A Substantial Study on the History of Climate Change in South Asia for Sustainable Development

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Abstract

Due to climate change effects, South Asia is acknowledged as the most dangerous area in the world and the most susceptible region due to the high rate of shortage of food security and high rates of population growth. In South Asia, there has been a growing development in the strength and occurrence of risky climate actions in the last few years. Himalayan Hilltops and fertile areas of South Asia in which the latest modeling testing explained that the warming up would be insignificant. It is predicted that climate change effects will differ across the sites, populations, and regions in South Asia. In humid parts of South Asia, temperature rise will have negative effects; indirect effects are related to water accessibility, soil moisture gradation, pests, and other occurrences that may be identified. In this article, the influence of climate change is defined in dissimilar portions of South Asia. In the bordering areas, sustainable development planning is in dire need to handle climate change effects.

Keywords: Climate change, Environmental changes, Environmental impacts, Temperature changes, Water resources

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INTRODUCTION

South Asia, which consists of eight nations and the world's most densely populated region, is the place where more than 1/5 of the total world's population lives.[1] According to the United Nations Environment Programme, South Asia is the continent with the highest risk of natural disasters.[2] Despite South Asia's agricultural sector's continued expansion, it is losing ground to other industries in terms of both GDP and labor force participation and the non-agricultural income sources of farm households are growing as urbanization increases. However, a sizable portion of South Asia's population, which is economically active, continues to work in agriculture, which is vital for the survival of some poor families.[3] Recent years have seen the rise of climate change to the top of the list of global concerns, with significant effects on billions of people's access to food in developing countries.[4] Due to its rapid population growth, South Asia is among the areas most vulnerable to the effects of climate actions, depletion of its natural resources, persistent food insecurity, and high poverty rates.[5] Their effects on climate, land degradation, land use degradation, urbanization, and pollution have a direct and indirect impact on the ecosystems in this region. Long-term consequences of changes in climate, such as temperature changes, shifts in the growing storms, seasons, drought, floods, and altered rainfall patterns, endanger the way of life of populations living in dry lands. Therefore, managing sustainable land resources for the sake to adapt to negative results of climatic change is an important and difficult task.[6]

The IPCC defines climate change as any long-term shift in climate, whether as human activity or natural variability.[7] The earth's atmosphere is warming as consequences of human being activity and the quantity of atmospheric components or characteristics of the radiant energy that is absorbed or scattered by the surface of the earth are being altered by human activities, most notably the fossil fuel use and alterations to land use.[8] Increases in greenhouse gas (GHG) and aerosol concentrations, in particular, have been strongly linked to the climate change seen in the 20th century and predicted to continue to do so into the twenty-first and beyond. Since the beginning of the industrial era, there has been an approximate 35% increase in atmospheric carbon dioxide.[9] This growth has been observed to cause by humans activity, particularly the burning of fossil fuel along with the clearing of trees. The natural environment and human systems depend on precipitation patterns, extreme events, temperatures, sea level, and other climate-related factors,

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and these changes could be affected by changes in atmospheric composition.[10] In this article, the influence of climate change is defined in dissimilar portions of South Asia. In the bordering areas, sustainable development planning is in dire need to handle climate change effects. Enhanced understanding of the environmental alteration influences and version training to handle weather alteration can support this procedure.

Current Climate Changes and Future Perception

Scientists at IPCC's third Assessment Report in the 1990s stated that the plenty of all blended greenhouse gases were higher than they had ever been in the previous half a million years.[11] The level of CO2 in the air was higher in 2005 than it had been naturally for over 650,000 years. 0°74-0°18°C were added to the average surface temperature worldwide between 1906 to 2005, according to data from monitoring of the climate system, and there was a stronger warming trend between 1956 and 2005 than there had been over the previous 100 years combined. Oceans have warmed more slowly than land areas; Sea surface temperature and the ocean breeze temperature upon the sea at night have both increased, as have other ocean and land-based temperatures.[12] However, the rate of increase in surface air temperatures over land since 1979 has been roughly twice that of oceans.[13] An increase in the temperature of the air, which becomes more obvious in the winter than the warm season, can be used to describe variability and trends in Asia's climate from the present and past. The observed increases in some Asian regions over the last few decades have varied from less than 1-3°C per century. Over the past few decades, inter-annual, spatial inter-seasonal and inter-annual variability in shower burst trends have all been noted throughout Asia. Pakistan's arid plains and coastal belts, as well as some areas of North-East India, annual mean rainfall has been seen to be decreasing, while Bangladesh has seen an increase.[14] In many South Asian nations, heat waves have frequently been extremely severe and lasted for a long time.[15] In many areas of Asia, the frequency of heavier rainfall has increased leading to more frequent severe floods, landslides, debris, and mudflows. It is intriguing that less precipitation has fallen overall and on fewer rainy days at the same time.[16] As a result, although the amount of rain has decreased overall, it has been intensive a few days.

