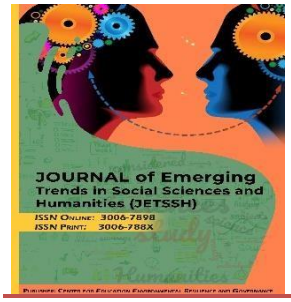

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Pakistan's Climate Change Dilemma: Challenges and Opportunities for Sustainable Development

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ABSTRACT

Pakistan is facing severe climate related risk making climate change a critical national concern. Pakistan is among the countries that are mostly exposed to climate hazards and have substantial impact on climate change. According to the United nations report Pakistan places on 8th position among nations which are most effective by extreme climatic events. In the light of all development, it may be possible to assess the susceptibilities of different regions of various and suggest applicable coping mechanisms and resilience techniques. The primary goal of the research is to assess the influence of climate change on agriculture. The research paper explains that what adaptation strategies formals employ in response to frustrations in temperature in rainfall. As one of South Asia's most climate exposed countries Pakistan climate change has intensified the occurrence of flood and drought while Pakistan continues to experience these changes. Indians are a major cause of climate change influencing agriculture livestock full history federation and its overall food water in energy security. Research emphasizes that the need for strong government intervention to ensure sustainable development by enforcing resource regulations and strengthening climate policy framework is very crucial.

Introduction

Climate change is defined as long term variations in climatic pattern and average temperature. These shifting temperatures occur naturally due to different events such as volcanic eruptions or variations in solar radiation. Since the early 1800 human activities have been the prominent cause of these climate shifts. Fossil fuel combustion EMIT screen house gases that act like an insulating blanking around the planet trapping heat. Methane and literacy oxide at the main gases responsible for the warming of earth. These gases originate from everyday activities like heating buildings with coal or fueling vehicles with gasoline. Deforestation releases large quantities of carbon dioxide while agriculture in the oil and gas sector are significant producers of methane and often neglected. Meat industry, textile industry, plastic and leather product industries are also major contributor. The countries such as Pakistan, climate change is becoming an increasingly harsh reality. The severity of climate change was recognized by the international community, and global warming emphasized the urgency of taking immediate action. However, climate change has severe effect on economy sector and state development Shifting to low carbon system immediate is strongly tried to advancement in social economic and environmental sector development. The international framework functioning as a mutual supporter and interconnected manners is important. Although Pakistan's is contributing only less than 1 percent of the green house emission of the world, its production is more affected by climate change. Depending on this region, the climate varies from extremely low temperature in winter to pleasant and very high temperature in summer, increasing the average temperature. Rainfall in different parts of the country Occurring mainly in July September, while the remaining months receive little rain for the rest of the year. Alternation in climate result in more severe and unpredictable weather events in Pakistan such as droughts, floods, and storms. Higher temperatures cause polar ice to melt, leading to rising sea levels and coastal flooding. Many plants and animals are struggling to survive as their natural habitats change or disappear. In 2022, Pakistan faced a vulnerable effect of climate change i.e. floods affect more than 33 million people and 20 million people required humanitarian assistance. This flood caused changes in weather patterns, low agriculture production, and reduced freshwater supply. Pakistan's economy is highly vulnerable it cannot tackle the climate issue effectively so Pakistan is aided by the United Nations development program. Climate change affects everyone differently. The main purpose of the United Nations is to help countries to reach sustainable goals. It promotes a circular economy, waste management, and recovery of wildlife population, habitat conversation, and agro biodiversity [1] . In 2017 a climate change act was formed by the government in which all provinces ministers and high officials were present. It creates a national climate change council, makes different strategies, and gives plans which are implemented on local levels. Provide funds and giving awareness included in it. Pakistan's government is contributing its part to control climate change several new policies have been made in 2024 to preserve Pakistan's climate.

