

# ENVIRONMENTAL CHALLENGES IN PAKISTAN: ASSESSING IMPACTS AND EXPLORING SOLUTIONS

# 1. Abdul Aziz, 2. Prof. Dr. Manzoor Khan Afridi

1. Corresponding author, Ph.D. Scholar at the Department of Politics & IR, Faculty of Social Sciences, International Islamic University, Islamabad

Email address: 70chinar @ gmail.com

2. Prof. Dr. Manzoor Khan Afridi, Dean Faculty of Social Sciences, International Islamic University, Islamabad

Email address: manzoor.afridi@iiu.edu.pk

### Abstract

The global environmental crisis, marked by climate change, biodiversity loss, pollution, and environmental injustice, presents a critical challenge requiring comprehensive action. These interlinked issues emphasize the necessity of an integrated approach to environmental governance that addresses both systemic inequalities and root causes. Human activities such as deforestation, land degradation and unsustainable resource exploitation continue to destabilize ecosystems, reducing their resilience and exacerbating climate change. Pollution and inadequate waste management disproportionately affect marginalized communities, particularly in the Global South, highlighting the deep-rooted inequities in environmental justice.

Pakistan, despite its low contribution to global carbon emissions, faces severe climateinduced challenges, including extreme weather events, flooding and resource depletion. The country's vulnerability is exacerbated by weak governance, resource constraints and ineffective enforcement of environmental policies. While Pakistan has committed to international environmental agreements, significant gaps remain in policy implementation and institutional capacity.

To address these challenges, strengthening environmental governance at all levels is essential. This requires improved policy enforcement, equitable resource distribution and enhanced international cooperation to support Pakistan. A holistic, justice-driven approach is imperative to building resilience, promoting sustainable practices and mitigating the longterm impacts of environmental degradation. This paper underscores the urgency of coordinated efforts to safeguard the environment.

# Keywords:

Pakistan's Environmental Challenges, Environmental Policy Implementation, Environmental Justice, Environmental Governance, Climate Change, Biodiversity Loss, Air Pollution, Industrial Pollution, Ecosystem, Deforestation, Land Degradation, Waste Management, Urbanization, Water Scarcity and Contamination, Energy Crisis.

# Introduction

Pakistan faces numerous environmental challenges that threaten its ecosystems, public health and economic development. Key environmental problems include climate change, deforestation, water scarcity, air and water pollution and waste management issues. These challenges are compounded by rapid urbanization, population growth and industrialization, creating stress on natural resources and exacerbating environmental degradation. Pakistan's vulnerability to climate change, with frequent floods, droughts and glacial melt, places additional pressure on its agricultural productivity and water resources, further impacting food security and livelihoods.



Major cities like Lahore and Karachi are experiencing hazardous air quality levels, particularly during winters. This contributes to severe public health problems, including respiratory diseases. Additionally, deforestation and mismanagement of water resources threaten biodiversity and disrupt ecosystems, leading to habitat loss and reduced agricultural output. Despite efforts through policy reforms and environmental diplomacy, weak governance, inadequate enforcement mechanisms and limited financial resources hinder sustainable environmental management (Farzana et al, 2024). Addressing these interconnected issues requires a comprehensive approach involving policy intervention, regional cooperation and public awareness to safeguard Pakistan's environmental future.

### Key Environmental Issues in Pakistan and Associated Impacts

# **1. Environmental Governance and Policy Gaps**

### Weak Implementation of Environmental Laws

Despite the presence of several environmental laws and regulations in Pakistan, their implementation remains weak. Key legislation, such as the Pakistan Environmental Protection Act 1997 (PEPA–1997), provides a legal framework for environmental protection, but enforcement is often inconsistent. One of the primary reasons for weak implementation is the lack of monitoring mechanisms and accountability within institutions responsible for environmental governance. Regulatory agencies such as the Environmental Protection Agencies (EPAs) at the federal and provincial levels often suffer from inadequate funding and personnel, limiting their ability to enforce compliance. Political influence and corruption further impede enforcement, as industries and businesses often bypass environmental regulations without facing significant penalties. Environmental courts exist to address violations, but their limited capacity results in slow proceedings and low conviction rates. Weak law enforcement undermines the effectiveness of policies aimed at addressing air pollution, deforestation and waste management, contributing to the degradation of natural resources.

