



RESEARCH PAPER

Global and South Asian Environmental Challenges: An In-Depth Analysis of Balochistan's Ecological and Socio-Economic Risks

¹Sarfraz Ahmed and ²Prof. Dr. Muhammad Usman Tobawal

1. Ph.D. Scholar, Pakistan Study Center, University of Balochistan, Quetta, Balochistan Pakistan

2. Director, Pakistan Study Centre, University of Balochistan, Quetta, Balochistan Pakistan

Corresponding Author: sarfrazahmed38808@gmail.com

ABSTRACT

This study aims to examine global, regional, and provincial environmental challenges, with a specific focus on Balochistan, to identify key ecological risks and propose pathways for resilience. Environmental stress is unevenly distributed, and communities in the Global South face greater vulnerability to climate change, biodiversity loss, and weak governance. Balochistan exemplifies these challenges, where fragile ecosystems and socio-economic pressures converge, threatening food security, health, and livelihoods. A qualitative systematic literature review was conducted using peer-reviewed journals, books and conference proceedings published between 2018 and 2025. Sources were thematically analyzed across global, South Asian, and provincial contexts to identify patterns of risk and adaptation gaps. Findings highlight water depletion from over-extraction, desertification driven by overgrazing and deforestation, biodiversity loss, and increasing climate-induced disasters. Pollution and weak policy enforcement further worsen ecological and health conditions. Future strategies should integrate water management, sustainable agriculture, and climate-smart technologies, alongside governance reforms and community participation, to build resilience in Balochistan.

KEYWORDS Balochistan, Climate Change, Ecological Resilience, Global South, Environmental Adaptation

Introduction

The environment remains the foundation for human survival, influencing food security, health, and development pathways (Hayat et. al., 2021). Ecosystem stability regulates climate, sustains biodiversity, and underpins economies across regions (Naeem et. al., 2024; Ahmed, et. al., 2021). Growing recognition of environmental fragility has placed sustainability at the center of global policy agendas (Khan et. al., 2021). Agreements such as the Paris Agreement, commitments under Sustainable Development Goals, and outcomes from COP meetings highlight the urgency for climate action, ecological protection, and inclusive growth (Sajjad et. al., 2023). Despite growing awareness, environmental challenges impact societies unevenly. Communities in the Global South face greater exposure to climate change, pollution, biodiversity decline, and land degradation, while limited resources reduce their capacity for adaptation (Makki et. al., 2025). Within Pakistan, Balochistan represents an acute case where fragile ecosystems converge with weak governance and socio-economic pressures (Khan & Zahid, 2024). Populations dependent on agriculture, livestock, and rangelands endure compounding stress driven by water scarcity, desertification, and recurrent natural disasters (Rasheed & Sadozai, 2024).

This review selects Balochistan due to its strategic position, arid climate, and high reliance on natural resources. Environmental decline in this province threatens livelihoods, triggers migration, and undermines social stability. Its situation reflects

broader South Asian vulnerabilities and contributes to global discussions on sustainability and resilience. Main objectives of this review are to synthesize global, regional, national, and provincial environmental challenges, to show disproportionate risks across Global South, to identify key threats in Balochistan, and to present adaptation pathways that address ecological decline. Article proceeds by outlining global challenges, then narrowing analysis through regional and national contexts, and finally examining Balochistan's environmental crisis together with policy gaps and future strategies.

Material and Methods

This research employs a qualitative systematic literature review to analyze global, South Asian, and Balochistan-specific environmental challenges. The review was guided by three objectives: (i) to synthesize international and regional debates on climate change and ecological resilience, (ii) to contextualize South Asian vulnerabilities, and (iii) to identify Balochistan's unique ecological and socio-economic risks. The study is based entirely on secondary data, drawing from peer-reviewed journals (*Climatic Change*, *Environmental Geochemistry and Health*, *Journal of Hydrology*, *Urban Water Journal*, etc.), books (*Springer International Publishing*, *IGI Global Scientific Publishing*) and conference proceedings (*IOP Conference Series*). References published between 2018 and 2025 were prioritized to ensure contemporary relevance. A thematic analysis approach was used to organize the literature into four tiers: (1) global environmental challenges, (2) Global South vulnerabilities, (3) South Asian regional dynamics, and (4) provincial risks in Balochistan. Each source was coded for recurring themes such as water scarcity, desertification, biodiversity loss, climate change impacts, pollution, and governance gaps. The methodology is delimited to published literature and policy documents, excluding primary data collection, fieldwork, or quantitative modeling. This ensures a broad comparative perspective, though it does not capture real-time community-level experiences.

