Replicate the World Bank's Regional Aggregation" at <http://iresearch.worldbank.org/PovcalNet/povDuplic.html> (accessed May 7, 2010).

Rising cost of energy, water shortage and continuous natural disaster makes a vulnerable position in the ground of food security in South-Asia. Unfortunately there is absence of cross-boundary water sharing agreement which is one of the inescapable crises for originates this kind of food security.

Agriculture production

Climate change will make precipitation level increase to 3.6% in 2020 which cause raising temperature and humidity in South Asia. For tropical areas, increased temperature above a critical temperature greater than 300C by itself could lead to grain yield decreases and will decline up to 10% of paddy production.

Economic Agriculture as critical sector in South Asian countries contributes industrialization and economic growth. Climate change impacts will decline agriculture productivity, rising food prices and cause negative GDP (Gross Domestic Product) in agrarian countries.

Social Agriculture sector absorb most of labor (almost 50-75%). Unsustainability in agriculture sector will cause poverty, unemployment and hunger problems.

Food security About 90% of world's rice production is in Asian countries, productivity losses and high population growth in the world (population growth 1.25-1.50) will risk food security and hunger problems.

5.2 Climate change effect on crop production:

The major food crops in South-Asian are wheat and rice. Regarding wheat the two major South Asian wheat producing countries (India, Pakistan) achieved substantial gains in wheat productivity between 1970 and 2000 but have faced stagnation since then. Productivity improvements and yield per hectare compare positively with North America but yield remains way behind European Union (EU) countries and East Asia. South Asian countries show significant gains in rice production since 1970, especially in Bangladesh and Sri Lanka, but the productivity gap with most of the world (except Sub-Saharan Africa) is large.

Table 3: Production of Rice and Wheat in South-Asia

Country name	2009		2010	
	Rice (1000 MT)	Wheat(1000 MT)	Rice (1000 MT)	Wheat(1000 MT)
Pakistan	6800	24000	4700	23900
India	89090	80680	95300	80800
Sri Lanka	2650	-	2400	-
Afghanistan	335	4250	275	3700
Bangladesh	31000	850	32900	1200
Nepal	2900	1400	2900	1400
Bhutan	-	20	-	20

Source: World Bank, 2010

The average per hectare yield in the better performing countries of Sri Lanka and Bangladesh around 3.7 MT/Ha is still 80 percent lower than the yield in North Africa 7.0 MT/Ha, 60 percent lower than North America and 30 percent lower than in East Asia (5.5 MT/Ha). The gaps are even larger for India and Pakistan. The major constraints of poor productivity is lack of technology, unavailability of inputs like energy, fertilizer and water , poor incentives and the most significant issues is that climate changes. In the year of 2011 the population is around 700 billion and in the year of 2050 the total population may be double but the production of different crops like rice, wheat, Maize, Millet, Sorghum not increase at all. Average temperature rise (2°C- 3.5°C) and sea level rise create the insufferable crisis in this South-Asian region. The given table illustrated that without having any effect of climate change in the year of 2050 rice, wheat and maize production are around 168.9,191.3 and 18.7mmt but if consider of climate change the condition is perplexing .

Table 4: Climate-change effects on crop production, no CO2 fertilization

Agriculture Product	South Asia	East Asia and the Pacific	World
Rice			
2000 (mmt)	119.8	221.7	390.7
2050 No CC (mmt)	168.9	217	455.2
2050 No CC (% change)	41	-2.1	16.5
CSIRO (% change)	-14.3	-8.1	-11.9
NCAR (% change)	-14.5	-11.3	-13.5
Wheat			
2000 (mmt)	96.7	102.1	583.1
2050 No CC (mmt)	191.3	104.3	917.4
2050 No CC (% change)	97.8	2.2	57.3
CSIRO (% change)	-43.7	1.8	-23.2
NCAR (% change)	-48.8	1.8	-27.4
Maize			
2000 (mmt)	16.2	141.9	619.2
2050 No CC (mmt)	18.7	264.7	1061.3
2050 No CC (% change)	15.4	86.5	71.4
CSIRO(1) (% change)	-18.5	-12.7	0.2
NCAR (2) (% change)	-8.9	8.9	-0.4