### Limited Institutional Capacity and Coordination

Environmental governance in Pakistan is hampered by weak institutional capacity and lack of coordination among government bodies. Following the 18<sup>th</sup> Constitutional Amendment in 2010, environmental management was devolved to the provinces, leading to fragmented policies and overlapping responsibilities. Provincial governments often lack the technical expertise and financial resources needed to implement sustainable environmental policies effectively. The absence of inter-agency coordination further exacerbates the issue. Different departments such as agriculture, water management and industries work independently, resulting in policy conflicts and inefficiencies. For example, the lack of coordination between water and agriculture authorities has led to inefficient water use and exacerbated water scarcity. Similarly, environmental protection efforts are undermined by inadequate collaboration between provincial EPAs and national agencies. Strengthening institutional capacity and fostering coordination are essential for ensuring effective environmental governance in Pakistan.

#### Lack of Public Awareness and Stakeholder Involvement

Public awareness and stakeholder involvement are crucial for the success of environmental governance, but both are limited in Pakistan. Environmental issues receive minimal attention in educational curricula and public discourse, contributing to low levels of awareness about climate change, biodiversity loss and pollution (Hamad et al., 2024). The lack of community engagement and grassroot participation makes it difficult to implement policies that require public cooperation, such as waste management programs and air pollution control measures. Civil society organizations and non-governmental organizations



(NGOs) have made efforts to raise awareness, but their reach remains limited, especially in rural areas. Additionally, there is minimal stakeholder involvement in environmental policymaking, with key sectors such as industry and agriculture often excluded from the decision-making process. Strengthening public awareness campaigns, incorporating environmental education and encouraging participatory governance can play a vital role in bridging these gaps.

#### 2. Climate Change / Global Warming Rising Temperatures and Heatwaves

Pakistan has witnessed a significant rise in temperatures over recent years, with heatwaves becoming more frequent and severe. Major cities like Karachi, Lahore and Jacobabad experience extreme temperatures, sometimes surpassing 50°C. A heatwave in Karachi in 2015 claimed over 1,200 lives, highlighting the vulnerability of urban areas with limited access to cooling infrastructure and healthcare services. Prolonged high temperatures also aggravate health issues, increase energy demand and strain public utilities like water and electricity supply. According to the Global Climate Risk Index, Pakistan ranks among the most affected countries by climate-induced disasters (Eckstein et al., 2021). These rising temperatures also contribute to urban heat islands, posing additional challenges for the urban poor and workers exposed to outdoor environments.

### **Glacial Melt in the Northern Areas**

The northern regions of Pakistan, home to the Himalayas, Karakoram and Hindu Kush ranges, contain some of the world's largest glaciers. Climate change is accelerating the melting of these glaciers, leading to Glacial Lake Outburst Floods (GLOFs) and increasing the risk of flash floods downstream (Hamad et al., 2024). The Pakistan Meteorological Department has warned of an alarming reduction in glacier mass, threatening the long-term water availability of the Indus River, which supports agriculture, hydropower and drinking water needs. The GLOF Risk Reduction Project, funded by the UNDP, has identified dozens of glacial lakes at risk of bursting. Communities in Gilgit-Baltistan and Chitral are particularly vulnerable, with frequent GLOF events disrupting lives and livelihoods.

# **Increased Frequency of Floods and Droughts**

Pakistan experiences both excessive flooding and prolonged droughts due to changing weather patterns. Intense monsoon rains have become more erratic, resulting in devastating floods, as witnessed in 2010 and 2022. The 2022 floods alone displaced millions of people, submerged one-third of the country and caused economic losses exceeding \$30 billion (World Bank, 2022). On the other hand, parts of Sindh and Balochistan suffer from chronic droughts, impairing agricultural output and threatening food security. The combination of floods and droughts poses a severe challenge to the country's infrastructure and disaster management capacity, demanding greater investment in climate-resilient infrastructure and early warning systems.

# **Impact on Agriculture and Water Resources**

Agriculture, which accounts for around 19% of Pakistan's GDP and employs a large segment of the population, is highly sensitive to climate change. Erratic rainfall patterns and rising temperatures reduce crop yields, particularly for wheat, cotton and rice, staple crops that are vital for food security and exports (Abid et al., 2015). Additionally, droughts in arid regions disrupt livestock farming, further impacting rural livelihoods. Water resources are also under threat. Pakistan depends heavily on the Indus River system, which is fed by glacial melt and monsoon rains. Reduced water availability, coupled with inefficient irrigation practices, worsens water scarcity, impacting agricultural productivity and drinking water



supplies. The government is under increasing pressure to implement water conservation policies and modern irrigation techniques to cope with these challenges.

### 3. Air Pollution

The primary sources of air pollution in Pakistan include industrial emissions, vehicle exhaust and the burning of agricultural residues. Industrial units, many of which operate without adequate pollution control measures, release large amounts of sulphur dioxide, carbon monoxide and particulate matter into the air. In urban areas, vehicle emissions are major contributor, where outdated public transportation systems and poorly regulated fuel quality intensify air pollution.