Literature Review

Pakistan is a low-middle-income country with poor levels of human development. Rural and urban areas differ in terms of infrastructure, income, and poverty. Most [2]people reside in semi-arid regions, and agriculture is the main industry, employing 44% of the labor force, with 68% of those employees in Pakistan's rural areas (GOP, 2017b). While semi-arid areas with more sustainable water supplies typically have irrigation-based farming, rain-fed regions are mostly used for sustenance farming. In desert areas, where impoverished populations occasionally relocate in quest of food and water, pastoralism is most prevalent. Despite the widespread observation that dry and semi-arid regions have higher rates of rural poverty, Homelessness, erratic availability to basic requirements, and exposure to climate difficulties or often associated with it (Saleem, 2013). Although small farmers hold 86% of farms with acreages under 12 acres, 50% of rural residents lack land (GOP, 2017a). In contrast, Pakistan's urban economy generates 78% of the nation's GDP, even though it houses a third of the nation's

people (Cu, Abbasid, Hussain, Albaker, Almulhim, Alvarado,2023). With between 35 and 50 percent of the urban population living in informal settlements, several Pakistani cities are experiencing an annual urbanization rate of 3 percent. By 2030, the Pakistani government predicts that more than half of the people of pakistan will reside in metropolitan areas (GoP,2014).

A few studies have tried to look at the relationship between the interdependent components. These findings imply that variations in meteorological factors, including average temperature and precipitation, affect agricultural output in rural regions. Heat stress in particular has been shown to affect agricultural productivity over the winter (Nadeem et aI.,2018). One important food that is consumed by the majority of Pakistanis, wheat, may see a 5-25% decline in production due to climate change (Gul et aI.,2022). In their analysis of how climate change affects socioeconomic vulnerabilities and agricultural output in Punjab and Sindh (Majid and Zaheer, 2014). They claim that drought is the primary climatic element that significantly affects the yields of wheat, rice, cotton, and sugar cane. Because crop yields are dropping, many farmers are forced to find alternative kinds of income and sometimes even move to cities. This is similar to the groundbreaking study conducted by (Kombi et aI., 2016), which found that heat stress contributes to internal migration in Pakistan. Pakistan is on the frontline of a climate crisis, with extreme weather events posing significant threats to its socioeconomic fabric. With rising temperatures, erratic rainfall, and increasing sea levels, the need for comprehensive climate adaptation strategies that align with development goals is critical. The months of September 2017 and 2018 temperature breeds the 4th highest level in the past 139 years with 10th of the warmest summers documented since 2003. Land and ocean surface temperature during 2014 to 2018 or recognized among the five warmest September on record (CO2, Earth 2018). Climate change exerts significant effects the short term effects arise from greenhouse gas emissions while long term consequences influence critical human activities, especially agriculture in Asia (Shaffril et aI.2018). Pakistan’s GHG emissions increased at comparable rate to the world’s historic 5.8% growth in 2010 (Carter et aI.2015; Hussain et aI.2019a). Pakistan's economic stability, social progress, and environment are all at risk due to rapid urbanization, transportation demands, agriculture, and waste. This could drop the country's global environmental ranking by 2030. (Khan et aI.2016). Recent floods killed over 1,100 people and affected 33 million. Around 75,000 people lost their homes (Ahmed et al., 2021). This feels really unfair because Pakistan is so vulnerable to climate disasters because of where it is, its economy, and its infrastructure, even though it doesn't contribute much to emissions (Jibran et aI.2015). Heat waves, overflowing lakes, storms, hurricanes, landslides, earthquakes, health problems, outbreaks of disease, shifting seasons, and changes in how people live are all making the country more vulnerable (Met aI.2012). Because of all this, Pakistan urgently needs ways to cut emissions and adapt to the changing climate. Cutting emissions means reducing greenhouse gases, while adapting means getting communities ready for the changes (Abid et aI.2016b). Pakistan is getting slammed by climate change, even though it produces less than 1% of the world's greenhouse gases. Rapid industrialization, fossil fuels, plastic, and deforestation are making things worse. Each Pakistani produces about 2 tons of greenhouse gases a year, which is less than half the global average. In 2015, Pakistan released 408 million tons of carbon dioxide, with 43% coming from agriculture and 46% from energy. Most agricultural emissions are methane and nitrous oxide. Methane comes from livestock digestion and manure, as well as rice farming. Nitrous oxide comes from fertilizers. Oil contributed about 18 million tons of emissions in 2019 (GoP 2017-)

Causes and Impacts of Climate Change

Greenhouse Gas emission

Heat waves, overflowing lakes, storms, hurricanes, landslides, earthquakes, health problems, outbreaks of disease, shifting seasons, and changes in how people live are all making the country more vulnerable. Because of all this, Pakistan urgently needs ways to cut emissions and adapt to the changing climate. Cutting emissions means reducing greenhouse gases, while adapting means getting communities ready for the changes. Pakistan is getting slammed by climate change, even though it produces less than 1% of the world's greenhouse gases. Rapid industrialization, fossil