Source: International Food Policy Research Institute (IFPRI)

5.3 Price escalation:

World prices are a useful single indicator of the effects of climate change on agriculture. With no climate change, world prices for the most important agricultural crops—rice, wheat, maize, and soybeans

Note: 1. The National Center for Atmospheric Research, US (NCAR) model

2. The Commonwealth Scientific and Industrial Research Organization, Australia (CSIRO) model

will increase between 2000 and 2050, driven by population and income growth and biofuels demand. Even with no climate change, the price of rice would rise by 62 percent, maize by 63 percent, soybeans by 72 percent, and wheat by 39 percent. Climate change results in additional price increases— a total of 32 to 37 percent for rice, 52 to 55 percent for maize, 94 to 111 percent for wheat, and 11 to 14 percent for soybeans. If CO₂ fertilization is effective in farmers' fields, these 2050 prices are 10 percent smaller. So that in near future food crisis creates catastrophe condition to the poor people in this region and due to the effects of climate changes the price of the necessary products is unattainable.

Table 5: World food prices (US\$/metric ton) in 2050 and present changes for selected crops and livestock products.

Agriculture Product	2000	No Climate Change	2050		NCAR CF effect (% change from CF)	CSRO CF effect (% change from CF)
			NCAR no CF	CSRO no CF		
Rice (US\$/mt)	190	307	421	406	-17.0	-15.1
% change from 2000		61.6	121.2	113.4		
% change from 2050						
no climate change			36.8	32		
Wheat (US\$/mt)	113	158	334	307	-11.4	-12.5
% change from 2000		39.3	194.4	170.6		
% change from 2050						
no climate change			111.3	94.2		
Maize (US\$/mt)	95	155	235	240	-11.2	-12.6
% change from 2000		63.3	148	153.3		
% change from 2050						
no climate change			51.9	55.1		
Soybean(US\$/mt)	206	354	394	404	-60.6	-62.2
% change from 2000		72.1	91.6	96.4		
% change from 2050						
no climate change			11.4	14.2		

Source: International Food Policy Research Institute (IFPRI)

5.4 Impact of climate changes: The impact of climate change making an adverse effect on the entire world but there will be distressing situation in South Asia. The rapid melting of glaciers is initially expected to contribute to excessive water flow and flooding in this region. Eventually, the full loss of glaciers, if it happens, would have a severe affect on the availability of fresh water to the three mighty rivers of Indus, Ganges and Brahmaputra. These rivers are the life line for an estimated 500 million people in India, Pakistan and Bangladesh who are dependent on water from these rivers. Much of this population is very poor. The coastal population in South Asia is already facing a serious flooding problem from rising sea level due to climate change. The sea level could rise to 40 cm higher than the present level by the end of the 21st century and submerge a huge area of the South Asian coastal belt (Ahmed, 2010). Over 70 million people living in this area will face multifarious peril situation. The threat is particularly serious for the Maldives and Bangladesh. Human health is also at risk from growing incidence of diseases linked to rising temperature and rainfall. Effects may range from diarrheal diseases to increase malnutrition and also cause different untold disease because of lack of calories.

Table 6: Daily Per Capital Calorie Availability With And Without Climate Change

Region	2000	2050				
		No Climate change kcal/day	NCAR no CF Kcal/day	CSIRO no CF Kcal/day	NCAR CF effect (% change relative to NCAR no CF in 2050)	CSIRO CF effect (% change relative to NCAR no CF in 2050)
South Asia	2424	2660	2226	2255	4.3	4.3
East Asia and the pacific	2879	3277	2789	2814	4.3	4.3
Europe and Central Asia	3017	3382	2852	2885	2.7	2.9
Developing countries	2696	2886	2410	2432	5.7	5.7
Developed countries	3450	3645	3190	3215	2.3	2.5

Source: International Food Policy Research Institute (IFPRI)