### **Pollution in Urban Areas**

Air pollution has become a significant concern in Pakistan's major cities, especially Lahore and Karachi. Lahore, often listed among the world's most polluted cities, experiences severe smog episodes due to seasonal weather patterns and local pollution sources. Here, smog frequently blankets the urban landscape, particularly during winters. Smog events in Punjab not only reduce visibility but also cause transportation disruptions, leading to social and economic losses. Karachi also suffers from deterioration of air quality driven by industrial emissions and vehicular traffic, increasing health risks for millions of residents.

# **Health Impacts**

Air Pollution in Pakistan contributes to a range of health problems, particularly respiratory diseases such as asthma, Chronic Obstructive Pulmonary Disease (COPD) and lung cancer. Children and the elderly are especially vulnerable to polluted air, with research showing that exposure to particulate matter (PM2.5) increases the risk of respiratory infection and cardiovascular diseases. The World Health Organization (WHO) has highlighted that air pollution is a leading cause of premature deaths in Pakistan, with thousands of fatalities attributed to respiratory conditions impaired by poor air quality.

# **Economic Costs Due to Health Burden**

The economic consequences of air pollution in Pakistan are severe, as the health burden from respiratory and cardiovascular diseases results in significant healthcare costs and productivity losses. According to estimates, Pakistan loses billions of dollars annually due to pollution-related healthcare expenses, reduced workforce productivity and environmental degradation. Frequent smog events also affect transportation, tourism and commerce, further straining the economy. Despite efforts to mitigate pollution, weak regulatory enforcement and a lack of public awareness continue to hamper progress in addressing these challenges.

# 4. Industrial Pollution and Environmental Degradation

### **Discharge of Untreated Industrial Waste into Rivers**

Pakistan's industrial sector significantly contributes to environmental degradation, primarily through the discharge of untreated waste into rivers and water bodies. Industrial hubs, e.g. in Karachi, Faisalabad and Lahore, release large volumes of untreated effluents containing toxic chemicals, heavy metals and organic waste directly into rivers like the Ravi and the Indus. These pollutants severely degrade water quality, posing risks to aquatic life and the health of nearby communities. According to the Pakistan Environmental Protection Agency (Pak-EPA), only a fraction of industries complies with environmental regulations requiring proper wastewater treatment, exacerbating pollution issues. In the absence of effective monitoring and enforcement, industrial waste continues to accumulate in rivers, leading to oxygen depletion and harmful algal blooms. This not only threatens biodiversity but also renders water unfit for drinking, irrigation and other uses. The textile and chemical industries are among the major polluters, contributing to environmental degradation through the release of dyes, acids and solvents.



### **Contamination of Soil and Water Bodies**

Industrial activities also contribute to the contamination of soil and groundwater in Pakistan. Hazardous waste, including heavy metals such as lead, chromium and cadmium, is often disposed off improperly, contaminating agricultural soil and posing risks to crop production. Groundwater contamination is a severe issue, particularly in urban areas where industries dump untreated waste. Studies have shown high levels of heavy metals and other toxic substances in both surface and groundwater sources, making them unsuitable for human consumption and agricultural use. Additionally, industrial contamination has led to a loss of arable land in various regions, particularly in the vicinity of industrial zones, further affecting the country's food security. The lack of environmental regulation and waste management infrastructure allows factories to operate without implementing sustainable waste disposal practices, aggravating the contamination problem (Pak-EPA, 2016).

### **Impact on Agriculture and Fishing Communities**

The contamination of rivers, soil and groundwater has profound impacts on Pakistan's agriculture and fishing communities. Polluted water bodies reduce fish populations, directly affecting the livelihood of communities dependent on fishing along rivers like the Indus. Fisherfolk in Sindh and Punjab have reported declining fish stocks due to industrial pollution, forcing many to abandon traditional livelihoods. Agricultural productivity is also impacted as polluted irrigation water degrades soil health, reduces crop yields and contaminates food crops. Industrial pollutants, including heavy metals, enter the food chain through contaminated crops and water, posing serious public health risks. Farmers in regions reliant on irrigation from polluted rivers report declining productivity and financial hardships due to crop failures and soil degradation. In the long term, these issues undermine rural economies and contribute to poverty and food insecurity.

