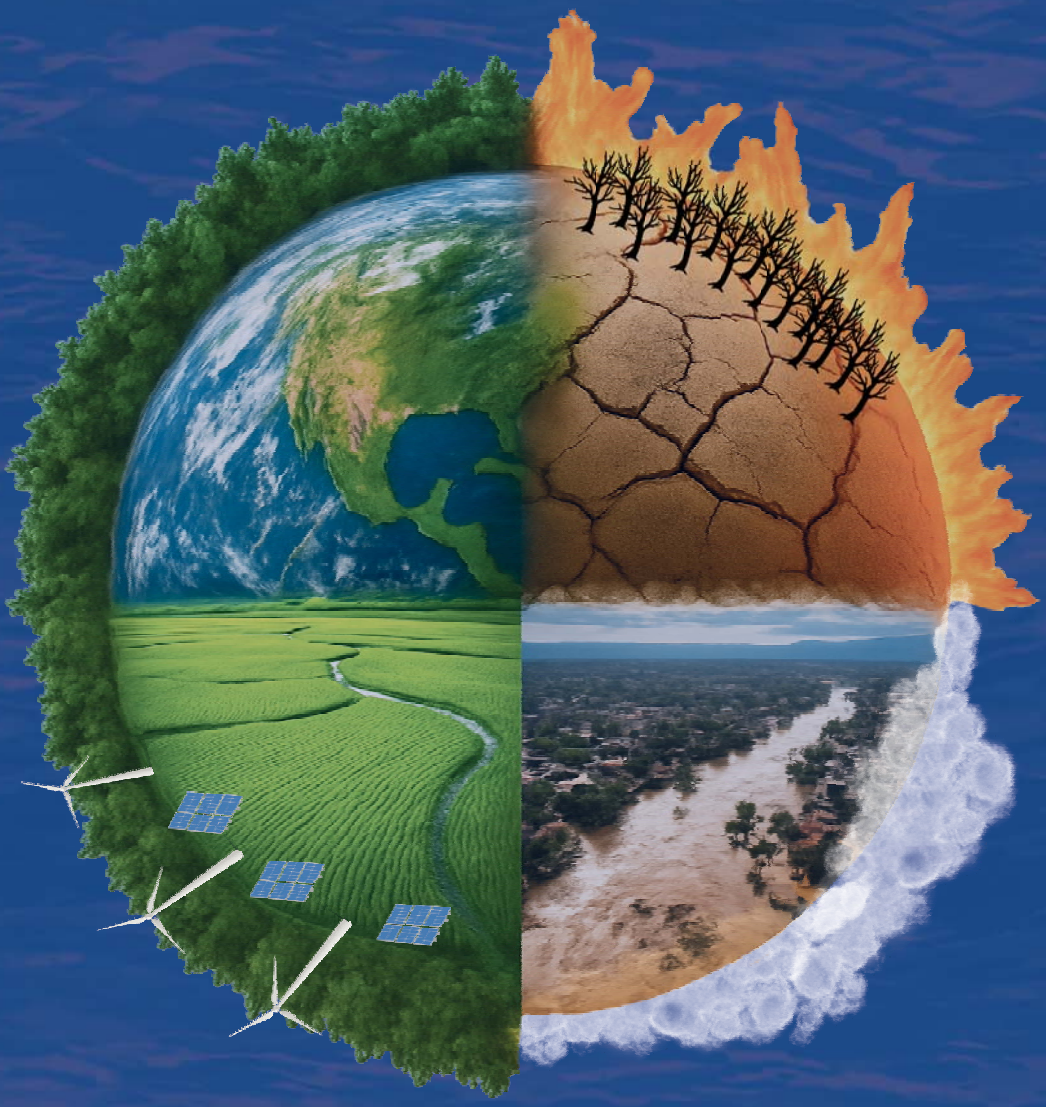
18TH ANNUAL REPORT 2025

State of the Economy: Climate Change - Mediating Chaos and Crisis



The Shahid Javed Burki Institute of Public Policy at Netsol

BIPP 18th Annual Report 2025

The State of the Economy
Climate Change - Mediating Chaos and Crisis

The Shahid Javed Burki
Institute of Public Policy at NetSol

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The Shahid Javed Burki Institute of Public Policy at Netsol (BIPP) is committed to synergizing the research, education, think tank and knowledge management functions to become a Centre of Excellence in Public Policy. Its mission is to improve the welfare of the citizenry with particular emphasis on identifying policy measure that will lead to inclusive and people centered growth, political stability and sustainable development besides fully harnessing the potential of the country to integrate into the regional and global order. BIPP's areas of interest are social, economic, environmental and political development, security, trade and foreign policy issues. The institute also nurtures leadership through an intensive internship scheme, collaboration with the universities and educational institutions and merit-cum-need based scholarships for female students to help them realize their career goals, exercise and expand their choices and contribute to the achievement of national development goal.

In order to enrich and ensure high quality of its research and analytical work, BIPP benefits from an Advisory Council which consists of renowned scholars and experts drawn from various disciplines and domains. The Advisory Council, at present, consists of: Mr. Asim Imdad, Dr. Athar Mansoor, Mr. Dennis de Tray, Mr. Mujahid Sherdil and Dr. Mahmood Ahamd Saleem Ranjha. Dr. Muhamad Ejaz Sandhu is working as Director Research and Operations with BIPP while Dr. Syed Ifitikhar Hussain Shah, Dr. Sajjad Haider and Mr. Ahsan Sarwar Khan assist BIPP as permanent consultants.

BIPP's Board of Directors comprises eminent economist, experts, member of academic and development practitioners from private, public and non-governmental sectors who are committed to strengthen the evidence based public policy formation and implementation in Pakistan. The members of Board of Directors are:

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Foreword

The Shahid Javed Burki Institute of Public Policy (BIPP) is launching its 18th annual report a few weeks after the conclusion of the 30th annual conference sponsored by the United Nations. The conference was attended by almost all UN member states. The only absence was the United States, which has scaled back its commitment to addressing the challenges posed by global warming. This slow walk by Washington reflects the belief held by the country's current leadership that the global attention on climate change is doing more harm than good. The conference was held in the Brazilian town of Belém, on the edge of the Amazon forest. One key takeaway from the conference deliberations was the recognition of China's significantly positive role in using technological advancements to promote a greener world. Before describing the Annual Report 2025, I will say a few words about the founding of the BIPP and the thinking behind the writing of this annual report.

I was on a visit to Pakistan in the spring of 2004. I had then taken early retirement from the World Bank, where I was working as the Vice President of the institution's Latin America and Caribbean region. I had been in that position for eleven years, having worked for eight years as the Director of World Bank Chief Operations, I could have stayed on in the Bank until I had reached the retirement age of 66 years. That would have taken me to the year 2004, but Moeen Qureshi, who had worked at the Bank as Vice President of Operations, had left the institution to found a private equity firm, he was to lead the Emerging Markets Partnership (EMP). He had been persuading me to join his institution as an economic advisor, and I did that for five years.

Having left EMP, I visited Pakistan in the spring of 2004 and spent some time with the late Sartaj Aziz, who was then President of Beaconhouse National University. We talked, and he was concerned that the Planning Commission of Pakistan which was the "central body responsible for national development, planning and implementation" was facing "challenges." There were issues with implementation and coordination. Furthermore, it was influenced by external factors such as availabvility and dependance on foreign aid. These were just one of the few reasons why Pakistan had lost the capacity and ability to do public policy work "Why don't we do it as the private sector?" he suggested. "You had the institution, and the BNU will fund it", I replied that I was not in a position to return to Pakistan, but I could lead the institution as a visiting chairman. Thus, was founded the Institution of Public Policy, which, after Aziz left Lahore for Islamabad, and BNU ceased funding the IPP; I, along with some other members of my family, provided some funding, and IPP became the Burki Institute of Public Policy, i.e., BIPP.

Sartaj and I had decided that the BIPP would issue an annual report, similar to the World Bank's World Development Report (WDR), which had two parts. The Bank's report would first examine the state of the global economy, and the second would take up the discussion of a policy in which the Bank's staff had done excellent work. It was then handed over to the Policy Planning Department of the Bank. As the Chief of the Policy Planning Division, I had a lot to do in shaping the WDR.

Following the same design, we founded our policy reports covering such publications as China Pakistan Economic Corridor (CPEC), socio-economic status of women, issue of Governance reform and the frontiers of artificial intelligence. This year, we focus on climate change as Pakistan stands at the frontline of escalating climate risks. Intensifying heatwaves, floods, glacial -melt, and water stress are deepening existing economic and governance challenges, posing a serious threat to long-term stability. The 2025 Annual Report presents a clear, integrated analysis to guide climate-sensitive decision-making and support Pakistan's transition toward greater resilience and sustainable development.

Reflecting on recent developments, two articles that appeared side by side in the November 24th, 2025, pages of the newspaper, Express Tribune, are worth mentioning here. One was by Dr Syed Akhtar Ali

Shah on “What the 26th and 27th amendments seek to change”, and the other by the title “China's impact on the global economy.” Shah states at the conclusion of his thought on the article that “Pakistan stands at a constitutional crossroads. The proposed reforms risk centralizing power in the hands of the Executive, weakening the judiciary, and unsettling the carefully crafted equilibrium that prevents the rise of unrestrained state authority.” In my article, I look at the possible extension of the CPEC with Afghanistan and possibly with the “Stairs” of Central Asia. “The result of this extension will be to link China with Central Asia, and then that region would provide Beijing with land access to Europe. It is this development that has brought the United States back to Pakistan.” The developments that will be the basis of the next annual report to be issued in the winter of 2026.

Before concluding, I would like to acknowledge my heartfelt gratitude to Ms. Nauina Asim for her outstanding efforts in editing this year's report, offered once again on a pro bono basis. We are equally thankful to Mr. Ahsan Sarwar khan for his generous sponsorship of BIPP's Annual Report 2025. His support is a testament to his unwavering commitment to strengthening evidence-based and rational policymaking in Pakistan. I also wish to acknowledge the hard work put in by BIPP staff in the production and publication of this report.

Shahid Javed Burki
December 05, 2025

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(in alphabetical order)

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Mr. Shahid Javed Burki

Mr. Burki is a prominent Pakistani economist and the Chairman of the Shahid Javed Burki Institute of Public Policy at NetSol (BIPP). He held high level prestigious positions during the course of his professional career with Government of Pakistan and the World Bank including the Finance Minister of Pakistan (1996-1997), Chief Economist, Planning and Development Department, Government of the Punjab, the first Director World Bank for the China Department (1987-1994) and the Regional Vice President for Latin America and the Caribbean during 1994-1999. He retired from the Bank in 1999. He has also been a member of the faculty at Harvard University, USA, and visiting fellow of Institute of South Asian Studies-National University of Singapore. Mr. Burki has authored books besides regularly contributing to international, national journals and newspapers.

Mr. Shahid Najam

Mr. Najam is the Vice Chairman of BIPP. He has four Masters including LLM and MSc. Public Policy form London School of Economics, UK and MSc. Rural Development from Wye College London. He has more than 40 years of experience with Government of Pakistan and the UN System in policy and strategy formulation; development planning and programming; and implementation of large scale programmes for sustainable development. He joined the Pakistan Administrative Services in 1974 and held important assignments including Commissioner Lahore Division (1999-2001), and the first Chief Operating Officer, of the Punjab Board of Investment and Trade (2009). Mr. Najam held senior positions with the UN System as FAO Representative, Iran (2007-2009) and Resident Coordinator/Resident Representative of the UN system in Turkey (2009-2013).

Dr. Farrukh Iqbal

Dr. Iqbal is a world renowned economist who has more than thirty years of Research and Management experience in the World Bank across a-diverse range of countries and sectors. He has worked on Korea, Philippines, Indonesia, China, Iran, Egypt, and the Gulf Cooperation Council (GCC) involving various aspects of economic development including growth, poverty, small and medium enterprises, trade and foreign investment, health insurance, local government development, and political economy issues. He was the Executive Director of the Institute of Business Administration, Karachi from August 2016 to December 2019. He holds a Bachelor's degree from Harvard University and a PhD in Economics from Yale University, USA.

Shahzad Shaukat

Mr. Shahzad Shaukat is a distinguished Financial Economist with over 30 years of experience in financial systems, accounting, auditing, and corporate resource utilization. He holds a Master's degree in Commerce from Hailey College, University of the Punjab, and is a Chartered Accountant from the Institute of Chartered Accountants of Pakistan. He has advised multilateral organizations, state-owned enterprises, and leading conglomerates across the GCC, Europe, and the USA, collaborating with professional teams that previously worked with the World Bank and Chinese state-owned enterprises on policy development initiatives. His expertise spans international trade, transportation, aviation, special economic zones, infrastructure projects, reforms, Halal Banking, and non-banking financial services.He is currently the CEO of SEZ and Gulf Asia Management Limited, a special purpose vehicle established to design and implement policy frameworks aimed at achieving the Sustainable Development Goals (SDGs), while also advising Chinese state-owned enterprises on business and economic development.Mr. Shaukat has also made notable scholarly contributions to financial economics and Islamic finance. His submissions to the Federal Sharia Court include pioneering work on Real Business Valuation (challenging the MM Theory), the True Islamic Economic System, and Financial Economics and Value Mismatch - an emerging field in the Muslim world. He has presented at the 7th and 8th International Assam Islamic Union Model Congresses in Turkey on themes including justice systems in the Islamic Union and economic security through a common currency.

Dr. Khalid Mahmood

Dr. Mahmood has been instrumental in developing a digital farm advisory and farm data platforms supporting smallholder farmers and improve traceability across supply chains. Trained as an agricultural economist (PhD, University of Göttingen), he combines scientific depth with real-world innovation to address global challenges in food security, ESG reporting, and climate resilience. He is a recognized leader in sustainable agriculture, especially his role at the British Society of Soil Science leading on partnerships. He is actively leading projects positioning soil health as a climate mitigation strategy, with links to carbon sequestration, water, air quality, and bio-diversity restoration. His past roles include leadership in research programs on carbon reduction in rice and livestock systems and strategic work with institutions such as Rothamsted Research, AHDB UK, and the Von Thünen Institute, Germany. Dr. Mahmood is also a Fellow of the Higher Education Academy (UK) and has contributed to networks like IFCN and UPSIGN. Dr Mahmood was among the world top Net Zero 50 leaders, he continues to advance international partnerships using soil as the foundation for regenerative agriculture, natural capital, and ecosystem restoration.

Dr. Mahmood Ahmad

Dr. Ahmad is internationally renowned expert on agriculture and water policy. He did his PhD from the University of Massachusetts in Resource Economics (1979). He carries an experience of around 40 years, including 24 years with the Food and Agriculture Organization of the United Nations, working in more than 15 countries. He led the formulation of FAO programmes on agriculture and water policy for the Near East countries; supported member countries in preparing agriculture strategies under water scarce conditions; spearheaded the World Bank assisted Regional Initiative on Water Scarcity of the FAO Regional Office in Cairo; and assisted in formulating the ECO national and regional food security policies and strategies. He is a member of BIPP's Advisory Council.

Rehmat Ullah Gill

Mr. Rahmat Ullah Gill is a seasoned professional with a diverse background in policy research, advocacy, training, and publications in the field of Science and Technology (S&T). With a rich and versatile career spanning several years, he has made significant contributions to technology management, S&T planning, commercialization of S&T projects, and innovation management. His work has been primarily focused on fostering collaboration between academia, industry, and government, leading to the successful implementation of numerous S&T projects under university-industry partnerships.

Atr-un-Nisa

Ms. Atr un Nisa holds a M.phil degree in Business Economics from Beaconhouse National University. She has vast research experience in economics. She has done various research projects for international development agencies, provincial and federal government, and private sector. Currently, she is working as a senior research fellow at BIPP and carrying out BIPP's Research and consultancy functions.

Muhammad Firas Shams

Mr. Muhammad Firas Shams is currently working as a Research Associate at Shahid Javed Burki Institute of Public Policy (BIPP). He was previously associated with the Islamabad Policy Research Institute (IPRI). He holds an MPhil degree in Public Policy from the Center of Public Policy and Governance (CPPG), Forman Christian College, University, Lahore (FCCU) and was awarded a gold medal as well as Summa Cum Laude. He also holds a BA (Hons) degree in Journalism from the Beaconhouse National University (BNU) and was awarded the highest honor of gold medal. His research interests include, counter-extremism, public policy and governance, sustainable development and global politics.

Contents

Tables:

List of Acronyms

AC	Air Conditioner
AC	Adaptation Committee
ADB	Asian Development Bank
ADP	Annual Development Plan
AEDB	Alternate Energy Development Board
AI	Artificial Intelligence
AOSIS	Alliance of Small Island States
AQI	Air Quality Index
ARs	Assessment Reports
ASAR	Advanced Synthetic Aperture Radar
ASTER	Advanced Spaceborne Thermal Emission and Reflection Radiometer
AVHRR	Advanced Very High Resolution Radiometer
AWD	Alternate Wetting and Drying
B2B	Business to Business
BBC	British Broadcasting Corporation
BINGO	Business and Industry Non-Government Organization
BIPP	Burki Institute of Public Policy
BOS	Bureau of Statistics
BRI	Belt and Road Initiative
C&W	Communication & Works
CBOs	Community-Based Organizations
CCA	Common Country Analysis
CCDR	Country Climate and Development Report
CBDRRC	Common but Differentiated Responsibilities and Respective Capabilities
CBAM	Carbon Border Adjustment Mechanism
CDM	Clean Development Mechanism
CDM EB	Clean Development Mechanism Executive Board
CERIC	Crop Environmental Risk Information Center
CFS	Climate Finance Strategy
CGIAR	Consultative Group on International Agricultural Research
CKNP-DNP	Central Karakoram National Park – Deosai National Park
CLIS	Crop Loan Insurance Scheme
CNG	Compressed Natural Gas
COP	Conference of the Parties
COPD	Chronic Obstructive Pulmonary Disease
CPEC	China-Pakistan Economic Corridor

CSOs	Civil Society Organizations
CSR	Corporate Social Responsibility
CSV	Climate Smart Village
CSVI	Climate Smart Village Initiative
DARA	Direct Assessment and Research Associate
DESA	Department of Economic and Social Affairs
DRM	Disaster Risk Management
DRR	Disaster Risk Reduction
EBSCO	Elton B. Stephens Company
HEIS	High-Efficiency Irrigation System
IAEA	International Atomic Energy Agency
IASC	Inter-Agency Standing Committee
ICIMOD	International Centre for Integrated Mountain Development
ICESat	Ice, Cloud, and Land Elevation Satellite
IDRA	Irrigation Development and Regulation Authority
IEA	International Energy Agency
IEEFA	Institute for Energy Economics and Financial Analysis
IFC	International Finance Corporation
IFoA	Institute and Faculty of Actuaries
IFRS	International Federation of Red Cross and Red Crescent Societies
ILO	International Labour Organization
IMF	International Monetary Fund
RSF	Resilience and Sustainability Facility
EFF	Extended Fund Facility
SBA	Stand-by Arrangement
PRGF	Poverty Reduction & Growth Facility
IPCC	Intergovernmental Panel on Climate Change
IPC	Inter-Provincial Coordination
IPM	Integrated Pest Management
IPWIC	Inter-Provincial Water Innovation Council
ISO	International Organization for Standardization
IT	Information Technology
IUCN	International Union for Conservation of Nature
IWT	Indus Waters Treaty
IWRM	Integrated Water Resources Management
IoT	Internet of Things

KPK	Khyber Pakhtunkhwa
LDA	Lahore Development Authority
LDC	Least Developed Country
LEED	Leadership in Energy and Environmental Design
LGMA	Local Government and Municipal Authority
LTAs	Long-Term Actions
MAF	Million Acre Feet
MAR	Managed Aquifer Recharge
MHVRA	Multi-Hazard Vulnerability Risk Assessment
MIT	Massachusetts Institute of Technology
MPI	Multidimensional Poverty Index
MTAs	Medium-Term Actions
MW	Megawatt
NAMA	Nationally Appropriate Mitigation Action
NAPAs	National Adaptation Programmes of Action
NARC	National Agricultural Research Centre
NCFS	National Climate Finance Strategy
NCEI	National Centers for Environmental Information
NDC	Nationally Determined Contribution
NDCs	Nationally Determined Contributions
NDMA	National Disaster Management Authority
NDR	Needs Determination Report
NEPRA	National Electric Power Regulatory Authority
NGFS	Network for Greening the Financial System
NGOs	Non-Government Organizations
NIAB	Nuclear Institute of Agriculture & Biology
NIH	National Institute of Health
NOAA	National Oceanic and Atmospheric Administration
NOC	No Objection Certificate
NRW	Non-Revenue Water
NSAs	Non-State Actors
NWIS	National Water Information System
O&M	Operation & Maintenance
OECD	Organisation for Economic Co-operation and Development
OFWM	On-Farm Water Management

OPEC	Organization of the Petroleum Exporting Countries
P&D	Planning & Development
P&DD	Planning & Development Department
PAs	Priority Actions
PCRET	Pakistan Council of Renewable Energy Technologies
PCSGP	Punjab Climate Smart Green Plan
PCRWR	Pakistan Council of Research in Water Resources
PDMA	Provincial Disaster Management Authority
PDNA	Post-Disaster Needs Assessment
PEECA	Punjab Energy Efficiency & Conservation Agency
PHA	Punjab Housing Authority
PHED	Public Health Engineering Department
PM	Particulate Matter
PMD	Pakistan Meteorological Department
PMFBY	Pradhan Mantri Fasal Bima Yojana
PPP	Public-Private Partnership
PPPs	Public-Private Partnerships
PSDP	Public Sector Development Programme
PTSD	Post-Traumatic Stress Disorder
RACC	Regenerative Agriculture Cotton Cluster
RARC	Regenerative Agriculture Rice Cluster
RBP	Raised Bed Planting
R&D	Research & Development
REDD	Reducing Emissions from Deforestation and Forest Degradation
RQBS	Rasul–Qadirabad–Balloki–Sulemanki
RS	Remote Sensing
RSF	Resilience & Sustainability Facility
RUDA	Ravi Urban Development Authority
SBI	Subsidiary Body of Implementation
SBP	State Bank of Pakistan
SBSTA	Subsidiary Body for Scientific & Technological Advice
SCCF	Special Climate Change Fund
SDG	Sustainable Development Goal
SDGs	Sustainable Development Goals
SDO	Sustainable Development Organization

SEZs	Special Economic Zones
SFC	Standing Committee on Finance
SFM	Sustainable Forest Management
SIDS	Small Island Developing States
SIFC	Special Investment Facilitation Council
SII	Sustainability Impact Index
SMAP	Soil Moisture Active Passive
SMEDA	Small & Medium Enterprise Development Authority
SMEs	Small & Medium Enterprises
SMOS	Soil Moisture and Ocean Salinity
SOEs	State-Owned Enterprises
SPOT	Satellite Pour l'Observation de la Terre
SRI	System of Rice Intensification
SRTM	Shuttle Radar Topography Mission
SSM/I	Special Sensor Microwave/Imager
STAs	Short-Term Actions
SWM	Solid Waste Management
TUNGO	Trade Union Non-Government Organization
TFP	Total Factor Productivity
TRMM	Tropical Rainfall Measuring Mission
UAVs	Unmanned Aerial Vehicles
UN	United Nations
UNCCD	United Nations Convention to Combat Desertification
UNCTAD	United Nations Conference on Trade and Development
UN DESA	United Nations Department of Economic and Social Affairs
UNDP	United Nations Development Programme
UNDRR	United Nations Office for Disaster Risk Reduction
UNEP	United Nations Environment Programme
UNESCO	United Nations Educational, Scientific and Cultural Organization
UNFCCC	United Nations Framework Convention on Climate Change
UNICEF	United Nations Children's Fund
UNIDO	United Nations Industrial Development Organization
UNPF	United Nations Population Fund

Executive Summary

The world is confronted with an extremely severe planetary emergency a "Code Red for Humanity" marked by record-breaking increase in temperatures and intensified and escalating climate crisis. Scientific evidence confirms that global warming is advancing faster than the threshold of 1.5°C internationally agreed and pledged for achievement by 2030. The future risk is potentially turning to an imminent reality. This global crisis is indeed destabilizing economies, endangering the survival of vulnerable regions, and exposing the structural limitations of international climate governance where political inertia, chronic underfinancing, and North–South inequities continue to impede meaningful collective action.

Against this rapidly deteriorating global backdrop, Pakistan stands at the frontlines of the climate emergency. As one of the most vulnerable countries in the world, the country faces an unprecedented convergence of external climate threats and internal structural fragilities. The recurrent heatwaves, glacial melt, erratic monsoons, catastrophic floods, and long-term water scarcity are intertwined with a weakening economic base, fragmented governance, and deep social inequalities to aggravate the degree and scale of climate-related crisis. The combined effect is not just a cyclical downturn but an existential challenge that threatens Pakistan's long-term stability, development trajectory, and societal resilience.

The scientific consensus is unequivocal; climate change is already inflicting a huge socio-economic and environmental setback to humanity. Global estimates show that the world loses approximately 12% of GDP for every 1°C of warming, with projected annual damages of up to USD 38 trillion by 2050. For Pakistan, the impacts are already visible and severe. The 2022 & 2025 floods inflicted over billion dollars in losses, displacing millions and pushing vulnerable populations deeper into poverty.

With temperatures rising and hydrological instability increasing, the frequency and magnitude of such disasters will continue to intensify and exact their toll on the lives and livelihood of not just the common man but especially the underprivlaged.

These external shocks will continue to collude with our domestic structural constraints and complexities. Long-term growth has steadily declined due to collapsing investment, low productivity, weak human capital accumulation, and insufficient technological modernization. Pakistan's economic challenge is no longer "stabilization", it is the urgent reversal of a systemic decline in the drivers of growth. Meanwhile, the Indus Basin is entering a national water emergency, driven by accelerated glacial melt and inefficient water governance, with per capita water availability projected to fall below the absolute scarcity threshold by 2040.

The crisis is profoundly unequal. Pakistan's gender and equity trap means that women and girls face disproportionate vulnerabilities from heightened exposure to food insecurity and unpaid care burdens to reduced access to economic opportunities and increased susceptibility to gender-based violence. Similarly, the agri-food system employing nearly 40% of the labor force and contributing 23% of GDP is under severe threat. Widespread soil degradation, low organic content, land salinization, and climate-induced yield losses pose grave risks to food security, rural livelihoods, and agricultural competitiveness.

Underlying these challenges is a deeper policy–governance gap. At the global level, the Climate Governance System (GCGS) remains constrained by a design paradox it reinforces state sovereignty and national interests over scientific urgency and global equity. This fragmentation has led to a persistent climate finance gap, where developing countries including the most climate-vulnerable, receive a fraction of the resources required for adaptation and resilience. At the domestic level, Pakistan's institutional response remains reactive, fragmented, and under-resourced. Federal spending on Environmental Protection stands at an alarmingly low 0.0195% of total expenditure, reflecting a chronic under prioritization of climate action. Meanwhile, coal-heavy CPEC Phase I has increased the national carbon footprint and now poses both fiscal and environmental liabilities.

This intersecting climate, economic, and gover-

nance failures demand a decisive break from traditional policy approaches. Incremental reforms will not suffice. What is required is a systemic transformation anchored in an integrated, AI-enabled, and justice-driven paradigm. This paradigm must prioritize AI-enabled climate governance and predictive systems, green assetization of CPEC and climate-smart economic corridors, regenerative agriculture and soil restoration, gender sensitive-equitable and inclusive policy frameworks, and mandatory budgetary prioritization of climate resilience across federal, provincial and local levels.