The above-mentioned changes in precipitation and temperature during 20th century led to significant hydrological changes across a wide area. Falling spring snow cover was one change and typically, less snow means lower reservoir levels.[17] This issue is made worse by how quickly spring snowmelt starts; the decrease in the glaciers' mass balance, which has serious effects on

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[16] J. Afzal, et al., Effects of dam on temperature, humidity and precipitation of surrounding area: a case study of Gomal Zam Dam in Pakistan. *Environmental Science and Pollution Research*, 2023. 30(6): p. 14592-14603.

[17] J.P Hardy, et al., Snow depth manipulation and its influence on soil frost and water dynamics in a northern hardwood forest. *Biogeochemistry*, 2001. 56: p. 151-174.

South Asia's more than 500 million individuals' access to water, is particularly alarming. The warming of the world's oceans is another sign that the climate system is changing.[18] From the surface to 700m below the surface, the temperature of the world's seas has grown by 0°10°C as per the IPCC 2007 report and a decrease in ice caps and mountain glaciers is another factor that has contributed to sea water level increase during the past ten years.[19] In the last ten years, the sea level has increased at a rate of 3 mm /year as compared to the 20th century; this shows an increased rate of seawater level in comparison to the overtime average. In terms of agriculture, the production of wheat, maize, and rice has decreased in recent years due to growing water stress, which is caused by hotness, an increase in El Niño's frequency, and a decrease in rain.[20] Since glaciers provide more than 10% of the freshwater supplies in Asia's drier regions, melting glaciers are a concern for water resources.[21] Asian glaciers have been observed to be melting more quickly than in the past, particularly in the Central part of Mongolia, China, and South Asia.

Research in northern areas of Pakistan; however, suggests that the glaciers of the Indus Valley may be increasing as a result of an increase in winter drizzles on the western Himalayas during the previous forty years.[22] Rapid industrialization, population growth, inefficient water, and urbanization have all been linked to water shortcomings in Pakistan, India, Bangladesh, and Nepal. Climatic change has a negative impact on water supply, quality, and demand. South Asia's coastlines are vulnerable highly to cyclones, and extreme non-climatic and climatic events that caused marginal flooding, leading to significant fatalities and economic losses.[23] Wetlands have undergone significant changes recently in the region's major river deltas because of logging, extensive sedimentation, human settlement and changing land utilization. Additionally, during the dry season, tributary channels of Bengal Bay are said to have allowed salt water to reach 100 km or further inland.[24] Over the past 50 years, significant amounts of the mangroves that shield South Asian coastlines from saltwater intrusion have been lost, largely resulted from human activity.[25]

As per the prediction of the researchers, warming will increase during the twenty-first century, primarily due to increases in the concentrations of organic evolution gases, with hotness being proportional to resulting radioactive energy.[26] A professional evaluation rooted in the strength of observed feedback restorative in models utilized to produce climatic change predictions and

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available constraints from observations specify that global mean SAT warming at equilibrium for a CO2 doubling, or "equilibrium climate sensitivity," is most likely to be between 2-4.5°C, with a value of about 3°C. The highest levels of warming are anticipated to occur over land and the century's most northernmost latitudes and in a future warmer climate, heat waves are very likely to become more intense, frequent, and persistent.[27] Due to improvements in modeling and knowledge of the physical procedures of climatic systems, a change forecast is now available. More warming occurs in drier subtropical areas than in the tropics, which are generally more humid, and in South Asia, warming exceeds the global average. Climate models for South Asia predict a marked increase in warming during the last century.[28] Compared to global mean warming, the rate of temperature increase is least pronounced in South-East Asia, larger in East Asia and South Asia, and highest in multicultural Asia (North and West Asia). Additionally, Over Asia, the anticipated warming is generally greater at all times, but winter is preferable to summer. Recent modeling studies suggest that the Tibet Plateau, arid Asia, and Himalayan Highlands would experience significant warming.[29]

Climate Changes and Food Security Challenges

According to predictions, South Asia will experience a variety of different climate variations, with some areas likely to see more extreme precipitation and elevated risks of floods while others may experience scattered rainfall and protracted dry spells.[30] In addition, the effects will differ over industries, regions, and inhabitants. In South Asia's tropical regions, the places where the particular crops are grown already at temperatures beside their gate to temperature drawing and people tolerance[31] will have an adverse influence on yields of the wheat and rice. Although an increase in temperature has a direct influence, there are also indirect effects related to water accessibility, changing soil humidity status, and the development of diseases and pests. Smallholder unirrigated farmers that make up majority of compatriot in this area have less technical and financial capacities to adapt the climate change variability are probably going to be hardest hit. In terms of fisheries, a development in frequency of El events could mostly result in observable decreases in the abundance of larva's of fish in the marginal waters of South East and South Asia.[32] The most affected cities will be those on low-lying coasts that are at risk of a rise in sea levels and storms. Among them are Mumbai, Dhaka, and Karachi, all of which have recently experienced remarkable environmental stresses.[33] Increased sea levels would decrease coastal drainage, which would increase the chance of flooding brought on by cloudbursts. The water table would rise with an increase in sea level, further decreasing drainage in marginal areas. The socioeconomic ramifications of all these factors could be disastrous, especially for the infrastructure of deltaic

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[28] Ibid.