### **5. Deforestation and Land Degradation**

#### **Causes of Deforestation**

Deforestation in Pakistan is driven by several key factors, including illegal logging, urban expansion and the conversion of forest land for agriculture. The country's forests, which cover about 5% of its land area, are under significant threat from unauthorized tree felling, which is often carried out to meet the growing demand for timber and fuelwood. Illegal logging is rampant, particularly in the northern regions of Khyber Pakhtunkhwa and Gilgit-Baltistan, where regulatory oversight is weak. Additionally, rapid urbanization has led to the clearing of forest areas to make way for infrastructure development, further worsening deforestation rates. According to the World Bank (2020), Pakistan's deforestation rate is among the highest in Asia, posing significant environmental challenges.

### Soil Erosion and Desertification

Land degradation in Pakistan is closely linked to deforestation, leading to widespread soil erosion and desertification. The removal of forest cover leaves the soil vulnerable to erosion by wind and water, especially in hilly regions. This is compounded by unsustainable agricultural practices and overgrazing, which deplete the soil of its nutrients, reducing agricultural productivity. Desertification is particularly severe in the arid regions of Sind and Balochistan, where the combination of poor land management and changing climate patterns has turned once fertile land into barren deserts. According to a report by the United Nations Convention to Combat Desertification, approximately 43% of Pakistan's land area is classified as degraded, with severe consequences for food security and rural livelihoods.

# **Impact on Biodiversity and Forest-Based Livelihoods**

The destruction of Pakistan's forests has dire consequences for the country's biodiversity. Forests in Pakistan are home to a wide variety of flora and fauna, many of which



are endangered or vulnerable. Deforestation leads to habitat loss, threatening species as the snow leopard, Himalayan brown bear and numerous bird species. In addition to its environmental impacts, deforestation also has significant social and economic effects. Forest-based livelihoods, particularly in rural areas are dependent on the sustainable use of forest resources, including timber, fuelwood and non-timber forest products. The depletion of forests has left many communities struggling to make a living, exacerbating poverty and contributing to rural-urban migration.

# 6. Biodiversity Loss and Wildlife Threats

### Habitat Destruction and Illegal Wildlife Trade

Pakistan's biodiversity is severely threatened by habitat destruction and illegal wildlife trade. Rapid urbanization, agricultural expansion, deforestation and infrastructure development have led to the large-scale destruction of natural habitats, particularly in areas such as the Himalayan and Karakoram Mountain ranges, the Indus River delta and the Thar Desert. As habitats shrink, wildlife populations are forced into smaller areas, leading to increased human-wildlife conflict. In addition to habitat destruction, illegal wildlife trade is a major concern in Pakistan. Poaching and trafficking of endangered species, including the illegal hunting of snow leopards, pangolins and freshwater turtles, have escalated in recent years. These activities are driven by local and international demand for animal parts used in traditional medicine, exotic pet trade and fashion (ENMPK, 2021). Pakistan is key transit country in the illegal wildlife trade, further exacerbating threats to its biodiversity (UNODC, 2020).

### Impact on Ecosystems and Endangered Species

The destruction of habitats and illegal wildlife trade have cascading effects on ecosystems and endangered species in Pakistan. Fragmented ecosystems, such as the forests of Khyber Pakhtunkhwa and Balochistan, are becoming less resilient to environmental changes, resulting in biodiversity loss and weakened ecosystem services, such as water purification and soil stabilization. Among the most vulnerable species is the snow leopard, which inhabits the mountainous regions of northern Pakistan. Habitat destruction, poaching and retaliation killings by livestock herders are the primary threats to the species' survival. As a keystone species, the decline of snow leopard populations can have detrimental effects on the broader ecosystem, affecting prey populations and overall ecological balance. Other endangered species, such as the Indus River dolphin and the houbara bustard, also face threats due to habitat loss, pollution and hunting.

# **Protected Areas and Conservation Challenges**

Pakistan has established several protected areas, including national parks, wildlife sanctuaries and game reserves, to conserve its biodiversity. Some prominent protected areas include Khunjerab National Park, Hingol National Park and the Central Karakoram National Park. However, these areas face significant conservation challenges, such as inadequate funding, lack of enforcement and encroachments by local communities. Additionally, the involvement of local communities in conservation efforts remains limited, which hampers the effectiveness of these initiatives. Pakistan's wildlife conservation efforts also suffer from weak institutional capacity and governance. Despite policies such as the National Biodiversity Strategy and Action Plan (NBSAP), implementation remains weak due to insufficient resources, lack of coordination between government agencies and limited public awareness. Addressing these challenges requires stronger conservation frameworks, improved enforcement mechanisms and greater engagement with local stakeholders to protect the country's rich biodiversity.