Such a transformation requires unwavering political commitment, institutional coherence, and an economy-wide shift toward climate-informed planning and programming paradigm. Every policy from fiscal decisions and infrastructure development to agriculture, water, and urban planning must be climate-proofed, inclusive, and aligned with the realities of a rapidly warming world.

Against this backdrop, the 2025 Annual Report, structured across 11 chapters, provides an integrated assessment of global and domestic risks, sectoral vulnerabilities, policy gaps, and the systemic reforms required for climate sensitive and resilient transformation. Chapter 1 demonstrates that global warming is accelerating beyond scientific expectations, exposing vulnerable countries to intensifying heat and hydrological instability. Chapter 2 identifies that Pakistan's economic challenge is no longer cyclical stabilization but a long-term structural decline driven by falling investment, low skills, and weak productivity. Chapter 3 analyzes the failure of global climate governance, highlighting structural barriers, political fragmentation, and chronic underfinancing. Chapter 4 links climate change to macroeconomic instability, emphasizing the catastrophic long-term effects on global and national GDP, poverty, and inequality. Chapter 5 argues that CPEC must shift from infrastructure expansion to climate-smart activation, ensuring the corridor supports green competitiveness rather than long-term emissions and fiscal burdens. Chapter 6 outlines Pakistan's escalating climate vulnerabilities and the urgent need for integrated governance, ecological restoration, and proactive risk reduction. Chapter 7 highlights that soil degradation threatens food security and that Climate Smart Agriculture (CSA), particularly regenerative models like SAWiE's clusters, provides scalable adaptation and mitigation benefits. Chapter 8 frames Pakistan's climate crisis as a moral and economic injustice shaped by debt-driven policies, loss cycles, and institutional neglect, calling for debt reform and climate justice. Chapter 9 presents the Punjab Climate Smart Green Plan (PCSGP), a comprehensive, technology-driven strategy to green the province's economic and infrastructure systems. Chapter 10 proposes an AI-driven overhaul of water governance to address scarcity, mismanagement, and hydrological volatility while the last Chapter 11 demonstrates how climate change disproportionately harms women and emphasizes the need for gender-responsive budgeting, women's leadership, and gender-sensitive climate planning.

The report underscore that Pakistan's climate and economic crises cannot be solved through business-as usual, fragmented, uncoordinated and "quick-fix" approach. A holistic, inclusive and urgent strategic shift involving government, non-government and indeed whole-of-society rooted in science, equity, technology, and fiscal realignment is an absolute necessity to combat the burgeoning threat of climate change. The security of the eco-and bio-system of planet earth is indeed sin qua non for a resilient, just, and sustainable future.

The Table below attempts to capture the key findings and recommendations of the 2025 Report.

Summary Findings and Recommendations

Key Findings	Recommendations
Chapter 01: Global Warming: The Situation is Worse than Generally Believed	
Human-caused warming is scientifically certain; IPCC AR6 declares a "code red for humanity."	Ensure strong, sustained political commitment and treat IPCC findings as binding scientific consensus.
Global temperatures are set to exceed 1.5°C, confirming faster-than-expected warming.	Integrate the 1.5°C reality into national planning and shift to urgent mitigation and adaptation.
Himalayan glacier melt will intensify short-term floods and worsen long-term Indus Basin water scarcity.	Fast-track the Indus Cascades program to capture meltwater and stabilize medium-term supply.
A "solar divide" is widening, with the poor bearing costs of an aging grid.	Reform the power sector to stop inequitable cost transfers and ensure fair tariffs for low-income, non-solar users.
Chapter 02: Beyond Stabilization: Pakistan's Growth Challenge	
Long-term growth has structurally declined, falling 1.5 percentage points after 2008.	Address all three growth drivers (Capital, Labor, TFP) simultaneously after stabilization.
Declining capital formation is the primary driver of growth deterioration.	Prioritize reversing declining investment trends and restoring capital accumulation.
Labor contribution remains low despite a labor-abundant economy.	Strengthen education and training to enhance skills and raise labor productivity.
TFP growth is unsupported by strong R&D or technological diffusion.	Strengthen R&D systems and ensure IT and innovation reach manufacturing and production.
Chapter 03: Governing the Ungovernable: The Challenge of Coordinating Global Climate Action	
Temperatures may rise 1.9–3.4°C by 2100, far exceeding 1.5°C and triggering severe climate extremes.	Build a science-led, apolitical global consensus on climate as an existential threat.
Climate governance is slowed by sovereignty politics, fragmentation, and bureaucratic inertia.	Replace full consensus with a two-thirds majority and make COP deliverable-focused.Establish independent climate commissions and inter-

Fragmented institutions and overlapping mandates weaken implementation.	ministerial boards.
Annual climate finance needs (USD 6.3–6.7T) far exceed current flows; access remains loan-heavy.	Shift to grants, deliver COP29's USD 300B, ease access, and prioritize adaptation.
Fossil-fuel dependence and lobbying obstruct mitigation.	Enact binding climate laws, embed net-zero pathways, and restrict fossil-fuel lobbying.
Non state actors are largely excluded from governance.	Institutionalize inclusive governance (assemblies, indigenous and youth platforms).
Global commitments are voluntary and unenforced.	Introduce binding compliance, sanctions, transparent monitoring, and verification.
The Global South faces higher vulnerability despite low historic emissions.	Apply justice-based frameworks ensuring fair and equitable burden-sharing.
Developing countries lack strong MRV systems and data capacity.	Provide technical support to strengthen MRV, data, and governance systems.
National governance is weak, with poor alignment and low enforcement.	Enact national climate laws and integrate climate goals into budgets and sector plans.
Provincial/local capacity for NDC implementation is limited.	Adopt bottom-up governance with provincial NDCs, KPIs, and capacity-building.
Exclusion of women and marginalized groups reduces resilience.	Promote inclusive governance with women's leadership and community mechanisms.
Chapter 04: Economy in a Warming World: The Climate-Economic Nexus	
Global warming may cut global GDP 4–40%; disasters caused USD 320B losses in 2024.	Strengthen climate response across agriculture, infrastructure, finance, and social sectors.
56–67% of climate losses in developing countries are uninsured.	Expand climate finance, insurance, and risk-transfer tools.
Each 1°C rise cuts rice yields 10% and wheat 6%; Pakistan's cereal output may drop 24% by 2050.	Scale climate-smart agriculture, resilient seeds, irrigation, and crop insurance.
Heat stress may cut global working hours 2.2% and Pakistan's 4–5% by 2030.	Implement heat-health plans, cooling systems, and safety standards.
Climate health costs may reach USD 2–4B/year; heatwaves raise hospital cases 300–400%.	Strengthen climate-resilient health systems and surveillance.
Warming worsens inequality; poorest countries lost 17–30% income; SIDS lose 2% GDP yearly.	Expand gender-responsive and pro-poor social protection.
South Asia may lose 8–10% GDP by 2100; 90%	Improve regional cooperation on water, early

face severe heat stress by 2030.	warnings, and resilience.
Pakistan's floods caused major damages (USD 14.9B + 15.2B in 2022; 6.9M affected in 2025).	Integrate climate resilience into national planning and infrastructure.
Major crops fell 13.5%, reducing GDP by 0.6 points.	Support climate-resilient farming, women farmers, and rural livelihoods.
2022 floods destroyed key infrastructure; reconstruction needs USD 16.3B.	Develop risk-informed, resilient infrastructure.
Pakistan has a 95–97% climate-finance gap (needs USD 43.5B/year, mobilizes ~USD 2B).	Mobilize climate finance, debt-for-climate swaps, and green investments.
Climate shocks pushed 9M into poverty; malnutrition up 23%; 230,000 children lost schooling.	Expand adaptive social protection, nutrition, and school recovery.
Chapter 05: Climate Injustice and Economic Extraction	
Pakistan faces a moral, governance, and climate management failure; the poor bear costs of decisions they didn't make.	Shift from donor dependence to ethical, justice-based stewardship.
Only Rs 5 per Rs 100,000 goes to environmental protection.	Align federal budgets with climate priorities and increase funding.
128,000 air-pollution deaths and 49% lacking safe water reflect severe neglect.	Improve environmental governance, cut pollution, and expand safe water access.
WHO indicators show high WASH, pollution, and heat-mortality risks.	Strengthen health systems, WASH, and climate-adaptive healthcare.
WB warns of heatwaves, droughts, water scarcity, floods, GLOFs, and food insecurity.	Adopt proactive climate policies and risk-informed planning.
UN reports USD 38B annual losses, worsening HDI, and rising climate-driven poverty.	Integrate climate, development, and justice into national planning.
IMF estimates USD 348B climate needs by 2030—far above current flows.	Improve climate finance governance and mobilize international finance.
Only USD 4B climate finance mobilized in 2021.	Use blended finance and green instruments to close the gap.
Weak inter-ministerial coordination hinders climate action.	Create unified governance frameworks and stronger coordination.
Energy misgovernance and circular debt worsen	Reform pricing, governance, and shift to clean,

vulnerability.	affordable energy.
85–90% of federal budget goes to debt servicing, leaving little for climate.	Restructure fiscal policy, reduce debt dependence, and free fiscal space.
PKR 289T repaid in 8 years, yet debt still rising.	Use ethical, low-interest financing with transparency.
Provinces and federal government severely underinvest in environment.	Mandate meaningful climate budgets with measurable outcomes.
Pakistan earns only $2–5/ton in carbon credits vs Europe's €85/ton.	Demand fair carbon pricing and reform market participation.
Outdated trucks and dirty fuels raise emissions.	Transition to low-emission freight, clean fuels, and expanded clean energy.
Climate inaction cost ≈ USD 3T (2010–2025).	Invest in climate-smart infrastructure and anticipatory governance.
Low wages, unfair carbon pricing reflect climate injustice.	Link carbon economics to ethical labor rights and equity.
Islamic teachings emphasize stewardship and ecological responsibility.	Use Islamic finance (Waqf, Sukuk, Zakat) for climate justice.
Ministries work in silos; Pakistan lacks emissions registry; climate economics is inaccessible; donor-driven frameworks overshadow local knowledge; the poor face survival-based environmental harm.	Mandate inter-ministerial coordination; establish emissions registry; simplify climate economics; reclaim local knowledge; ensure climate justice and protect vulnerable communities.
Chapter 06: Pakistan Climate Risks: Global to Local Perspective	
The U.S. recorded 403 billion-dollar events (1980–2024) costing USD 2.7 trillion.	Strengthen global-to-local disaster preparedness and integrate DRR with development planning.
Europe's 2025 wildfires burned 1 million+ hectares, the largest since 2006.Pakistan's 2022 floods killed 1,700+, displaced 33 million, and caused USD 30+ billion in losses.	Invest in climate forecasting, early warnings, and coordinated emergency planning. Prioritize resilient infrastructure, expand early warning systems, and protect high-risk districts.
Pakistan faced 224 disasters since 1980; damages reached USD 36.4 billion.	Shift to proactive disaster management and strengthen DRM institutions.
Poverty rose 7% in three years, reaching 25.3% in 2023–24, increasing vulnerability.	Expand climate-linked social protection for high-poverty, high-risk regions.
Severe environmental degradation: forest loss, mangrove decline, wetland damage, and watershed erosion.	Restore forests, mangroves, wetlands, and watersheds through ecosystem-based adaptation.

Pakistan's 13,000 glaciers are rapidly melting; 5 GLOFs identified as high-risk.	Expand GLOF early warnings, glacier monitoring, and national water security planning.
CSA can raise yields 12%, improve water efficiency, and AWD cuts irrigation 25–50% and methane up to 85%.	Promote CSA practices: drip irrigation, AWD, SRI, soil-health regeneration, climate-resilient seeds.
Agroforestry sequesters 30–45% more carbon and increases yields 15%.	Scale agroforestry and regenerative agriculture.
Post-harvest losses reach 20–30%, worsening farmer income.	Improve storage, market access, and expand warehouse receipt financing.
Insurance remains minimal despite PKR 800 billion agri losses in 2022.	Introduce inclusive, index-based climate insurance via public–private partnerships.
Green/grey hybrid systems are cheaper: 20–40% lower capital costs, 25% lower maintenance.	Expand wetlands, mangroves, floodplains alongside grey infrastructure.
Smart irrigation improves efficiency 20–30%, but adoption remains low.	Reform water pricing and incentivize HEIS adoption.
Pakistan needs USD 348 billion for climate action by 2030 but mobilizes <USD 1 billion/year.	Expand access to global funds, carbon markets, green bonds, and transparency.
Population will reach 338M by 2050, increasing resource stress.	Integrate resilience into urban planning, land-use control, and service delivery.
Weak climate data and forecasting reduce preparedness.	Upgrade hydromet systems, research capacity, and data platforms.
Policy gaps and mandate overlaps allow harmful practices like illegal groundwater mining and floodplain encroachment.	Enforce regulations, align climate and development planning, and streamline mandates.
Ravi River: flow dropped 7 MAF → 1.2 MAF; 31 fish species extinct; 2025 floods worsened by illegal housing.	Enforce floodplain rules, control pollution, remove encroachments, and set up a basin authority.
Ravi floods 2025 showed governance failures: illegal development and weak coordination.	Strengthen RUDA/LDA enforcement and adopt nature-based urban planning.
Cholistan Canal Project: Phase I to develop 455,000 acres, but water supply uncertain.	Conduct full hydrological and environmental feasibility; ensure equity.
Silviculture offers 20–22% IRR and cost-benefit ratio 2.8–3.2.	Prioritize nature-based alternatives—silviculture, silvopasture, rangeland restoration.
Chapter 07: Climate Smart Agriculture for Soil Health in Pakistan	
Agriculture contributes 23% GDP, 25% exports,	Strengthen agri-food policy, support smallholders,

40% labour; 61% rural population and 65% are smallholders.	improve rural services, and invest in soil and climate resilience.
Women form major agricultural labour but own <5% land in Sindh.	Expand women's land rights, credit, CSA roles, and women-led enterprises.
76% of land eroded; 96% soils lack organic matter; 6M ha salinized (rising 40,000 ha/yr).	Scale soil regeneration, organic matter restoration, residue management, and salinity control.
43% of cultivated land degraded; 70% has <0.5% organic matter; 2M ha waterlogged; widespread micronutrient gaps.	Promote balanced fertilizers, composting, micronutrients, and soil testing.
Pakistan warmed 0.6°C; projected 1.5–2°C by 2050, intensifying soil and climate stress.	Integrate CSA and regenerative practices into adaptation plans and early warnings.
CSA boosts productivity, resilience, and mitigation.	Mainstream CSA in provincial programs; strengthen coordination and financing.
SAWiE rice cluster: AWD cut water 30–40%, GHGs 41%, improved yield stability 15%.	Scale AWD, laser leveling, advisories, and field schools.
SAWiE cotton cluster: 30% water efficiency, +0.25% SOM, fewer pesticides.	Expand regenerative cotton with raised beds, composting, IPM, livestock integration, traceability.
Climate Smart Villages improved soil & water retention 15–20%, cut fertilizer costs 30%.	Replicate CSVs via community-led, digital, and gender-inclusive models.
Soil regeneration is essential for food security in arid/semi-arid areas (80% farmland).	Make soil regeneration a national priority through CSA + regenerative agriculture.
Chapter 08: CPEC 2.0 in Action	
CPEC Phase 1 increased Pakistan's carbon footprint by ~30 Mt CO_2 annually. $3.8B+ in climate damages since 2015 directly affected CPEC assets.	Embed climate standards in Phase 2 projects; align with NDCs and 5Es. Climate-proof existing infrastructure with resilient materials and hazard-based design.
90% of freight moves by diesel trucks, producing 62 g CO_2/ton-km vs 8–12 g for rail.	Accelerate modal shift: upgrade ML-1, electrify freight, expand intermodal terminals.
Freight emissions along Karakoram Highway exceed 400–480 kt CO_2/year.	Mandate emissions monitoring; incentivize hybrid/electric logistics fleets.
2022 floods destroyed 6,700 km roads, 439 bridges ($30B loss), showing vulnerability.	Prioritize rail expansion, elevated corridors, and climate-resilient roads.
Road pavement fails under heatwaves (>60°C), reducing life by 30–40%.	Use heat-resistant materials and embed climate stress testing in NHA standards.
CPEC operates at <30% capacity; SEZs	Activate SEZs with green standards, monetize

underused; dormant assets increase costs.	throughput, and convert assets to productive use.
Debt crisis: 82% of budgets on debt; public debt rose Rs 25T → 95T.	Shift financing from debt-heavy to equity and climate-finance models.
Coal power under CPEC (3,960 MW) risks stranded assets.	Gradually retire coal, replace with renewable-powered SEZs and green grids.
$16B spent on flood recovery (2022–23), amplifying fiscal risk.	Establish a Climate Infrastructure Fund leveraging GCF & carbon markets.
China invested $500B+ globally, only $2–4B equity in Pakistan; firms favor sovereign-guaranteed loans.	Provide legal guarantees, climate-risk insurance, and transparent B2B frameworks.
EU CBAM threatens high-carbon exports; potential penalty 20–35%.	Mandate renewable energy in SEZs; certify low-carbon production for export markets.
Pakistan can access $15–25B climate finance via green-certified corridors.	Develop carbon credit pipelines, green bonds, and climate-labeled SEZs.
Climate-smart agriculture + green logistics could cut emissions 70–80% per ton-km.	Expand rail-electric corridors linked to agri-value chains and cold storage hubs.
CPEC 2.0 includes ML-1 and digital integration, but weak environmental pillar.	Add mandatory climate-proofing, emissions monitoring, and circular economy requirements.
Security risks for Chinese workers reduce investor confidence.	Strengthen enforcement, joint security protocols, and SEZ-specific protection units.
Pakistan has $298–308B addressable market via climate-competitive exports.	Build climate-certified re-export hubs with bonded warehousing and renewable energy.
Chapter 09: Punjab Climate Smart Green Plan **Adaptation Strategies** **Agriculture:**	**Mitigation Strategies**
• Develop climate-resilient risk management and early warning systems Promote R&D for drought/flood-resilient crops Conserve agricultural land through climate-inclusive zoning Introduce heat-resistant crops and rainwater harvesting Provide financial incentives and training for farmers.	• Reduce GHG emissions (methane, nitrogen) through Integrated Pest Management Improve soil-carbon storage capacity Encourage use of organic manures Promote energy conservation in agriculture.
Livestock:	
• Improve quality and conservation of feed and fodder. • Promote biotechnology for climate-resilient livestock breeds	• Reduce methane and nitrogen emissions through best management techniques • Develop efficient biogas and manure plants • Use adequate feedstock additives to reduce

• Establish vaccination facilities for climate-induced diseases • Develop cost-effective and nutritious feed production	GHG emissions
Forestry:	
• Map forest ecosystems and develop risk management for climate impacts • Prioritize planting indigenous and climate-adaptive species • Implement Sustainable Forest Management (SFM) criteria • Strengthen community participation in forest conservation	• Enhance carbon storage through effective monitoring and regulation • Develop regulatory framework for REDD+ • Promote large-scale afforestation and agro-forestry as carbon sinks • Provide alternate fuel sources to prevent deforestation
Urban Planning:	
• Develop climate-resilient town planning and building designs • Conduct multi-hazard vulnerability and risk assessments • Control urban expansion into ecologically fragile zones • Encourage urban forestation and green spaces	• Promote low-carbon footprints and energy-efficient buildings • Relocate hazardous industries away from urban centers • Incentivize solar water-heating systems • Implement integrated solid waste management to reduce landfill emissions
Water:	
• Promote High-Efficiency Irrigation Systems and rainwater harvesting • Construct new water storages and protect groundwater resources • Develop plans to cope with droughts and water shortages Rehabilitate irrigation infrastructure to withstand extreme weather • Promote community-based watershed management	Water sector strategies are primarily focused on adaptation to ensure water security in a changing climate
Disaster Management:	
• Develop GIS-based decision support systems for disaster risk reduction • Improve flood and drought forecasting systems • Prepare climate-inclusive hazard, vulnerability, and risk zoning maps • Strengthen and expand early-warning systems • Design and build climate-resilient infrastructure	This sector is focused on adapting to and managing the impacts of climate-related disasters
Health:	
• Assess and monitor climate-induced diseases	Health sector strategies are focused on adapting the

and identify vulnerable areas • Formulate and implement a "One Health" policy • Design emergency response programs for vulnerable communities • Analyze health and WASH nexus for integrated approach	healthcare system to climate change impacts
Energy:	
The energy sector is primarily focused on mitigation	• Promote hydropower and green energy generation (solar, wind, biogas) • Enforce building codes for energy conservation • Discourage coal use and promote low-carbon fuels • Develop waste-to-energy plants • Improve energy transmission systems to reduce losses
Industries:	
The industrial sector is primarily focused on mitigation	• Incentivize GHG emissions reduction and conduct energy efficiency audits • Prepare and implement CSR guidelines for emissions • Promote cleaner production techniques and technologies • Enforce wastewater treatment and solid waste management
Transport:	
The transport sector is primarily focused on mitigation	• Raise public awareness about GHG emissions from transport • Develop efficient public transport systems to reduce private car use • Encourage use of biofuels, e-cars, and hybrid vehicles • Establish and enforce strict vehicle emission standards • Improve road infrastructure to reduce congestion and fuel consumption
Chapter 10: AI Vision for Water Security and Governance in Pakistan	
Pakistan is highly climate-vulnerable; 2022 floods caused $30B losses and displaced 33M people.	Implement AI-enabled early warning systems, climate surveillance, and water-smart infrastructure.
India manipulates Indus flows; Pakistan lacks storage infrastructure.	Strengthen transboundary governance, enhance monitoring, pursue treaty amendments or new frameworks.

Per capita water availability dropped from 5,600 → 1,000 m^3/year; storage only 13.7 MAF (~30 days).	Promote groundwater recharge, rainwater harvesting, efficient irrigation, and drought-resilient crops.
Major dams need monitoring; GLOF-prone zones require early warnings.	Deploy AI-powered vision systems and satellite monitoring in high-risk areas.
Over 50% of wetlands lost; Indus Delta mangroves and fisheries degraded.	Restore habitats, improve water quality, integrate AI real-time monitoring.
Institutional fragmentation and siloed data lead to inefficient water management.	Establish unified National Water Information System and Inter-Provincial Water Innovation Council.
IoT, AI, and remote sensing can detect contamination and collect real-time data.	Develop National Water–AI Integration Strategy and AI-driven hydrological mapping linked to disaster response.
Singapore, Netherlands, Kenya demonstrate successful AI water management.	Replicate global models via digital infrastructure, data-sharing, and public-private partnerships.
Drought affects 55M people annually with rising severity.	Implement AI-assisted drought forecasting, satellite monitoring, and link meteorological data to agricultural advisories.
Aging infrastructure suffers high leakage and inefficiency.	Modernize systems with AI leak detection, smart metering, and climate-finance-enabled innovation hubs.
Limited capacity, outdated frameworks, and technical gaps hinder water management.	Establish National Water Data Governance Framework and train staff in digital tools.
Current approaches lack public participation and gender sensitivity.	Promote community engagement and train communities in early warning interpretation.
Chapter 11: Analyzing Hyphenated Climate and Gender Challenge	
Women disproportionately bear climate burdens, water, energy, food, caregiving.	Promote women's rights and leadership from grassroots to national levels.
By 2030, 351M women may live in extreme poverty; only 26% of countries track gendered resource allocation.	Implement gender budgeting for health, education, and climate; apply intersectional approaches.
47.8M more women face hunger than men; by 2050, 158M more females may enter poverty.	Fund women-led climate initiatives, supporting sustainability visions.
Climate change increases GBV by 28% during heat waves; 1 in 10 intimate violence cases may link to	Create regional disaster councils including indigenous and rural women to mitigate risks.

climate.	
Women have limited mobility, information, resources; disaster relief access is restricted.	Enact laws ensuring climate justice, equal land, tenure, and resource rights.
Men occupy 67% of climate decision roles; women's representation <30%; only 3% of climate philanthropy funds women.	Increase women in climate negotiations and decision-making, especially from Global South, rural, indigenous communities.
2022 floods: 650,000 pregnant women needed maternal care; 73,000 required delivery services; GBV and shelter insecurity high.	Integrate women and youth in climate strategies and NDC development.
67% of Pakistani women work in exploited agriculture; floods exacerbate food insecurity and poverty.	Prioritize marginalized rural and indigenous women; focus on climate justice and sustainability.

Chapter

1 Global Warming: The Situation is Worse than Generally Believed

Global Warming: The Situation is Worse than Generally Believed

Shahid Javed Burki

This has been an unusual summer for many parts of the world. High temperatures and droughts have affected most of the western United States. There were widespread fires that burned significant acreage in California, Oregon, and Washington states. Fires also burned the forests on Canada's border with the United States. The smoke produced by the fires was visible in cities as far south as Washington, the American capital. There were also fires in Siberia. Heavy rains in India's western states resulted in floods. Heavy rains also affected Pakistan. This has now become a regular feature of the weather pattern in Pakistan. This time around, there were property damages and death in Chakwal, a city southeast of Pakistan. Heavy rains in the hills that overlook the city brought landslides that destroyed many houses and killed scores of people. There were also heavy rains in central China, which caused destructive floods. The ice shield in Antarctica began to melt at a faster rate than had been expected.

The latest report by a high-powered panel of climate scientists, which closely monitors global weather patterns, attributed these and other extreme events to accelerating climate change. The body, the Intergovernmental Panel on Climate Change (IPCC) issued its latest report on August 9, 2021, describing how human action had altered global environment at an "unprecedented pace." But first, a few words about the panel, its creation, and the work it does.

The IPCC is an intergovernmental body of the United Nations that was set up in 1988 "to provide governments at all levels with scientific information that they can use to develop climate policies. The World Meteorological Organization (WMO) and the United Nations Environment Programme (UNEP) jointly established the Intergovernmental Panel on Climate Change (IPCC), with its headquarters in Geneva, Switzerland home to several other major international organizations. The IPCC informs governments about the state of knowledge of climate change. It does this by examining all the relevant scientific literature about climate change. It also covers possible response options. The organization does not conduct its own research. Thousands of scientists and other experts volunteer to review the IPCC publications. They compile key findings into "Assessment Reports" for policymakers and the general public. Leading climate scientists and all member governments endorse the IPCC's findings. The Intergovernmental Panel on Climate Change (IPCC) reports play a pivotal role in guiding the annual climate negotiations conducted under the United Nations Framework Convention on Climate Change (UNFCCC).

The Intergovernmental Panel on Climate Change (IPCC) has consistently underscored the urgency of

collective global action to confront the accelerating climate crisis. Its *Fifth Assessment Report* (2014) provided the scientific foundation for the *Paris Agreement* of 2015, shaping global commitments on mitigation, adaptation, and climate finance. Building on that foundation, the *Sixth Assessment Report*, released in August 2021, presented the most comprehensive evidence yet on the physical science of climate change. The report warned that catastrophic and potentially irreversible consequences are inevitable unless nations worldwide take rapid and far-reaching measures to reduce greenhouse gas emissions. The IPCC called for immediate, decisive, and sustained action, describing the next decade as critical for safeguarding planetary stability. Reflecting this sense of alarm, *The Guardian* characterized the 2021 report as the "starkest warning yet" of "major, inevitable, and irreversible climate changes."

The panel included a number of historians who looked at deep past to see how climate has already affected the Earth and the people who live on the planet. Each of the past four decades has been successively warmer than the one that came before it, a trend that extends back to 1850. Humanity has warmed the planet at a rate unmatched since before the fall of the Roman Empire. According to the panel's analysis, to find a time when atmospheric carbon dioxide levels changed as rapidly and as dramatically as they are changing now, one would have to look back 66 million years when dinosaurs still walked the Earth. Current carbon dioxide concentrations have now reached levels not experienced in the last two million years.