Results and Discussion

Environmental Challenges in Global North and South

The advanced industrial economies have characterised themselves with excessive adaptation capability but are still experiencing significant deterioration to their environments. The US east coast periodically sustains infrastructure destruction, population displacement, and economic blows due to the destructive impacts of tropical systems, such as cyclones and hurricanes (Shrestha et. al., 2023). The rest of Europe, however, spends lavishly constructing climate infrastructure such as seawalls, dikes, and drainage systems, which are latterly required to counter the impacts of climate change due to rising sea levels and the protection of low-lying coastal regions (Abdelhafez et. al., 2024). Munro et al. (2023) state that Canada undergoes the most climate degradation due to reckless deforestation and constant striking of forest fires, which compromises biodiversity and emits more carbon than needed, while the foresting population undergoes displacement. Further, within the broader context of climate change, the issue of industrial waste disposal remains unsolved, and all advanced economies are in the deadlock of suffering due to the piled-up waste that threatens to soil, air and water (Ritchie, 2021). These regions are indeed capital-rich, which is evident in the fact that finance is not a problem in adopting cutting-edge tech and investing in sustainable infrastructure, such as forests and warning systems integrated with hurricanes as a proactive adaptation measure to climate change (Amer et. al., 2022). These regions also

finance research and advocacy in 'radical' measures such as the circular economy, aggressive waste reduction, and more (Plotnic & Praporscic, 2024). Such challenges still need to be solved. Increasing intensity of climate disasters often surpasses adaptation capacity, forcing repeated reconstruction attempts (Li et. al., 2025). Likewise, political arguments, competing priorities, and the unequal allocation of resources stymie effective strategies with long-term horizons (Fiksel et. al., 2021). While nation-states of the Global North possess stronger institutional frameworks and scientific capacity, the environmental pressures continue to escalate. Disasters grow more severe, ecosystems decline, and the quantity of waste generated skyrockets, demonstrating that economic strength is not a sufficient protective shield for societies. Building long-term resilience will include, but not be limited to, shared responsibility, innovative behavioural shifts, and sustained heavy investment (Bouziotas et. al., 2023).

The Global South continues to demonstrate considerable susceptibility, especially with limited economic opportunity as well as institutional capacity. Droughts, food insecurity, and floods create dire situations for various countries in Africa, South Asia, and Latin America (Munyai et. al., 2021). El-Mahdy (2022) illustrates how severe water scarcity greatly undermines farming, diminishes crop yields, and sabotages farmers' and livestock herders' livelihoods. Many smallholder populations and communities have difficulty gaining access to water and, as a result, suffer chronic poverty and malnutrition because rainfall patterns have become increasingly erratic (Aryal et. al., 2021; Farid & Ashraf, 2025). Large-scale deforestation in the Amazon Basin, Central Africa, and Southeast Asia greatly speeds up the collapse of diversity of life there (Chen et. al., 2024). The clearing of forests to obtain timber, ranch cattle, or grow certain commercial crops creates an ecosystem collapse while releasing carbon and destabilising climate in that region (Prestes et. al., 2024). Further disappearance of natural habitats endangers the existence of certain indigenous people dependent on the forest as a resource (Rorato et. al., 2022). The increased rate of deforestation greatly furthers the limits of ecological resilience. The results are floods and droughts that are far more destructive (Saatchi et. al., 2021).

Case studies depict the gravity of the issues at hand. For example, in East Africa, pastoralists have suffered the consequences of recurrent drought, causing conflict over dwindling grazing land (Kusangaya et. al., 2021). In South Asia, the monsoon floods have resulted in the submersion of villages, which displaces millions of people and stretches the already fragile health system to its limits. In Latin America, the deforestation of the Amazon has increased the likelihood of wildfires while also reducing the sinks needed to regulate global carbon levels (Martins et. al., 2022). A comparison made with the Global North reveals some striking differences. In the case of North America, investments in infrastructure, coastal defences, and advanced early warning systems are all easily accessible (Mutambisi et. al., 2021). Table 1 compares environmental challenges across the Global North and South, highlighting their distinct impacts, causes, affected regions, and severity. Unlike them, Southern countries do not have appropriate funding available and, as a result, depend on short-term relief to cope with the devastating consequences of climate change while ignoring long-term planning (Hussainzad & Gou, 2024). Disproportionate slices of the global investment pie are available to poorer countries, and the investment that is there suffers from incompetent administration. This climate of low investment adaptability in poorer, more exposed places creates a paradox; the more confined a region is for natural resources, the more the repercussions of climate change are felt (Wang & Sun, 2023). In such situations, the consequences of climate change are only of national concern. Global and Global South collaboration is also necessary to protect land, climate, and climate-sensitive communities. This increased

vulnerability is coupled with the cycles of poverty, loss of habitat, and degradation of the earth.

Table 1
Environmental Challenges in the Global North and South: Impacts, Causes, and Solutions (Source: Author creation)