# 7. Waste Management Problems Poor Waste Disposal Systems in Urban Centres

Pakistan's urban centres face significant waste management challenges, primarily due to inadequate waste disposal systems. Rapid urbanization has led to increased waste generation, outpacing the capacity of municipal authorities to manage it effectively. Cities like Karachi, Lahore and Islamabad struggle with inefficient collection, inadequate infrastructure and insufficient budget allocations for waste management (Zafar et al., 2024). According to a report by the Pakistan Environmental Protection Agency (Pak-EPA), less than 50% of urban waste is collected and disposed off properly, leading to the accumulation of waste in streets, drains and open areas. The lack of segregation of waste at the source further complicates the issue, resulting in mixed waste streams that hinder recycling efforts and exacerbate landfill overuse. Many urban areas lack sufficient landfills and existing facilities often operate under poor conditions leading to leachate and other environmental hazards.

# **Plastic Pollution in Rivers and Coastal Areas**

Plastic pollution is a pervasive issue in Pakistan, with significant impacts on rivers and coastal areas. The country generates approximately 3.9 million tons of plastic waste annually, with a considerable portion ending up in water bodies and marine environments. Major rivers, such as the Indus and Ravi, serve a conduit for plastic waste, contributing to pollution downstream and affecting communities that rely on these water sources for drinking and irrigation. Coastal areas, particularly around Karachi, face severe challenges due to plastic debris accumulation. Studies have shown that microplastics are prevalent in marine ecosystems, posing risks to marine life and human health through the food chain. The lack of effective policies and public awareness campaigns to combat plastic pollution exacerbates the situation, with limited recycling and waste management options available.

### Impact on Human Health and Marine Life

The mismanagement of waste has significant repercussions for human health and marine life in Pakistan. Poor waste disposal practices contribute to air and water pollution, which can lead to various health issues, including respiratory diseases, gastrointestinal disorders and skin infections (Zafar et al., 2024). Vulnerable populations, especially those living in close proximity to open dumpsites, are at a higher risk of health problems due to exposure to hazardous waste and unsanitary conditions. In marine environments, plastic pollution adversely affects biodiversity. Marine species ingest plastic debris or become entangled in it, leading to injuries, reduced reproductive success and in some cases, mortality. Additionally, pollutants from plastic waste can accumulate in marine food webs, posing risks to fish populations and the communities that depend on fishing for their livelihoods.

# **Challenges of E-Waste and Hazardous Waste Management**

The increasing production and consumption of electronic devices in Pakistan have led to a growing challenge of electronic waste (e-waste) management. The country generates an estimated 50,000 tons of e-waste annually, with only a small percentage being properly managed. Much of the e-waste is disposed off in landfills or open areas, leading to the leaching of hazardous materials such as lead, mercury and cadmium into the environment. Hazardous waste management is also a critical issue in Pakistan, as industrial facilities often lack proper disposal mechanisms for hazardous by-products. This results in environmental contamination and poses risks to public health (Zafar et al., 2024). The absence of stringent regulations and enforcement mechanisms further complicates waste management efforts, leaving communities and ecosystems vulnerable to the impacts of improperly managed waste.



# 8. Water Scarcity and Contamination Issues Depletion of Freshwater Resources

Pakistan faces a severe depletion of freshwater resources due to a combination of rapid population growth, inefficient water management and climate change. The per capita water availability in the country has drastically declined from 5,260 cubic meters in 1951 to less than 1,000 cubic meters today, pushing Pakistan into the category of water-stressed nations (Shakeel et al., 2023). Climate-induced changes, such as glacial melt and erratic rainfall patterns, further exacerbate water shortages. The Indus River, the lifeline of Pakistan's water supply, is under pressure due to increased water demand, pollution and disputes over water-sharing with neighbouring India.

### **Groundwater Contamination and Waterborne Diseases**

Groundwater resources, a critical component of Pakistan's water supply, are amply contaminated by industrial waste, agricultural runoff and untreated sewage. Arsenic, fluoride and heavy metal contamination have been reported in groundwater across the country, posing serious health risks. Typhoid, hepatitis and diarrhoea are among the waterborne diseases that can spread when polluted water is consumed. According to the Pakistan Council of Research in Water Resources (PCRWR), nearly 60% of the population consumes unsafe drinking water, contributing to the high prevalence of water-related illnesses, especially in rural areas (PCRWR, 2021).

# Poor Access to Clean Drinking Water

Access to clean drinking water remains a major challenge for millions of Pakistanis. According to UNICEF, nearly 21 million people in Pakistan lack access to safe drinking water, particularly in underdeveloped regions such as Balochistan and parts of Sindh. Poor infrastructure, lack of investment in water treatment facilities and weak regulatory frameworks contribute to the widespread water crises. Urban areas are also affected, with intermittent water supply and contamination due to aging pipelines, further straining the already limited water resources.