If action was not taken, the situation would worsen quickly. "The chances of unknown unknowns become increasingly large," said Zeke Hausfather, director of climate and energy at the Breakthrough Institute and a member of the United Nations Panel. "We don't have any great comparable analogues in the last 2 million years or so. It is hard for us to predict exactly what will happen to the Earth's systems." The evidence for mankind's influence on the climate system, "once a fiercely debated topic, is now overwhelming," the report says. What started as a scientific hypothesis has become an "established fact." The report's 42-page "summary for policymakers" uses the phrase "virtually certain" nearly a dozen times. The words "high confidence" is repeated more than a hundred times. The rate of sea-level rise, the retreat of ice sheets and glaciers, and the acidity of the oceans are all described as "unprecedented in the past several thousand years." Even the certainty with which the panelists presented their findings has not caused the skeptics in the world of policymaking to stop resisting action. The effort by President Joe Biden did not persuade the Republican opposition to accept his climate agenda. Donald Trump, the Republican president who succeeded Biden and moved to the White House on Jan 20, 2025, the presidential residence in Washington showed no interest in taking action to address the causes of climate change.

Thirty years ago, the same panel warned that humanity was causing a dangerous greenhouse effect and cautioned that, without collective action to slow the planet's warming, there would be "profound consequences" for both people and nature. The latest report was compiled by 234 scientists who used 14,000 studies from around the globe to arrive at their findings. The report was released less than three months before the climate summit scheduled for November, which was held in Scotland. The United Nations Secretary General called the report's conclusions "a code red for humanity" and said nations needed to find ways to limit global warming as much as possible. The report took serious issue with the position taken by President Trump and his political associates, who dismissed global warming as a Chinese hoax perpetrated to set back American economic growth. It states that there is no remaining scientific doubt that human action was fueling climate change. That much is unequivocal. The only remaining uncertainty was that the world could gather the will to prevent darker times.

To guide policymakers, the United Nations (UN) panel presented its recommendations for action in

four key areas. It noted that heatwaves have already become more frequent and intense, and projections indicate that extreme heat will continue to rise throughout the 21st century—even if global warming is limited to 2.7 degrees Fahrenheit above pre-industrial levels. That was equivalent to 1.5 degrees Celsius. Places such as Jacobabad in Pakistan's Sindh province will become unlivable in a few years. The temperature rise is resulting in heavy downpours. The Panel states in its report that heavy precipitation events have increased across most land areas of the world since the 1950s. With more warming, the experts predict, heavy precipitation events will intensify further, increasing by 7 percent for every 1.7-degree Fahrenheit of warming. For South Asia, summer monsoons bring most of the subcontinent's annual rainfall. These would become heavier and longer in duration, bringing destructive floods. On the other end of the weather spectrum, droughts will become drier. Observations show that drought is increasing across substantial land areas. Several countries across Africa and the Middle East have experienced a decline in agricultural output due to increasing land dryness. Scientists also see windier and rainier hurricanes. Major hurricanes rated Category 3 or higher have struck the United States, the Caribbean and Central America in recent years, seriously damaging coastal properties and displacing tens of thousands of people. The tropical Atlantic has seen several Category 5 storms in recent years. In Asia, hurricanes—known by different names in various regions—have also become more frequent and destructive.

What are the policy options for the countries in South Asia that result from the findings of the United Nations Panel? Experts recognize that much of global warming has been caused by human activities in the more developed regions of the world. However, poor and developing nations such as Pakistan are left to deal with a number of consequences. Among these, the most significant is the faster melting of the glaciers in the mountain ranges that feed the rivers in the area. For some decades, the result will be destructive floods in the rivers, as happened in the stretch of land in India's Himalayan region. A small dam was destroyed by the fast run-off in the river and several people were killed. Such incidents are likely to occur with some frequency in the future.

Some years ago, the World Bank published a report on the medium-term impact of glacier melting in the Himalayan region from which the Indus system of rivers gets its water. The main conclusion of the study was that the rapid melting of glaciers would lead to increased runoff in the short term, followed by severe water shortages in the rivers later this century. To address this challenge, the World Bank proposed a program called the *Indus Cascades*. This was to be a series of 12 dams to be constructed on the Indus River. Rather than allow the fast-melting ice cover to produce water that would flow into the sea, the storage would save the water for programmed use. The under-construction Dasu dam, being built by a Chinese company, is one dams in this program. The tree-planting initiative launched by the government of Imran Khan was also intended to address climate change; however, Pakistan has long suffered from extensive deforestation, progressing at a rate that threatens to turn large parts of the country into desert. The main point of this analysis is that the situation the United Nations panel warned would affect much of the world has already begun to unfold in Pakistan.

The Coming Climate Catastrophe

If more evidence was needed to point towards the coming climate catastrophe, it came with the release of the report by Copernicus Climate Change Service on January 9, 2024. Earth's average temperature in 2023 was 1.48 degrees Celsius hotter than the preindustrial average, before humans began to warm the planet through the burning of fossil fuels, emission of greater quantities of methane gas and other polluting activities such as the reduction of the planet's forest cover. The year 2023 shattered the global temperature record by almost two-tenths of a degree – the largest jump climate scientists have ever observed. Scientists predict that 2024 will be even hotter. By the end of January or February, the

European agency warned that the planet's 12-month average temperature is likely to exceed 1.5 degrees Celsius, passing the goal adopted by the nations that met in Paris in 2015 to lay down a series of targets. Public policy should aim to achieve to save the planet from a catastrophe from which it will be very hard to recover.

According to a review of the latest scientific evaluation by Scott Dance, Sarah Kaplan and Veronica Penney published by *The Washington Post*, the announcement of a temperature record comes as a little surprise for those who have witnessed the past 12 months of raging wildfires, deadly ocean heatwaves, cataclysmic flooding and worrisome Antarctic thaw. A scorching summer and unusually hot autumn temperature anomalies had all but guaranteed that 2023 would be a year for history books. But the amount by which the record was broken shocked even climate experts. "I don't think anybody was expecting anomalies as large as we have seen," said Copernicus Director Carlo Buontempo. "It was on the edge of what was plausible."

Each of the previous eight years was already among the eight warmest ever observed. A combination of climate-worsening events ushered in an age of "global boiling" in the words of United Nations Secretary General Antonio Guterres. The U.N. Secretary General has taken the lead to urge member nations to take actions that would be serious and enduring. Unless nations transform their economies and rapidly transition away from pursuing the activities that cause global warming, the unraveling of global webs would occur and cause human-built systems to collapse.

The issue of global warming has risen to the top of the domestic political agenda in several countries, not just in the United States but even more so in Europe. Experts and those who wished to get the governments around the globe to take action to reduce the amount of carbon that was being thrown into the atmosphere used breaking of records, especially those that were set in the distant past as a way to motivate action. The most profound change has come in the way policymakers in the United States view climate change. When Donald Trump was president from 2017 to 2021, he termed anxiety about climate change as a "Chinese hoax," pushed by Beijing to hurt growth in the American economy. However, President Joe Biden, his successor, had moved to take several actions to limit those activities that emit large doses of global warming gases. His administration pushed the conversion of the country's vehicle fleet to be electric-driven. Biden had appointed John Kerry, who, as Secretary of State in the Obama administration, had negotiated the 2015 Paris deal that accepted 1.5 degrees Celsius above pre-industrial levels as the goal the world must not cross.

But as a newspaper analysis put it, we're now living in a climate that is breaking records for breaking records. "News of the hottest June was quickly eclipsed by the declaration of Earth's hottest day, a record that would be 16 times by the end of July, which is registered as Earth's hottest month," wrote William Booth in a story in The Washington Post. These events are not rare anymore. Ten years ago, "we were talking about climate change and the impacts as something that you would see in the future. I think everybody now sees it on their television screens or even just outside the window," said Jim Skea, a professor at Imperial College London and the newly appointed chair of the U.N. Intergovernmental Panel on Climate Change. The National Oceanic and Atmospheric (NOAA) tallied that the United States broke nearly 3,000 heat records in the month of July 2023. The historic heights included 128 degrees registered in Death Valley, California – two degrees short of the highest reliably measured temperature on Earth – as well as a dangerous 31 straight days of above 110 degrees in Phoenix, Arizona. There is agreement among scientists that the worse is still to come. They say that in 20 or 30 years, 2023 will not be remembered as a very hot year.

At the Paris 2015 meeting of the Conference of the Parties (COP) – participating nations agreed to the

goal of "pursuing efforts to limit the temperature increase beyond pre-industrial levels to 1.5 degrees Celsius. Large nations went to Paris to work towards the goal of 2.0 degrees, but the limit was lowered by the urging of small island nations that feared that an increase in sea levels would drown them. At least one climate-science organization, Berkeley Earth, believes that the limit has already been crossed. Scientists are already speculating that the planet could set another record in 2024. Some also suggest that the latest increase in global temperatures is a sign that the rate of global climate change has accelerated and unless urgent measures are adopted around the globe, we are heading towards a catastrophe.

To quote Carlo Buontempo again, who is of the view whether we cross it to this extent or not, the "1.5-degree limit, the year (2023) has given us a glimpse of what 1.5 may look like." He was referring to many climate-related crises around the globe. "As a society, we have to be better at dealing with the current crisis because the future will not be like our past."

"Summer heat isn't just for the summer anymore," wrote Kasha Patel and Naema Ahmed in a story published by *The Washington Post* on August 25, 2025, titled *"Summer is bringing the heat for longer than before."* They observed: "In recent decades, sweat-inducing temperatures have been arriving earlier and ending later in the year" (Patel & Ahmed, 2025). Washington, D.C., the capital of the United States, used to experience summer temperatures starting at around 73 degrees Fahrenheit from June 9 to September 6. Now, the city begins to see summer heat around June 5 and cools off only by about September 11. They quoted Michael Allen, a climatologist at Towson University, who explained that "what we think of as summer isn't necessarily the same today as it was 30 years ago."

The rate of change over the past 30 years is "faster than anticipated," said Yuping Guan, a physical oceanographer at the Chinese Academy of Sciences. A few years ago, Guan and his team conducted a global study showing that summer temperatures have lasted several more days each decade across the Northern Hemisphere. The root cause of this prolonged summer heat is the overall increase in global temperatures — the past ten years have been the hottest on record.

According to Guan, factors such as latitude, topography, elevation, and cyclical weather patterns like El Niño and La Niña also influence which areas are generally the warmest. However, the lengthening of the summer season is primarily driven by global warming. In his 2021 study, he projected that summer temperatures could last up to six months in parts of the Northern Hemisphere by the end of this century.

Global warming has also become a subject of several books that examine the phenomenon from many different angles. Two examples of this are the books by Eugene Linden (*Fire and Flood: A People's History of Climate Change from 1979 to the Present*, 2022) and by Thane Gustafson — *Perfect Storm: Russia's Failed Economic Opening, the Hurricane of War and Sanctions, and the Uncertain Future*, and *Klimat: Russia in the Age of Climate Change*. Both try to explain why, when climate science was making rapid strides, politicians were so slow to act. This was the case in both the capitalist and communist worlds — in the United States, and in what was then the Soviet Union and is now Russia (Gustafson, 2025).

Rising temperatures in countries where summers have become unbearably hot have caused significant stress, particularly for the poor, who depend on electricity to cool their homes. It has long been recognized that several cities in the lower parts of Sindh province could become unlivable without electricity to power fans and air conditioners. Examples of climate change and its damaging effects can be found across the world. Cyclone activity in the western Atlantic has broken numerous records. As detailed by Ian Livingston in a story contributed to *The Washington Post* and published by the newspaper under the heading of "Erin adds to

unusual trend of category 5 storms," the author examined the records of storms that hit the Atlantic Coast when a disturbance given the name Erin hit the Atlantic Coast. "The environment that sent Erin into the history books was primed thanks largely to another year of widespread warm water across the Atlantic Ocean. Erin became yet another storm to rapidly intensify well beyond the criteria for explosive development, taking advantage of those conditions. The ten-year running sum of Category Fives is now at its mark for modern records. And with the bulk of the season still to come, historical odds suggest the Atlantic could churn out another monster hurricane or two." (Livingston, 2025) witnessed some of the warmest water temperatures on record globally, boosted during the rise and fall of a powerful climatic event called El Nino. The footprint of warm and very warm water can now be seen in all the oceans around the world.

A rapidly warming world needs devices to protect the inside of homes from the blazing sun outside. This means electric fans and for those who can afford them air conditioners to cool the inside of homes. With not enough energy available in the grid systems, electricity prices have gone through the roof, and the poor are unable to afford even fans to move around the inside air. This has led to a boom in solar energy. Two years ago, solar energy was the fifth largest source of electricity in Pakistan. Now it is at the top, accounting for about one-fourth of the national power supply. Its extensive use for cooling homes as well as bringing water from the ground to irrigate dry land was initially welcomed by the government as the sharp drop in prices of solar panels imported from China resulted in what experts call the solar boom. Wealthy people, including well-to-do farmers, began to buy panels in bulk, going off the aging and overburdened national grid entirely. But 45 percent of Pakistanis live below the poverty line, according to the World Bank, putting solar panels well beyond their reach. The spread of solar power has meant that the pool of customers for the national grid has gotten smaller and the costs of financing old coal-powered electric plants have been increasingly passed on to those who can least afford it. Electricity prices roughly doubled between 2021 and 2024 before the government's recent intervention lowered the price of power but not enough to bring power into the homes of the poor. "High-income consumers go solar while non-solar users absorb the costs," said Hasanat Khan, senior vice chairman of the Pakistan Solar Association. He was interviewed by Rick Noack and Shaiq Hussain, who wrote a story for *The Washington Post* titled, "In Pakistan, the poor face higher bills as solar booms." (Rick & Hussain, 2025)

On the flip side, the outdoor units of the air conditioners increase the "surrounding urban temperature by 1-2 degrees Celsius in the immediate vicinity. This can increase more during heat waves. This heating is called heat island effect an article by Sophie Khatsenkova in Euro News titled, Fact-Check: is air conditioning making cities hotter? It details how the heat-pumping system has a localized and cumulative effect. Scientists found that the link between Air Conditioner (AC) use and increasing temperatures has already been documented-cities are likely to demand more indoor air conditioning. The alternative to this is making people more aware of its hazards, creating more green spaces, insulating buildings and advising the population how to keep cool during a heat wave." (Euronews Green, n.d.).

The government has mismanaged the power sector. In the early 2000s, those in power panicked by the people's reaction to frequent power outages. Islamabad borrowed heavily to construct new coal-fired power plants, building up debt to foreign lenders amounting to $5.6 billion. While the cost of carrying the large debt was passed on to power consumers through high tariffs, the rich turned to solar power by installing panels on the rooftops of their large homes. According to the above-quoted Washington Post story by Noack and Hussain, "the solar divide is particularly pronounced in Pakistan's martial belt, in northern Punjab province, which has been the army's most fertile ground for army recruits. Field Marshal Asim Munir, the current head of the army, belongs to the area. According to one small farmer interviewed by the Post correspon-

dents, “every month, I have to pay a higher electricity bill, I have to choose whether to feed my family or to have power.” The government's mismanagement of the power sector was acknowledged by the current Power Minister, Awais Leghari, who spoke with Noack and Hussain about the serious income disparities caused by policies implemented by his administration and those that preceded it. He admitted that successive governments had contributed to widening inequality through their handling of the energy sector. Officials encouraged solar producers to offset their power bills by selling surplus energy they generated from their rooftops to the government-owned power grid. As a result, the government wound up paying for power it didn't need; wealthy landowners and businessmen were able to access vast amounts of electricity at low cost, or even for free, while much of the population paid higher prices. “We need to improve,” said the minister, “so that windfall profits do not exist for anybody on the system and they don't start acting as a burden on the rest.”

Chapter

2

Beyond Stabilization: Pakistan's Growth Challenge

Beyond Stabilization: Pakistan's Growth Challenge

Dr. Farrukh Iqbal

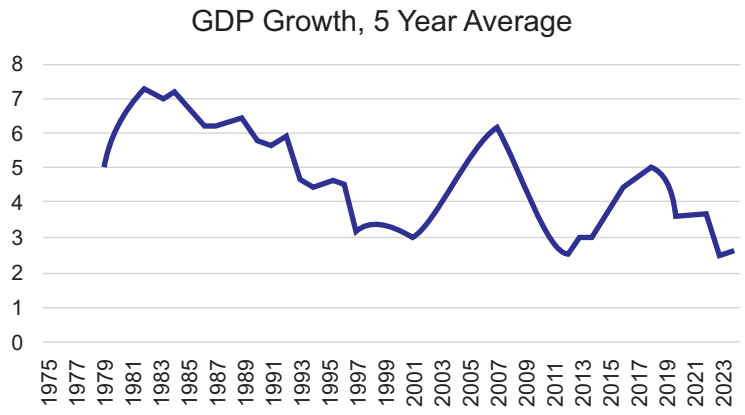
Introduction

In recent decades, Pakistan has faced two persistent challenges macroeconomic stabilization and long-term economic growth. The stabilization challenge is manifested in periodic crises in which the country faces severely depleted international reserves (less than two months of import cover), raising the prospect of default on external debt obligations. These crises are usually resolved through undertaking stabilization efforts under the aegis of three-year long Extended Fund Facility (EFF) programs of the International Monetary Fund (IMF). During the last twenty years, Pakistan has undertaken four such programs. The below discussion examines how the most recent stabilization effort, initiated in Financial Year (FY2023) and extended via an EFF for FY25-27, has been faring.

The growth challenge goes beyond stabilization considerations. It is motivated by the observation that, despite annual fluctuations, the growth rate of the economy has trended down since the mid-1980s. Figure 2.1 shows this pattern using 5-year average growth data to reduce the effect of annual fluctuations. The average growth rate after 2008 has been about 1.5 points lower than the average for the 1980s. The subsequent analysis explores several factors that may underlie the declining long-term growth rate.

Figure: 2.1

GDP Growth Decline Since 1980s



Source: World Bank: World Development Indicators (WDI)

Stabilization Under the Ongoing IMF Program

The Pakistani economy suffered a major crisis in FY23 when international reserves fell to $4.5 billion, which was barely enough to cover a month of imports. Short-term financing was arranged to meet external debt servicing requirements and negotiations were started with the IMF to arrange a fresh medium-term loan, Pakistan's fifth in the last twenty years. A $7 billion three-year Extended Fund Facility (EFF) came into effect in September 2024. In June 2025, additional resources were approved in the amount of $1.4 billion under the IMF's Resilience and Sustainability Facility (RSF) to support Pakistan's efforts to cope with natural disasters and climate vulnerability.

Macroeconomic Developments in FY2025

Highlights for FY25 include the following (see Table 2.1)

(i) Real Gross Domestic Product (GDP) grew by 2.6 percent. While this was higher than the level of 2.4 percent achieved in FY24, it was below the expected level of 3.2 percent forecast in the FY24 EFF program document. This was likely due to sluggish industrial activity and only a modest increase in agricultural output relative to expectations.

(ii) The Consumer Price Index (CPI) dropped dramatically to 5.1 percent from recent highs of 29.2 percent in FY23 and 23.4 percent in FY24 and lower even than the 9.5 percent forecast in the EFF program document. This was due to tight monetary policy and some easing of cost-side pressures in the food and energy sectors. Declining inflation has allowed the State Bank of Pakistan to cut its policy rate by 1100 basis points since June 2024, sharply reducing prospective domestic debt financing payments.

(iii) Revenues improved substantially to 15.9 percent of GDP, up from 12.6 percent in FY24, mostly due to higher tax collections from the same base but also from higher indirect tax collections from energy use. Public expenditure continued to rise, reaching 21.6 percent of GDP in FY25. As revenues rose more than expenditures, the fiscal deficit was cut to 5.7 percent of GDP from 6.8 percent in FY24. This was even lower than the 6.0 percent expected at the start of the EFF program.

(iv) The current account position continued to improve, almost reaching balance in FY25. This was due to increases in exports and remittances which offset higher imports. The overall improvement was better than expected in the program profile.

Table: 2.1

Key Macroeconomic Indicators, FY22-FY26

	FY22	FY23	FY24	FY25 (exp)	FY25 (est)	FY26 (proj)
Real Gross Domestic Product (% change)	6.2	-0.2	2.5	3.2	2.6	3.6
Consumer Price Index (period average)	12.2	29.2	23.4	9.5	5.1	7.7
Revenue and Grants (% GDP)	12.1	11.5	12.6	15.4	15.9	15.2
Public Expenditure (% GDP)	20	19.2	19.4	21.4	21.6	20.3
Budget Balance, incl. Grants (% GDP)	-7.8	-7.7	-6.8	-6	-5.7	-5.1
Current Account Balance (% GDP)	-4.7	-1	-0.5	-0.9	-0.1	-0.4
Gross Reserves (in billion US dollars)	9.8	4.5	9.4	13.4	13.9	17.7
Govt. and Govt. Guaranteed Debt (% GDP)	82.3	83.2	74.1	75.1	77.6	75.6

Source: Data taken from IMF 2025.

(v) The improvement in the current account and in other flows led to a healthy increase in gross reserves to a level of $13.9 billion or 2.3 months of import cover. This was better even than program targets, contributing to exchange rate stability during the year as well as a decrease in bond spreads for Pakistani sovereign paper.

The overall impression is that the current stabilization effort has been successful. The government has adhered to a wide range of policy commitments for two years now and has achieved a turnaround in inflation and the fiscal and external deficits. The circular debt situation in the energy sector has also improved, driven by improvements in collection, lower interest charges on arrears enabled by State Bank of Pakistan (SBP)'s policy rate decline and timely tariff adjustments.

Based on the macroeconomic performance shown in Table 2.1 as well as other developments, Pakistan passed the First Review of the EFF successfully in May 2025. The IMF's overall assessment was that downside risks had declined in FY25 but remained high. The IMF pointed to risks for trade emanating from recent tariff actions taken by the US outside the framework of World Trade Organization (WTO) agreements, upside risks for commodity prices and natural disasters inherent in continued global warming, and domestic policy slippages that might arise as powerful groups (political, business, bureaucratic and military) seek to minimize adverse impacts on their financial interests from continued adherence to disciplined monetary and fiscal policies.

Pakistan's Growth Challenge

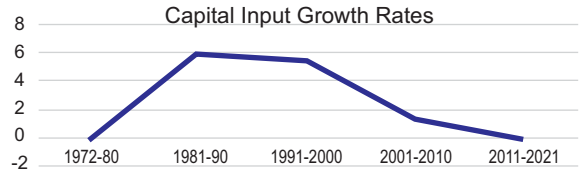
What accounts for Pakistan's declining growth rate? The growth literature suggests that the critical determinants are inputs, such as capital and skill-augmented labor, and productivity improvements that enable higher amounts of output to be derived from available inputs. We start, therefore, by examining trends in these three variables. Our task is made easier by a recent study (Siddique, 2022) from which the following table showing relevant rates of growth in GDP and key determinants (capital, human capital, adjusted labor, and total factor productivity) has been adapted. The table 2.2 presents the relevant data for a fifty-year period divided into five decades.

Trends in Capital Formation

Using decadal averages of rates of gross fixed capital formation, Figure 2.2 shows that capital inputs grew at different rates in different decades but with a downward trend after the 1980s. In the most recent decade, capital growth was negative. This suggests that declining rates of capital formation are likely to be one cause of the declining growth of GDP.

Figure: 2.2

Declining Capital Input Growth Since 1980s



Source: Siddique (2022)

Table: 2.2

Growth of GDP and Key Inputs (Annual Percent Change)

	1972-80	1981-90	1991-00	2001-10	2011-21
GDP	5	6	4	5	4
Capital	0.13	5.9	5.4	1.2	-0.2
Labor	5.1	0.5	3.5	4.6	2.6
TFP	2.4	2.8	-0.4	2.1	2.7

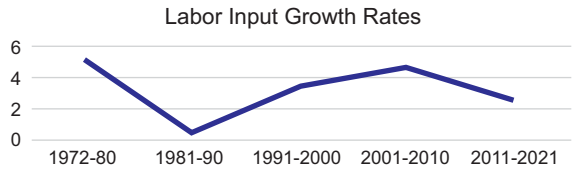
Source: Siddique (2022)

Trends in Labor Inputs

The labor inputs relevant for growth are the employed labor force classified by hours worked and education attainment levels. "Siddique's compilation of a relevant labor input measure for Pakistan shows it has grown at varying rates across decades with no secular trend (see Figure 2.3)." The rate of growth of the labor input has been close to the rate of growth of the employed labor force (between 2 percent and 3 percent). This suggests that the human capital adjustment factor has not been substantial, reflecting slow growth in the number of years of education attained per person.

Figure: 2.3

Fluctuated Human Capital–Adjusted Labor Growth



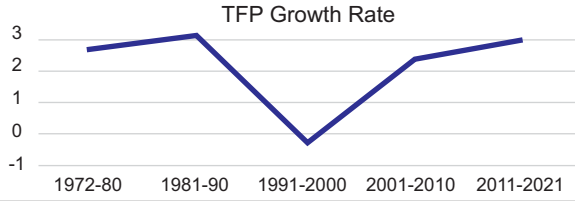
Source: Siddique (2022)

Trends in Total Factor Productivity (TFP) Growth

Siddique (2022) finds TFP growth to have been the highest in the 1980s and 2000s and lowest in the 1990s. Indeed, in the 1990s, TFP growth was calculated to be negative. No clear trend can be detected across decades. The average for the past fifty years was 1.8 percent per annum. This is on the high side among estimates for Pakistan calculated in other studies (Siddique, 2022, Table 2.2). It is also high among international comparisons: for the period 1971-2017, TFP growth in Pakistan exceeded that in India and even some East Asian countries except for Taiwan (Siddique, 2022, Table 2.3). of course, given differences in sample periods and calculation rules and assumptions, such cross-country comparisons should be interpreted with caution. It is also problematic to reconcile a declining investment rate with a rising TFP growth rate since the 1990s.

Figure: 2.4

Fluctuated: TFP Growth Across Decades



Source: Siddique (2022)

Accounting for Growth

The above shows that while the growth of capital inputs has declined since the 1990s, the same is not the case for labor inputs and TFP. These have fluctuated without a strong trend. How much did each factor contribute to overall growth performance? Siddique (2022) reports the following growth accounting results:

(i) For the full fifty-year period, each of the three determinants, capital, labor and TFP, accounted for a third of total output growth.

(ii) Taken decade by decade, capital contributed the most during the 1980s and 1990s, labor during the 1970s and the 2000s, and TFP during the 1970s and 2010s.

(iii) The decline of the investment rate since the 1990s has resulted in a diminished contribution of capital inputs to economic growth. For the period 2001-2021, the rate of economic growth was almost entirely accounted for by labor and TFP.

(iv) Overall, the contribution of labor to economic growth has been low for a labor-abundant country like Pakistan. This suggests low levels of skill-accumulation and arising most likely from deficiencies in the education and training systems.

The above results suggest that the declining investment rate in Pakistan has been the most important driver of declining growth, especially since the 1990s. Meanwhile, the labor force growth rate mostly reflects demographic momentum, without a fillip from higher skills. Furthermore, while the academic literature shows a reasonably high TFP growth rate in the 2010s, there is little corroborative evidence from other sources. Pakistan does not have a strong research and development system and has

not distinguished itself in process or product innovation. It has a nascent Information Technology (IT) community that has built an encouraging export presence (about $5 billion per annum), but there is little evidence to suggest that IT has percolated into local manufacturing to a sufficient extent to produce visible gains in productivity. Accordingly, as policy makers grapple with the challenge of restoring growth after stabilization has been achieved, they must address all three drivers of growth simultaneously.