6. Climate change and its effect on agriculture in South Asia:

India: The major food grain producing regions of Haryana, Punjab and western Uttar Pradesh experience the most negative effects, along with the coastal districts of Tamil Nadu. Wheat yields in central India may drop by 2% in a pessimistic climate change scenario. Districts in western Rajasthan, southern Gujarat, Madhya Pradesh, Maharashtra, Northern Karnataka, northern Andhra Pradesh, and southern Bihar are highly vulnerable to climate change in the context of economic globalization. Temperature rise of 1.5 degree centigrade and 2 mm increase in precipitation could result in a decline in rice yield by 3 to 15 %. Sorghum yield would be affected and yields are predicted to vary from +18 to -22 % depending on a rise of 2 to 4 degree centigrade in temperature and increase by 20 to 40 % of precipitation. The loss in net revenue at the farm level is estimated to range between 9% and 25% for a temperature rise of 2°C- 3.5°C.

Pakistan: Over the past month the country's southern region has received the highest monsoon rains ever recorded. In 2010 at least 20 million people were directly affected and nearly one million homes were destroyed in the flood. Deforestation has been another cause of this vulnerable situation. Wheat yields are predicted to decline by 6-9 % in sub-humid, semiarid, and arid areas with 1°C increase in temperature while even a 0.3°C decadal rise could have a severe impact on important cash crops like cotton, mango, and sugarcane.

Bangladesh: Bangladesh is the most vulnerable country due to climate changes. According to the coastal zone policy (CZPo, 2005) of the Government of Bangladesh, 19 districts out of 64 are in the coastal zone covering a total of 147 upazillas of the country. Out of these 19 districts, only 12 districts meet the sea or lower estuary directly. The coastal zone covers 47,201 square kilometer land area, which is 32 percent of total landmass of the country. Water area covers 370.4 km (200 nautical miles) from the coastline (UNCLOS, 1982; Article 57), estuaries and the internal river water. According to National Adaptation Programs of Action (NAPA, 2002) dialogue, per capita CO₂ emission in Bangladesh is 0.2 ton per year. But that figure for developing countries, world average, industrial world and United State of America (USA) is 1.6, 4.0, 6.0 and 20.0 ton respectively. Bangladesh is highly vulnerable to sea level rise, as it is a densely populated coastal country of smooth relief comprising broad and narrow ridges and depressions (Brammer et al., 1993). World Bank (2000) showed 10 cm, 25cm and 1 m rise in sea level by 2020, 2050 and 2100; affecting 2%, 4% and 17.5% of total land mass respectively (Frihy, 2003) reported 1.0 cm per year sea level rise in Bangladesh.

Table 7: Sea level rise (SLR) in Bangladesh and its possible impacts

Year	2020	2050	2100
Sea level rise	10cm	25cm	1m
Land below SLR	2 % of land (2,500 km ²)	4 % of land (6,300 km ²)	17.5 % of land (25,000 km ²). Patuakhali, Khulna and Barisal regions will be most affected
Flooding	20% increase in inundation	Increase flooding in Meghna and Ganges floodplain. Monsoonal floods increase yield loss.	Both inundation area and flood intensity will increase tremendously.
Agriculture	Inundate 0.2 Mmt. of production; < 1 % of current total.	0.3 m SLR inundate 0.5 Mmt. of production; 2% of current total.	Devastating flood may cause crop failure for any year.
Ecosystem	Inundates 15% of the Sundarbans	Inundates 40% of the Sundarbans.	The Sundarbans would be lost.
Salinity	Increase	Increase	Increase

Source: (World Bank, 2000)

Sea level rise will increase flood frequency and flooding duration, affecting Aman production. Due to sea level rise, salinity of water and soil will increase, and this will damage Aman cultivable land. Because of the shortage of fresh water, Boro rice production will be decreased. IRRI and wheat production will also be affected by salinity increase. The vulnerable areas in Bangladesh are Bagerhat, Barguna, Bhola, Chittagong, Cox's Bazar, Feni, Khulna, Lakshmipur, Noakhali, Patuakhali, Satkhira, Bhola, Barisal and so many areas will be the victim.