Sr. No .	Environmental Challenges	Impact	Cause	Global North (Affected Areas)	Global South (Affected Areas)	Solutions	Severity
1	Cyclones and Hurricanes	Damage to infrastructure, loss of life	Climate change, warm ocean waters	Coastal USA	Coastal Africa, South Asia	Improved forecasting, disaster preparedness	High
2	Rising Sea Levels	Flooding, erosion, habitat loss	Melting ice caps, thermal expansion	Coastal Europe	Coastal Asia, Africa	Coastal defenses, emissions cuts	High
3	Air Pollution in Major Cities	Respiratory diseases, poor air quality	Vehicle emissions, industry	London, New York	Urban centers (India, China, Latin America)	Emission controls, green transport	High
4	Increasing Greenhouse Gas Emissions from Transportation	Global warming, climate change	Fossil fuel use	Global	Global	Clean energy, public transport	High
5	Melting Glaciers	Sea level rise, habitat loss	Global warming	Arctic region	South America (Andes), Asia (Himalaya)	Emission reduction	High
6	Heatwaves and Droughts	Crop failures, water shortages	Climate change	Southern Europe	Southern Asia, Africa	Water management, heat adaptation	High
7	Overfishing	Fish stock depletion, ecosystem damage	Unsustainable fishing practices	North Atlantic	Southeast Asia, South America	Fishing regulations	High
8	Contamination of Groundwater Supplies	Unsafe drinking water, health risks	Industrial and agricultural runoff		Rural and urban areas (South Asia, Africa)	Pollution control, monitoring	High
9	Increased Frequency of Extreme Weather Events	Damage to infrastructure, human displacement	Climate change	Global	Global	Disaster preparedness, mitigation	High
10	Challenges in Managing Nuclear Waste Disposal	Long-term environmental contamination	Nuclear energy production	Nuclear sites (USA, Europe)	Nuclear sites (South Asia, Africa)	Safe storage, new technologies	High
11	Deforestation and Forest Fires	Loss of biodiversity, carbon release	Logging, climate change	Canadian forests	Amazon, Southeast Asia, Africa	Reforestation, fire management	Medium-High
12	Loss of Biodiversity Due to Urban Expansion	Ecosystem imbalance, species loss	Habitat destruction	Urban and suburban areas	Urban and suburban areas (South Asia, Africa)	Protected areas, green spaces	Medium-High
13	Urban Sprawl Leading to Habitat Fragmentation	Loss of wildlife habitats,	Expanding cities	Urban fringes (North	Urban fringes (South Asia, Africa)	Smart growth, green belts	Medium-High

		reduced biodiversity		America, Europe)			
14	Water Pollution	Harm to aquatic life, unsafe drinking water	Agricultural runoff, industry	Great Lakes, rivers and lakes (USA, Europe)	Rivers and lakes (South Asia, Africa)	Pollution control, regulations	Medium-High
15	Industrial Waste Management Problems	Soil and water contamination	Industrial activities	Industrial regions (North America, Europe)	Industrial regions (South Asia, Africa)	Better waste treatment	Medium
16	Soil Contamination from Chemical Use	Reduced soil fertility, health risks	Pesticides, fertilizers	Agricultural areas (North America, Europe)	Agricultural areas (South Asia, Africa)	Sustainable farming practices	Medium
17	Acid Rain Affecting Forests and Lakes	Forest damage, water acidification	Industrial emissions	Scandinavia, Europe	Southeast Asia, Latin America	Emission controls	Medium
18	Noise Pollution	Health problems, stress	Traffic, industry	Urban centers (North America, Europe)	Urban centers (India, Africa)	Noise barriers, regulation	Medium
19	Waste Disposal and Landfill Overflow Issues	Land contamination, health hazards	Population growth, poor waste management	Urban areas (North America, Europe)	Urban areas (Africa, South Asia)	Recycling, better waste management	Medium
20	Coastal Erosion	Land loss, habitat destruction	Rising sea levels, storms	Northern European coasts	Coastal regions (Asia, Africa)	Shoreline protection	Medium

Environmental Challenges in South Asia

South Asia shares ecological patterns and socio-economic conditions that shape regional vulnerabilities. Water scarcity remains a critical concern, particularly within the Indus basin where agricultural demand continues to rise while glaciers retreat under climate stress (Giese et. al., 2022). Rural populations depending on irrigation face declining yields and growing uncertainty regarding future water supplies (Rashid et. al., 2022). Megacities such as Delhi, Karachi, and Dhaka experience extreme air and water pollution, with rapid industrialization and expanding populations contributing to hazardous conditions (Bandara & Thilakarathne, 2025). Air quality frequently exceeds safe limits, raising health risks such as respiratory illness and cardiovascular disease (Siyal & Gerbens-Leenes, 2022). Water bodies near urban centers often carry untreated waste, endangering communities living downstream (Pasha et. al., 2023). Table 2 ranks environmental challenges in South Asia, with high-severity issues like water scarcity and air pollution having significant impacts on health, agriculture, and infrastructure. Medium to low-severity challenges, such as soil erosion and deforestation, also contribute to long-term environmental degradation, highlighting the need for urgent action across the region.

Table 2
Environmental Challenges in South Asia: From High to Low Severity (Source: Author creation)

Sr. No.	Location	Environmental Challenge	Cause	Impact	Severity
1	Indus River Basin (Pakistan)	Water scarcity due to over-extraction and pollution	Over-extraction, pollution	Limited water supply for agriculture and drinking	High
2	Delhi (India)	Severe air pollution, often exceeding safe limits	Vehicle emissions, industrial pollution	Respiratory diseases, poor air quality	High