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[33] M. Ranagalage, et al., Spatial analysis of urbanization patterns in four rapidly growing south Asian cities using Sentinel-2 Data. *Remote Sensing*, 2021. 13(8): p. 1531.

low-lying areas. Cruz.[34] States that studies suggested that in Asia's temperate regions, longer growing seasons and higher temperatures might lead to an increase in pest populations. Increased insect populations and decreased winterkill would result from warmer winter temperatures. The number of reproductive generations per season may increase as a result of higher pest and disease growth rates, and the crop may become more vulnerable as a result of lower disease and pest mortality brought on by warmer and winter temperatures. Overall temperature increases may also affect the interactions between crop pests and diseases. Climatic change, evolving disease patterns, and pests will affect crop production systems' future responses.

Several economies in South Asia depend heavily on agriculture and additionally, it is the main employer. The industry still contributes the most to the region's GDP overall. The wealth of SA depends heavily on the yearly success of monsoons because three-fifths of the cropped area is rained. The poor and landless, whose farming is their only source of income and its related activities, are the ones who suffer the most in the event of a failure. The crop yield has decreased in many Asian nations, in part because of the extreme weather and rising temperatures, as well as the likelihood that agriculture will be impacted by future climate change the risk of hunger, and the scarcity of water resources [35] due to increased climate variability and faster glacier melting. The findings of some studies indicate that at the close of the century, significant reductions in the production potential of cereal could be anticipated in Asia as a result of climatic change. Even when beneficial physiological effects of carbon dioxide are considered crop cultivation projections. According to the most traditionalist climatic change scenario, South Asian countries' net production of cereal is expected to decrease by 4 to 10 percent by the close of the century.[36] The variations in cereal crop production potential point to increased resource stress brought on by climatic change in many developing nations of Asia. The area of production as well as crop production per unit area may be impacted by climate change. Fast-growing, frequently short-lived species found in South Asian grasslands make them vulnerable to CO^2 and climatic change, with consequences for the resilience and stability of plant communities; experiments back up the idea that species diversity and composition will change rapidly as a result of climate change. In dry areas, there is a danger that severe vegetation deterioration will result in positive feedback loops between soil erosion, decreased vegetation, and decreased rainfall, leading to the loss of farmland and pastoral areas.[37] Higher temperatures and more evaporation are anticipated to result in a decrease in the natural grass yield and grassland coverage across Asia.[38] Livestock may be in danger of dying due to thermal stress because it lowers productivity and conception rates.[39]

Precipitation, Water Resources, Extreme Events, and Natural Disasters

[34] J. Cruz, *Ocean wave energy: current status and future prespectives*. Springer Science & Business Media. 2007

[35] J. Afzal, et al., *A study on thermal analysis of under-construction concrete dam.* Case Studies in Construction Materials, 2022. 17: p. e01206.

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[37] M. Daoudy, *The origins of the Syrian conflict: Climate change and human security*, Cambridge University Press. 2020

[38] M.V. Sivakumar and R. Stefanski, *Climate change in South Asia.* Climate change and food security in South Asia, 2011: p. 13-30.

[39] S. Dash, et al., Effect of heat stress on reproductive performances of dairy cattle and buffaloes: A review. *Veterinary world*, 2016. 9(3): p. 235.