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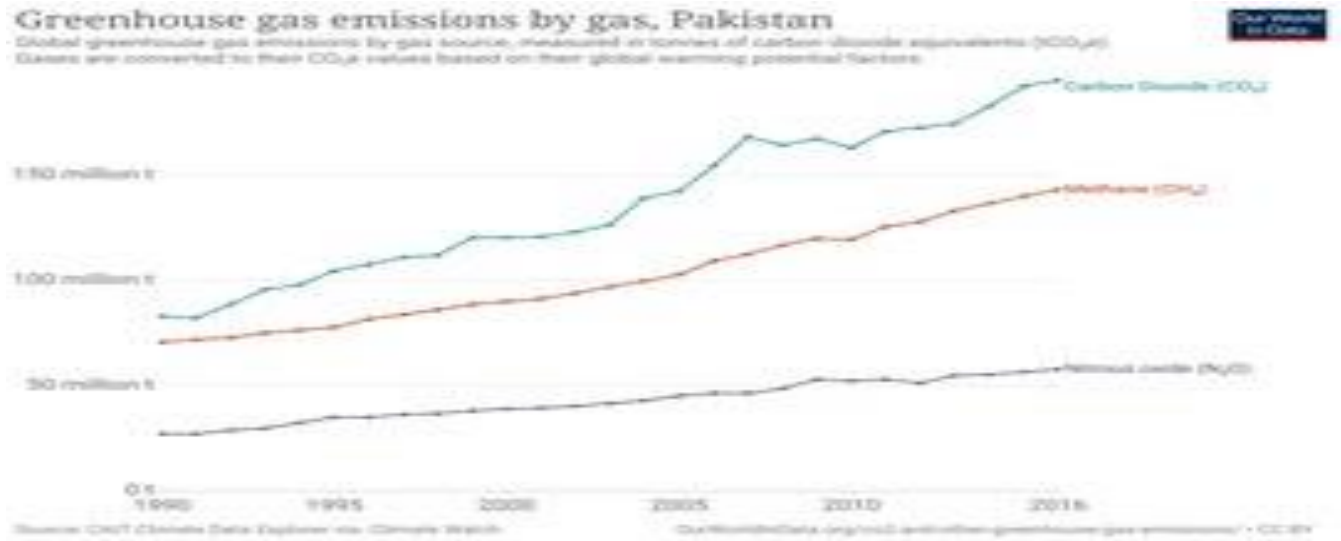

(Pakistan greenhouse gas emissions 1990–2016)

To cut pollution, experts suggest raising taxes on motor fuels. In 2020, Prime Minister Imran Khan said no new coal power plants would be approved, but projects already permitted are still expected to be built. (Hussain et aI.2018). Climate change will have different effects across the country, but overall, temperatures are rising and extreme weather is becoming more common. This disrupts natural processes and affects things like farming. In May 2022, Pakistan and India had a heat wave with temperatures hitting 51°C. Without climate change, heat waves like this would happen once every 312 years; now they're expected every 3 years. These temperatures hit water-dependent sectors like agriculture and energy hard reducing productivity and making water even scarcer. (Enriquez-de-Salamanca et aI.2017).

Temperature Change

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(Temperature anomaly in Pakistan between 1901 and 2020)

Extreme Weather Events

Pakistan's likely to see more crazy weather, with hotter temperatures and more intense events. Expect more cyclones, heat waves, and monsoon disasters. The monsoon seasons are wacky, bringing floods and droughts all the time.

Between 1998 and 2018, Pakistan had over 150 terrible weather events. In 2022, crazy floods swamped a third of the country because of heavy rains and melting glaciers. This keeps happening constantly.

Water is getting scarce in Pakistan. Glaciers in the Himalayas are melting fast, leading to glacier floods. The 2020 Shisper Glacier incident in Hassanabad, Hunza, forced people to evacuate. It shows how bad things are. Studies indicate that how glaciers melt changes from place to place, but they're generally melting fast.

Economic Impacts

Pakistan economic fragility has intensified under climate stres. with more than half the population living One less than two dollars per day provincial disparities are at stark. according to IPCC 5th assessment report agriculture based economy suggest Pakistan or accidentally sensitive to climate change due to their geography demographic pressure so should economic vulnerabilities and limited adaptive capacity the structural constraint collectively define Pakistan climate vulnerability.