3	Karachi (Pakistan)	Water shortages and deteriorating air quality	Overuse of water, vehicle emissions	Decreased water availability, health issues	High
4	Dhaka (Bangladesh)	Air pollution and flooding caused by poor drainage systems	Industrial emissions, inadequate infrastructure	Increased health risks, frequent flooding	High
5	Himalayas (India, Nepal, Bhutan)	Deforestation leading to soil erosion and landslides	Logging, climate change	Loss of biodiversity, increased landslides	High
6	Cox's Bazar (Bangladesh)	Coastal erosion and loss of habitat due to rising sea levels	Climate change, rising sea levels	Loss of mangroves, habitat destruction	High
7	Madhya Pradesh (India)	Severe droughts leading to agricultural loss and water scarcity	Climate change, overuse of water	Crop failure, reduced agricultural productivity	High
8	Ganges River Basin (India, Bangladesh)	Water pollution from industrial runoff and sewage discharge	Industrial activity, untreated sewage	Contaminated water, health risks	High
9	Punjab (India and Pakistan)	Groundwater depletion from intensive agricultural irrigation	Overuse of groundwater for farming	Decreased water availability for drinking and agriculture	High
10	Sundarbans (India, Bangladesh)	Coastal flooding and loss of mangrove forests due to rising sea levels	Climate change, deforestation	Habitat loss, increased storm damage	High
11	Assam (India)	Frequent floods caused by heavy monsoon rains and deforestation	Deforestation, climate change	Damage to infrastructure, displacement	High
12	Chittagong Hill Tracts (Bangladesh)	Deforestation causing soil erosion and landslides	Logging, agriculture	Soil degradation, increased flooding	Medium-High
13	Western Ghats (India)	Loss of biodiversity and habitat destruction due to logging	Deforestation, urbanization	Loss of endemic species, environmental degradation	Medium-High
14	Kashmir Valley (India)	Deforestation and soil erosion exacerbated by climate change	Logging, unregulated land use	Landslides, loss of forest cover	Medium-High
15	Sri Lanka's Central Highlands	Soil erosion and loss of agricultural land due to deforestation	Logging, unsustainable farming practices	Reduced agricultural productivity, land degradation	Medium

Deforestation and soil erosion dominate hilly and mountainous landscapes. Logging, unregulated construction, and overgrazing strip land of vegetation cover, increasing landslide risk and undermining agricultural productivity (Choudhury et. al., 2022). Floods and droughts occur frequently, magnified by shifting monsoon cycles (Das et. al., 2024). Such extremes displace large numbers of people, damage infrastructure, and strain already fragile economies (Lal, 2023). Resource limitations compound these challenges. Governments often lack financial capacity, institutional strength, and technical expertise required for climate adaptation (Sato & Yoshimura, 2023). Governance inadequacies and dispersed policy frameworks impact the effectiveness of environmental programmes (Ahmadzai et. al., 2022). Although strategies are developed, climate strategies are usually inconsistent in enforcement and implementation, as initiatives are often left underfunded and poorly coordinated (Pichler et. al., 2020). While there is considerable potential for regional cooperation, political tensions often work against cooperative initiatives. Joint initiatives in river basin management, cross-border air pollution, and disaster management rest on cooperative principles which are still underdeveloped (Ansari et. al., 2024). In the absence of cooperation, countries are left tackling cross-border problems in a piecemeal manner. South Asia is in a unique position where environmental vulnerability coexists with population growth and economic ambition (Lal 2023). Meeting these challenges will need funding, new and flexible

governance mechanisms aimed at regional robust resilience, and strategies for adaptive cooperative regional frameworks.

Environmental Challenges in Pakistan

Of all the nations in the world, Pakistan is ranked among the most vulnerable to the impacts of climate change, with the surge in temperatures, unpredictable rainfall and extreme weather conditions being most severe in the country (Rehman et. al., 2018). A country's geographic diversity, agricultural dependency and rapid urbanisation, as seen in Pakistan, all work in tandem to increase the country's environmental suffering (Raza et. al., 2020). The response and capacity regarding policies is limited, even though the potential of such policies being useful is acknowledged, leaving so many in the shackles of recurring catastrophes (Shahzad et. al., 2021). Henceforth, change in Pakistan's climate is a growing concern. It is not just urban centres but also rural areas that are suffering from heat waves, where the food system, public health and energy are equally affected (Hussain et. al., 2020). Farmers in rural areas are faced with the problem of late sowing periods, and urban areas are burdened with a dip in temperature during the period where electricity is required most (Zia, 2023). The controversy around rainfall cycles is a big issue, for farmers who depend on the seasons for agriculture (Abro et. al., 2025). The most intense problem is the destructive floods that are becoming a persistent phenomenon in the country and that are growing unmanageable with each passing year (Mehmood et. al., 2022; Nadeem, et. al., 2023). Pakistan is facing many environmental issues, most of which are mentioned in Figure 1. Water scarcity, air pollution, deforestation and climate change are the country's most pressing issues. These issues are driven by factors such as rapid urbanization, industrial pollution, and unsustainable agricultural practices. Addressing these challenges requires comprehensive policy interventions, resource management, and a shift toward sustainable practices to mitigate their impact on public health, agriculture, and biodiversity.