Chapter

3 Punjab Climate Smart Green Plan

Punjab Climate Smart Green Plan

Shahid Najam and Areeba Naveed

Introduction

Pakistan is the worst-affected country globally, according to the Climate Risk Index 2025, due to the disproportionate disasters, including floods, droughts, intense off-season rains, and heatwaves, inflicted by climate change. Punjab, the most populous province with around 127 million inhabitants (Ministry of Finance, 2024) and the country's economic hub, is highly vulnerable to the extremity of climate change in view of the rigours of weather variations, condensed monsoon period, and rising temperatures, which have led to an estimated increase of 20 summer days in some parts of the province. It contributes around 60 percent to the country's agriculture, around 54.2 percent to industry, provides employment to 37.4 percent of the population, and supports over 65 percent of the rural population's livelihood. The heavy reliance on agriculture further exacerbates its fragility to climate-induced events manifested every year in widespread inundation of fertile land, crop damages or reduced crop yields, loss of livestock and destruction of the agricultural infrastructure and livelihood assets of especially those of the poor. The 2025 floods affected more than 4.2 million people across 1,928 villages (UNOCHA, 2024), destroyed 462 km of roads and 213,097 houses (NDMA, 2024). Glacial melt in the northern catchments of the Indus Basin, often referred to as the "water tower" of South Asia, directly influences the province's water security (Immerzeel et al., 2010), water variability and disaster frequency (Kaab et al., 2015). It is estimated that by 2100, precipitation in Punjab could rise by 10–25 percent in northern and central regions, while mean maximum temperatures may increase by 3°C–5.5°C under high-emission conditions (BIPP, 2025).

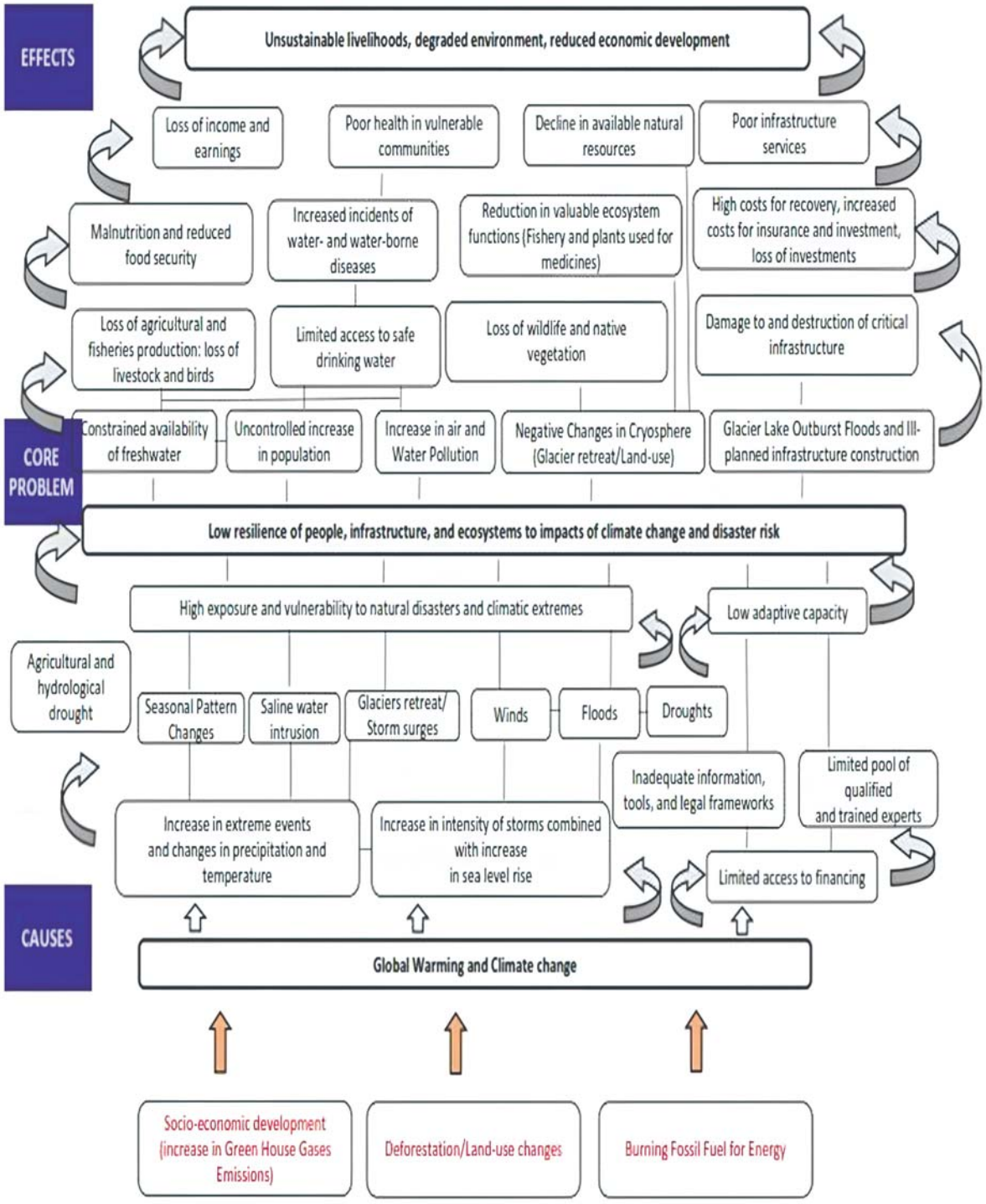
Punjab, as such, continues to remain one of the most climate-susceptible provinces of the country and has to confront huge challenges and potential impact across all sectors and at all levels, as depicted in Figure 3.1, problem tree:

Punjab Government: Combating Climate Change

In the wake of these challenges, the Punjab government has attempted to mainstream climate change in its policy, planning and development frameworks. The Annual Development Plan (ADP) 2025–26 envisages an allocation of nearly 64 percent of the total development budget toward climate adaptation and mitigation projects, including sustainable water management, urban resilience, and green infrastructure (Dawn, 2025). The provincial government committed PKR 26 billion for youth skills and green entrepreneurship programs under the Skilled Punjab initiative to facilitate climate-smart growth (Khyber News, 2025). Punjab also plans to deploy 1,115 electric buses across major cities by the end of 2025, to advance clean transport goals (Aho News, 2025). These policy directions show Punjab's commitment to transition to a green economy, but in the absence

Figure 3.1

Potential Impact: The Problem Tree



Source: BIPP Expert's Computation

of an implementation framework and an inclusive, integrated and holistic plan of action are not likely to effectively combat the enormity of climate change impact.

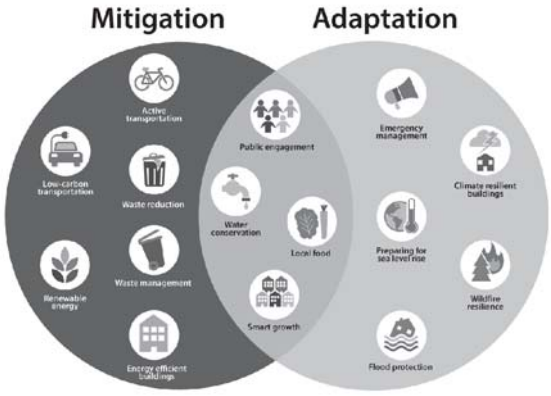
It is also a worrying concern that air pollution and smog have become a frequent phenomenon in the province, to the great socio-economic detriment of the people, especially human health and the environment. The Air Quality Index (AQI)of Lahore on 5 November 2025, had fallen to 158, dropping below major polluted cities around the world, including Beijing, Delhi, Cairo, Kolkata, and Dubai while that of other most polluted cities in Punjab e.g., Bahawalpur, Multan, Faisalabad, and Jhelum, registering AQI levels of 434, 392, 178, and 171, respectively (AQI, 2025). Despite some initiatives by the government, e.g., "anti-smog gun", sustainable development of Lahore, stricter enforcement measures and traffic controls, etc., to improve air quality, dense smog continues to adversely affect the economy, health and education, school attendance and cognitive decline (Mendoza et al, 2020). According to the World Health Organisation (WHO), exposure to fine particulate matter ($PM_{2.5}$) and other pollutants leads to decreased lung function, aggravated asthma, increased risk of stroke, heart disease, Chronic Obstructive Pulmonary Disease (COPD), and cancer; children, pregnant women and the elderly are especially vulnerable (WHO). In Pakistan and Punjab specifically, a systematic review found that air pollutants such as NO_x, SO_x, $PM_{2.5}$, PM_{10}, O_3, CO and CO_2 from traffic, industry and crop-burning are strongly correlated with respiratory and cardiovascular disease, eye and throat irritation, skin allergies, etc.

The Approach to Combating Climate Change

It is critical to espouse a holistic approach and blend a comprehensive set of mitigation and adaptation interventions across all the major sectors to effectively combat the rapidity and severity of climate change impact. The Mitigation-Adaptation blend and connectivity, as depicted in Figure 3.2 below, should form the basis for formulating an action plan.

Figure 3.2

Mitigation – Adaptation Measures Complement



Source: BIPP Expert

Punjab Climate Smart Green Plan

This section proposes "Punjab Climate Smart Green Plan" (PCSGP) to effectively address the climate induced impact on various sectors. The proposed Plan is derived from the review of international and national literature related to policies, strategies, and international best practices as well as inclusive stake holder consultations, and field visits. PCSGP lays out Adaptation and Mitigation measures, Strategies, Actions, Priority Areas and the Implementation Agencies for ten identified sectors i.e., Agriculture, Livestock, Forestry, Urban Planning, Water Resource, Disaster Management, Public Health, Energy, Industry and Transport which are fully anchored in the updated NCCP 2021, the Provincial Climate Change frameworks and NDCs 2025. Each sector identifies in specific terms the following time frame for Actions:

- Priority-Actions (PAs): within 2 years
- Short-Term Actions (STAs): within 5 years
- Medium-Term Actions (MTAs): within 10 years and
- Long-Term Actions (LTAs): within 20 years

The Sector wise components of the plan as follows:

	Actions	Priority	Implementing Partnerts
	Climate Change Adaptation and Mitigation Measure		
	Agriculture		
	Adaptative Measures		
	Strategy 1.1: Climate-resilient agriculture risk management system		
1	Identification of agricultural areas susceptible to climate extreme events, vulnerability, risk assessment and surveillance system	PA	PDMA, Provincial Agriculture Department
2	Farmers to adopt indigenous safeguard measures to manage potential risks	PA	Same as above
3	R&D for drought- and flood-resilient crop varieties	STA	NARC, Provincial Agriculture Universities and Research institutes
4	Sunken fields for rainwater harvesting and protection against floods	PA	Provincial Agriculture and Extension Directorates
	Strategy 1.2: Agricultural land conservation: Land-use planning		
1	Enforce agricultural land conservation and land-use planning	STA	Provincial Agriculture Department, Urban Unit
2	Preparation/revision of climate-inclusive agriculture ecological zones	PA	Same as above
	Strategy 1.3: Heat and drought-resistant agriculture in rain-fed areas		
1	Identify the climate change induced drought vulnerable agricultural areas	PA	Research Institutions
2	Preparation of climate induced crops failure catalogue	PA	PDMA, Agriculture/Arid Agriculture Departments
3	Sync local markets to changes in cropping-patterns	STA	Agri Marketing Wing
4	R&D to introduce heat and drought resistant crops	STA	Research Institutions
5	Involve farmers in climate change induced drought management using indigenous solutions	STA	Provincial Agriculture Extension Directorate
6	Incentives re-use of wastewater for plants and kitchen gardening	PA	Same as above
	Strategy 1.4: Farmers friendly financial environment		
1	Introduction of Farmers' friendly financial environment to adapt to technologies in climatically stressed areas	STA	Provincial Agriculture Extension Directorate, Finance Department
2	Training and awareness related to new financial rules, technologies, and new seeds and crops	STA	Same as above + Punjab Seed Corporation
3	Reduce taxes on climate-resilient agricultural products	STA	Same as above + P&D

	Strategy 1.5: Use of bio-technology for more carbon-responsive crops through genetic engineering and other relevant fields		
1	Capacity building of line departments for more carbon-responsive plants and crops, and drought resistant	STA	Provincial Agriculture Department
2	Infrastructure, R&D for biotechnology and genetic engineering	STA	Same as above
	Strategy 1.6: Spatial expansion of cultivable lands		
1	Mapping of provincial cultivable waste lands	STA	Urban Unit, Provincial Agricultural Departments
2	Capacity building of communities to carry out rainwater harvesting through small ponds and dams	PA	Same as above
3	Land-use planning for agricultural land	PA	EPA, Urban Unit
4	Financial support for rainwater harvesting, dam construction for future expansion	STA	Water Management, and Irrigation Department
	Strategy 1.7: Developing climate inclusive smart agriculture plan		
1	Develop climate-inclusive smart agriculture plan	PA	EPA and Agriculture Department
2	Capacity building of line departments for use of climate change simulation models	STA	NARC, Agriculture Department Universities and Research
3	Climate change assessment to study changes in nutrition, chemical and physical properties of	PA	Same as above
4	Increasing financial aid for relevant R&D	STA	Finance Department, EPA Donor Agencies
	Strategy 1.8: Centralized data-bank for climate change and agriculture		
1	Develop a centralised databank for climate change and agriculture data, together with capacity building	STA	BOS, NARC, Agriculture Departments
	Strategy 1.9: Institutions: Departmental climate change cells		
1	Establishment of departmental climate change cells	STA	All Departments
2	Establishment of climate, climate change, soil and crops information database centres	PA	Agriculture Department, PMD, PDMA
	Strategy 1.10: Early warning and communication centers		
1	Develop early warning centres in various line departments	PA	Line departments, PMD, PDMA
2	Establish communication centres for information dissemination related to climate change and crop information in various languages	PA	Line departments, Print and Electronic Media

Mitigation Measures

	Actions	Priority	Implementing Partners
	Strategy 1.11: Use of technology to reduce GHG emission		
1	Establish Integrated Pest Management (IPM) techniques to prevent the pest attacks	PA	Agriculture Research and Extension Department
2	Application of best practices to reduce GHG emissions, particularly methane and nitrogen emissions	PA	Same as above
3	Trainings and awareness programs on IPM for line departments and farmers	STA	Provincial Agriculture Extension Department
4	Improved soil-carbo storage capacity through robust and state-of-the-art practices in soil management	STA	Provincial Agriculture Extension Department
5	R&D in the field of low-delta rice and other crops varieties	PA	Universities and Research Institutes
6	Encouraging use of organic and green manures and best storage management practices	PA	Provincial Agriculture Extension Department
7	Adopt energy conservation practices in agriculture	STA	Provincial Agriculture Extension Department
8	Pilot-scaled bio-fuel crops cultivation and viability assessment	PA	Provincial Agriculture Extension Department

Livestock

Adaptation Measures

	Actions	Priority	Implementing Partners
	Strategy 2.1: Providing good quality feed and fodder		
1	Classification of quality fodder and mapping range-lands at provincial scale	PA	Veterinary and Livestock Department,
2	Development of efficient farm to market/livestock locations transport system	MTA	Livestock and C&W Depart,
3	Identification and optimization of climate change adverse impacts on livestock	STA	Livestock and Agriculture Research
	Strategy 2.2: Promoting biotechnology for improved livestock production and breeds		
1	Improve Bio-technology research in livestock sector	STA	Livestock Department and Research Institutes
2	Establish infrastructure for bio-technology labs throughout the province	STA	Crops, Livestock, Dairy Departments
3	Establish vaccination facilities against the climate induced viral diseases	PA	Livestock, Dairy Development Department
	Strategy 2.3: Identification of high-productive climate sensitive livestock		
1	R&D and Identification of highly-productive climate resilient livestock	PA	Livestock, Dairy, Veterinary and Research Departments

2	Improved climate resilient practices to avoid epidemics and viral diseases	PA	Same as above
3	Develop capacity to enhance livestock reproduction using latest technologies and techniques	PA	Same as above
	Strategy 2.4: Improving nutritional quality of livestock feed		
1	Improving quality of livestock feed and supplements	PA	Livestock, Dairy Veterinary and Livestock Research
2	Carry out research on nutritional quality of livestock feed	STA	Same as above
3	Development of cost-effective feed production through robust techniques: “Silage making-Urea treatment”.	PA	Same as above
4	Encourage development and improvement of rangelands	STA	Arid Agriculture Departments
	Strategy 2.5: Feed and fodder conservation		
1	Introduction and use of latest state of the art technologies for enhanced livestock feed production	STA	Livestock, Veterinary and Research Institute
2	Introduce and use of best practices for feed conservation and fodder banks	STA	Same as above

Mitigation Measures

	Strategy 2.6: Improved livestock management techniques for GHG reduction		
1	Methane and nitrogen reduction in livestock-sector through best management techniques and practices	PA	Veterinary and Livestock Research
2	Develop efficient biogas and manure plants	STA	Veterinary and Livestock Research Institutes
3	Use of adequate feedstock additives to reduce GHG emissions	STA	Agrki, Livestock Departments

Forestry

Adaptation Measures

Actions		Priority	Implementing Partners
	Strategy 3.1: Identification and addressing knowledge gap between provincial climate change adaptation/mitigation and forestry		
1	Identification of knowledge gap between provincial climate change and adaptation/mitigation measures	STA	EPA, Forest Department, Relevant Education & Research Institutions
2	Mapping of provincial forests ecosystem	PA	EPA, Forest Department, Urban unit

3	Develop and carry out research on linkages between climate change and provincial forestry to achieve NDCs	STA	Forest department and research institutes
4	Identification and control of climate change induced insects and outbreaks in forest sector	STA	Same as above
5	Development of an adequate 'Risk Management Framework' and best practice guidelines for forests	MTA	P&DD, Forest and Environment Departments, PDMA
	Strategy 3.2: Climate resilient forest ecology and eco-system		
1	Mapping of historic forest fires and suggesting control and protection measures	PA	Provincial Forest and Wildlife Departments, Urban Unit
2	Prioritising plantation of indigenous and climate-adaptive species	PA	Provincial Forest and Wildlife Departments
3	Development and use of best forest-management practices	STA	Same as above
4	Afforestation, particularly in dams' watersheds	PA	Provincial Forest and Wildlife Departments, SDO, MoCC
5	Use of GIS/RS for forest cover monitoring and future planning	PA	Forest Department, P&DD, Urban Unit
	Strategy 3.3: Developing criteria and indicators for sustainable forest management		
1	Identify and develop indicators and criteria for SFM	PA	Forest and Wildlife Departments, EPA
2	Enforcing SFM through adequate rules, regulations and legislations	STA	Same as above
3	Assessment of livelihood improvement due to the potential afforestation using SFM	PA	CBOs, Provincial Forest and P&D Department
4	Land-use planning and management for efficient forest expansion	PA	Urban Units, Provincial Forest Department
5	Establishment of forest management units to strengthen forest department	STA	Same as above
6	Forest protection through stoppage of encroachments	PA	Forest Department, District Administration
7	Encouraging local communities' participation in plantation and afforestation	STA	CBOs, Forest Department, District Administration
	Strategy 3.4: Awareness campaigns and trainings		
1	Develop awareness campaigns, programs and training modules to disseminate the role of forestry in climate change	PA	CBOs, Provincial Forest and Information Departments
2	Development of Forest and Climate Change Experts committee to provide insights related to the latest research and technologies	STA	Provincial Forest, Wildlife Departments, EPA Media
3	Development of forestry and climate change curriculum for academia	STA	Provincial Forest and Education Departments, Universities

Mitigation Measures

	Actions	Priority	Implementing Partners
	Strategy 3.5: Capacity building to enhance carbon-stocking and reduce de- forestation		
1	Estimation and mapping of carbon storage in provincial forests	PA	EPA, Forest and Environment Departments
2	Defining carbon-stocking rights through effective rules, regulations and legislation	STA	Same as above
3	Developing strategy and regulatory framework for REDD	STA	P&DD, Forest department, and CSOs
4	Capacity building/training of the Forest Department to reduce tree and soil damage and conserve carbon-stocking	STA	Same as above and EPA
	Strategy 3.6: Afforestation		
1	Mapping available forests as carb sinks and afforestation	PA	Forest Departments, EPA, Urban Unnit
2	Encourage Agro-forestry	PA	CSOs, Forest and Agriculture Departments
3	Providing alternate fuel and energy sources to communities to avoid deforestation, and provide compensations for afforestation	PA	Same as above and Alternative Energy Development Board
	Strategy 3.7: Effective monitoring, reporting and evaluation systems		
1	Developing and maintaining an adequate afforestation	PA	Provincial Forest
2	Climate change monitoring, reporting and evaluation systems for better management	PA	Departments, EPA
3	Bi-annual and annual public reports publication	PA	Same as above

Urban Planning

Adaptation and Mitigation Measures

	Actions	Priority	Implementing Partners
	Strategy 4.1: Climate resilient town-planning designs		
1	Develop climate resilient town planning designs for low-carbon foot-prints, energy efficient buildings construction and retrofitting at public and private sectors	STA	Urban Unit, City Development Authorities, EPA
2	Carryout research and studies related to the future towns and urban expansion needs and quantify energy needs	PA	Same as above WAPDA
3	Historic and future urban areas carbon profiling	STA	City Development Authorities, EPA

4	Encourage urban forestation	PA	Same as above
5	Develop and implement energy-efficient and climate resilient building laws and bye-laws	PA	Law Department, EPA City Development Authorities
	Strategy 4.2: Development of agro-towns		
1	Discourage rural to urban migration through development of small agro-based townships	STA	P&D and Provincial Town Planning and Development
2	Develop farm to market roads, storages and markets	STA	Agriculture and C&W Departments
	Strategy 4.3: Climate resilient land use planning		
1	Develop climate resilient Land Use plan to be updated at least once every 20 years	PA	EPA, Urban Unit
2	Encourage high-rise expansion, curtail horizontal expansion	MTA	Urban Unit, City Development Authorities
	Strategy 4.4: Multi-hazard and vulnerability assessment inclusive planning and construction		
1	Carryout MHVRA studies and preparation of risk maps to be considered for future planning and construction of townships	STA	PDMA, Urban Unit, P&DD, Municipal Authorities
2	Identification of agro-ecologically fragile zones and controlling expansion of urban areas in these zones	STA	Same as above
3	Development of MHVRA-Indices and score cards for provincial urban areas	STA	Same as above
	Strategy 4.5: Relocating and limiting industries in urban areas		
1	Limiting and relocating existing hazardous industries from urban areas, with an emphasis on air and water quality	PA	Provincial Town Planning Departments, City Development Authorities
2	Planning industrial areas away from the urban areas	PA	Same as above
3	Urban and industrial areas greening through buildings, roof top and road-side plantation	STA	Same as above
	Strategy 4.6: Solar water-heating systems		
1	Assessment and mapping of solar potential in urban areas	PA	P&DD, City Development Authorities
2	Incentivize solar systems and solar water heaters in industrial and commercial areas	STA	City Municipal Authorities and AEDB
	Strategy 4.7: Waste management		
1	Estimation and assessment of linkages between waste management and climate change mitigation together with identification of critical zones	PA	Urban Unit, P&DD, City Development Authorities

2	Encourage effluents disposal and wastewater treatment plants	PA	Industries and Environment Departments
3	Discourage disposal of untreated water and waste in river and water bodies	STA	Same as above and Irrigation Department
4	Ensuring water quality near main sewerage lines disposal points	PA	P&DD, City Municipal Authorities
5	Develop and implement integrated waste management for various wastes treatment and disposal	STA	Same as above
6	Providing adequate solid waste management facilities at the door steps of communities and industries	STA	Same as above
	Strategy 4.8: Efficient solid waste management and latest technologies		
1	Develop, manage and ensure door-step segregation of solid- waste at collection prior to transport	PA	Municipal Authorities, CSOs
2	Develop and manage efficient solid waste transport and treatment	STA	Same as above + District Administration
3	Discourage open air burning of waste material	PA	Same as above
4	Discourage use of plastic bags and bottles, and encourage use of bio-degradable bags	PA	EPA, City Municipal Authorities, CSOs

Water Resources

Adaptation Measures

	Actions	Priority	Implementing Partners
	Strategy 5.1: Promoting High Efficiency Irrigation System (HEIS)		
1	Promote the preparation of water conservation strategies.	PA	Local government, EPA and OFWM outfit
2	Develop and use local low-cost HEIS	STA	Irrigation department, Agriculture department
3	Promoting low-delta cropping patterns	STA	Agriculture department, Research Institutes
4	Promote incentives and subsidies to small farmers for HEIS technology	STA	Local government, Agriculture department
5	Water conservation through construction of new storages	MTA	Irrigation department, Local government
6	Review and optimize water-pricing for irrigation	MTA	Same as above and P&DD

	Strategy 5.2: Promoting rain-water harvesting		
1	Identify rain-water harvesting potential, particularly in rural terrains.	PA	Local government, Housing and Physical Planning Department, and PHED
2	Promote rain-water harvesting at house-hold level	PA	Municipal Authorities PHED
3	Strengthen community capacity in rainwater harvesting practices at village / local level	STA	Municipalities, EPA, PHED
4	Incorporate rainwater harvesting systems in building bye-laws	MTA	EPA, Local government, PHED
5	Plantation in various watersheds with no or low adverse impact on groundwater table	STA	Agriculture department, Irrigation and Forest departments
	Strategy 5.3: Climate inclusive water demands and allocations		
1	Estimate and ensure climate sensitive sectoral water allocative efficiency for short-, medium and long-term	STA	Municipal Authorities, WAPDA, Urban Water Supply Departments
2	Promote community participation in water systems planning, design, implementation, monitoring and O&M	STA	Same as above
	Strategy 5.4: Groundwater conservation		
1	Identify and map groundwater resources in Punjab	STA	WAPDA, Irrigation Department, WASAs
2	Prepare groundwater plans for each aquifer by location at district and tehsil level, particularly threatened ones	STA	Same as above
3	Management of groundwater through licensing and water pricing	PA	EPA, Provincial water regulatory authorities
4	Prepare groundwater regulatory framework for water conservation	STA	WAPDA, WASAs
	Strategy 5.5: Wastewater recycling and re-use		
1	Estimate and map provincial waste-water potential of recycling	STA	WAPDA, WASAs, Municipal Authorities
2	Estimate water treatment cost for various contaminated water	STA	Same as above
3	Install and rehabilitate wastewater treatment-plants at urban centers of the province	STA	WASAs, Municipal authorities
4	Promote recycling and re-use of wastewater in the province	STA	Same as above
5	Re-use of recycled water for irrigation, monitoring the adverse impacts	PA	Irrigation, Agriculture Departments, PHED
	Strategy 5.6: Encouraging participatory water management		
1	Trainers training for farmers training in participatory irrigation water management	PA	Irrigation and Agriculture Departments