Box: Impacts of sea level rise on the basic needs of the people of Bangladesh

Food: Rise in sea level would flood agricultural lowlands and deltas in parts of Bangladesh (Miller, 2004; Bennett et al., 1991) that will decrease food production, causing shortage of food. Only salinity intrusion due to sea level rise will reduce 0.2 million metric ton of rice production

Poverty: Sea level rise will increase poverty. Increased poverty will decrease cloths buying capacity of the people of Bangladesh

Housing: In Bangladesh, 29,846 sq. km. area of land will be lost and 14.8 million people will be landless by sea level rise (IPCC, 2001a), losing their house.

Health: Sea level rise by extending coastal area and by increasing salinity in the area will increase the risk of cholera.

Education: Sea level rise will cause destruction of infrastructure including educational institutes.

Sri Lanka: Half a degree temperature rise is predicted to reduce rice output by 6 %, and increased dryness will adversely affect yields of key products like tea, rubber, and coconut. Most cropping activities for e.g., coarse grain, legumes, vegetables, and potato are likely to be affected adversely due to the impacts of climate change. Around 55 % of the coast has eroding at rate of around point 3 meters a year. On an average 70% of natural disaster in Sri Lanka are weather and climate related.

Nepal: Nepal's climate is influenced by the Himalayan mountain range and the South Asian monsoon. Temperature varies with altitude and season, Temperature and precipitations have been the major climate variability and observed changes over time. According to a study conducted by OECD (2003) projects a scenario that mean annual temperature to increase by an average of 1.2 degree celsius by 2030, 1.7 degree celcius by 2050 and 3 degree celcius by 2100 compare to pre 2000 baseline. The modest projection in winter precipitation is almost no change in western Nepal and up to 5-10% increase in eastern Nepal. However, in summer months the study depicts an increase in precipitation across the country in the range of 15-20%. Different cities like Kathmandu, Ramechhap, Udayapur, Lamjung, Mugu, Bhaktapur, Dolakha, Saptari, Jajarkot are in very vulnerable position due to climate changes

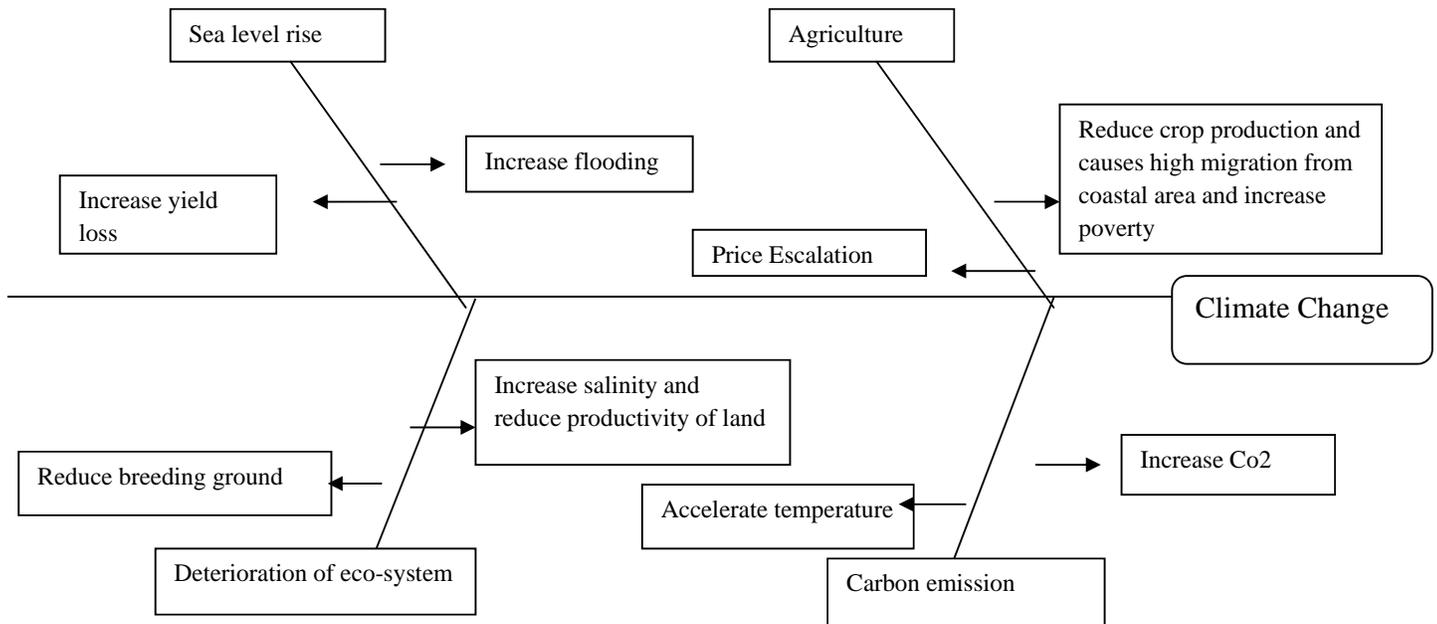
Table 8: Vulnerability of Climate Change in Agriculture in South-Asia