Water depletion represents another pressing challenge. Pakistan depends heavily on the Indus basin, yet glaciers feeding rivers continue to shrink (Ashraf & Akbar, 2020). Groundwater tables fall rapidly due to unregulated extraction for agriculture and urban consumption (Hasan & Fatima, 2025). Rural households already face water scarcity, while industrial zones compete for dwindling reserves (Muzammil et. al., 2020). Mismanagement of irrigation further wastes precious supplies, contributing to lower yields and food insecurity (Qureshi & Perry, 2021). Forests cover less than five percent of land area, among the lowest ratios within South Asia (Janjua et. al., 2021). Deforestation driven by fuelwood demand, illegal logging, and urban expansion erodes biodiversity and accelerates soil degradation (Zakir-Hassan et. al., 2024). Loss of vegetation also intensifies flood impacts, as landscapes lose natural absorption capacity (Steenbergen, 2020). Communities in mountainous regions face growing risks from landslides due to weakened slopes (Ashraf et. al., 2023). Pollution compounds environmental fragility. Industrial emissions, vehicular exhaust, and unchecked plastic use generate serious health hazards (He et. al., 2024). Air pollution levels in cities such as Lahore and Karachi frequently exceed safe thresholds, raising the incidence of asthma and heart disease. Rivers and canals receive untreated industrial waste, contaminating drinking supplies and threatening aquatic ecosystems (Qazlbash et. al., 2020).

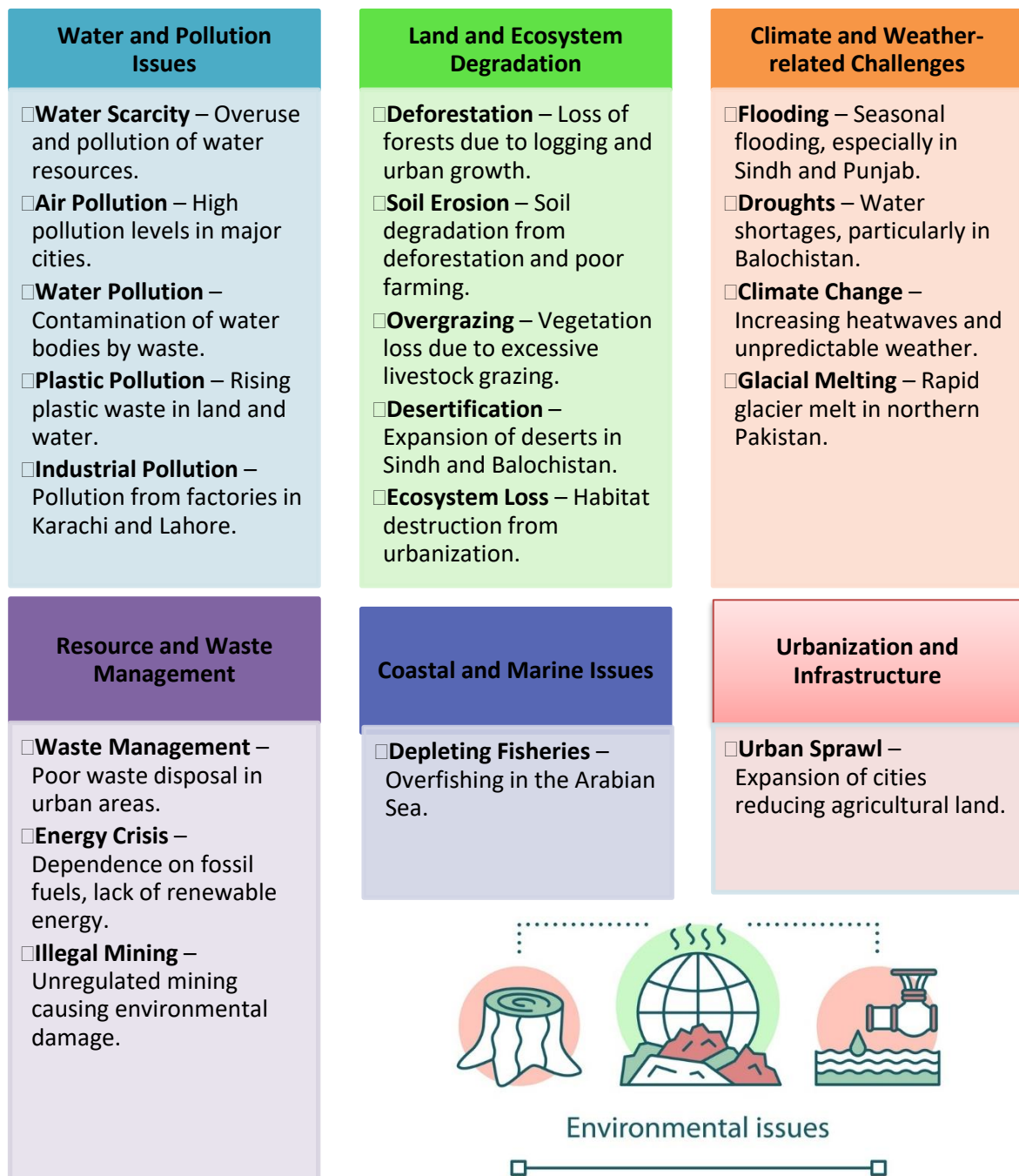


Figure 1: Environmental Challenges in Pakistan: Key Issues Impacting Sustainability
(Source: Author creation)