# Impact on Agriculture, Energy Production and Livelihoods

The water scarcity crises in Pakistan have far-reaching impacts on agriculture, energy production and livelihoods. Agriculture, which accounts for 90% of Pakistan's water consumption, faces severe challenges due to dwindling water availability. Crop yields are affected, particularly in water-intensive crops such as wheat and rice, threatening food security. The energy sector, reliant on hydroelectric power, also suffers as reduced water flows limiting the generation of electricity. Additionally, water shortage and contamination undermine the livelihoods of rural communities, forcing migration to urban areas in search of better opportunities.

## 9. Urbanization and Infrastructure Development

### Impact of Urban Sprawl on Green Spaces and Ecosystems

Urbanization in Pakistan has resulted in the rapid expansion of cities, leading to significant losses of green spaces and ecosystems. Major cities such as Karachi, Lahore and Islamabad have experienced unchecked urban sprawl, with forests, wetlands and agricultural land being converted into residential and commercial areas (Rana & Bhatti, 2017). This encroachment on natural spaces reduces biodiversity and threatens urban ecosystems that provide essential services, such as air purification and temperature regulation. Green areas, including parks and public gardens, are shrinking, compromising recreational spaces and the overall environmental quality of cities. The degradation of ecosystems due to urban sprawl also exacerbates climate risks, including the urban heat island effect, which makes cities hotter than surrounding rural areas (Aslam et al., 2022). In addition, the reduction of tree



cover and green belts limits the ability of cities to mitigate air pollution. Environmental experts emphasize the need for sustainable urban planning policies that prioritize green infrastructure to balance urban development with environmental conservation.

# Waterlogging and Drainage Issues in Cities

Pakistan's cities, especially during the monsoon season, frequently experience waterlogging and flooding due to inadequate drainage infrastructure. Urban expansion without proper planning has obstructed natural drainage paths, leading to frequent flooding in areas like Karachi, Lahore and Rawalpindi. Poor waste management, including the dumping of solid waste into drainage systems, exacerbates waterlogging and further damages existing infrastructure (Hamad et al., 2024). The lack of an effective drainage system also poses health risks, as standing water contributes to the spread of waterborne diseases, including dengue and malaria. Addressing these issues requires significant investments in urban drainage infrastructure and the adoption of climate-resilient urban planning practices to prevent flooding and ensure sustainable urban growth.

# Strain on Public Services and Infrastructure

Rapid urbanization has placed immense pressure on public services, such as transportation, healthcare and education, as well as on housing and sanitation systems in Pakistan's major cities. The influx of rural migrants to urban areas has resulted in overcrowded neighbourhood, informal settlements and slums, leading to a shortage of affordable housing and sanitation facilities. Infrastructure, including roads, public transit systems and electricity grids, is often overburdened and inadequate to meet the growing demands of urban populations (PIDE, 2021). Public services, such as hospitals and schools, are also struggling to cope with rising populations, resulting in reduced quality of services and widening inequalities in access. Urban planners highlight the need for smart cities and integrated urban infrastructure development that can address these challenges through sustainable and inclusive policies. Strengthening urban governance and improving coordination between municipal authorities and provincial governments are essential to mitigate the strain on infrastructure and public services.

# 10. Energy Crisis and Environmental Impact

### Heavy Reliance on Fossil Fuels for Energy

Pakistan's energy sector is heavily dependent on fossil fuels, particularly oil, natural gas and coal, which account for the majority of its energy mix. As of 2021, over 60% of the country's electricity is generated from thermal power plants that rely on imported and domestic fossil fuels. This reliance not only makes the country vulnerable to global energy price fluctuations but also contributes significantly to greenhouse gas emissions and environmental degradation. Pakistan imports a large portion of its fossil needs, increasing its economic burden and contributing to its trade deficit (Pakistan Energy Yearbook, 2022). The government's efforts to diversify energy sources and reduce reliance on fossil fuels have been slow, although there has been some investment in renewable energy projects. The continued expansion of coal-fired power plants under the China-Pakistan Economic Corridor (CPEC) further entrenches Pakistan's dependence on carbon-intensive energy sources, with adverse environmental consequences (Ali et al., 2020).