Climatic variability, particularly variability in precipitation, is strongly correlated with current climate vulnerabilities. Large regions of dry lands, concentrated rainfall and flow of stream for few months, and significant yearly variations are all characteristics of arid and semi-arid and less-income nations with considerable vulnerabilities. Since there are not any reservoirs or groundwater wells in these areas results in a high level of vulnerability to climatic variance, as well as future climatic changes are likely to make variance in the climate even more pronounced.[40] Due to the indissoluble relationship[41] between climate and water resources, the possibility of world climatic change has significant ramifications for both regional development and water resources. Water recharge rates and soil moisture conditions are likely to be affected by trends toward more extreme rainfall, along with the possibility of heavy events of rainfall spread on some days. A warmer climate will raise the chance of droughts and floods due to the increased climate variability it brings.[42] Substantial rivers, which are the lifeblood of the region's wealth, are abundant in South Asia. During the dry season, a large population of people in Asia depends on ice-mass melted water. The rise in glacial melt raises doubts about rivers flowing through the Himalayas' perennial status. Glacial lake outburst floods (GLOFs) are caused in Bhutan and Nepal by melting ice masses that are overfilling lakes of glaciers and 20 of Nepal's glacial lakes have been nominated to be hazardous in terms of GLOFs.[43] The results of climatic change over freshwater are especially noticeable in arid and semi-arid areas; climate change can lengthen the dry spell in semi-arid regions, which has an effect on users of water that do not rely on deep groundwater wells, reservoirs. Rainwater and groundwater are the main sources of freshwater used by the Maldives' population. Both of these water sources are susceptible to climatic shifts and sea level rise. Low-lying islands like those in the Maldives make it likely that saltwater will seep into freshwater lenses as sea levels rise. The groundwater is replenished by rain. Uncertainty exists regarding the rainfall pattern's temporal and spatial distribution, Despite the fact that an improved climatic regime is expected to result in more rainfall.[44] The reduction in groundwater recharge in some areas where vulnerability is common and some areas are already water-stressed made worse by rapid increase in water demand and population will make it more difficult to counteract the decreased surface water accessibility caused by growing precipitation variability. The poor, who have less access to resources of water, will resume to be the group that will be most affected. Many South Asian nations are already concerned about the rapid depletion of their water supplies. By the year 2050, water scarcity and stress will affect around 2.5 billion persons in SA. Farmers and pastoralists in dry lands must deal with other extremely difficult resource problems, such as low fertile soil, crop diseases and pests, and lack of accessibility to better seeds. Long-lasting droughts and/or floods frequently make these problems worse, and El Nino events frequently make them particularly bad.

[40] K.A Miller, *Climate change and water resources: a primer for municipal water providers*. American Water Works Association. 2006

[41] J.Afzal, et al., Relationship between Organizational Silence and Commitment of Employees at University Level. *Siazga Research Journal*, 2023. 2(1): p. 58-65.

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[43] A. Chanda and B. Biswas, *Glacial Lake Outflow Hazard and Risk Probability in Sikkim*, in *Recent Technologies for Disaster Management and Risk Reduction: Sustainable Community Resilience & Responses*. Springer. 2021, p. 3-26.

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Changes in rainfall and increased evaporation may have a significant impact on some reservoirs and lakes.[45]

Natural disasters strike SA remarkably frequently over 750 million people, or 50% of the population of the region, experienced a natural disaster between 1990 and 2022. Several pieces of research revealed, that while days of rainfall and the total annual amount of drizzles have decreased, the regularity of intense rainfall events, that cause landslides severe floods, and mud and debris flows, have generally risen in many areas of SA. In many areas of South Asia, droughts are becoming more frequent and more severe, and this is largely due to an increase in the temperature, especially during the warm season and other typically dry months. Tea yield could decrease because of more frequent droughts and extreme precipitation events, with the greatest impact in areas with elevations under 600m. The effects are likely to be severe given that Sri Lanka's tea industry is a significant source of convertibility and workers' significant source of income. Floods in Bangladesh resulted in the loss of roughly 0.5 million tons of rice annually from 1962 to 1988, which accounted for about 30% of the country's average yearly imports of food grain.[46] The production of crops, pastures, and forests is significantly impacted by short-term natural calamities like floods and storms, decadal and inter-annual climatic variations significant changes in huge circulation patterns like the ENSO. Climate extremes on the rise may encourage outbreaks of plant disease and pests.[47] The regularity and severity of droughts have risen as a consequence of global warming, according to mounting evidence. Global analysis has revealed that semi-arid and arid areas are more susceptible to abrupt changes in rainfall and that this vulnerability may be related to strong constructive feedback between climatic interaction and vegetation. The interconnection of human factors and natural phenomena, such as modifications in land cover and land use, water use, and demand, may result in the socioeconomic effects of droughts. A drought's effects may be worsened by excessive water withdrawals. Increases or decreases in frequency of utmost events will have effect on the procedures that cause land to deteriorate, including flooding, mass tremors, wind and water erosive landslides.[48]

CONCLUSION

To conclude we can say that, South Asia is one of the most climate change vulnerable areas in the world due to its large population, a large number of hungry people, land management and infertile soil on marginal lands in semi-arid areas, growing rates of land humiliation, and anticipated effects of climatic change on fisheries, forestry, and agriculture sectors. The poor rural have a poor ability to cope, particularly in the marginal areas, so it is important to integrate effective methods for coping with climate change into the region's plans for sustainable development. This procedure might be assisted by greater information about the effects, adaptation strategies, and vulnerabilities connected to the change in the climate.

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