Floods remain Pakistan's most destructive hazard. In 2022, unprecedented rainfall triggered super floods that displaced over 33 million people, destroyed crops, and caused widespread infrastructure loss (Muzammil et. al., 2024). Damages exceeded billions of dollars, highlighting limited resilience capacity. Recovery efforts exposed institutional weaknesses, as relief distribution faltered and coordination among agencies proved inadequate (Janjua et. al., 2021). This case illustrates how climate extremes can reverse development gains, pushing vulnerable communities deeper into poverty. Institutional and policy gaps persist despite numerous strategies. Environmental regulations exist but enforcement remains weak (Muzammil et. al., 2023). Overlapping mandates across federal, provincial, and local authorities create confusion and slow

responses (Steenbergen, 2020). Stakeholder coordination often breaks down, leading to duplication or neglect. Financial allocation for climate programs remains insufficient, while dependence on external aid undermines sustainability (Muzammil et. al., 2024). Public awareness campaigns exist but fail to translate into behavioral change at scale (Ashraf et. al., 2023). Pakistan's environmental trajectory underscores the urgent need for stronger governance, resource efficiency, and community-based adaptation. Without comprehensive reforms, climate shocks, water depletion, pollution, and ecological decline will continue to erode resilience, threatening both livelihoods and national stability.

Environmental Challenges in Balochistan

Water Scarcity, Desertification, Climate Change, and Pollution

Balochistan faces acute water scarcity due to rapid aquifer depletion driven by over-extraction for agriculture and urban growth. In addition, the region's annual water deficit, along with under rainfall and the inability to recharge aquifers, adds to the resource scarcity (Hayat et. al., 2021; Ashraf & Adnan, 2022; Ashraf, 2021), which continues to get worse. Balochistan's remaining aquifers are practically useless for farming, and as a result crop yields are diminished, livestock face death, and urban areas face critical shortages. In particular, the case of Quetta city has assumed alarming proportions, as the water table in Quetta has plummeted, and as a result, reliance on borewells has increased, which in turn strains the energy resources (Qureshi et. al., 2022; Khan, et. al., 2022). Balochistan has been the subject of criticism because of the depletion of aquifers, a situation that has derogatorily been termed 'collapse of supply'. Urban centres, which are akin to magnets, have also been victims of this criticism, as are the migrants who are drawn to cities in search of better opportunities. Based on the findings of Iqbal et al. (2024), the lack of secure systems to recharge systems, together with block irrigation systems, results in food insecurity. Coupled with the diminished livelihood and socio-economic stability, the rural components of the province's farmers are at the bottom of the pack.

The desertification process in Balochistan seems to be aggravated by overgrazing on the already fragile rangelands. Overgrazing leads to loss of fertility on pastures, decreased vegetation cover, increased soil erosion, and, in the process, lowers ecosystem resilience (Durrani et. al., 2021). People engage in tree cutting, not realising that overutilisation of these resources leads to deforestation and ecosystem degradation. The effect of ecosystem degradation is directly borne by pastoral households that rely on grazing for their livelihood, resulting in declining income and livestock (Naz et. al., 2020). The destruction of habitat directly endangers the loss of biodiversity, and in the process endangers the entire ecosystem, including all the living beings that reside in it. The consequences of this route are ecosystem services loss on top of food and rural economy sustenance. The lack of a plan for rangeland restoration and grazing control is a cause for concern, for it indicates that desertification is a growing risk of vast, barren, and dry areas. Restoring the damage caused by this, on the other hand, seems impossible (Ahmad et. al., 2023).

Rafiq et al. (2022) have noted that crops have rhythm; in layer-sowed rain-fed crops, the first ones arrive in the rainy season, and the last ones sown in the rainy season flower and set pods. However, less predictable weather has brought uncertainty to both the growing and harvesting periods. The productivity of agriculture is directly linked to the security of food. The capacity to adapt to the effects of drought and floods is minimal

due to the absence of internal resources (Iqbal et. al., 2024). The health consequences of climate change can be particularly worrisome in the poorer districts of the region that have little access to reliable electricity and health care, which makes them more susceptible to the heat (Durrani et. al., 2021). Adaptation to vulnerabilities of the region is analogous to the more general South Asian region, which brings local realities in sync with global climate change. Poor conditions of the climate change agriculture of Balochistan, certainly without planning for climate change, combined with the shifts of being more articulate, the region can be more articulate and precise in planning for the harvest of crops; the deteriorating conditions of the region will undoubtedly be met with harsh rain.

Pollution in Balochistan intensifies environmental and health stress. Quetta suffers from rising air pollution due to unchecked vehicle emissions, dust from rapid construction, and emissions from small-scale industry (Khan et. al., 2021). Rural communities face contaminated groundwater, often unsafe for drinking, leading to widespread waterborne diseases (Qaisrani et. al., 2022). Expansion of towns brings noise pollution from traffic and urban growth, reducing quality of life. Residents frequently report respiratory issues, skin conditions, and long-term health damage linked to poor environmental standards (Durrani et. al., 2025). Limited waste management and weak regulatory oversight allow pollutants to accumulate unchecked, creating a cumulative hazard for communities already struggling with resource scarcity (Iqbal et. al., 2024).