### Air Pollution from Thermal Power Plants

The extensive use of thermal power plants for electricity generation is a major contributor to air pollution in Pakistan. These plants emit large quantities of particulate matter, sulphur dioxide (SO2), nitrogen oxides (NOx) and carbon dioxide (CO2), contributing to poor air quality, particularly in industrial areas such as Lahore, Karachi and Faisalabad. This air pollution has severe health consequences, including respiratory diseases,



cardiovascular problems and premature deaths (WHO, 2021). In addition to human health impacts, thermal power plants contribute to environmental degradation by emitting toxic pollutants that harm ecosystems and wildlife. Acid rain, a result of sulphur and nitrogen compounds released from power plants, damages crops and forests and contaminates water bodies. Despite the obvious environmental and health risks, Pakistan has struggled to implement stringent regulations on emissions from power plants, due to both financial constraints and the lack of political will.

# **Challenges in Transitioning to Renewable Energy**

Pakistan faces several challenges in transitioning to renewable energy sources such as solar, wind and hydropower. While the country has significant potential for renewable energy, with abundant sunlight and wind resources, the development of these sectors has been slow (Asfand et al., 2022). Structural challenges, including inadequate infrastructure, financial constraints and regulatory barriers, hinder the growth of renewable energy projects. Moreover, the heavy reliance on fossil fuels, entrenched interests in the oil and gas industry and lack of technological capacity further complicate efforts to shift towards clean energy. Although the government has set targets for increasing the share of renewable in the energy mix, the progress has been limited due to the lack of investment and the absence of coherent policy frameworks (Asif, 2009). The transition to renewable energy is critical not only for addressing Pakistan's energy crisis but also for mitigating the environmental impact of its energy sector. International cooperation, public-private partnerships and capacity-building initiatives are necessary to accelerate the adoption of renewable energy technologies in Pakistan.

### Recommendations

### 1. Environmental and Climate Injustice and Inequality

Addressing global environmental challenges requires industrialized nations to equitably share the burden of greenhouse gas emissions, acknowledging their historical contributions to climate change. Governments must embed environmental protection and sustainable practices into their legal frameworks, demonstrating unwavering political commitment to their enforcement. Developed countries should actively work towards reducing regional geopolitical tensions, fostering stability essential for environmental protection and sustainable development. Furthermore, they must extend financial and technological support to the Global South, facilitating a transition towards greener economies. All nations must honour their commitments under international agreements with integrity and accountability, ensuring collective action in the fight against climate change.

### 2. Climate change, Global Warming, Air Pollution and Biodiversity

A comprehensive approach is essential to effectively tackle climate change / global warming, air pollution and biodiversity loss. Large-scale tree plantation efforts should be emphasized to enhance carbon sequestration and restore natural ecosystems. Industrial emissions must be regulated through advanced smoke treatment technologies, while sustainable agricultural methods, such as the environmentally friendly disposal of crop residues, should be adopted to curb air pollution. Biodiversity conservation requires the protection and sustainable management of designated protected areas. Regional cooperation is key to addressing transboundary environmental challenges, and developed nations must assist the developing nations through financial support, technology transfer and capacity-building initiatives. Equitable distribution of the climate change burden is crucial to ensuring fairness in mitigation and adaptation efforts. Furthermore, transitioning to a circular economy can minimize waste and optimize resource use, while strengthening urban resilience through



sustainable infrastructure and disaster preparedness will help cities adapt to climate challenges. Effective multi-level governance, involving national, regional and local stakeholders, is essential for the successful implementation of environmental policies and long-term sustainability.

# 3. Land and Water Pollution

To effectively address land and water pollution, a multi-dimensional approach is necessary, starting with inculcating cleanliness habits in children from an early age through school education. Stakeholders must engage in proper planning to prevent land pollution, while public awareness can be enhanced through green and cleanliness campaigns. Ensuring the availability and proper management of landfills, along with comprehensive waste management systems, is essential to reducing environmental contamination. Industrial waste should be disposed off responsibly, with a strong emphasis on recycling and minimizing plastic bag usage. Efficient sewerage and sanitation infrastructure must be established to prevent water pollution, while relevant departments and agencies should take ownership of land and water bodies to control pollution spread. Adopting clean practices in workplaces and integrating religious motivation-such as Friday sermons by scholars, can further reinforce the importance of cleanliness. Additionally, combating corruption at all levels of governance and improving institutional mechanisms are critical to ensuring the effective implementation of pollution control policies and sustainable environmental management.

### 4. Waste Management and Recycling

Efficient waste management and recycling demand strategic planning and the implementation of well-defined policies and mechanisms. Sufficient mechanical resources should be allocated to facilitate the systematic collection, segregation and disposal of waste. Establishing garbage collection points at suitable locations, considering population density and urban requirements, is essential for maintaining cleanliness. Embracing innovative approaches like the waste-to-energy model, as demonstrated by Singapore, can help transform waste into a renewable energy source, thereby reducing reliance on landfills. Furthermore, setting up recycling plants in accordance with waste generation levels is vital for advancing a circular economy, mitigating environmental impact and ensuring sustainable resource management.