Country	Vulnerability of Climate Change in Agriculture
Bangladesh	The estimated impacts on rice yield shall vary between -6% to +14% depending on different climate change scenarios. Agricultural areas in tropical Asia and Bangladesh in particular, are vulnerable to many environmental extremes such as floods, cyclones, and storm surges.
Bhutan	A temperature increase of 2 °C would shift the cultivating zone further into higher elevation.
India	Temperature rise of 1.5 degree centigrade and 2 mm increase in precipitation could result in a decline in rice yields by 3 to 15 %. Sorghum yields would be affected and yields are predicted to vary from +18 to -22 % depending on a rise of 2 to 4 degree centigrade in temperatures and increase by 20 to 40 % of precipitation.
Maldives	Over 80% of the land area in the Maldives is less than 1 m above mean sea level. Being so low-lying, the islands of the Maldives are very vulnerable to inundation and beach erosion. Presently, 50% of all inhabited islands and 45% of tourist resorts face varying degrees of beach erosion.
Nepal	Soil loss is a major cause of decline in agriculture production in Nepal and the negative effects of climate change may further aggravate this situation. The impact of rise in temperatures on wheat and maize are expected to be negative.
Pakistan	In the hot climate of Pakistan, cereal crops are already at the margin of stress. An increase of 2.5oC in average temperature would translate into much higher ambient temperatures in the wheat planting and growing stages.
Sri Lanka	An increase in the frequency of droughts and extreme rainfall events could result in a decline in tea yield, which would be the greatest in regions below 600 meters.

Source: Human Development Report, 2007-2008. Fighting climate change: Human solidarity in a divided world