Groundwater Depletion, Loss of Biodiversity, Socio-Economic Impacts, and Governance Failures

Balochistan's dependence on tube wells has created severe groundwater mining, often unregulated and unsustainable (Iqbal et. al., 2024). With limited surface storage such as dams, communities rely heavily on underground reserves, depleting aquifers at rates far faster than recharge (Akhtar et. al., 2021). Groundwater depletion emerges as a hidden crisis with irreversible impacts on agriculture and drinking water supply (Rizwan et. al., 2021). Farmers depend on deeper wells, requiring higher energy inputs, raising production costs, and reducing profit margins (Iqbal et. al., 2024). Urban households face shortages, forcing reliance on tanker water at high prices (Rizwan et. al., 2021). Without integrated management and investment in storage infrastructure, groundwater collapse risks destabilizing Balochistan's agricultural economy and human settlements (Ayub & Ahmad, 2020).

Native plant species across Balochistan face disappearance due to overexploitation and climate stress (Durrani et. al., 2025). Species like the markhor and the houbara even today remain threatened due to rapid habitat destruction, poaching, and desertification (Hayat et. al., 2021). Dissolution of ecosystem services diminishes agricultural sustainability through the depletion of soil, pollination, and water (Durrani et. al., 2025). Besides this, the rich cultural legacy of the region is lost, especially when the traditional ways of utilising and acquiring wild foods and materials and even practising herbal medicine collapse (Hayat et. al., 2021). People start losing both the tangible and intangible aspects of wildlife which migrate positively and enhance the community's resilience ever so slightly (Rizwan et. al., 2021). There is a loss of community, especially when talking about conservation, repair efforts, and community participation, and this is correlated directly with the imbalance of nature, as well as the rural community's way of life and the loss of the region's cultural mosaic (Akhtar et. al., 2021).

Figuring out the environmental problems in Balochistan carries inestimable socio-economic problems. Rural households are forced to migrate due to declining water and land availability equally burden already strained urban centres (Iqbal et. al., 2024). The impoverishment of the region, particularly among women and the disadvantaged, is due to dwindling employment opportunities because of declining agriculture and livestock (Iqbal et. al., 2024). Scarcity of resources leads to violence and losses in community cohesion and security (Akhtar et. al., 2021). The breakdown of food systems and loss of traditional means of livelihood due to rampant displacement subject most people to vulnerable and dependent conditions (Rizwan et. al., 2021). The prevailing cycles of poverty and inequality leave no option but socio-economic instability to reinforce the already lacking resources for climate change adaptation, which leads to environmental decline and persistent poverty, making climate change more inevitable in one of the most impoverished provinces of Pakistan, Balochistan (Iqbal et. al., 2024).

The Balochistan province suffers from failure to govern its climate and environmental policies coherently and in sufficient detail (Hayat et. al., 2021). Their policies exist on paper, but they fail to configure and exert adequate positive efforts due to low 'coordinate and control' capability (Durrani et. al., 2025). Moreover, to the failure to implement cohesive policies and other absences such as Integrated Water Resource Management (IWRM) and sustained financing of major programs in afforestation and rangeland rehabilitation (Rizwan et. al., 2021). Attempts at participatory irrigation policies as well as community rangeland management have proven ineffectual due to lack of multilevel governance and absence of governing community-configured interventions (system governance, silos in governance) (Durrani et. al., 2025). Deficient community-based climate adaptation (CBCA) policies also add to failure and weaken community resilience (Hayat et. al., 2021). Lasting solutions require entrenched governance, strong capacity, and local ownership via democratic mechanisms emplaced to reverse the ecological decline and foster sustainable 'progress' and development (Akhtar et. al., 2021).

Table 3 provides a comprehensive summary of environmental challenges in Balochistan, outlining key issues such as water scarcity, desertification, and pollution. It highlights the causes behind these problems, including over-extraction, deforestation, and industrial activities. The table also offers suggested solutions, focusing on sustainable practices like efficient irrigation, afforestation, and climate-resilient agriculture.

Table 3
Summary of Environmental Challenges in Balochistan: Key Issues and Solutions
(Source: Author creation)

Sr. No.	Environmental Challenge	Description	Impact	Examples	Cause	Suggested Solutions
1	Water Scarcity	Rapid depletion of aquifers due to over-extraction for agriculture and urban needs.	Declining water availability for agriculture, livestock, and urban centers.	Quetta's falling water table, villages facing forced migration.	Over-extraction, lack of rainfall	Sustainable recharge systems, efficient irrigation.
2	Desertification and Rangeland Degradation	Overgrazing by livestock, deforestation of firewood, and soil erosion.	Loss of fertility, reduced vegetation cover, and habitat loss.	Overgrazing in rangelands, deforestation for firewood.	Overgrazing, deforestation	Controlled grazing, afforestation, soil conservation.
3	Climate Change Effects	Rising temperatures and erratic	Increased frequency of droughts,	Droughts in low-lying areas, crop	Rising temperatures,	Climate-resilient crops, water