### 5. Urban Sustainability

Promoting urban sustainability requires a multifaceted approach that integrates awareness, policy enforcement and sustainable planning. Conducting seminars and workshops can educate communities about sustainable practices and their benefits. Strict implementation of existing environmental laws is essential to ensure compliance with sustainability standards. Urban planning must be holistic, incorporating carbon-sequestering plants into architectural designs to enhance green spaces and mitigate pollution. The widespread adoption of renewable energy in transportation and daily activities can significantly reduce carbon emissions. Maintaining a clean atmosphere through proper waste management and pollution control is crucial for public health and environmental well-being. To reduce excessive rural-to-urban migration, essential services and infrastructure must be improved in rural areas. Enhancing governance mechanisms is imperative to ensure the effective execution of sustainability policies and long-term urban resilience.

### 6. Transition to Renewable Energy

To accelerate Pakistan's transition to renewable energy, a comprehensive strategy addressing structural, financial and regulatory challenges is essential. The government must strengthen policy frameworks to attract investment in solar, wind and hydropower sectors



while ensuring regulatory clarity and incentives for private sector participation. Upgrading infrastructure and enhancing technological capacity through research, development and skillbuilding initiatives will be crucial. Reducing reliance on fossil fuels requires phasing out subsidies for non-renewable energy and promoting clean energy alternatives. Additionally, fostering international cooperation and public-private partnerships can facilitate knowledge transfer, financial support and technology adoption, ultimately ensuring a sustainable and resilient energy future for Pakistan.

### 7. Scarcity of Water

To address Pakistan's severe freshwater depletion, a comprehensive and sustainable water management strategy is essential. The government must prioritize the efficient use of water resources by implementing modern irrigation techniques, promoting water conservation and upgrading aging infrastructure to reduce wastage. Strengthening regulatory frameworks to prevent industrial and agricultural water pollution is critical, along with strict enforcement of wastewater treatment standards. Enhancing groundwater monitoring and controlling over-extraction will help mitigate contamination risks. Additionally, investment in desalination and rainwater harvesting projects can supplement existing water sources. Public awareness campaigns on water conservation and hygiene practices, particularly in rural areas, are necessary to reduce waterborne diseases. Strengthening transboundary water diplomacy with neighboring countries can also help ensure equitable water distribution from shared sources. Collaborative efforts between government, private sector and international organizations will be crucial to securing Pakistan's long-term water sustainability.

### 8. Biodiversity Loss and Wildlife Threat

To protect Pakistan's biodiversity, urgent and multifaceted conservation measures must be implemented. Strengthening and enforcing environmental laws against deforestation, habitat destruction and illegal wildlife trade is crucial to preserving the country's ecosystems. Expanding and effectively managing protected areas, such as national parks and wildlife reserves, will provide safe habitats for endangered species. Community-based conservation initiatives should be promoted, ensuring local populations benefit from biodiversity protection while mitigating human-wildlife conflicts. Enhancing surveillance and border control mechanisms can help curb the illegal wildlife trade, while stricter penalties for poaching and trafficking will serve as deterrents. Public awareness campaigns on the ecological importance of species like the snow leopard, Indus River dolphin and houbara bustard should be conducted to foster a culture of conservation. Additionally, international cooperation with organizations such as the UNODC (United Nations on Drugs and Crime) and CITES (Convention on International Trade in Endangered Species of Wild Fauna and Flora) is essential to combat transnational wildlife trafficking. Investing in sustainable ecotourism and afforestation projects will further support conservation efforts while promoting ecological resilience.

# Conclusion

Pakistan's high vulnerability to climate change and environmental degradation, despite its minimal contribution to global emissions, underscores the broader challenges faced by developing countries. Limited resources, weak governance and insufficient enforcement of environmental policies hinder effective action, even as Pakistan aligns itself with international environmental agreements.



To resolve these complicated challenges, strengthening global environmental governance is imperative. This requires enhancing compliance mechanisms, fostering equitable resource distribution and ensuring that international agreements translate into actionable outcomes at the national and local levels. The interlinked nature of the environmental crisis necessitates a coordinated and inclusive global response that prioritizes the needs of vulnerable populations and promotes sustainable practices. By adopting a holistic and justice-oriented approach, Pakistan can move closer to mitigating the environmental crisis, threatening the health and well-being of its inhabitants.

Moreover, the above recommendations, provide an insight into the solution of our multiple prevailing environmental issues which may be adopted at various levels of governance with cooperation from concerned stakeholders and civil society.

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