Agricultural Impact

Agriculture face server risk from rising temperature prolong draft frequent flood and worsening soil degradation. the stressors threaten food security across the region while projections indicate substantial decline in major crop yield especially wheat and rice. research doctor Adil Najam at the Lahore university of management sciences suggest that by 2040 climate change could reduce agriculture productivity by up to 7% increasingly erratic whether has also displaced large number of rural households question them towards major cities. Experts anticipate that newly 20% of the population may you when you migrate to urban centers.

Challenges Faced by Climate Change

1. **Temperature Increase**

2. Pakistan's every temperature has increased by approximately .6 centigrade over the last century with not with northern region experience in higher warming than the south regions. the rate of increase has accelerated in recently kids rising from point .06°C per decade in the early 20th century of 0.24 °C per decrease between 1960 and 2007. multiple regional studies confirm a persistent warming thread mirroring global pattern. These studies experienced at the local and state levels (Cheema etal , 2006 ; Sajjad et al.2009; Saiq and Qureshi 2010 ; Mahar and Zaigham 2010) have also shown the escalating trend in temperature.

3. **Water Scarcity**

Pakistan's freshwater resources are already under severe strain. Per capita water availability has plumed from 5600 cubic meter in 1951 to around 12 cubic meters in 2003 edging close to water scarcity threshold international water security

assessments categorized Pakistan as an extremely high-risk country (Commission Planning 2007). According Maplectoft water scarcity index 2010, Pakistan ranked 7th among 19 countries, classifying its extreme high risk. Moreover, the Indus River system depends heavily on rainfall and glacial melt both are being disrupted by climate change. with limited potential to expand water supplies Pakistan must urgently improve water use efficiency in agriculture (Commission Planning 2010). study indicate that up to 60% of irrigation water is lost during transmission while the annual wastage of Indus water exceed what can be stored at the Terbala Dam lost (Janjua, Hassan, Muhammad, Ahmed, & Ahmed, 2021).

4. Food Security and Agriculture

Pakistan rank among the high risk countries in global food security and indices. it irrigation depend upon agriculture relies on diverting river water through one of the word largest canal system declining river flows degraded watershed and changing rainfall patterns threaten this system. Pakistan's agriculture is having a tough time keeping up with food production and getting it where it needs to go. When it comes to keeping people fed, Pakistan is number 30 out of 163 countries worldwide and is seen as a high-risk country (Maple croft 2010c). Reduced crop used to cleaning soil health and adverse effects on livestock productivity or expected to intensify food insecurity. These challenges compounded by demographic precious and limited adaptive capacity height in Pakistan suscepility to climate induce crisis. Canal base irrigation of land systems is based on transforming water from rivers to farms through the world's huge and well establish irrigation networks. Rise water levels are decreasing as a result of ongoing challenges to their watersheds. The problem will get worse because of global warming. Reduced cultivation of land and in result the productivity of crop as well as negative effects on animal productivity, health, and repeatability will be the main ways it affects food security (Sarwar & Farid, 2025).

Similarly, Pakistan has faced many other challenges due to climate change.

Opportunities to Control Climate Change

1. Renewable Energy

Pakistan has numerous prospects for the solar and other renewable energy development, such as wind, photovoltaic, and biomass. Anchor Pakistan's littoral regions of Sindh and Baluchistan (in southern Pakistan) offer considerable opportunity for harnessing wind power generation A wind power energy corridor has been established by the GOP along Sindh and Baluchistan's southern coastline districts. The coastal region of Pakistan stretch 180km in length and span 60km in width, according to air current statistics from the country's meteorological department. It can generate 50,000MW of electricity using wind turbines (Gharo-Keti Bandar). There are 36 private wind farms in operation right now, with a combined output of about 1845MW. The government's renewable energy program anticipates that renewable sources will supply 60% of Pakistan energy needs by 2030. The lofty goal offers Pakistan's wind energy business many prospects. A number of working industries are using self-assumed solar energy for onsite consumption on account of it Pakistan's unstable grid supply and growing electricity costs. Larger cities have seen a sharp increase in rooftop solar panel installations.