		weather patterns.	heatwaves, and floods.	failure due to erratic weather.	unpredictable weather patterns	management strategies.
4	Pollution	Air, water, and noise pollution due to industrial and urban expansion.	Health issues like respiratory diseases, waterborne diseases, and reduced quality of life.	Quetta's vehicle emissions contaminated groundwater.	Industrial activity, poor waste management	Pollution control measures, waste management.
5	Groundwater Depletion	Over-reliance on groundwater due to lack of surface storage, unregulated tube wells.	Long-term crisis with irreversible impacts on water access and agriculture.	Excessive use of tube wells, absence of dams for water storage.	Unregulated water extraction, lack of dams	Surface water storage, regulation of tube well use.
6	Loss of Biodiversity and Ecosystem Services	Overexploitation of native species and climate stress lead to biodiversity loss.	Collapse of ecosystem services like pollination and water regulation.	Disappearance of native plants, endangered species like Markhor.	Overexploitation, habitat destruction, climate change	Conservation, habitat restoration, sustainable practices.
7	Socio-Economic Consequences	Migration from rural areas due to environmental pressures and loss of agricultural productivity.	Increased unemployment, poverty, especially among women, and heightened resource conflicts.	Migration to urban centers, reduced agricultural income.	Water scarcity, land degradation, economic decline	Livelihood support programs, community resilience.
8	Policy and Governance Gaps	Weak implementation and coordination between provincial and federal authorities in environmental governance.	Lack of comprehensive policies for water management, afforestation, and land rehabilitation.	Lack of effective climate and water management policies.	Poor policy enforcement, lack of coordination	Stronger policy enforcement, community-based initiatives.

Policy Measures, Adaptation, and Way Forward

Global frameworks provide essential direction for tackling climate risks. The Paris Agreement emphasizes emission reduction and resilience building, while the Sustainable Development Goals (SDGs) highlight links between poverty eradication, environmental protection, and social inclusion (Lozano, 2022). Annual COP decisions continue to refine collective commitments, offering financial and technical assistance for vulnerable regions such as South Asia (Raazia et. al., 2023). At the national level, Pakistan has introduced the Climate Change Policy and National Adaptation Plan, aiming to address rising climate threats through mitigation and adaptation pathways (Ahmed et. al., 2020). Yet, capacity for implementation remains weak, with resource constraints and fragmented institutional coordination slowing progress (Iqbal et. al., 2023). Integration of climate action into agriculture, water, and energy sectors still lags, limiting effectiveness (Chirambo, 2024).

The provincial context in Balochistan reflects even greater challenges. Despite high exposure to droughts, water depletion, and desertification, policy execution stays minimal (Ullah et. al., 2025; Muzaffar, et. al., 2018). Investments into integrated water management systems, afforestation programmes, and renewable energy programmes remain critical, yet severely underfunded (Mumtaz and Oliveira, 2023). Community-based programmes, especially those which facilitate the strengthening of local governance, can help foster resilience by integrating along contemporary adaptation frameworks (Raazia et. al., 2023). These suggestions stress how strengthening

transparent coordination-based governance frameworks among federal, provincial, and local-level actors can help support local institutions (Leiter, 2022). Adopting gender-responsive strategies helps in addressing the indirect yet pronounced impacts on women who, within the context of rural households, remain heavily reliant on water and land (Ullah et. al., 2025). Funding in research, warning systems, and a more sustainable form of agriculture is indispensable. Strategies such as drought-resistant crops, more integrated irrigation systems, and dispersed renewable energy sources can help address vulnerabilities while also supporting livelihoods (Fuldauer et. al., 2022; Muzaffar, et. al., 2021). There is a need for resilience governance and inclusive, knowledge-based planning through which Pakistan and Balochistan stand to benefit from improved community wellbeing, climate objectives, and ecological balance.

Conclusion

This study explored the critical environmental challenges facing Balochistan, including water scarcity, desertification, climate change, and pollution. The findings show that these issues are significantly exacerbated by unsustainable resource use, weak governance, and climate stress. Water depletion, caused by over-extraction and limited recharge, is a major concern, along with soil degradation and biodiversity loss, which further threaten the region's agricultural and pastoral livelihoods. Climate change is compounding these issues, driving extreme weather patterns and creating a cycle of poverty and displacement. The review highlights the need for integrated water resource management, sustainable agricultural practices, and community-driven solutions to mitigate these challenges. Implications suggest that improving governance, enhancing resource management, and increasing public participation are essential for strengthening the region's resilience. Future directions include research into climate-smart agriculture, innovative water conservation technologies, and policy reforms that address the local and regional vulnerabilities to ensure the long-term environmental sustainability and socio-economic stability of Balochistan. These steps are vital for ensuring a sustainable future for the province.

Recommendations

Future studies should focus on localized empirical research in Balochistan to complement existing literature reviews. Field-based data on groundwater recharge, rangeland restoration, and biodiversity loss would provide critical evidence for policy design. There is also a need to explore climate-smart agricultural innovations, renewable energy adoption, and community-led water management models. Comparative research across South Asia can highlight shared vulnerabilities, while policy-oriented studies should assess the effectiveness of adaptation frameworks and governance reforms for ecological resilience.

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