2	Encourage Private-Public-Partnership (PPP) for enhanced public access to good quality water and O&M of water supply systems	STA	PHED, Municipal Authorities
	Strategy 5.7: Distributing water according to crop sowing timing		
1	Estimate seasonal water availability and crop-water requirements for various crops	STA	Irrigation Departments, Agriculture Departments, WASAs
2	Decide the allocated water share for crop sowing according to their planting season	STA	Same as above
3	Estimate and allocate water for drinking purposes on priority basis	PA	PHED, WASAs
	Strategy 5.8: Developing adequate plans to cope with water-shortages and droughts		
1	Identify and map drought affected areas or with potential future droughts	PA	Agriculture and Irrigation Departments
2	Estimate water availability and storage capacities in drought affected or potential future drought areas	STA	Same as above
3	Prepare and implement contingency plans to cope with water shortages or droughts	STA	Agriculture and Irrigation departments, PHED, WAPDA, IRSA
	Strategy 5.9: Water resources management through legislation		
1	Review and gap-analysis of existing water management related legislation	PA	EPA, IRSA, Irrigation and Agriculture Departments
2	Improve and amend laws and regulatory frameworks for climate-sensitive and efficient water management	PA	Same as above
3	Estimate e-flows and enforce releases of the same at critical locations	STA	Same as above
4	Groundwater conservation and protection through adequate laws and regulations	STA	Same as above
	Strategy 5.10: Strengthening the hydro-met telemetry system		
1	Evaluate existing telemetry system for identification of improvement gaps and introduce improved telemetry system for the province	PA	WAPDA, IRSA, PMD, Irrigation Department
2	Expand hydro-met telemetry system to monitor impacts of climate change	STA	PMD, City Development Authorities
3	Assess river flows variability under changing climate	PA	Same as above and WAPDA
	Strategy 5.11: Domestic and drinking water conservation		
1	Domestic and drinking water conservation using latest technology e.g., water meters and automatic taps	PA	EPA, PHED, WASAs, /Municipal Authorities
2	Monitoring and billing of water through water meters	STA	Municipal Authorities, PHED

	Strategy 5.12: Enhancing water storage capacities		
1	Identify and develop through feasibility studies new potential dams and storages sites	STA	WAPDA, P&DD, Irrigation Department, SDO
	Strategy 5.13: Infrastructure development and rehabilitation to cope with climate change related extreme events		
1	Estimate impact of climate extreme events on the existing water and irrigation infrastructure	PA	Irrigation, Agriculture Departments, PMD
2	Remodeling and rehabilitation of existing irrigation infrastructure to cope with climate change impacts	STA	Same as above
3	Modeling of future climate-sensitive infrastructure	MTA	Same as above
	Strategy 5.14: Promoting climate inclusive watershed-management		
1	Assess impacts of climate change on high-hill watersheds and their downstream water supplies	STA	WAPDA, IRSA, Irrigation, and Forest Departments, CBOs
2	Carryout community inclusive plantation in watersheds of high erodibility	STA	Same as above
3	Promote community based watershed management, construction of check dams and sub-surface dams, to increase water recharge and reduce sediment transport	STA	Same as above
	Strategy 5.15: Improving water conservation and groundwater recharge		
1	Improve available irrigation systems to reduce losses and groundwater extraction	STA	Irrigation and Agriculture Departments
2	Encourage groundwater artificial recharge, particularly in arid areas	MTA	Same as above

Disaster Preparedness

Adaptation Measures

	Actions	Priority	Implementing Partners
	Strategy 6.1: Spreading awareness related to climate change mitigation measures		
1	Identify and communicate through media, workshops and seminars potential climate change extreme hazards and possible mitigation measures to stakeholders	PA	PDMA, PMD, WAPDA, NARC, EPA

2	Identify and develop linkages of climate change and potential disasters together with their management	PA	Same as above
3	Carry out trainings of trainers to handle critical situations	STA	Same as above
4	Develop and include climate change and disaster management in curriculum of schools, colleges and universities	STA	Research Institutes, PDMA, Academia
5	Develop and maintain GIS-based decision support system for disaster risk reduction and management	STA	P&DD, PDMA, and line departments
	Strategy 6.2: Improving knowledge related to climate change, health and disasters		
1	Collaborate with the Ministry of National Health Services, Regulations and Coordination to strengthen research on the linkages between climate change/ gender, disasters and health	STA	NHSRC, Provincial health department, PDMA, and P&DD
2	Improve monitoring systems using satellite datasets and latest techniques for better future projections and forecasting	MTA	PDMA, PMD
3	Improve flood and drought forecasting systems and develop linkages with future climate change	STA	Same as above
4	Provide trainings to forecasters using latest technologies and techniques for better forecasting	STA	Same as above
	Strategy 6.3: Climate inclusive hazard, vulnerability and risks zoning		
1	Assess and prepare climate inclusive hazards, vulnerability and risks zoning maps for various districts of the province	STA	PDMA and P&DD
2	Prepare DRR plans and management strategies for various risk zones in the province	STA	Same as above
	Strategy 6.4: Improving early-warning system		
1	Improve hydro-climate monitoring and telemetry systems	MTA	PMD, PDMA
2	Establish and upgrade early-warning systems at district levels, particularly in districts with high risk and vulnerability	MTA	Same as above
3	Devise an adequate early warning dissemination system through media and community participation	PA	Same as above+ CBOs
	Strategy 6.5: Climate resilient infrastructure development		
1	Carryout assessment of climate change and flood modelling to analyze status of available bunds and dykes in the province	PA	PDMA, P&DD, Irrigation Department

2	Propose and implement strengthening of vulnerable flood protection measures	PA	Same as above
3	Include climate change in future design of various infrastructure, such as schools, bridges, barrages.	STA	Same as above and relevant line departments

Public Health

Adaptation Measures

	Actions	Priority	Implementing Partners
	Strategy 7.1: Climate change, health and implementation of "One Health" policy		
1	Carry out assessment of climate change induced diseases and identify most vulnerable areas in the province and formulate and implement "One Health" policy	PA	Provincial Health Departments, PDMA
2	Develop, assess future projections and design emergency response programs to target and reach the most vulnerable communities	PA	Same as above
3	Develop a resource mobilization strategy to identify and access international funding for climate and health resilience and adaptation projects (e.g., GCF, GEF and bilateral donor agencies)	STA	Provincial Health department, NGOs, private sector, P&D department
4	Analyze health and WASH nexus for an integrated approach to maximize synergies	PA	Provincial health department, WHO, Academia, think tanks.
5	Establish climate change induced diseases monitoring system to reduce the spread and to plan timely remedial measures	STA	Same as above

Climate Change Mitigation Measures

Energy

Mitigation Measures

	Actions	Priority	Implementing Partners
	Strategy 8.1: Promoting hydropower generation		
1	Identify potential sites for hydropower, carryout feasibility studies of the identified potential sites and furnishes detailed design	PA	WAPDA
2	Promote use of kinetic energy of canals for energy generation	STA	Same as above

	Strategy 8.2: Promoting green energy generation		
1	Identify and promote green energy potential and generation, such as solar, wind, biogas	PA	WAPDA, Alternate Energy Development Board (AEDB)
2	Incentivizing use of green energy for public, private and industrial purposes	STA	Same as above
3	Promote research and development in the field of green energy And arrange research funding for the same	STA	Same as above, research institutes and Academia
	Strategy 8.3: Use of building codes for energy conservation		
1	Enforce use of building codes developed by PEECA for energy conservation	PA	WAPDA, AEDB, PEECA
2	Identify and use energy efficient materials for construction and conserve energy	STA	Same as above
	Strategy 8.4: GHG emissions reduction in energy generation		
1	Discourage use of coal for energy generation and reduction of GHG emissions	STA	Minerals, Departments, WAPDA, AEDB
	Strategy 8.5: Promoting waste to energy generation		
1	Identify and use municipal waste to generate energy	PA	PCRET, AEDB, PEECA
2	Encourage local municipal agencies and private sector to install waste to energy plants	STA	Same as above
	Strategy 8.6: Promoting use of low-carbon fuels and energy-mix		
1	Promoting and incentivizing use of low-carbon fuels and energy-mix for public, private and industrial purpose	STA	PCRET, WAPDA, AEDB, PEECA
2	Promote research in the field of low-carbon fuel, waste to energy solutions and benefits of use of energy-mix to reduce GHG emissions	MTA	Research institutes and academia
3	Improve energy efficiency and reduce energy losses in transmission using state of the art technologies and energy audit methods	PA	Same as above
4	Promote e-cars and hybrid cars in transport sector	STA	Same as above
5	Encourage green energies in the industrial sectors by incentivizing the same	MTA	Same as above
	Strategy 8.7: Energy conservation through legislation and standards		
1	Prepare adequate legislations and audit standards to enhance energy conservation and reduce losses	PA	EPA, WAPDA, PEECA
2	Strengthening the current legal system that ensures energy efficiency audits and energy conservation	PA	Same as above

3	Implementation of energy conservation, policies, codes and standards at local and regional levels	STA	Same as above
	Strategy 8.8: Improving energy transmission and distribution systems		
1	Improve the available transmission and distribution systems to reduce losses	PA	WAPDA, PEECA
2	Use of state-of-the-art energy audits to control and reduce transmission and distribution losses	STA	Same as above

Industry

Mitigation Measures

Actions		Priority	Implementing Partners
	Strategy 9.1: Incorporating economic incentives and financial subsidies to improve GHG emissions reduction		
1	Prepare baseline to identify main GHG industrial emitters for monitoring	PA	Ministry of Industries
2	Incentivize GHG emissions reduction in the industries	STA	Same as above
	Strategy 9.2: Preparing Corporate Social Responsibility (CSR) guidelines		
1	Prepare and implement CSR guidelines to reduce GHG emissions and develop industrial fund for the same	PA	Ministry of Industries, EPA
2	Encourage energy efficiency audit in the industries for energy conservation and GHG emissions reduction	PA	Ministry of Industries, PEECA, EPA
3	Capacity building of various industries to monitor GHG emissions and their reduction	PA	Ministry of Industries, EPA
	Strategy 9.3: Promote GHG emissions reduction by cleaner production		
1	Identify the industries and industrial processes those emit most of the GHGs	PA	Ministry of Industries, EPA
2	Identify and promote techniques and technologies to replace processes where most of the GHG emissions occur	STA	Same as above
3	Promote research in the field to introduce latest technologies for clean production processes	STA	Same as above and research organizations
4	Provide training to the staff of industries to monitor GHG emissions and reduction	STA	Same as above
	Strategy 9.4: Promoting the use of energy efficient machinery, equipment and motors in the industries		
1	Identify, encourage and incentivize use of energy efficient equipment in the industries	PA	Ministry of Industries, PEECA, EPA

	Strategy 9.5: Accelerated technology transfer in cement and steel industries to reduce GHG emissions		
1	Promote accelerated technology transfer in cement and steel industries for GHG reduction without losing productivity	STA	Ministry of Industries, EPA
	Strategy 9.6: Wastewater treatment and Solid Waste Management (SWM)		
1	Industrial wastewater treatment plants should be enforced as responsibility of the industries	PA	EPA, Industries
2	Enforce solid waste management by industrial units	PA	EPA, Industries

Transport

Mitigation Measures

	Actions	Priority	Implementing Partners
	Strategy 10.1: Public awareness related to GHG emissions in transport sector		
1	Spreading awareness related to GHG emissions and fuel efficiency in transport sector through media, seminars and conferences	PA	Ministry of Communication, National and Provincial Highway Authority, EPA, NGOs, CSOs
2	Assess and disseminate knowledge of GHG emissions based on use of different types of fuels, age and type of vehicles and conditions of roads	PA	Same as above and research organizations
	Strategy 10.2: Encourage public transport		
1	Provide quality public transport and encourage its use over private cars	MTA	Provincial Highway Authority, EPA
2	Develop efficient public transport system and encourage use of fuel-efficient transport	STA	Same as above
	Strategy 10.3: Use of biofuel in transport sector		
1	Identify and encourage biofuel in transport sector	STA	National and Provincial Highway Authority
2	Use of hybrid vehicles, which can be driven on biofuels and petrol	MTA	Same as above
	Strategy 10.4: Encouraging private commercial and private transport sector for GHG emissions reduction		
1	Encourage private commercial transport to reduce GHG emissions	STA	National and Provincial Highway Authority
2	Promote use of hybrid vehicles, best available fuels, and low resistance tires to reduce GHG emissions	STA	Same as above

3	Promoting use of latest technologies to reduce GHG emissions in transport sector, such as e-cars and hybrid cars	STA	National and Provincial Highway Authority, EPA
	Strategy 10.5: Setting-up and enforcing vehicle emission standards through Vehicle Emission Testing Stations (VETS)		
1	Set-up state-of-the art VETS at provincial level	PA	National and Provincial Highway Authority, EPA
2	Develop annual certification system from VETS	PA	Same as above
3	Develop separate categories and fee structure for E-cars, hybrid, CNG and other vehicles	PA	Same as above
4	Update and strictly enforce vehicle emission standards	PA	Same as above
	Strategy 10.6: Improvement in the transportation infrastructure for GHG emissions reduction		
1	Ensure proper Maintenance and Rehabilitation (M&R) of roads for the improvement of GHG emissions reduction	PA	National and Provincial Highway Authority, EPA
2	Improve conflict points through construction of subways and flyovers	PA	Same as above
3	Provide traffic signals at the intersections to avoid extra delay at peak hours	PA	Same as above
4	Provide extra lane for peak hour morning and evening traffic	PA	Same as above
5	Ensure median plantation	PA	Same as above
	Strategy 10.7: Practicing innovative and recycling techniques for the improvement of transportation infrastructure		
1	Use of rubber as asphalt binder in the asphalt mix	PA	National and Provincial Highway Authority, EPA
2	Use Hot and Cold recycling techniques for the M&R of the pavements	PA	Same as above

Conclusion

The PCSGP attempts to suggest a blue print for the government of Punjab to move forward with a long term vision to transform Punjab into a more resilient, low-carbon and productive "Climate Smart Green Province" of Pakistan. It simultaneously addresses major challenges and recommend context and local specific strategies and solutions and adaptation and mitigation measures to combat climate crisis and threat. The distinctive feature of the Plan is the holistic, inclusive and technology-driven approach in prescribing a composite set of climate-smart practices (e.g., conservation tillage, crops, agro-forestry, and efficient water/nutrient management etc.) instead of advising in isolation a single practice or solution. The pre-requite for its implementation is the creation of conducive environment through supportive policies (climate-poverty nexus, population planning etc.), incentives structure (e.g., access to finance, technology, markets etc.), capacity-building initiatives especially for smallholder farmers and climate-sensitive development planning, programming budgeting.

Above all, good governance is quintessential to ensure people centered, inclusive, gender and youth sensitive implementation of the plan knowing fully well that climate warming and vagaries of weather will continue to remain a daunting challenge for

decades to come. If action is not taken today with urgency and commitment, the negative impacts of climate change may have existential threat for the generations to come. It will be a “moral failure and deadly negligence” as vehemently averred by the UN Secretary General António Guterre in his opening remarks at COP 30 in Brazil.

Chapter

4 The Climate-Economic Nexus

The Climate-Economic Nexus

Atr-un-Nisa

Introduction

Climate change has evolved from being an environmental issue into a characteristic macroeconomic challenge for the 21st century. The complex nexus between increasing global temperatures and economic stability has become more apparent as intense weather conditions, changing precipitation patterns, and long-term climatic tendencies directly affect global markets, public finances, and household survival. Research studies estimate that climate change costs the world 12 percent of Gross Domestic Product (GDP) per degree Celsius (1°C) of warming, showing the scale of this economic threat (Bilal & Känzig, 2024).

Each year, climate disasters push nearly 26 million individuals into poverty, revealing the far-reaching economic consequences of climate shocks worldwide (World Bank, 2016). This articulation from environmental to economic crisis affirms the intricate interplay of physical climate effects with the economy such that changes in temperature, precipitation patterns, and extreme weather events influence productivity, infrastructure, and human well-being directly.

The transmission mechanisms through which climate impacts affect economic systems operate across multiple timescales and sectors. Short-term disruptions manifest through immediate disaster costs, supply chain interruptions, and emergency expenditures, while medium-term effects include reconstruction burdens, displaced populations, and reduced investor confidence. Long-term structural changes emerge through persistent productivity declines, permanent infrastructure losses, and fundamental shifts in comparative economic advantages across regions (Kahn et al., 2021). Understanding these layered pathways is essential for designing effective policy responses that address both immediate shocks and underlying vulnerabilities.

The economic consequences of climate change are no longer distant projections but present-day realities. By 2050, global annual damages are projected to reach around United States Dollar (USD) 38 trillion, with an estimated range between USD 19 trillion and USD 59 trillion (Potsdam Institute for Climate Impact Research (PIK, 2024). Already, this trend is visible: in 2024 alone, climate-related natural catastrophes caused approximately USD 320 billion in global economic losses, demonstrating that these impacts are no longer hypothetical but unfolding in real time (Munich Re, 2025).

This chapter analyzes five of the most important areas where climate change causes quantifiable macroeconomic impacts: costs of rebuilding

infrastructure and vulnerability to infrastructure, loss in labor productivity from excessive heat and weather-related events, health burdens of climate-related diseases, fiscal consequences of disasters, and the emerging inequality among and within countries. Through the examination of these interlinked pathways from global, regional, and national views with specific emphasis on South Asia and Pakistan this analysis reveals why climate change is now a core threat to economic development and stability globally.

Global Overview

Macroeconomic Risks and GDP Losses

The global economy is in severe danger from the effects of climate change, and the harm could be far greater than previous estimates indicated. Recent research warns that if global temperatures climb by 4°C by the end of this century, the world could face a 40 percent collapse in GDP, signaling one of the most profound economic shocks in human history (Neal et al., 2025). The Institute and Faculty of Actuaries (IFoA), in collaboration with the University of Exeter, predicts that without drastic mitigation, climate shocks could lead to a 50 percent contraction in global GDP between 2070 and 2090, representing a severe economic collapse scenario (IFoA & University of Exeter, 2025).

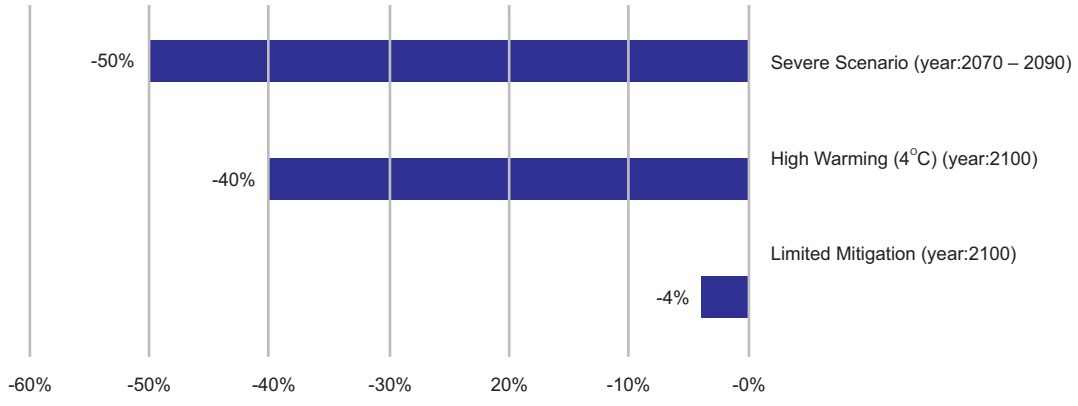
In more conservative projections, scenarios with limited mitigation efforts suggest climate change could reduce global GDP by approximately 4 percent over the course of the 21st century still a significant economic loss despite being lower than more severe estimates (Congressional Budget Office, 2025).

Beyond aggregate GDP impacts, climate change is fundamentally altering the structure of global capital markets and investment flows. Climate-related financial risks including both physical risks from extreme events and transition risks from policy shifts are increasingly incorporated into asset valuations, credit ratings, and insurance pricing. The Network for Greening the Financial System (NGFS) estimates that unmitigated climate change could trigger financial losses of USD 4.2 trillion across G20 economies by 2050, potentially destabilizing banking sectors and pension funds that hold long-term assets vulnerable to climate depreciation (NGFS, 2022). These financial transmission channels amplify macroeconomic vulnerabilities by constraining credit availability, increasing borrowing costs for climate-exposed entities, and reducing the capacity of financial institutions to absorb future shocks.

Climate disasters storms, floods, wildfires, and droughts continue to exact increasing economic

Figure: 4.1

Projected Global GDP Losses from Climate Change



Source: Congressional Budget Office (2025) Neal et al. (2025) IFoA & University of Exeter (2025)

damages across the globe. Globally, between 1993 and 2022, more than 9,400 extreme events have caused over USD 4.2 trillion in direct inflation-adjusted losses (Germanwatch, 2025). In 2024 alone, natural disasters drove USD 320 billion in overall losses USD 140 billion of which were insured highlighting a huge "protection gap" as depicted in Table 4.1.

Table: 4.1

Global Economic Losses from Climate Disasters (1993-2024)

Period/Year	Total Economic Losses (USD billion)	Insured Losses (USD billion)	Uninsured Losses (USD billion)	Protection Gap (%)*	Major Events
1993-2022	4,200+	~1,400	~2,800	66.70%	Storms, floods, droughts, wildfires
2024	320	140	180	56.30%	Global climate catastrophe

Source: Germanwatch (2025) & Munich Re (2025). ***Note:** The protection gap represents the percentage of losses that are not covered by insurance, highlighting vulnerability in developing nations.

The geographic distribution of these losses shows horrific inequalities. North America has an inordinate proportion of insured loss because of high penetration, and developing countries have much larger uninsured loss because of their low adaptive capacity and underdeveloped insurance markets.

Climate Change, Agriculture, and Global Food Security

Recurrent droughts and floods are damaging farmlands, reducing yields of major crops, and driving up production costs, according to the Food and Agriculture Organization (FAO, 2025).

Smallholder farmers responsible for nearly one-third of the world's food supply are especially vulnerable, as many lack irrigation, crop insurance, and access to climate-resilient seeds (World Bank, 2025).

The economic ripple effects of agricultural disruption extend well beyond farm-level income losses to encompass broader macroeconomic destabilization through food price inflation, trade imbalances, and social unrest. Historical analysis demonstrates that food price spikes triggered by climate shocks have precipitated political instability in at least 60 countries since 2007, with governments facing fiscal pressures from both import costs and subsidy demands (Benton & Bailey, 2019). In 2022-2023, wheat prices surged by 37 percent globally following drought conditions across major exporting regions, forcing import-dependent nations in North Africa and the Middle East to redirect scarce foreign exchange reserves toward emergency food procurement, thereby constraining their capacity for development investments and debt servicing (World Bank, 2023).

The disruption of agricultural systems has directly translated into worsening global food insecurity. The *Global Report on Food Crises 2025* reveals that 295 million people across 53 countries experienced acute food insecurity in 2024 an increase of nearly 14 million from the previous year (FAO, 2025). Within this group, 1.9 million people faced catastrophic hunger (IPC Phase 5), marking the highest level since monitoring began. The World Food Programme (WFP, 2025) further reports that one in eleven people globally is now undernourished, with the heaviest burdens concentrated in Africa and Western Asia.

The nutritional dimension of this crisis is equally alarming. The World Health Organization (WHO, 2025) estimates that 673 million people about 8.2 percent of the global population are undernourished, including 38 million children under five suffering from acute malnutrition in 26 crisis-affected countries. Moreover, rising atmospheric carbon dioxide concentrations are lowering the nutrient

content of grains and legumes, reducing protein, zinc, and iron levels in staple crops.

Labor Productivity and Health Impacts

Heat stress is one of the most direct and measurable impacts of climate change on global economic productivity. According to the International Labour Organization (ILO, 2019), at a global temperature rise of 1.5°C, the world could experience a 2.2 percent loss of total working hours by 2030, equivalent to approximately USD 2.4 trillion in lost productivity. These losses are concentrated among outdoor workers in agriculture, construction, and informal services, where exposure to heat is unavoidable and adaptive capacity remains limited.

The cognitive dimension of heat stress presents additional challenges for knowledge-intensive sectors previously considered insulated from climate impacts. Emerging research indicates that elevated indoor temperatures increasingly common as heat-waves overwhelm cooling infrastructure reduce cognitive performance, decision-making quality, and test scores by 5-10 percent even at temperatures below outdoor extremes (Heyes & Saberian, 2019). This extends productivity losses beyond manual labor to encompass service sectors, educational outcomes, and administrative efficiency. In developing economies where air conditioning penetration remains below 20 percent, these cognitive impairments affect students, office workers, and government employees. The physical effects of heat stress upon workers' productivity are well established, with measurable declines in cognitive performance, manual dexterity, and total work capacity at temperatures above human thermal comfort zones. Present estimates indicate productivity loss of around 10 percent in heat-exposed industries with possible rises to 30-40 percent under conditions of high warming (ILO, 2019; Kjellstrom et al., 2021).

Healthcare systems across the globe are coming under increasing pressures from health issues brought about by climate change. The World Health Organization estimates direct damages to the health sector of USD 2-4 billion each year by 2030, excluding broader economic consequences due to further deterioration in population health (WHO, 2023). Vector-borne diseases are spreading geographically as warmer temperatures enable vectors of disease to thrive in climates previously deemed unsuitable, imposing new public health issues and costs.

Climate Inequality: A Global Development Challenge

Climate change acts as a "threat multiplier" for already prevailing global imbalances, with least developed countries incurring uneven costs despite having marginal contributions to global greenhouse gas emissions. For instance, a Stanford study indicates that global warming decreased per-capita wealth in the world's poorest nations by 17-30 percent since 1961, while enriching most other countries to some extent, increasing the income gap by roughly 25 percent from what it would be under no warming (Diffenbaugh & Burke, 2019).

The intergenerational dimensions of climate inequality compound existing disparities by constraining future economic opportunities in vulnerable regions. Children born in low-income countries today face lifetime income reductions of 20-30 percent compared to scenarios without climate change, as educational disruptions, malnutrition, and health burdens during formative years permanently diminish earning potential (Thiede et al., 2021). This creates a vicious cycle wherein climate impacts reduce human capital formation, which in turn limits adaptive capacity for future generations, thereby entrenching poverty traps across entire regions. The phenomenon is particularly acute in Sub-Saharan Africa and South Asia, where youth populations are expanding rapidly even as climate pressures intensify, raising fundamental questions about intergenerational equity and development prospects.

The economic burden of climate change falls most

heavily on countries with limited adaptive capacity and constrained fiscal space. Small Island Developing States (SIDS) illustrate this disproportionate vulnerability, losing on average over 2 percent of their GDP annually to climate- and weather-related disasters a cumulative cost exceeding USD 141 billion between 2000 and 2020 (UN, 2023; Greenpeace, 2023). In particularly severe cases, climate-induced damages consume more than one-third of government revenues, as observed in Haiti (36.7 percent) and Dominica (54.7 percent) (Otto et al., 2025; Panwar, 2023).

The concept of "loss and damage" has therefore emerged as a critical framework for addressing climate inequality. Developing nations are projected to require between USD 128 billion and USD 937 billion annually by 2025 to finance loss and damage associated with climate impacts. Yet, as of late 2024, only USD 749 million had been pledged globally and less than USD 70 million had actually been disbursed (Climate Foresight, 2024; Loss and Damage Collaboration, 2024).

Regional Overview

Climate Vulnerability and Economic Losses in South Asia

South Asia stands among the most climate-vulnerable regions globally, consistently ranking near the top of climate risk indices due to its acute exposure, high sensitivity, and limited adaptive capacity. Home to nearly 2 billion people, the region faces intensifying threats from rising temperatures, erratic monsoon patterns, accelerated glacial melting in the Himalayas, and more frequent and severe weather events. Economically, South Asia is already losing an estimated 1-2 percent of GDP annually to climate-related damages, with projections suggesting potential losses of 8-10 percent of GDP by 2100 under high-warming scenarios (ADB, 2014; World Bank, 2021).

Warming in South Asia is accelerating faster than the global average, with temperatures rising by about 0.15-0.20°C per decade across much of the region (IPCC, 2021; World Bank, 2021). The Hindu Kush-Himalayan region supplying water to over one billion people is experiencing rapid glacial retreat, threatening long-term water security for the Indus, Ganges, and Brahmaputra River systems.

The macroeconomic consequences of these shifts are already profound. Nearly 90 percent of the region's population is projected to experience severe heat stress by 2030, while more than one in five people will face flood-related risks threatening lives, infrastructure, and productivity (World Bank, 2025).