2. Sustainable Agriculture

Climate Smart Agriculture (CSA) has enormous potential in Pakistan, as agriculture plays a crucial role in the nation's social structure, economics, and culture. Communities that depend on agriculture are increasingly at risk from climate change. These alterations impede a country's economic development and undo years of advancement. Expanded and intensified and successful land cultivation system could be achieved by leveraging operational money, creating fresh source of funding, encouraging environmentally conducive practices, and empowering associations to take action. Currently, the nation uses a variety of CSA measures. Through the application of innovative technologies like solar-powered irrigation systems and laser land leveling, as well as management changes like crop diversity, suitable cropping patterns, and early planting dates, CSA can boost Pakistan's economy. East of the Indo-Gang etic, Laser land leveling (LLL), weather warning services, crop insurance, and plains (IGP) are the most popular CSA technologies. Farmers in the western IGP, however, favor synchronized irrigation with crop insurance, LLL, zero tillage, and direct planting.

3. Developing Resilient Varieties

Funding to exploratory bodies to create a better producing assembly of animal and agricultural kinds that are endurance to pests, heat, and drought is the most crucial thing the government can do. Flood-resistant rice, known as scuba rice, can tolerate 17 days of complete soaking and yield up to 3 tons of rice per hectare during torrential flood, demonstrating its ability to respond to these extreme water stressors. In a similar vein, rice cultivars that can withstand drought can boost yields by 2–9%. An increase in soil salinity is another consequence of climate change, especially in agricultural regions close to the coast. For example, Bangladesh and other Asian nations are seriously threatened by the fact that over 30% of the nation's arable land is situated in coastal areas. The salinity resistant oryza sativa cultivars CSR 26 and CSR 43 were thus created to address Bangladesh's climate issues.

Policy and Governance for Climate Change in Pakistan

(a) National Climate Action Plan

Pakistan's first ever NCCP in 2012 mainly centered on climate resilient development and adaptation because the country is quite vulnerable to the adverse impact of climate change, particularly extreme events. But after the 2015 Paris Climate Accord, Pakistan committed to help global efforts combat climate change and limit greenhouse gas emissions. Pakistan’s policy has subsequently shifted and the NCCP-2021 gives equal priority to adaptation and mitigation, with specific focus on nature-based solutions. The 083 initiatives have been launched in parallel with the Prime Minister's Urban Forest Project, Clean Green Pakistan Movement a and Protected Areas and National Park Initiatives to raise the coverage of protected areas to at least 15% of Pakistan's land area by 2023. Additionally, the Ecosystem Restoration Initiative (ESRI), through ecosystem-specific projects, is center of attention in order to mainstream adaptation and mitigation activities and assist Pakistan tread the path towards environmental sustainability.

The policy also provides adjustment coping strategies and shows which industries are most vulnerable to climate change.

(b) Provincial and Local Governance

Countries can accomplish their climate goals with the aid of efficient climate change governance institutions. Many government and non-government actors must coordinate their efforts to solve climate change. Given the length of time that climate change takes to manifest, it is necessary to be able to maintain a credible commitment to bold climate policy across several election cycles. Institutions of governance can assist in addressing these issues. Legislation creating legally obligatory targets in the context of climate change frameworks can aid in addressing the issue of credible commitment. Independent climate advisory organizations can help connect policy with long-term objectives and bolster the evidence base for climate policy. Climate policy is translated into climate action by governance institutions as well. Planning, intergovernmental fiscal systems, procurement, public investment, and budgeting all work together to match public resources with climate objectives.

Civil Society Management

The Civil Society Coalition for Climate Change (CSCCC) is a licensed coalition (registered under Section 42 of the Companies Ordinance, 1984) that uses advocacy, knowledge-sharing, and research to raise awareness of climate change in Pakistan and impact regional, national, and sub-national policymaking. As part of the French Embassy's efforts to unite stakeholders in pursuit of an "Agenda of Solutions," the concept of creating a networking platform was proposed in the run-up to COP21. While maintaining and enhancing the autonomy and independence of its members, CSCCC offers a networking platform for concerned citizens, academics, researchers, media, the private sector, and civil society organizations to share ideas and create synergies. The coalition approach was chosen to increase civil society's ability to effectively interact with policymakers to support adaptation and mitigation efforts that decrease vulnerability and increase resilience at all levels by incorporating adaptation into pertinent environmental and socioeconomic policies for sustainable development.