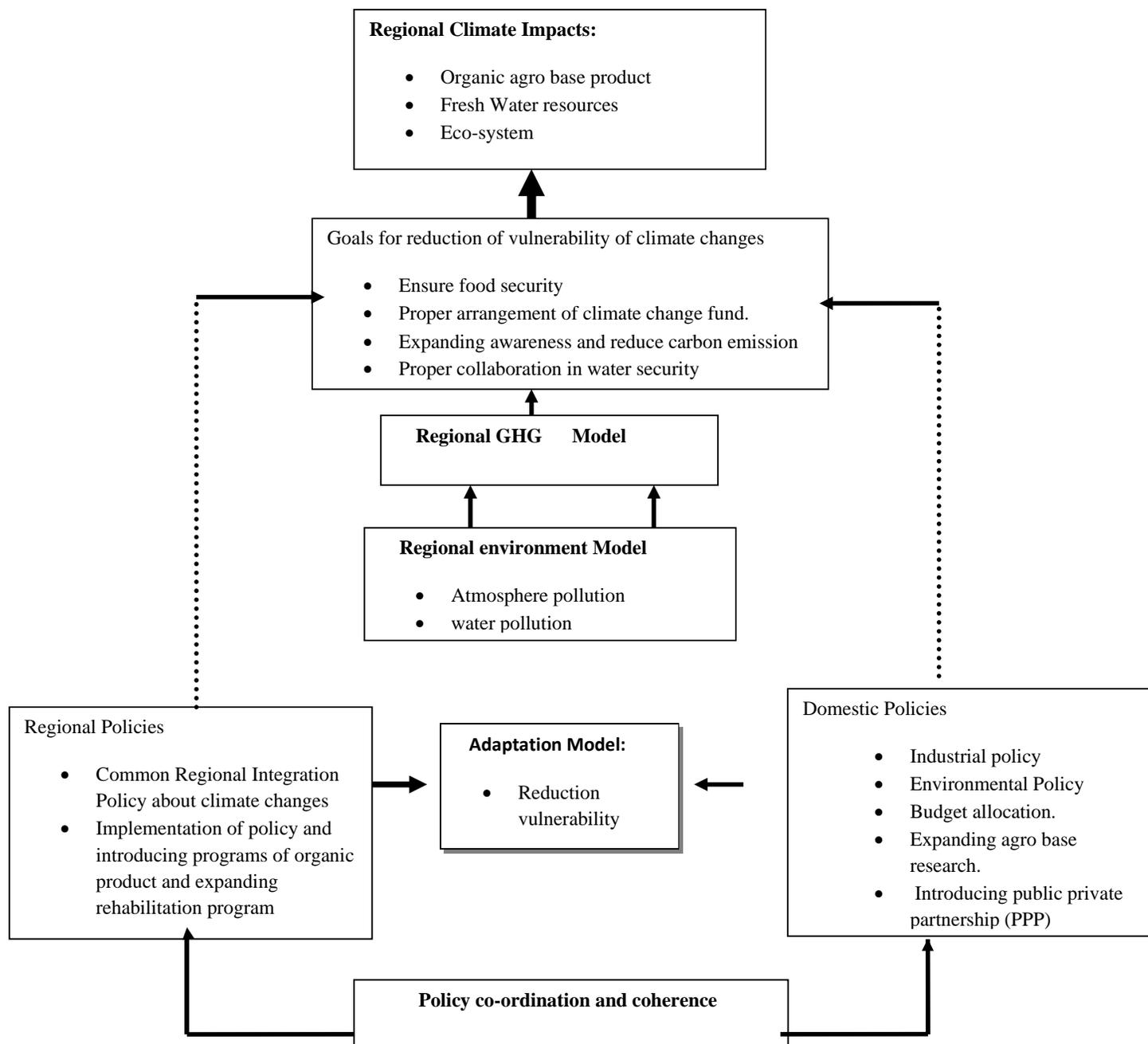
7.Cause and Effect analysis due to Climate Changes:

Climate changes reduce agriculture production, increase Salinity, enhance temperature, sea level rise and causes extreme flood, deteriorating health and expand poverty in near future. The following graph interprets the scenario of this South-Asian region in upcoming future.



8. Regional framework for mitigation of the negative effect of climate change in South-Asia: The goal of this South-Asian region is to diminishing the vulnerability of climate changes and it is possible with collective endeavor and admissible co-operation. There should be substantial and consistent relationship of local policies and also regional policies to eradicate this vulnerable crisis. The government has to play a vital role in establishing and ensuring the link between local and cross border framework. Domestic policies includes industrial policy, environmental Policy, budget allocation, expanding agro base research, private investment that make assists to resolve the local crisis of climate changes and for ensure better region, SAARC need to play a vital role of Common Regional Integration Policy about climate changes, implementation the policy with extensive work on the subject matter of climate changes and introducing programs of organic product and expanding rehabilitation program. Figure:1 interpret the framework where the South-Asia can mitigate the catastrophe problem like climate change.