Country-specific experiences highlight the scale of vulnerability. Pakistan ranked among the world's most climate-affected countries in the Germanwatch Climate Risk Index 2025, with the 2022 floods submerging one-third of the nation, displacing 33 million people, and causing economic damages estimated at USD 30 billion (World Bank, 2022). Bangladesh, located on the world's largest delta, suffers recurrent cyclones and storm surges; Cyclone Amphan in 2020 caused losses worth roughly USD 129 million across key sectors (Government of Bangladesh, 2020). India has faced record-breaking heatwaves, such as in 2022 when temperatures in Delhi exceeded 49°C, cutting labor productivity and reducing wheat yields by up to 15 percent. Sri Lanka's 2017 floods and landslides affected nearly 880,000 people and caused damages of about USD 468 million (World Bank & Government of Sri Lanka, 2017).

Climate change is thus already costing South Asia billions in lost output and asset damage each year, with total regional losses estimated at around USD 160 billion annually by 2030. If current trends persist, the region could lose about 1.8 percent of annual GDP by 2050 and nearly 9 percent by 2100 under a high-emission, business-as-usual scenario (ADB, 2017). Projected country-level GDP losses by 2100 are highest for Maldives (12.6 percent), followed by Nepal (9.9 percent), Bangladesh (9.4 percent), India (8.7 percent), Bhutan (6.6 percent),

and Sri Lanka (6.5 percent).

Despite this, adaptation investment remains significantly below required levels.

Agriculture and Food Security

Agriculture remains a cornerstone of South Asian economies employing around 36 percent of the workforce in Pakistan and over 61 percent in Nepal while contributing roughly 23-24 percent and 27-30 percent of their respective GDPs (World Bank, 2023). Climate change threatens agricultural systems through temperature stress to crops, changed precipitation patterns, enhanced pest and disease pressure, and weather extremes that damage crops and infrastructure.

Rising temperatures pose a significant threat to staple crop productivity across South Asia. Research shows that each 1°C increase in minimum growing-season temperature can reduce rice grain yields by about 10 percent (Peng et al., 2004). Similarly, wheat yields are projected to decline by approximately 6 percent globally with a 1°C rise in temperature (Hussain et al., 2021). Long-term climate projections indicate a substantial decline in cereal output across South Asia by 2050 if current warming trends continue. Yields are expected to decrease by 31.5 percent in Bangladesh, 24.2 percent in Pakistan, 25.7 percent in Sri Lanka, and 6.4 percent in India compared to baseline production levels (Krishak Jagat, 2023). Within Bangladesh, rice production fell from 62.5 million tonnes in 2022-23 to 58.5 million tonnes in 2024-25, while average per-hectare yields declined from 5.29 tonnes to 4.94 tonnes (South Asian Climate Change Journal Forum, 2025).

Climate impacts on agriculture extend beyond the farm gate to affect wider economic sectors. Together, farm revenues and textile exports a key downstream industry dependent on agricultural raw materials generate over USD 120 billion annually, underscoring the scale of potential economic disruption if climate risks remain unmitigated (UNCTAD, 2024). Rising climate variability makes agricultural production increasingly unpredictable, which in turn amplifies food price volatility across South Asia. Food price volatility intensifies household vulnerability, particularly among the poorest, who spend up to 60 percent of their income on food (FAO, 2022).

Urbanization, Infrastructure Vulnerabilities, and Fiscal Pressures

South Asia's accelerating urbanization is intensifying exposure to climate risks. With over 36 percent of the region's two billion people now living in cities, urban centers such as Mumbai, Dhaka, Karachi, and Colombo are expanding rapidly often without climate-resilient planning or enforcement of building and drainage codes (World Bank, 2024). Many of these cities are located in low-lying coastal zones or river deltas, making them highly vulnerable to sea-level rise, cyclones, and storm surges.

Weak and aging infrastructure magnifies these vulnerabilities. Inadequate drainage and solid-waste management systems contribute to recurrent flooding during monsoon seasons, while power grids and transport systems struggle under rising temperatures and peak-load demands. As noted earlier, the 2022 floods in Pakistan demonstrated how fragile infrastructure can amplify both human and fiscal costs, while Sri Lanka's 2017 floods strained national recovery budgets.

These shocks are translating into significant macroeconomic and fiscal pressures. As previously mentioned, the ADB projects that South Asia could lose about 1.8 percent of its annual GDP by 2050, rising to 8.8 percent by 2100 under high-emission scenarios. Post-disaster spending and emergency borrowing often exceeding domestic fiscal space have contributed to rising public debt across the region. Meeting adaptation needs will require annual investments of USD 40-73 billion, equivalent to roughly 0.5-0.9 percent of regional GDP (ADB, 2017; UNEP, 2023).

Health and Productivity Impacts

South Asia is confronting some of the globe's highest heat-related productivity losses, with outdoor workers particularly affected during increasingly hotter and more recurrent heatwaves. Cities such as Jacobabad in Pakistan consistently show temperatures well above human survivability limits, generating acute health hazards and productivity hurdles.

The intersection of heat stress and informal employment creates particularly severe economic vulnerabilities across South Asia, where approximately 80 percent of non-agricultural workers operate outside formal labor protections (ILO, 2023). Unlike salaried employees with sick leave and workplace safety regulations, informal workers including street vendors, construction laborers, and domestic workers face binary choices between income and health during extreme heat episodes. Studies from Indian cities demonstrate that informal workers lose an average of 6-8 working days per month during peak summer, translating to income reductions of 20-25 percent during the hottest quarters (Mani et al., 2018). This income volatility compounds pre-existing economic insecurity and forces households into negative coping strategies such as asset sales, debt accumulation, and reduced food consumption, thereby amplifying poverty persistence across generations.

Heat-related health effects have both direct medical expenses and indirect economic losses in terms of diminished work capacity and increased caregiving loads. There is a sharp spike in emergency hospital admissions during heatwaves, putting public health systems under stress and incurring heavy treatment expenses.

Vector-borne diseases are increasing across South Asia as warmer temperatures enable disease vectors to live and breed in previously unviable locations. Dengue fever, malaria, and chikungunya are expanding to higher latitudes and more northern locations, posing new public health concerns and related economic burdens for prevention and treatment. Water-borne illness worsens during flood events, which are on the rise and getting worse across the region.

Regional Inequality Dimensions

Climate effects worsen existing inequalities between and within South Asian nations. Rural groups, women, children, and disadvantaged groups absorb disproportionate costs with limited exposure to adaptation instruments or social protection mechanisms. Close to 60 percent of South Asia's population is livelihood-dependent on climate-sensitive agriculture, but rural households are overwhelmingly poor, with poverty levels that are almost 25 percent above urban levels (World Bank, 2022). The 2022 Pakistan floods pushed 9 million individuals into poverty primarily residing in rural areas and burdened disproportionately smallholder farmers and landless workers (ADB & World Bank, 2023).

The spatial concentration of climate impacts within marginalized communities reflects historical patterns of resource extraction and development neglect that have left certain populations systematically exposed. In India's Bihar and Assam states, recurrent flooding disproportionately affects scheduled castes and tribes who occupy low-lying lands with minimal flood protection infrastructure, perpetuating cycles of asset destruction and debt dependency that constrain upward mobility (Hallegatte et al., 2020). Similarly, in Bangladesh, coastal communities predominantly composed of ethnic and religious minorities face compounding vulnerabilities from cyclones, salinization, and land loss, yet receive less than 15 percent of national adaptation funding despite bearing over 40 percent of disaster costs (Rahman & Rahman, 2015). These patterns underscore how climate impacts interact with pre-existing social stratification to deepen structural inequalities.

Gendered impacts of climate change are acute across South Asia because women commonly have less access to information, assets, and decision-

making power. In southern Asia, about 71 percent of working women are employed in agrifood systems, concentrating female labor in climate-sensitive activities and unpaid care work (FAO, 2023). In India, droughts and worsening water stress substantially increase women's time burden for water collection studies estimate this can amount to roughly 200 extra hours per year in the most affected areas. In Pakistan, the 2022 floods pushed an estimated 8.4-9.1 million people into poverty, with rural women and smallholder households among those hardest hit. Comparable patterns appear in Nepal and Sri Lanka, where women comprise a large share of agricultural workers and face heightened risk of income loss, migration pressures, and food insecurity when climate events damage crops or livestock.

Pakistan Overview

Pakistan's Climate Vulnerability Profile

Pakistan remains one of the world's most climate-vulnerable nations, despite contributing less than 1 percent of total global greenhouse gas emissions. This stark imbalance between contribution and consequence epitomizes the broader climate justice challenge (Germanwatch, 2025; World Weather Attribution, 2025). The country consistently ranks among the top 10 most climate-affected countries in the Global Climate Risk Index, reflecting its acute exposure to extreme weather, water stress, and cascading socio-economic impacts.

Pakistan's geography and economic structure significantly amplify its climate vulnerability. The Indus Basin fed by Himalayan glaciers supports over 240 million people and irrigates almost 90 percent of Pakistan's agricultural production, which forms the backbone of rural livelihoods and national food security (FAO, 2023). Accelerating glacial melt, coupled with erratic monsoon cycles, is already undermining water availability and creating new patterns of hydrological instability (PMD, 2025).

The 2025 monsoon season marked one of the most devastating climate disasters in Pakistan's history. By mid-September, 946 people including 255 children had died, and more than 1,062 people had been injured due to floods and related hazards (UNICEF, 2025). According to the National Disaster Management Authority (NDMA, 2025), 8,217 homes were either partially or fully destroyed, while 6,508 livestock perished. Flooding also damaged 671.6 km of roads and 239 bridges, severely disrupting connectivity and relief operations. Overall, more than 6.9 million people were affected nationwide, and 3 million individuals were rescued in over 5,700 emergency operations (Dawn, 2025; WHO, 2025).

Agricultural losses were equally severe. Approximately 892,075 hectares of crop land were inundated, threatening food production and livelihoods across key agricultural belts (Relief Web, 2025). Heavy rainfall events intensified by anthropogenic climate change were identified by attribution studies as being significantly more severe than they would have been under pre-industrial climate conditions (World Weather Attribution, 2025).

Looking ahead, climate models and institutional projections indicate that the coming decade will see a further escalation of climate-related risks if adaptation and mitigation remain inadequate. Average annual temperatures are projected to rise by 1.5-2.0°C above 1990 levels by 2030, with interior Sindh, southern Punjab, and Balochistan experiencing the sharpest increases (GCISC, 2025; PMD, 2025). The population exposed to extreme heat events could grow by 30-36 percent under mid-range emissions scenarios, with direct consequences for public health, labor productivity, and energy demand (Pakistan Economic Survey, 2024).

Macroeconomic Impacts and GDP Losses

Climate change continues to exert profound macroeconomic pressures on Pakistan, undermining growth, fiscal stability, productivity, and public welfare through multiple interlinked channels. The catastrophic 2022 floods exemplify how climate-

induced disasters can cascade into nationwide economic shocks. Total direct damages from the 2022 floods were estimated at PKR 3,202 billion (US$ 14.9 billion), while economic losses reached PKR 3,272 billion (US$ 15.2 billion). The total recovery and reconstruction needs were assessed at approximately PKR 3,493 billion (US$ 16.3 billion), equivalent to roughly 4–5 percent of Pakistan's FY2022 GDP (PDNA, 2022). The housing sector bore the greatest share of the damage, accounting for nearly 38 percent of total losses, followed by agriculture, food, livestock, and fisheries (around 25 percent) and transport and communications infrastructure (22 percent). The

Table: 4.2

Pakistan 2022 Floods - Sectoral Damage Assessment

Sector	Damage (PKR bn)	Damage (US$ m)	Loss (PKR bn)	Loss (US$ m)	Needs (PKR bn)	Needs (US$ m)
SOCIAL SECTORS (total)	1,345	6,261	193	896	832	3,872
Housing	1,200	5,586	137	636	592	2,757
Health	23	109	7	34	40	188
Education	120	559	47	219	197	918
Culture & Heritage	1	6	1	7	2	9
INFRASTRUCTURE SECTORS (total)	843	3,927	85	396	1,168	5,437
Transport & Communications	701	3,264	60	281	1,073	4,994
Energy	19	88	1	3	25	117
WASH, Municipal Services & Community Infrastructure	123	575	24	112	70	327
PRODUCTIVE SECTORS (total)	996	4,635	2,853	13,281	1,022	4,760
Agriculture, Food, Livestock & Fisheries	800	3,725	1,986	9,244	854	3,976
Water Resources & Irrigation	153	711	-	-	168	782
Commerce & Industries	40	186	758	3,527	-	-
Finance & Markets	1	3	90	417	-	-
Tourism	2	10	20	93	0	2
CROSS-CUTTING SECTORS (total)	18	83	142	660	471	2,192
Governance	13	60	5	23	19	88
Social Sustainability, Inclusion & Gender	0	0	-	-	21	96
Social Protection, Livelihoods & Jobs	-	-	130	607	361	1,683
Environment & Climate Change	4	18	6	30	35	164
Disaster Risk Reduction & Resilience	1	5	-	-	35	161
GRAND TOTAL	**3,202**	**14,906**	**3,272**	**15,233**	**3,493**	**16,261**

Source: Pakistan Floods 2022: Post-Disaster Needs Assessment (PDNA) - Main Report (Oct 28, 2022). Supplemental sector details: PDNA Supplemental Report (Dec 2022).

productive sectors collectively absorbed nearly one-third of the overall economic impact, reflecting extensive damage to farmland, irrigation systems, and industrial supply chains. Social sectors such as education and health also suffered considerable setbacks, with combined damages exceeding PKR 144 billion (US$ 670 million), further straining the delivery of essential public services. The *cross-cutting sectors* including social protection, governance, and environment recorded lower direct damages but substantial recovery needs, underscoring the importance of resilience, institutional capacity, and climate adaptation mechanisms.

The economic repercussions of such shocks extend well beyond immediate asset destruction. Confidence effects, financial stress, and delayed project execution can persist for years, depressing private investment and consumption. Data from the State Bank of Pakistan (SBP) show that foreign direct investment (FDI) remained volatile in 2022–2023, while Gross Fixed Capital Formation (GFCF) recorded uneven movements rather than a steady recovery (SBP, 2023; Ministry of Finance, 2023; PBS, 2024). These outcomes reflect a self-reinforcing dynamic where high risk perceptions, credit tightening, and implementation bottlenecks impede reconstruction precisely when investment surges are most critical for economic revival (Khan & Ahmed, 2024).

The 2025 monsoon floods have further reinforced this trajectory, pushing Pakistan into another cycle of climate-related fiscal stress. Early situational assessments by the National Disaster Management Authority (NDMA) and international relief agencies report extensive damage to homes, agricultural land, and public infrastructure, although a consolidated government PDNA for 2025 has not yet been released (NDMA, 2025; ReliefWeb, 2025).

Agricultural Impacts and GDP Slowdown

The agricultural sector responsible for about 19 percent of GDP and employing nearly 37 percent of the labor force remains highly climate-sensitive (Pakistan Economic Survey, 2024-25). Extreme weather events, shifting monsoon patterns, and water stress continue to depress yields. According to the Pakistan Economic Survey 2024-25, principal crops including wheat and cotton recorded a combined 13.5 percent decline, shaving approximately 0.6 percent points off national GDP growth (MoF, 2025).

The cascading effects of agricultural decline ripple through Pakistan's rural economy via reduced demand for non-farm goods and services. Analysis of village-level economic data reveals that each 10 percent reduction in agricultural income generates secondary contractions of 6-8 percent in rural retail sales, transport services, and small-scale manufacturing, as farm households reduce discretionary spending (Arif et al., 2019). This multiplier effect is particularly pronounced in Pakistan's predominantly agrarian provinces Punjab, Sindh, and Khyber Pakhtunkhwa where non-farm rural enterprises depend heavily on agricultural purchasing power. The 2022 and 2025 flood-induced agricultural losses consequently triggered widespread closures of rural businesses, elevated unemployment among landless laborers and service providers, and accelerated rural-to-urban migration flows that strain urban infrastructure and labor markets (Planning Commission of Pakistan, 2024). These structural adjustments impose long-term economic costs as human capital depreciates during displacement, social networks dissolve, and rural productive assets remain underutilized.

These agricultural shocks ripple through the broader economy by reducing household incomes, lowering export revenues from the cotton-textile value chain, and increasing food import bills. They also exacerbate rural poverty and undermine national food security, thereby deepening structural vulnerabilities in the economy.

Infrastructure Damage and Fiscal Stress

Climate-induced disasters such as floods, landslides, and Glacial Lake Outburst Floods (GLOFs) inflict severe damage on Pakistan's infrastructure, imposing both immediate fiscal burdens and long-term productivity losses. The repeated reconstruction of roads, bridges, and transport networks absorbs an estimated 2-3 percent of annual government expenditure, diverting scarce resources from

essential sectors like education, health, and development (Pakistan Economic Survey, 2024-25).

The chronic cycle of damage and reconstruction creates a "infrastructure maintenance trap" wherein resources allocated to restoring pre-disaster service levels crowd out investments in resilience upgrades that could mitigate future losses. Detailed budget analysis reveals that Pakistan's annual infrastructure spending allocates approximately 75 percent to reactive reconstruction and only 25 percent to proactive climate adaptation, despite evidence that resilient design features reduce lifecycle costs by 30-40 percent through avoided future damages (Asian Development Bank, 2024). This imbalance reflects institutional constraints including short political time horizons, limited technical capacity for risk-informed planning, and donor financing structures that favor post-disaster relief over anticipatory investments. The resulting pattern of recurring destruction and hasty rebuilding perpetuates vulnerability while generating fiscal burdens that compound with each successive disaster, progressively eroding the state's capacity to provide public services and stimulate economic development (Government of Pakistan, 2024).

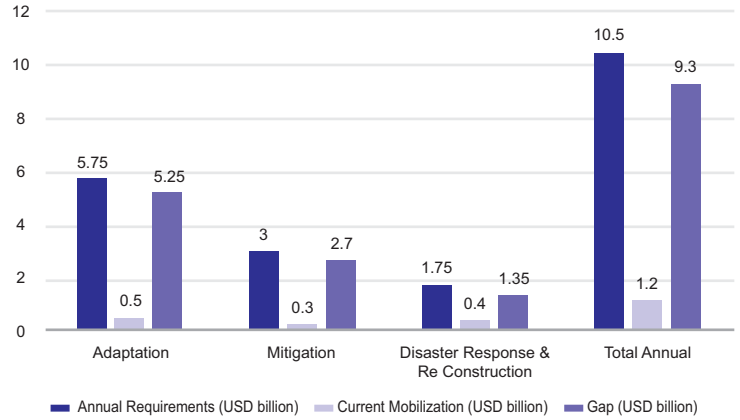
Climate change exerts fiscal stress through multiple channels: disaster response and reconstruction, adaptation investments, and reduced tax receipts from climate-affected sectors. Following the 2022 floods, Pakistan and the United Nations launched an USD 816 million humanitarian appeal to assist 9.5 million people, while reconstruction costs far exceeded domestic capacity necessitating extensive international support.

Pakistan's climate finance landscape remains heavily constrained, with widening gaps between estimated investment needs and actual resource mobilization. Despite being among the countries most affected by climate change, Pakistan attracts only a fraction of the financing required to build resilience, decarbonize its economy, and protect vulnerable communities. National assessments highlight that while the demand for both adaptation and mitigation funding is immense, current inflows are far from adequate to meet even short-term priorities.

Figure 4.2 illustrates the sectoral distribution of Pakistan's climate-finance requirements and current mobilization for the 2025–2030 period. Based on projections from the National Climate Finance Strategy (NCFS, 2024), Pakistan requires approximately USD 19.0 billion annually for adaptation and resilience measures, yet current inflows provide only USD 0.294–0.420 billion (about 21 percent of total climate finance), resulting in a 97.8–98.5 percent funding gap. Similarly, mitigation and decarbonization efforts demand around USD 24.5 billion per year, but receive just USD 1.106–1.580 billion (roughly 79 percent of flows), leaving a 93.6–95.5 percent shortfall.
Figure 4.3 illustrates Pakistan's aggregate climate finance position, revealing a critical mismatch

Figure: 4.2

Sectoral Climate Finance requirements



between requirements and mobilization. The country requires USD 43.5 billion annually (2025-2030) for comprehensive climate action equivalent to approximately 12 percent of GDP yet current average mobilization of USD 1.4-2.0 billion per year covers only 3.2-4.6 percent of needs. This creates an annual financing gap of USD 41.5-42.1 billion (95.4-96.8 percent unfunded), accumulating to a cumulative 8-year deficit of approximately USD 332-336 billion. Without transformative international support through enhanced grant-based finance and innovative mechanisms, Pakistan cannot simultaneously pursue climate resilience and sustainable development.

Labor Productivity and Heat Stress Losses

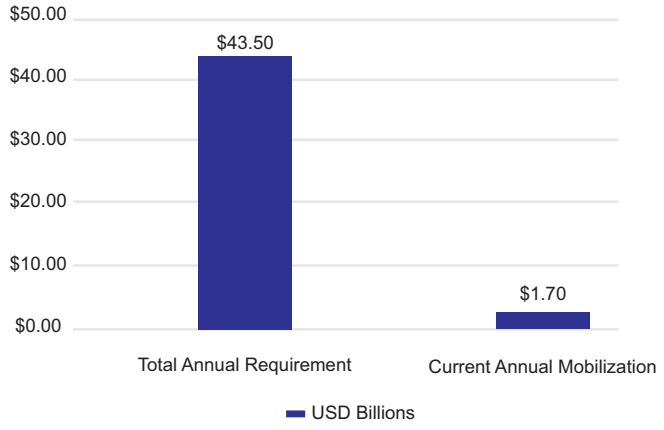
Pakistan is among the countries suffering the highest productivity losses globally from heat stress. Outdoor workers particularly in agriculture, construction, and informal services are frequently forced to halt operations during extreme heat events, directly lowering output. Recent ILO modeling projects that by 2030, Pakistan could lose 4-5 percent of total working hours annually to heat stress, equivalent to a GDP loss of USD 7-8 billion per year (ILO, 2024).

The economic burden of heat stress is amplified by Pakistan's demographic structure, wherein approximately 56 percent of the population falls within working-age cohorts (15-64 years), representing a potential demographic dividend that climate pressures threaten to undermine (Pakistan Bureau of Statistics, 2023). Youth unemployment already elevated at 10.5 percent rises further during extended heat episodes as construction sites close, agricultural work becomes hazardous, and manufacturing facilities reduce shifts to manage heat risks (ILO, 2024). This climate-induced underutilization of labor represents a significant opportunity cost for economic development, as productive potential remains unrealized precisely when Pakistan's large youth cohort should be driving economic dynamism. Moreover, repeated exposure to extreme heat during critical developmental periods impairs educational attainment and skill acquisition among young workers, potentially constraining lifetime earnings and perpetuating intergenerational poverty cycles (Garg et al., 2020).

Cities such as Jacobabad and Turbat already record wet-bulb temperatures above 35°C, a threshold beyond which human survival without active cooling becomes impossible. These conditions force complete shutdowns of outdoor economic activity, undermining earnings, tax revenues, and labor markets.

Figure: 4.3

Total Annual Climate Finance Comparison (2025-2030)



Source: National Climate Finance Strategy (2024), Government of Pakistan.

Health Costs and Disease Burdens

Climate-induced health burdens impose additional macroeconomic costs through increased public health expenditure, reduced labor supply, and lost productivity. Hospital admissions during heatwaves

surge by 300-400 percent, straining healthcare systems and increasing treatment costs for heatstroke, dehydration, and respiratory diseases (WHO, 2025).

The epidemiological transition induced by climate change is fundamentally altering Pakistan's disease burden profile, with emerging climate-sensitive conditions overlaying existing communicable and non-communicable disease challenges. Mental health impacts including anxiety, depression, and Post Traumatic Stress Disorder (PTSD) following disasters impose substantial yet often overlooked economic costs through reduced workforce participation, elevated caregiving demands, and long-term disability (Charlson et al., 2021). Post-flood surveys in Sindh province documented PTSD prevalence rates of 36-42 percent among affected populations, with symptoms persisting for years and constraining economic recovery through diminished cognitive function and labor force withdrawal (Pakistan Medical Research Council, 2023). Additionally, malnutrition rates spike during and after climate shocks, with the 2022 floods contributing to a 23 percent increase in acute malnutrition among children under five in affected districts imposing lifetime productivity penalties estimated at 10-15 percent of potential earnings (UNICEF, 2023).

Vector-borne diseases such as dengue fever are also expanding into previously unaffected regions due to shifting temperature and rainfall patterns. Annual outbreaks have increased treatment and prevention costs by USD 250-300 million and reduced labor productivity through worker absenteeism (NIH, 2025).

Poverty and Inequality Dimensions

Climate change in Pakistan particularly burdens those who are already struggling with poverty and limited resources, widening inequalities and creating new vulnerabilities. Around 60 percent of Pakistan's people depend on climate-sensitive sectors like agriculture and livestock, yet many lack access to adaptation infrastructure, insurance, or financial safety nets. Rural poverty remains significantly higher than urban rates, making rural communities especially exposed to floods, droughts, and heatwaves (ADB, 2023; World Bank, 2024).

Women carry a disproportionate share of climate burdens. In flood-affected areas of Sindh and Balochistan, more than 1 in 9 children admitted to health clinics were suffering from severe acute malnutrition. The floods have added to women's unpaid care loads and curtailed their livelihood options in livestock and kitchen gardening (FAO, 2024; UNICEF, 2022).

Children are severely threatened by climate shocks. UNICEF warned that close to 1.6 million children in flood zones could suffer from severe acute malnutrition (UNICEF, 2022), and in Sindh alone, 230,000 children had their schooling disrupted due to flooding (UNICEF, 2024).

Regional climate impacts accentuate inequalities: Sindh and Balochistan face extreme heat and recurring droughts, while northern Pakistan contends with glacier melt and glacial lake outburst flood threats (MoCC, 2024; NDMA, 2025).

Policy Directions

Pakistan's escalating climate pressures demand not fragmented interventions but a comprehensive, equity-centered transformation of economic and social policy. The country's experience shows that climate change is not merely an environmental issue it is an economic, gender, and governance challenge that will define the trajectory of sustainable growth and social cohesion.

***Transform Rural Livelihoods through Climate-Smart Agriculture*:** A central priority is the transformation of rural livelihoods that remain highly dependent on climate-sensitive agriculture. Promoting climate-smart agricultural practices such as drought-tolerant seeds, precision irrigation, and integrated pest management can reduce production losses and enhance resilience. Targeted support for women smallholders, who constitute nearly two-thirds of agricultural workers yet have limited access to finance and extension services, would simultaneously strengthen productivity and gender equity (FAO, 2023; UN Women, 2023). Expanding agricultural insurance, improving market linkages, and investing in rural infrastructure can further safeguard livelihoods against climate volatility.

***Integrate Social Protection and Gender-Responsive Adaptation*:** Equally important is the integration of social protection and gender-responsive adaptation within the broader climate governance framework. Recurrent disasters have pushed millions into poverty while disrupting education, nutrition, and food security (UNDP, 2024; UNICEF, 2024). Expanding adaptive cash transfer systems and linking them with early warning and disaster response mechanisms can provide immediate protection against shocks. Embedding gender budgeting and allocating dedicated funds for women-led recovery initiatives will ensure that adaptation finance reaches those most affected by climate stresses.

***Strengthen Health Resilience to Climate Shocks*:** The human cost of climate change extends to public health. Rising temperatures and erratic rainfall have intensified health burdens, with major cities witnessing surges in heat-related illnesses and vector-borne diseases such as dengue (NDMA, 2025; PMD, 2025). Investing in climate-resilient health infrastructure, expanding disease surveillance systems, and establishing localized heat response plans are crucial to safeguard public wellbeing and labor productivity.