Role of the Government in Controlling Climate Change

Under the leadership of Prime Minister Shehbaz Shareef and the Ministry of Climate Change government has taken some initiatives to minimize climate issues. To make better decisions and transparency in the action of climate change a dashboard is created i.e. National Determined Contributions (NDCs). A carbon credit policy is formed. This decision is taken to minimize carbon emission and make policies to tackle changes and minimize the hazards. Reforestation is also a key objective and the government is working on the ten billion tree tsunami initiative to save biodiversity and reforestation and to save the environment from sudden changes. The government has banned the use of plastic bags. People are also literate about climate change. Maryam Nawaz also made a smog awareness initiative at the very basic stage of country and all over the province of Punjab. Atmosphere is like a house in which humans live so it is very necessary to keep it clean so that a healthy and prosperous life could be spent.

Policies of Government in 2025

Every government introduces many initiatives to solve the problem of global warming. The government during 2025 introduces different climate related policies to enhance mitigation and adaptation measures. For the fiscal year 2025 to 2026 approximately 8.2% of the budget was allocated to climate related initiative it signals a strong financial commitment to climate resilience to discourage fossil fuel use and raise funds for green initiative government proposed a carbon levy of rupees 2.5 per liter on petrol diesel and furnace oil. specific allocation included 85.43 billion rupees for adaptation, 603 billion for mitigation and 28.33 billion for institutional development research and capacity building. The government started a mainstream resilience project that is "green budgeting" to mainstream climate resilience international development planning across ministries (Dawn, 2025a, 2025b).

To enforce climate governance, the Ministers of Pakistan's climate change department formed a Climate Finance Wing; appointed leadership to the Global Change Impact Study Centre, GCISC; and envisioned the establishment of a Pakistan Climate Change Authority to ensure more coordination in the execution of climate policy. The government then aligned the climate strategy with internationally agreed frameworks by revising the Land Degradation Neutrality targets in line with the Kunming–Montreal Global Biodiversity Framework (Dawn, 2025a). In this respect, the NCFS is designed to achieve the mobilization of domestic and international climate finance and close the estimated climate finance gap of USD 348 billion by 2030. The State Bank of Pakistan is expected to issue green economy financing guidelines to encourage investment in green initiatives (Profit by Pakistan Today, 2025a, 2025b). In July 2025, the government launched, in collaboration with the GCF and the World Wide Fund for Nature, a project aimed at making districts like Buner and Shangla resilient against floods by introducing an early warning system and enhancing community capacity for responding to climate shocks (The United Nations in Pakistan, 2025).

The government has also reiterated its commitment to clean energy and nature-based solutions. Initiatives include renewable energy, encouragement of electric vehicles (EVs), reforestation for carbon sequestration, a Green Stimulus Package for green jobs, off-grid solar in rural areas, and encouraging REDD+ initiatives (news.cgtn.com, 2025; Nation, 2025; uraanpakistan.pk, 2025a, 2025b). Public engagement has also been encouraged, with youth leaders calling on the leadership to dedicate 25% of national climate funding for youth-led climate initiatives, climate education, agro-forestry, and at the district level (Nation, 2025). Notwithstanding these, some criticism has emerged more recently over cuts to the environment protection budget in FY 26 that raise concerns over longer-term commitment (Pakistan Today, 2025). Government is trying both on national and international level to tackle the issue as it is becoming a national emergency.

Conclusion

Pakistan is the 8th most vulnerable country in accordance to climate change. In 2024, in summer the temperature exceeds more than 50 degrees in Celsius scale. Different areas face a shortage of rain which results in drought. Now in pollution and smog the capital of Punjab i.e. Lahore is one of the top polluted cities in the world. Several skin, lung, and eye infections are spread all around the

country. Climate change not only human life but also animals because of deforestation and no new diversity is migrating and staying in Pakistan and the living ones are facing the threat of instinct ion. Because of acid rain, the historical places are damaged and the fields are also destroyed in large numbers. To acquire a sustainable environment both governmental and non-governmental organizations are working. United Nations forms are also working for sustainable goals and aid is given to Pakistan. As a citizen, our responsibilities are also to protect animals, plants, and our generation by keeping the environment clean. We all should participate and should collaborate with the government to tackle this severe issue to save coming generations and nature.

Conflict of Interest

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