Figure: 1 Framework for regional integration for facing the vulnerability of climate changes



Source: Author's

9. Findings:

1. The South Asian region is facing atrocious condition at present and also will creating turmoil situation in near future because of climate change. Sea level rise, Saline water intrusion, drainage congestion, extreme events, changes in coastal morphology identified as key vulnerabilities in the coastal areas and that is the common phenomena in South-Asia. In Bangladesh 10 cm, 25cm and 1 m rise in sea level by 2020, 2050 and 2100; affecting 2%, 4% and 17.5% of total land and that reduce the production especially rice. In India Temperature rise of 1.5 degree centigrade and 2 mm increase in precipitation could result in a decline in rice yields by 3 to 15 %. In Pakistan wheat yields are predicted to decline by 6-9 % in sub-humid, semiarid, and arid areas with 1°C increase in temperature while even a 0.3°C decadal rise have a severe impact on important cash crops like cotton, mango, and sugarcane. Over 80% of the land area in the Maldives is less than 1 m above mean sea level and face fierce situation in upcoming future. Soil loss is a major cause of decline in agriculture production in Nepal and the negative effects of climate change. In Bhutan, temperature increase of 2 °C would shift the cultivating zone further into higher elevation.
2. CO₂ gas makes the biggest contribution to global warming, being about 56%, while CH₄ contributes 18% and N₂O about 6%. Due to the increasing temperature melting glaciers on the Himalayan-Hindu Kush mountain range. The rapid melting of glaciers is initially expected to contribute to excessive water flow and flooding in this region (Pakistan, Nepal) and if the full loss of glaciers then there will be a great threats of availability of fresh water from the river like Indus, Ganges and Brahmaptra. Climate changes cause to increase the poverty level and also price escalation of necessary products. South Asia is still a small player in global carbon emission but rapid economic growth in India there is growing demand of carbon emitter. Agricultural activities also contribute 13.5 % of GHG such as N₂O and CH₄, different chemical pesticides, herbicides and fertilizers also causes climate changes.
3. The impacts of climate change on food security, access to water, human health, ecosystems, urban areas, and frequency of disasters will have severe implications for the achievement of sustainable development in this region. Climate base work and agro base research are not substantially established. Sea level rise by extending coastal area and by increasing salinity in the area will increase the risk of cholera. It will accelerate flood intensity facilitating transmission of diarrheal disease. High migrations increase poverty and also disrupt education especially in coastal area. Poor Development of drought resistant varieties and salt tolerant varieties, lack of Promoting on-farm water management practices and promotion of water conserving technologies, poor crop diversification, Absence of Integrated Watershed Management Programme, unstructured Coastal Zone Management Plan, deficiency of Forestry Management Programme.

10. Recommendations:

1. The region should concentrate on increase investments in agricultural productivity. Climate change places new and more challenging demands on agricultural productivity. Crop and livestock productivity-enhancing research, including biotechnology, will be essential to help overcome stresses due to climate change. Enhanced food security and climate-change adaptation should go hand in hand in this vulnerable region. South Asian association for regional co-operation (SAARC) and national governments should work to ensure that technical, financial, and capacity-building support reaches local communities. They should also encourage community participation in national adaptation planning processes. Community-based adaptation strategies can help rural communities strengthen their capacity to cope with disasters, improve their land-management skills, and diversify their livelihoods. Increase funding for adaptation

programs by at least an additional \$7 billion per year. South-Asian region should focus on seed bank which can ensure food security in this region.

2. South-Asian region should concentrate on reduce the emission of carbon dioxide and other greenhouse gases through more sustainable use of energy , improve forestry management and better urbanization. This region should take the policy like, using tax, pricing and regulatory policies to discourage the use of technologies and activities that generates green houses. Every country in this region should concentrate on eco-friendly products like organic product which can enhance production as well as ensure better food security.
3. Regional cooperation for knowledge generation and sharing on climate change, water security and strengthen disaster management and promote private investment. Public private partnership (PPP) should undertake to resolve crisis. Reinvigorate regional and national research and extension programs that might help to development of drought resistant varieties and salt tolerant varieties, Promoting on-farm water management practices and promotion of water conserving technologies, crop diversification, Integrated Watershed Management Programme, Coastal Zone Management Plan. The most important issue for this nation is to regional cooperation and also implementing the adaptation policies as early as possible.

11. Conclusion: Climate change creates catastrophe situation in South-Asia and this collapse condition can extinguish regional collaboration and communication. The objective under this regional integration might be concentrate on food security and ensure new eco-friendly technology which flourishes the production of crops and making sustainable progress in this region.

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