Expand Climate Finance and Strengthen Fiscal Planning: Climate resilience in Pakistan depends on closing the massive financing gap highlighted in Figure 4.4, which shows that only USD 1.4–2.0 billion of the USD 43.5 billion required annually through 2030 is being mobilized leaving over 95 percent unfunded (MoCC, 2024; World Bank, 2024). Bridging this gap requires a multi-pronged strategy that expands access to international grants and concessional finance, introduces innovative instruments such as green bonds and debt-for-climate swaps, implements domestic fiscal reforms like carbon pricing and subsidy rationalization, and strengthens private-sector engagement all aimed at aligning national fiscal planning with climate resilience goals.

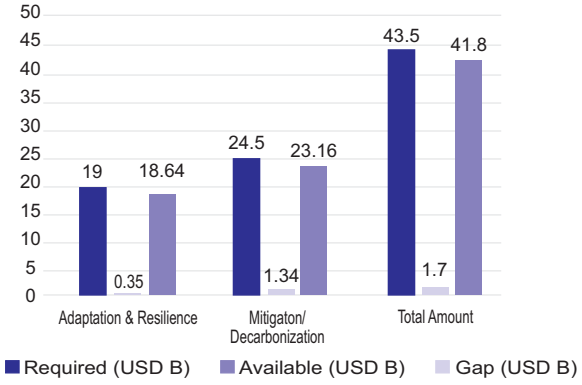
Enhance Institutional Coordination and Governance: Institutional coherence is critical for effective climate action. Coordination among federal, provincial, and local authorities must be strengthened to ensure integrated climate risk governance. Enhanced collaboration between the ministries of climate change, finance, agriculture, and disaster management will enable unified planning and efficient resource use. Increasing transparency, community participation, and accountability in climate finance decisions can build local trust and ownership. Moreover, regional cooperation especially on shared water systems and transboundary disaster management remains essential for addressing cross-border climate risks.

Build Knowledge Systems and Climate Data Infrastructure:

Beyond institutional reform, Pakistan must invest in knowledge systems and data infrastructure to

Figure: 4.4

Climate Finance Gap Analysis by Sector



Source: National Climate Finance Strategy (2024); World Bank (2022-2024); Asian Development Bank (2024)

support evidence-based decision-making. Developing a national climate risk database that integrates meteorological and economic data, along with localized early warning systems, can substantially reduce disaster losses (WMO, 2024). Strengthening domestic capacity in climate science, hydrology, and economics will enhance independent assessments of vulnerabilities and guide targeted investments. Integrating local and indigenous knowledge with scientific analysis can ensure socially legitimate and contextually appropriate adaptation strategies, especially in rural communities (Adger et al., 2023).

Engage and Empower the Private Sector: The private sector represents an underutilized yet vital partner in Pakistan's climate response. Creating enabling policies such as tax incentives, streamlined regulations, and public-private partnerships can mobilize domestic investment toward renewable energy, sustainable agriculture, and resilient infrastructure (UNCTAD, 2023). Introducing climate disclosure requirements for corporations and financial institutions will improve risk transparency and redirect investments away from vulnerable assets. Supporting small and medium enterprises (SMEs) which comprise over 90 percent of enterprises and employ nearly 80 percent of the non-agricultural workforce through green credit lines and technical assistance will mainstream climate resilience across the economy (SMEDA, 2024).

Advance International Climate Justice and Global Engagement: International climate justice must remain central to Pakistan's global advocacy. As a nation bearing disproportionate climate burdens despite minimal historical emissions, Pakistan has a legitimate claim to predictable and grant-based climate finance from developed countries (Roberts & Parks, 2023). Active engagement in UNFCCC negotiations, G77 coordination, and South-South cooperation can amplify Pakistan's voice in global climate governance while securing access to mechanisms like the Loss and Damage Fund, Green Climate Fund, and Adaptation Fund. Demonstrating transparent and effective use of climate finance will further strengthen Pakistan's credibility as both a responsible recipient and a global advocate for climate-vulnerable nations (Bracking, 2022).

Align Adaptation with Inclusion and Long-Term Resilience: Ultimately, Pakistan's climate future depends on aligning adaptation with fiscal reform, institutional coherence, and social inclusion. The way forward requires managing immediate disaster risks while building long-term structural resilience through diversified livelihoods, resilient infrastructure, and inclusive social protection. Achieving this transformation demands political commitment beyond electoral cycles, sustained investment despite fiscal constraints, and participatory governance that centers marginalized voices. Success will be measured not only by reduced disaster losses but by the creation of dignified livelihoods, equitable opportunities, and sustainable development for future generations.

Pakistan's experience offers a critical lesson for other climate-vulnerable nations: adaptation is inseparable from development, equity must guide resource allocation, and international solidarity is indispensable for confronting a global crisis that no nation least of all those least responsible should face alone (Schipper, 2020).

Conclusion

Climate change has become one of the most powerful forces reshaping global and national economies, and the evidence presented in this chapter shows that its impacts are no longer distant projections but present-day macroeconomic realities. Around the world, rising temperatures, extreme weather events, and shifting climatic patterns are eroding GDP, disrupting food systems, weakening labor productivity, damaging infrastructure, and widening inequalities between regions and social groups. These pressures are especially acute in South Asia, where rapid warming, volatile monsoons, and recurrent floods place nearly two billion people at risk and threaten to reduce regional GDP by up to 9 percent by the end of the century. The analysis demonstrates that agriculture, health, urban infrastructure, and fiscal systems across the region are already experiencing escalating stress, deepening

poverty, and intensifying vulnerability.

For Pakistan, the climate economy nexus is particularly stark. Despite contributing less than one percent to global emissions, Pakistan ranks among the world's most climate-impacted countries, repeatedly suffering catastrophic floods, extreme heat, water stress, disease outbreaks, and massive losses to agriculture, infrastructure, and livelihoods. The 2022 and 2025 floods underscore how climate shocks can trigger nationwide economic instability, destroying billions of dollars' worth of assets, pushing millions into poverty, straining food systems, disrupting schooling, and burdening an already fragile fiscal landscape. Heat stress, declining labor productivity, expanding disease burdens, and widening rural urban and gender inequalities further illustrate how climate change is undermining Pakistan's development trajectory. Meanwhile, a vast climate-finance gap where over 95 percent of annual needs remain unfunded continues to limit the country's ability to build resilience or pursue long-term adaptation.

The chapter's findings make clear that climate change is not a standalone environmental problem but a structural economic challenge that requires systemic transformation. Building resilience will demand climate-smart agriculture, gender-responsive social protection, climate-resilient health systems, risk-informed urban planning, stronger institutional coordination, and significantly expanded climate finance. It will also require Pakistan to continue advocating for climate justice at international forums to secure predictable, grant-based resources that reflect the country's disproportionate vulnerability and minimal historical responsibility.

Ultimately, the central message that emerges is that adaptation and development are inseparable. Climate resilience must be embedded across economic planning, investment decisions, and social policy. Equity must guide how resources are allocated within countries and globally and international solidarity remains essential in confronting a crisis that no nation, especially those that have contributed the least, should be left to face alone.

Chapter

5 CPEC 2.0 in Action: Transforming Liabilities into Climate-Resilient Assets Through the 5Es and Corridor Implementation Framework

CPEC 2.0 in Action: Transforming Liabilities into Climate-Resilient Assets Through the 5Es and Corridor Implementation Framework

Shahzad Shaukat

Introduction

The China–Pakistan Economic Corridor (CPEC) stands at a critical inflection point. So far, CPEC has not placed strong emphasis on climate change or environmental sustainability particularly during its first phase (2015–2020), when the focus was predominantly on energy generation (largely coal-based), transport infrastructure, and industrial cooperation. While this phase delivered substantial physical connectivity, it also heightened Pakistan's environmental vulnerabilities by expanding its carbon footprint by approximately 30 million tons of CO_2 annually and increasing exposure to climate-related shocks, including intensified floods, droughts, and extreme heat events that have cost Pakistan over $3.8 billion, annual, in climate-related damages since 2015.

As Pakistan transitions into CPEC Phase II (2025–2030), the challenge is not merely to activate infrastructure but to redefine it as climate-resilient economic infrastructure. The next phase must embed sustainability and low-carbon principles into every corridor, project, and investment framework. This transformation demands integrating climate action into economic activation, converting existing liabilities, such as high-emission assets, inefficient logistics, climate-vulnerable transport routes, and underutilized infrastructure, into green, productive, and inclusive assets that can withstand projected temperature increases of 1.5-2°C and shifting monsoon patterns.

This chapter therefore sets forth a dual strategic imperative: to operationalize CPEC at full capacity while ensuring that expansion aligns with Pakistan's Nationally Determined Contributions (NDCs), which target a 15 percent reduction in emissions by 2030 and 50 percent reduction by 2050 (conditional on international support), National Adaptation Plan (NAP), and 5Es Framework, particularly its environmental pillar. The vision is to transform Pakistan's connectivity assets, such as roads, ports, and industrial zones into climate-smart corridors that promote green trade, renewable energy, circular economy principles, and sustainable industrial relocation. These corridors are designed to reduce emissions intensity while enhancing climate adaptation capacity. Through this approach, CPEC 2.0 can shift from being a conventional infrastructure project to becoming a flagship model of climate-resilient development under the URAAN Pakistan Vision, positioning Pakistan as a regional leader in green Belt and Road Initiative (BRI) implementation.

In short, Pakistan is caught under a multi-dimensional Catch-22. If CPEC is fully activated, the surge in freight traffic triggers an environmental trap, where public funds and tax revenue are diverted into climate-related damages, health burdens, and mitigation costs. However, if activation is delayed, Pakistan remains trapped in a fiscal drain, where billions in public money continue to service interest payments and circular debt on dormant infrastructure. Both paths lead to sovereign erosion, but through different channels. Activation without climate safeguards leads to emissions, congestion, and public health costs; dormancy leads

to economic stagnation, debt accumulation, and loss of investor confidence. This dilemma demands a calibrated activation strategy, one that increases corridor throughput to unlock trade, jobs, and revenue, while simultaneously embedding climate resilience into the transport backbone. Only by managing both traffic and emissions (fiscal and environmental drains) can Pakistan transform CPEC from a corridor of compromise into a climate-resilient engine of inclusive growth.

CPEC Phase II: Activating Infrastructure as a Strategic Target

CPEC Phase 2.0 is designed to convert Pakistan's infrastructure from symbolic connectivity into active economic throughput. The strategic target is to maintain continuous engagement of highways, border terminals, and logistics corridors in high-volume freight, industrial relocation, and regional trade flows. This activation is essential for monetizing past investments, stimulating domestic production, and intercepting China's outbound exports. However, current CPEC freight operations rely almost exclusively designed for sustained high-volume freight (Pakistan Bureau of Statistics, 2023). However, once road infrastructure reaches full operational load, it triggers a parallel responsibility: environmental balancing and modal diversification. Heavy freight movement along CPEC routes, particularly the Karakoram Highway, Peshawar-Karachi Motorway (M1-M9), and Gwadar-Kashgar corridor, generates substantial CO_2 emissions. Research indicates that annual average CO_2 emissions from freight trucks along the Karakoram Highway could reach 424,218 metric tons in lower-altitude sectors, 489,212 metric tons at intermediate high altitudes, and 141,585 metric tons at the highest altitudes (Sheik et al., 2022). These routes also traverse climate-sensitive regions already experiencing glacial melt in the north, desertification in Balochistan, and flood-prone plains in Sindh and Punjab.

The Climate-Infrastructure Crisis

This road-centric model creates three critical problems: First, emissions intensity is unsustainable: road freight emits approximately 62 grams of CO_2 per ton-kilometer compared to just 8-12 grams for rail freight, meaning trucks produce over five times more emissions for the same cargo load (Ahmed et al., 2022). Second, infrastructure degradation accelerates under climate stress: Highways suffer extreme heat-induced pavement failures with surface temperatures exceeding 60°C, causing rutting that reduces road lifespan by 30-40 percent (National Highway Authority, 2022). Third, The 2022 event documented 13,115 km of roads and 439 bridges affected or destroyed. exceeding $30 billion, demonstrating the vulnerability ofroad-dependent transport to climate shocks (World Bank, 2023).

To balance economic activation with climate resilience, CPEC 2.0 must integrate three foundational principles:

First, modal shift strategies must be accelerated to transition freight from road to rail. This can reduce CO_2 emissions and costs by up to 70-80 percent per ton-kilometer (Ahmed et al., 2022; Mehdi et al., 2022). To absorb corridor pressure, Pakistan must upgrade its Railway Network to A-Class standards through: (a) track doubling and realignment on ML-1 mainline, (b) speed upgrades from 40-50 km/h to 80-100 km/h, (c) automated signaling and safety modernization, and (d) freight prioritization with electrified, climate-smart design. This railway upgradation can move thousands of tons of freight daily from road to rail, approaching near-zero emissions when powered by renewable energy.

Second, environmental accountability models should include per-kilometer afforestation targets (e.g., 100 trees per kilometer of active corridor), carbon offset protocols, and nature-based infrastructure. However, carbon sequestration from afforestation can offset only 5-10 percent of corridor emissions (IPCC, 2019), making modal shift to rail the primary emissions reduction strategy.

Third, green logistics standards should mandate emissions monitoring, fuel efficiency benchmarks, and incentives for electric and hybrid freight vehicles, particularly in Special Economic Zones (SEZs) and at Gwadar Port. Climate-proofing infrastructure through elevated tracks, improved drainage systems, and heat-resistant materials is essential to withstand extreme weather events becoming more frequent due to climate change.

By embedding these climate-responsive measures

into CPEC's activation strategy, Pakistan can ensure that infrastructure utilization drives inclusive growth without compounding environmental vulnerabilities, aligning with Pakistan's Nationally Determined Contributions (NDCs), which target a 50 percent reduction in projected emissions by 2030, with 15 percent from domestic resources and 35 percent contingent on international climate finance (Government of Pakistan, 2021).

CPEC Vision: Achievement Vs Opportunity

The vision alone is not enough. In order to unlock CPEC's full potential, we must confront a deeper structural reality: activation is not automatic, and infrastructure is not inherently productive. Despite the strategic frameworks and corridor ambitions outlined above, Pakistan's policy discourse often treats CPEC as a finished achievement rather than an unfinished opportunity. This misperception obscures the real challenge. The lack of consistent policy, institutional ownership, and operational framework makes it harder to convert the infrastructure into climate-resilient economic assets that can generate prosperity. It is here that the need for reform becomes urgent.

The Illusion of Completion

CPEC Phase I delivered impressive physical infrastructure: over 2,700 kilometers of highways and motorways upgraded or constructed, including the Sukkur-Multan Motorway (M-5), Lahore-Abdul Hakeem Motorway (M-3), and Peshawar-Karachi Motorway sections (M1-M9) (CPEC Authority, 2023). Yet physical completion does not equal economic activation. Many CPEC routes operate at less than 30 percent of design capacity, with industrial zones remaining underutilized and cross-border freight flows falling short of projections (Planning Commission of Pakistan, 2023).

More critically, the infrastructure built during Phase I was designed without comprehensive climate risk assessments or sustainability standards. The result: assets vulnerable to climate shocks that Pakistan is already experiencing with increasing frequency and intensity.

The Activation Gap: Policy, Institutions, and Climate Preparedness

Three structural gaps prevent CPEC from transitioning from achievement to opportunity. First, policy inconsistency undermines long-term planning. CPEC projects have suffered from changing priorities across government transitions, with each administration reinterpreting CPEC's scope and timelines. This includes shifting stances on coal-fired power plants, originally central to CPEC energy investments, as Pakistan grapples with balancing energy security against climate commitments (Dawn, 2023). Without policy continuity, investors face uncertainty, and climate-proofing measures remain ad hoc rather than systematic.

Second, institutional fragmentation dilutes ownership. Multiple ministries, provincial governments, and agencies claim jurisdiction over CPEC components, yet no single entity holds comprehensive operational authority. The CPEC Authority, established in 2019, lacks the regulatory teeth and inter-ministerial coordination power needed to enforce climate standards, environmental compliance, or modal shift targets across the entire corridor (Senate of Pakistan, 2022). This institutional vacuum means climate resilience remains rhetorical rather than operational.

Third, lack of implementation is a big huddle. Pakistan lacks integrated logistics management systems, emissions monitoring protocols, and green freight incentive structures that would transform CPEC infrastructure into climate-smart economic engines. For example, there are no mandatory emissions disclosure requirements for freight operators using CPEC routes, no carbon pricing mechanisms to incentivize cleaner transport modes, and no standardized climate risk assessments for new infrastructure projects (Pakistan Environmental Protection Agency, 2023).

Beyond economic underutilization, CPEC's unfinished business includes critical climate adaptation and mitigation imperatives that were absent from Phase I planning. These include retrofitting existing infrastructure with climate-resilient features such as improved drainage, heat-resistant materials, and elevated sections in flood-prone areas. Establishing green corridors with mandatory afforestation, wildlife crossings, and ecosystem buffers along highways remains largely unaddressed. Implementing modal shift infrastruc-

ture through dedicated freight rail capacity, intermodal terminals, and electrified transport options has yet to materialize at scale. Creating climate finance mechanisms to fund adaptation measures without straining Pakistan's fiscal capacity is still in conceptual stages. Developing early warning systems integrated with transport management to reroute freight during extreme weather events has not been systematically deployed.

These gaps represent not merely policy failures but existential risks. Climate projections indicate that Pakistan will experience more frequent and intense heatwaves, floods, and droughts over the coming decades (IPCC, 2023; Pakistan Meteorological Department, 2024). Infrastructure that cannot withstand these conditions will require constant expensive repairs, face extended closures, ultimately fail to deliver economic returns - transforming CPEC from an economic corridor into a fiscal liability.

From Perception to Performance: The Reform Imperative

Converting CPEC from perceived achievement to realized opportunity requires three foundational reforms. Institutional reform must strengthen the CPEC Authority with enforcement powers, a clear climate mandate, and dedicated budget allocation for green infrastructure implementation. Policy reform should establish a bipartisan CPEC sustainability framework that survives political transitions, with legally binding climate targets, modal shift goals, and environmental accountability measures embedded in legislation. Operational reform needs to deploy real-time monitoring systems for emissions tracking, freight flow optimization, and climate risk assessment; hence, transforming CPEC from passive infrastructure into an actively managed, climate-responsive economic system.

Without these reforms, CPEC risks becoming a monument to missed opportunity: physical infrastructure that exists but doesn't perform, generates emissions without prosperity, and becomes increasingly vulnerable to climate shocks that Pakistan can neither prevent nor afford to repeatedly incur costs like repair. The choice is clear, either activate CPEC as climate-resilient infrastructure asset now, or watch it degrade into stranded assets that burden future generations with both financial debt and environmental damage.

The Illusion of Infrastructure as an Asset

In Pakistan's policy discourse, the China-Pakistan Economic Corridor (CPEC) is often celebrated as a national asset, an emblem of Sino-Pak strategic partnership and development. Yet this perception is misleading due to inconsistent policies and a missing implementation framework. Infrastructure, by itself, is not an asset. Roads, ports, and power plants become assets only when they generate economic activities through trade, traffic, production, and fiscal returns. Without activation, they remain unproductive and fiscally burdensome. The illusion lies in mistaking concrete for commerce, and construction for contribution. CPEC's infrastructure is not a dividend; it is a dormant platform awaiting monetization.

The China-Pakistan Economic Corridor (CPEC), with over $60 billion in committed investments, shall be our national asset with certain prerequisites, but infrastructure alone does not create any value. Without active trade, traffic, and fiscal returns, these projects risk becoming liabilities, repayable through future taxation rather than economic output. As of 2025, CPEC's investments span energy, transport, logistics, and industrial zones, including major upgrades like Gwadar Port and national highways. Yet their true worth depends on activation. Moreover, infrastructure that is not climate-resilient or environmentally sustainable can transform from dormant liability into active burden, requiring continuous repair and adaptation expenditure while contributing to Pakistan's growing emissions profile.

The Climate Dimension of Dormant Assets

Dormant infrastructure generates costs without benefits, and climate change amplifies this problem. Unused roads still require maintenance, with climate change projected to increase road maintenance costs in South Asia by 15-25 percent by 2030 due to extreme weather events (ADB, 2021). Meanwhile, coal power plants built under CPEC Phase I operate under take-or-pay contracts, costing

Pakistan approximately $3-4 billion annually while contributing 35 percent of the power sector's CO_2 emissions (IEEFA, 2023). This creates a triple burden: fiscal (paying for unused capacity), economic (crowding out cheaper renewable energy), and environmental (locking in high-carbon infrastructure).

As global carbon border mechanisms emerge, such as the EU's Carbon Border Adjustment Mechanism implemented in 2023, Pakistan's exports produced using high-carbon CPEC energy will face tariffs and market access barriers (European Commission, 2023). Transforming CPEC from a dormant liability to a productive asset, therefore, requires simultaneous economic activation and climate integration, treating environmental compliance not as a constraint but as an enabler of competitive advantage in a carbon-constrained global economy.

The Cost of Non-Conversion: From Dormancy to Debt

If CPEC is not converted into an active asset, it becomes a long-term liability. Pakistan must repay billions in principal and interest to lenders from the (tax money) funds that will be drawn from public taxation, not corridor-generated revenue. This means the burden of repayment falls on citizens, not commerce. Without traffic, trade, and throughput, CPEC risks becoming a fiscal drag: a monumental investment that yields no return. Adding to this fiscal burden is the climate cost: non-productive infrastructure still requires climate adaptation expenditures, disaster recovery funding, and emissions-related penalties in global trade, compounding the debt without generating offsetting revenue. The strategic imperative is clear: "Pakistan must activate CPEC, assetize its infrastructure, and ensure that movement becomes monetization". Otherwise, the corridor will remain a concrete monument to missed opportunity with huge liabilities on people the of Pakistan.

In order to understand the fiscal pressure on people of Pakistan with respect to debt, it is pertinent to note that over the past eight budget cycles, Pakistan approved Rs 289 trillion in payments, yet Rs 238 trillion, nearly 82 percent, was devoured by debt and it's servicing alone, apparently to retire a Rs 25 trillion public debt that has instead exploded to Rs 95 trillion (Ministry of Finance, 2024). We may call it systemic extraction, as much of this bleed is tied to interest-based loans, including CPEC-linked infrastructure, energy, and road projects, where repayment terms have fed compound interest rather than national productivity. This debt spiral is further aggravated by climate-related expenditures: Pakistan spent over $16 billion on flood recovery in 2022-2023 alone, diverting resources from productive investment while adding to the debt burden (World Bank, 2023). When infrastructure generates neither economic returns nor climate resilience, it creates a dual liability—financial debt from construction and environmental debt from emissions and vulnerability.

Climate change intensifies this fiscal trap in three ways. First, stranded fossil fuel assets under CPEC, particularly coal plants operating below capacity, continue accruing debt while losing economic value as renewable energy costs decline. Second, climate disasters damage unproductive infrastructure, requiring reconstruction loans that add to debt without expanding capacity. Third, as carbon border mechanisms take effect, exports from high-emission CPEC industrial zones face tariffs, reducing revenue generation potential while debt obligations remain fixed. The result is a compounding crisis: paying interest on infrastructure that doesn't generate returns, while simultaneously paying for climate damage and losing competitive advantage in decarbonizing global markets.

The path forward requires activating CPEC not merely as economic infrastructure but as climate-smart and revenue-generating assets that can finance their own adaptation, reduce emissions and position Pakistan competitively in green trade corridors.

CPEC Phases: From Strategic Promise to Fiscal Liability

China-Pakistan Economic Corridor (CPEC) was envisioned as a game-changing platform to upgrade infrastructure, boost energy capacity, and connect Pakistan to regional trade routes. Phase I focused on Government-to-Government (G2G) projects, primarily energy and transport, while Phase II aimed to attract Business-to-Business (B2B) investments, especially in Special Economic Zones (SEZs).

However, despite over $60 billion in committed

investments, CPEC's implementation, unfortunately, has faced persistent challenges like weak planning, political instability, financial mismanagement, and lack of continuity across regimes. Many projects remain underutilized, and the expected economic activation, through trade, industrial output, and fiscal returns, has not materialized. Additionally, Phase I infrastructure was developed without comprehensive climate risk assessments or emissions reduction frameworks, creating environmental vulnerabilities that compound fiscal risks. Instead, Pakistan now bears the burden of repaying interest-bearing loans, often secured through commercial banks, without generating matching revenue. These gaps have turned CPEC from a strategic asset into a fiscal liability, demanding urgent reform and a unified implementation framework to unlock its true potential while integrating climate resilience and low-carbon development pathways.

We can summarize the phases as below:

Inception Phase (2013–2016): Infrastructure as Inheritance: CPEC was launched in 2013 as the flagship project of China's Belt and Road Initiative (BRI), with an initial investment commitment of $46 billion, later expanding to over $60 billion. The early phase focused heavily on energy generation, road construction, and the development of Gwadar Port. Pakistani policymakers largely viewed this infrastructure as a strategic inheritance, an automatic asset that would catalyze national growth. However, this mindset overlooked a critical economic principle: infrastructure alone does not generate value unless it is activated through commerce, traffic, and production. Moreover, the energy portfolio was heavily coal-dependent, installing approximately 3,960 MW of coal capacity that now faces stranded asset risks as global markets decarbonize (CPEC Authority, 2023).

Realization Phase (2017–2020): From Concrete to Commerce: *As* major projects neared completion, a shift in thinking began to emerge. Policymakers recognized that roads and power plants, while necessary, were not sufficient to transform Pakistan's economy. The focus turned toward Special Economic Zones (SEZs), industrial cooperation, and trade facilitation. Yet progress was slow. Bureaucratic inertia, security concerns, and a lack of institutional coordination hampered the operationalization of SEZs. Meanwhile, debt servicing obligations began to mount, raising concerns about the long-term fiscal sustainability of CPEC.

Strategic Reframing (2021–2025): CPEC Phase 2.0: In response to growing fiscal and operational challenges, Pakistan introduced a strategic reframing of CPEC. URAAN Pakistan initiative and the 5Es Framework, focusing on Exports, E-Pakistan, Environment, Energy, and Equity. However, despite renewed momentum, key gaps persisted: SEZs remained underutilized, trade throughput was low, and corridor-linked revenue generation remained insufficient to offset debt obligations. The Environment pillar of the 5Es Framework explicitly recognized the need for climate integration, yet implementation mechanisms for green infrastructure, emissions monitoring, and climate-proofing remained underdeveloped (Planning Commission, 2024).

Present Reality (2025): Dormant Infrastructure, Active Liability: *Today*, despite over $60 billion invested, CPEC remains a fiscal liability unless it is activated to produce economic value. The infrastructure—roads, ports, SEZs—will only become assets if they generate traffic, production, and fiscal returns. Without this activation, Pakistan must repay loans and interest from general public funds, effectively converting dormant infrastructure into long-term burden. Compounding this challenge, climate-related costs continue to accumulate. The strategic imperative now is to assetize CPEC and to transform it into a sovereign trade engine. This can only be done through legal recognition, operational throughput, and fiscal capture mechanisms while embedding climate resilience and emissions reduction as core design principles rather than an afterthought.

CPEC Action Plan 2025-2029

The CPEC Action Plan 2025-2029 envisions a multidimensional upgrade of China-Pakistan cooperation, anchored in strategic trust and aligned with Pakistan's 5Es vision. Key deliverables include accelerated industrialization via SEZs in Karachi and Islamabad, joint agricultural and marine zones, and transformative infrastructure upgrades like ML-1 and Karakoram Highway II. The plan promotes

digital integration through fiber optics, 5G, and AI, modernizes trade via green channels and B2B platforms, and deepens collaboration in science, education, and vocational training. Enhanced security protocols, cultural exchanges, and synchronized positions on global issues solidify CPEC's role as a resilient, inclusive, and future-ready corridor. However, the plan's environmental pillar remains underdeveloped, with limited mechanisms for emissions monitoring, climate-proofing infrastructure, or transitioning to low-carbon industrial processes, critical gaps that must be addressed to align CPEC with Pakistan's NDC commitments and global decarbonization trends (Planning Commission, 2024).

Strategic Risks and Apprehensions

Despite a well-structured action plan and clear acknowledgment of strategic risks, CPEC continues to face deep-rooted structural challenges that cannot be ignored. Debt sustainability is no longer a looming threat; it is a present fiscal burden, as infrastructure investments remain disconnected from economic activation. Special Economic Zones (SEZs), once envisioned as growth hubs, remain largely dormant, contributing little to trade, production, or employment. Security concerns have escalated to the point where even routine visits by Chinese personnel require bulletproof protection, reflecting a breakdown in local enforcement and investor confidence.

Pakistan's current policies, lack of a unified implementation framework, and frequent reversals due to political instability have forced Chinese investors to seek protective measures before committing capital. The absence of climate resilience frameworks further deters long-term investment, as infrastructure vulnerable to floods, heatwaves, and other climate impacts increases operational risks and insurance costs.

Active vs Non-Active Initiatives - Separating Symbolism from Substance

Despite billions invested under CPEC and the 5Es framework, only a handful of initiatives show signs of operational activation. Most remain dormant, disconnected from trade, production, or fiscal returns. This section categorizes key initiatives based on their current status, highlighting the urgent need for legal, fiscal, and operational activation.

Table 5.1 presents the Active vs Non-Active Initiatives under CPEC along with links to official sources from the CPEC website and the Ministry of Planning.

The persistent gap between CPEC's infrastructure buildout and its economic activation stems from deep-rooted structural, legal, and institutional failures. Climate considerations were largely absent from Phase I planning, creating environmental vulnerabilities that now compound economic and security risks. Table 5.2 presents a refined and evidence-backed breakdown of the barriers, their impacts, and the resulting risks if left unaddressed. Due to these reasons, the Chinese investor shifts their investment structure.

Investment Strategy Vs Structural Shifts in Chinese Strategy under CPEC

China's State-Owned Enterprises (SOEs) have emerged as global instruments of strategic investment, deploying over $500 billion in non-interest-based equity across top partners like the U.S, Germany, and Australia. These countries, through consistent legal frameworks and investor protections, have welcomed Chinese capital into energy, technology, and infrastructure. In fact, during the last two decades, the Chinese strategic investments have invested over $700 billion in only ten countries with a consistent legal framework.

In stark contrast, Pakistan, despite its corridor-enabled geography, deep diplomatic ties, and strategic location, has attracted only $2-4 billion in equity-based ventures. The core reason lies not in a lack of goodwill but in Pakistan's failure to offer a predictable, transparent, and throughput-linked investment framework. Without corridor activation laws, enforceable guarantees, and fiscal clarity, Pakistan's infrastructure remains a dormant liability rather than a sovereign asset. Additionally, the absence of climate risk frameworks and environmental compliance standards further deters long-term equity investment, as global investors increasingly factor climate resilience and ESG (Environmental, Social, Governance) criteria into investment decisions (IFC, 2023).

Table: 5.1

Active vs Non-Active CPEC Initiatives

Initiative / Status	Summary
Partially Active Initiatives	Energy Projects: Over 8,000 MW added; reduced load-sheddingbut worsened circular debt and locked in high-carboncoal capacity (3,960 MW) facing stranded asset risks (CPEC Authority, 2023)
Partially Active Initiatives	Gwadar Port: Operationalbut underutilized‡throughputbelow strategic thresholds and lacking green port infrastructure for emissions reduction
Partially Active Initiatives	Digital Customs Pilots: Border modernizationat Sost and Torkham shows promise
Partially Active Initiatives	VocationalTraining(E-Pakistan):Talent developmentunderwayunderE-Pakistan and CPEC 2.0
Dormant or Non-Activated Initiatives	Special EconomicZones (SEZs): Few tenants, minimalproduction,no export linkage and no green industrial standards to ensure climate-competitive exports
Dormant or Non-Activated Initiatives	Corridor Traffic: Roads exist, but trade volume insufficient to justify investmentand heavy diesel freight generates unsustainableemissions without modal shift to rail
Dormant or Non-Activated Initiatives	Debt ServicingBurden: Infrastructurenot generatingrevenueto repay loans while climatedamagesadd reconstructioncosts (e.g., $1.2 billion for 2022 flood repairs) (World Bank, 2023)
Dormant or Non-Activated Initiatives	DisconnectedSMEs: Common businessmenlack access to corridor-linked markets or incentives
Dormant or Non-Activated Initiatives	Policy Fetishism: Building mistaken for development
Dormant or Non-Activated Initiatives	BureaucraticInertia: SEZ approvals, customs integration, and logistics remain slow
Dormant or Non-Activated Initiatives	Security Concerns: Investor hesitation due to instability and unclear protections
Dormant or Non-Activated Initiatives	Elite-Centric Planning: Benefits concentrated in political or corporate circles, not SMEs

Source:cpec.gov.pk

Table: 5.2

Why the Gap Exists - Refined Analysis with References

Barrier	Impact
Policy Fetishism	Infrastructure mistaken for development; celebrated for scale, not yield (PIDE, 2025)
No Activation Framework	No corridor laws or fiscal tools to monetize infrastructure (CRSS, 2024)
Bureaucratic Inertia	SEZ approvals, customs integration, and logistics remain slow (Salman & Ayub, 2024)
Security Concerns	Investor hesitation due to instability and lack of protection (Aziz, 2024)
Elite-Centric Planning	Benefits concentrated in political or corporate circles; SMEs excluded (The Nation, 2024)
Climate Vulnerability	Infrastructure lacking climate-proofing faces increased maintenance costs and operational disruptions from extreme weather World Bank (2023); ADB (2021)
No Environmental Standards	SEZs lack emissions monitoring, green building codes, or renewable energy mandates, risking export competitiveness under carbon border mechanisms European Commission (2023); IEEFA (2023)

Chinese investors under CPEC have recalibrated their strategy from partnership to protection. Initial optimism has given way to risk-insulated financing models, where interest-based loans, often routed through commercial banks, carry fixed returns (3 percent to 10 percent) or KIBOR-linked rates, exceeding 22 percent during high-rate cycles. Equity ventures have declined, replaced by sovereign-guaranteed projects in energy and transport, where returns are secured via power purchase agreements and toll revenue models. This has inflated public costs while insulating investor risk.

SEZs, once envisioned as industrial growth engines, remain largely inactive due to overlapping bureaucracies, multiple levies, and weak legal assurances. Chinese firms avoid business ventures (B2B) unless backed by strong commercial and diplomatic guarantees. Security threats, where even routine visits require bulletproof vehicles have further raised operational risks. Climate vulnerabilities add another layer of risk: facilities built without flood protection, heat-resistant materials, or renewable energy integration face higher operational costs and potential disruptions during extreme weather events (ADB, 2021). Each investment phase now demands detailed risk assessments, legal cover, and diplomatic coordination, reflecting a shift from strategic partnership to transactional caution.

The cumulative effect is a strategic retreat, the Chinese capital now flows through insulated channels, focused on financial security rather than transformative growth. Pakistan's incomplete or inconsistent policies, frequent regime changes, and lack of unified implementation mechanisms have eroded investor confidence, converting what could have been a $30–50 billion equity inflow into a cycle of debt, delay, and diplomatic fatigue.

To reverse this trend, Pakistan must urgently enact corridor activation laws, streamline SEZ governance, integrate climate resilience and green industrial standards into investment frameworks, and offer throughput-linked incentives that reward performance, not paperwork. Establishing green SEZ certifications, emissions reduction targets, and climate finance mechanisms can attract ESG-conscious investors while positioning Pakistani exports competitively in decarbonizing global markets. Only then can it convert strategic goodwill

into sovereign capital and reclaim CPEC as a platform for shared prosperity, not just protected returns.

Strategic Clarity - 10th Man Rule

To bridge this gap, Pakistan must enact a unified implementation framework that legally activates infrastructure, monetizes corridor throughput, and democratizes access to economic opportunity. This framework must integrate climate resilience, emissions reduction targets, and green industrial standards as core components, not optional add-ons. Without this shift, CPEC risks becoming a monument to missed potential rather than a motor of national prosperity. If Pakistan fails to activate its infrastructure through legal, fiscal, and operational frameworks, public money will evaporate, not through corruption alone, but through debt servicing on dormant assets. Billions spent on roads, ports, and power plants will translate into recurring loan repayments, rising deficits, and circular debt cycles, without generating trade, jobs, or revenue. Moreover, climate damages will add continuous reconstruction costs while stranded fossil fuel assets depreciate without generating returns, creating a dual fiscal drain. This is not just a short-term inefficiency, it's a long-term economic trap. Until these assets are monetized through corridor throughput, SEZ production, industrial relocation and SME integration, and climate-proofed to withstand Pakistan's increasingly volatile weather patterns, Pakistan will continue to fund prosperity on paper while bleeding fiscal capacity in reality. The infrastructure will age, the debt will mature, and the coming generations will inherit liabilities without dividends. In effect, Pakistan risks becoming a textbook case of "Debt-Driven Developmentalism" where growth is financed by loans, not productivity, and where prosperity is promised but never delivered.

From Infrastructure to Impact: Climate-Smart Activation Framework

Pakistan's journey from infrastructure buildup to sustainable impact requires a decisive shift toward climate-smart industrial and economic activation. Under the URAAN Pakistan Vision and the 5Es framework, the next phase of CPEC, “CPEC 2.0” must not only expand trade and connectivity but embed climate resilience at its core.

Securing Market Access Through Legal and Climate Competitiveness

To attract industrial relocation and fully unlock the economic potential of Pakistan's infrastructure, structured market access for incoming manufacturers must be guaranteed. Without credible assurances of domestic and regional market share, especially across Gulf Asia, relocation will remain commercially unviable.

However, this access must be tied to climate competitiveness. As the EU's Carbon Border Adjustment Mechanism (CBAM) and similar global measures emerge, only low-carbon, climate-certified production will maintain export viability. What Pakistan needs, therefore, is not another policy statement but a legally empowered platform, one capable of de-risking investor entry, coordinating trade flows, economic activities, and ensuring compliance with international environmental standards. This approach would reposition Pakistan from a passive transit corridor into a climate-resilient trade destination, ensuring commercial viability through sustainability and environmental compliance.

Institutionalizing Climate Smart Economic Activation

To operationalize the URAAN Pakistan Vision in line with the 5Es framework and CPEC 2.0, a sovereign institutional platform must be legislated. This body (proposed authority) would activate dormant infrastructure, promote economic activities, facilitate climate-smart industrial relocation, and safeguard Pakistan's long-term trade competitiveness. Unlike a commercial venture, it would function as a strategic intervention, converting policy into productivity and transforming infrastructure from an environmental burden into a climate-aligned revenue generator.

Legal Framework: Climate Integration with 5Es and CPEC Phase 2.0

Table: 5.3

Strategic Features: Climate-Economic Integrated Deliverables

Feature	Function
Legal Activation of Infrastructure	Monetizes SEZs, EPZs, and CPEC infrastructure through throughput-linked incentives and customs facilitation, coupled with mandatory emissions monitoring and green certification.
Climate-Smart Industrial Relocation	Onboards manufacturers with verified environmental compliance, renewable energy commitments, and circular economy practices aligned with Pakistan's NDC targets.
Green Export & Re-Export Platform	Establishes carbon-neutral bonded warehousing, eco-friendly packaging hubs, and compliance systems to reduce import costs and expand climate-competitive exports.
Inclusive Economic Participation	Offers Shariah-compliant platforms for SMEs, youth, and underserved regions with green finance mechanisms and climate entrepreneurship training.
Anchor of URAAN Pakistan	Fully aligned with the Ministry of Planning's 5Es and 5Cs agenda, serving as a flagship climate-smart logistics and trade hub.
Fiscal & Environmental Resilience	Generates sovereign revenue, builds asset pools, reduces emissions intensity, and creates climate adaptation funds from green export premiums.

The proposed authority, implementation framework must be formally embedded within Pakistan's 5Es transformation agenda with explicit climate mandates, ensuring that economic activation aligns with environmental stewardship.

CPEC Phase 2.0's five corridors (5Cs) must also be operationalized with climate objectives at their foundation

Climate-Smart Market Analysis: Addressing the Green Trade Gap

Pakistan's geographical position offers immense opportunities if climate competitiveness is embedded in its trade model. China's exports to the GCC, valued at around USD 150 billion annually, face increasing carbon scrutiny as Gulf states implement their Vision 2030 sustainability targets. Pakistan can capture part of this trade by positioning itself as a lower-carbon, climate-certified manufacturing hub.

Key Climate Differentiators

- **Carbon Tariff Avoidance - Savings:** Renewable-powered SEZs help avoid 20-35 percent CBAM penalties.
- **Green Export Premiums - Foreign Exchange Earnings:** Certified products command 10-15 percent higher prices in climate-conscious markets.
- **Climate Finance Access: - FundRaising:** Certified infrastructure unlocks USD 15-25 billion in concessional green finance (Green Climate Fund, 2024).
- **Foreign Direct Investments for Trade Zone:** Attracting investments initial stage upto $1

Table: 5.4

Authority's Economic-Climate Integrated Role: 5Es Implementation Framework

5Es Pillar	Climate-Integrated Role
Exports	Enable carbon-neutral bonded re-export, low-emission value-added production, and green trade certifications for corridor-linked platforms.
Equity & Empowerment	Onboard SMEs with green finance access, climate entrepreneurship training, and inclusive clean energy solutions.
E-Pakistan	Deploy digital emissions tracking, carbon footprint monitoring, and compliance systems for trade facilitation.
Energy	Promote renewable energy-powered industrial parks, storage solutions, and grid integration for clean logistics hubs.
Environment & Climate	Mandate climate-proofing of all infrastructure, implement afforestation protocols (100 trees/km), designate biodiversity zones, and align with Paris Agreement targets.

Table: 5.5

Climate-Economic Integrated Smart Operationalization of 5Cs

5Cs of CPEC Phase 2.0	Climate-Economic Integrated Smart Operationalization of 5Cs
Growth Corridor	Monetize SEZs through green industrial standards, emissions caps, and renewable energy mandates.
Livelihood Corridor	Generate green jobs in renewable energy, climate adaptation, sustainable agriculture, and circular economy sectors.
Innovation Corridor	Introduce climate tech, AI-enabled emissions monitoring, green logistics optimization, and carbon credit trading platforms.
Green Corridor	Prioritize climate-resilient infrastructure, modal shift to electric rail, afforestation targets, and zero-emission SEZs.
Opening-Up Corridor	Facilitate onboarding of climate-certified manufacturers that meet ESG and export compliance standards.

Table: 5.6

Climate-Competitive Addressable Market

Target Market Segment	Value (USD Billion)	Climate Strategic Opportunity
Pakistan's Consumption (Local Market)	100	Replace high-carbon imports with corridor-linked, low-emission production, cutting the carbon footprint by 30–40 percent.
Pakistan's Exports	32	Expand climate-certified exports to avoid CBAM penalties and access green trade premiums.
China's Exports to GCC	151	Intercept trade via low-carbon ITCC SEZs, positioning Pakistan as a climate-compliant alternative.
Regional Climate Finance	15–25	Access green bonds, adaptation funds, and carbon credit markets through certified operations.
Total Addressable Market	298–308	Gain competitive advantage through verified emissions reductions and resilience.

Table: 5.7

Climate-Enhanced Fiscal Returns

Fiscal Lever	Climate-Enhanced Impact	Enabling Mechanism
Green Export Revenue	USD 28-30 billion annually with 10-15 percent green premium	Climate certification, CBAM compliance, renewable energy guarantees, Promoting Economic Activities.
Carbon Credit Revenue	PKR 15-25 billion/year	Verified carbon credits from renewable energy and modal shifts – foreign exchange earnings.
Climate Finance Access	USD 5-10 billion in concessional bonds	Green-certified infrastructure unlocking multilateral climate funds for 5Es.
Subsidy Rationalization	PKR 60-80 billion/year savings	Modal shift to electric rail, rail, reduced fossil fuel subsidies
Environmental Cost Avoidance	PKR 40-60 billion/year	Climate-proofed infrastructure and early warning systems
Avoided CBAM Penalties	USD 2-4 billion/year	Low-carbon production maintaining EU/GCC market access
Insurance Cost Reduction	PKR 10-15 billion/year	Climate-resilient infrastructure lowering premiums and damage claims

billion and the next stage US$5 billion.

Environmental, Climate & Economic Stewardship Framework

For long-term resilience, the activation framework must embed climate action at every level.

Mandatory Climate Standards:

- 100 percent renewable energy for SEZ operations by 2030.
- Net-zero industrial zones by 2040.
- *Afforestation:* Minimum 100 trees per km of corridor with biodiversity monitoring.
- *Water Conservation:* Rainwater harvesting, greywater recycling, and drought-resistant landscaping.
- *Circular Economy:* 60 percent waste diversion from landfills with mandatory recycling facilities.
- *Climate-Proofing:* Infrastructure designed for +2°C scenarios with flood protection and heat-resistant materials.

Green Building Certification:

All facilities must meet Leadership in Energy & Environment (LEED) Gold standards, incorporating passive cooling designs to reduce AC loads by 40 percent, solar panels covering at least half of roof areas, and green roofs or vertical gardens to mitigate heat islands.

Ethical and Environmental Supply Chain: Manufacturers must hold ISO 14001 certification, exclude deforestation-linked materials, and undergo annual third-party audits for labor and environmental compliance.

Conclusion:

Climate as a Competitive Advantage CPEC 2.0 must evolve beyond an infrastructure initiative into a climate-intelligent development model. The first phase laid Pakistan's physical foundation; the second must build its climate conscience. Integrating sustainability into CPEC's planning, financing, and execution ensures that every corridor contributes to Pakistan's climate goals rather than constraining them.

Anchored in the 5Es Framework: Exports, Equity, E-Pakistan, Energy, and Environment. This activation model can transform infrastructure into productivity, trade into resilience, investment into stewardship and policy into prosperity. The coming decade must convert carbon-intensive assets into green corridors and fiscal liabilities into adaptive prosperity.

If implemented as envisioned, CPEC 2.0 will reposition Pakistan as a regional leader in climate-smart connectivity, demonstrating how economic growth, fiscal prudence, and environmental responsibility can converge.

This is not an aspiration but a blueprint for climate resilience in motion and most importantly it is economic revival for coming generations, powered by environmental responsibility. This shall convert dormant infrastructure into dynamic economic platforms, fiscal liabilities into productive assets, and scattered ambition into strategic execution.

Chapter

6 Pakistan Climate Risks: Global to Local Perspective

Pakistan Climate Risks: Global to Local Perspective

Dr. Mahmood Ahmad and Arifa Younus

Introduction

Climate-induced disasters are increasing at a rate that exceeds current global preparedness levels. Recent events across the United States, Europe, South Asia, and Pakistan during the summer of 2025 have underscored the widening gap between the magnitude of environmental risks and the capacity of governments and institutions to respond effectively. Recent developments throughout the United States, Europe, South Asia, and Pakistan, particularly during the summer of 2025, underscore an increasing disparity between the magnitude of environmental risks and the ability of governments and institutions to address these challenges effectively. Pakistan's high position on the Climate Risk Index underscores the urgent need for institutional reforms, increased investment in climate resilience, and the integration of disaster risk reduction with national development and climate finance strategies.

The devastating floods in Pakistan reveal critical deficiencies in disaster preparedness, infrastructure, and climate resilience, especially in a country where many people live below the poverty line and are exposed to climate extremes. This chapter captures the scale, impact, and human dimension of recent floods and other natural and manmade disasters, portraying a tragic environmental and humanitarian crisis shaped by natural and climate-related factors. Pakistan's multi-risk assessment identifies a concerning pattern: high-risk areas face a double burden of frequent, multiple natural hazards combined with limited capacity to manage these threats, making these regions particularly vulnerable to climate impacts. Addressing this compound vulnerability requires targeted intervention strategies.

Environmental degradation presents the most direct barrier, with rapid declines in forest cover and mangroves reducing natural carbon sinks and increasing exposure to floods and sea-level rise. Wetland degradation compromises water security and flood protection, while watershed degradation in the Hindu Kush-Karakoram region diminishes resilience against climate stresses (NOAA NCEI, 2024). Recent reports by the World Bank, as recorded by Business Recorder have warned that Pakistan's once-successful poverty reduction drive has stalled and reversed, with the poverty rate climbing by 7 percent in the past three years to a projected 25.3 percent in 2023-24 (Tahir, 2025). The intersection of poverty and climate vulnerability is stark, with high poverty rates in vulnerable districts highlighted by the 2022 floods that predominantly impacted the poorest households.

This chapter highlights the need to mitigate agricultural and livestock risks through regenerative practices like no-till farming and cover cropping to strengthen resilience and improve yields. It highlights overcoming institutional barriers such as poor storage and limited credit access that force smallholders into distress sales. In the water sector,

it recommends innovative technologies, resilient infrastructure, and ecosystem-based approaches that align with adaptation strategies and climate finance opportunities.

Global and Regional Trends: Disasters on the Rise

***United States*:** In the United States, extreme weather events have increased in frequency and severity. Between 1980 and 2024, there were 403 separate billion-dollar weather and climate disasters, with cumulative costs exceeding USD 2.7 trillion (NOAA NCEI, 2024). The long-term annual average was 9 events per year, but in the most recent five years (2020–2024), this rose to 23 events annually, indicating a dramatic rise in climate-related risks (NOAA NCEI, 2024). In July 2025, Texas experienced a significant flash flood resulting in at least 135 fatalities statewide, including 27 campers and counselors who drowned at Camp Mystic on the Guadalupe River (Wikipedia, 2025). Summer months now see more severe weather events nationally, underscoring the intensification of climate impacts across diverse geographical regions.

Europe: In Europe, wildfires have reached unprecedented records. By August 2025, over 1 million hectares of land had burned across the European Union—the highest since EU wildfire statistics began in 2006 (Reuters, 2025). Various countries from the Mediterranean to the Balkans faced high temperatures, droughts, and strong winds that contributed to widespread fires, impacting emergency services and both rural and urban areas (Olive Oil Times, 2025). The scale and frequency of these fires reflect broader patterns of climate change affecting the continent, with implications for biodiversity, air quality, public health, and economic productivity.

South Asia and Pakistan: South Asia continues to experience substantial monsoon flooding with devastating consequences. In Pakistan, the 2022 floods resulted in more than 1,700 deaths, displaced 33 million people, and caused damages and losses exceeding USD 30 billion (World Bank, 2022). In 2025, heavy monsoon rains again triggered flash floods and mudslides in Pakistan and Indian-administered Kashmir, leading to significant fatalities and destruction across Punjab and northern regions, compounding displacement and trauma (Regional news reporting, 2025). These repeated events illustrate how climate change is intensifying seasonal extremes in South Asia, with cascading effects on livelihoods, infrastructure, and long-term resilience.

Pakistan A Deeper Analysis: Pakistan experiences floods, cyclones, earthquakes, landslides, and droughts, regularly encountering natural hazards of various scales and intensities. Between 1993 and 2022, climate-related disasters resulted in over 765,000 fatalities and nearly USD 4.2 trillion in losses from more than 9,400 extreme weather events, with storms responsible for the largest share of deaths and economic impact (Al Jazeera, 2025a). The earthquake on October 8, 2005, led to over 80,000 deaths and left 3.5 million people without shelter (Germanwatch, 2023). In recent years, flash floods, mudslides, and road blockages have caused at least 750 fatalities over two days, complicating rescue efforts in northern regions and areas administered by Pakistan in Kashmir (World Bank, 2005).

In 2022, floods caused at least 1,545 deaths, approximately 12,900 injuries, and affected about 33 million people across the country. These events also resulted in damage to nearly two million homes and close to one million livestock (World Bank, 2005; NDMA, 2022). The estimated damages and losses exceeded USD 30 billion. In 2025, severe monsoon flooding was reported, with at least 785 deaths by August, thousands injured, and significant destruction of property; earlier in July, 178 deaths were attributed to rain and flood-related incidents across the country (Pakistan Today, 2022; NDMA, 2025a). Overall, from 1980 to 2024, Pakistan recorded over 224 disaster events, including 109 floods, affecting more than 100 million people and incurring an estimated USD 36.4 billion in damages (NDMA, 2025b; Government of Pakistan, 2025).

The floods and other disasters severely damaged thousands of homes, crops, and critical infrastructure. Punjab, the nation's breadbasket, witnessed

extensive agricultural losses that threaten food security (Business Recorder, 2025). The crisis was worsened by climate change, with patterns of intensified rainfall and glacial melting contributing to the severity and unpredictability of the floods. Yet, despite mounting losses, Pakistan continues to respond reactively, with little institutional progress, no major water storage infrastructure, and underperforming early warning systems.

These recurring events underscore Pakistan's extreme vulnerability to climate change and highlight the urgency of institutional reform, investment in climate resilience, and integration of disaster risk reduction with broader development and climate finance strategies. The floods also highlight the urgent need for improved disaster preparedness, better infrastructure, and enhanced climate resilience to mitigate future catastrophes in a country where many live below the poverty line and are highly vulnerable to climate extremes.

Climate Risk Profile of Pakistan

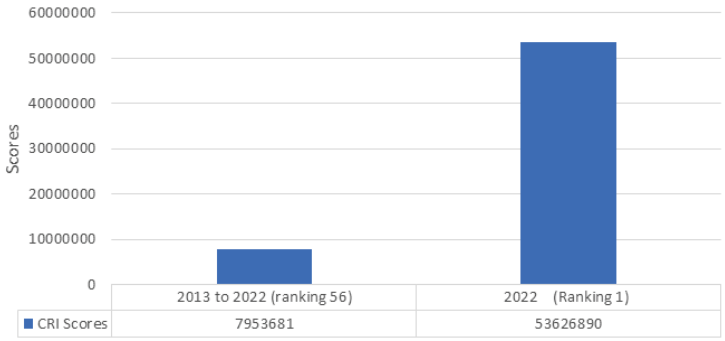
Pakistan faces significant risks stemming from both natural hazards and socio-economic vulnerabilities. Common natural hazards include floods, droughts, heatwaves, and earthquakes. Furthermore, ongoing global, regional, and local conflicts compound these risks, threatening human wellbeing and the economy. About half of Pakistan's population depends on agriculture, which is largely sustained by rivers and canals fed by some 13,000 glaciers. With global warming accelerating glacier melt, the stability of this system is at severe risk, threatening the country's river flows, barrages, and canal networks, and thereby endangering both its agricultural economy central to GDP and employment and national food security. The danger is compounded by the presence of vulnerable glacier lakes, with Pakistan's disaster authority identifying five at high risk of sudden Glacial Lake Outburst Floods (GLOFs) in early 2025, which could unleash catastrophic flooding downstream (Haruna et al., 2022).

The Climate Risk Index (CRI) ranking indicates that between 1993 and 2022, Dominica, China, and other nations were among the countries most affected by extreme events. The ranking further highlights that Pakistan, Belize, and Italy were among the most affected by extreme weather events. Over the past decade, particularly during the last five years and notably following the catastrophic floods of 2022, Pakistan has risen significantly in terms of vulnerability to extreme weather events. According to Germanwatch (2023), the country is projected to rank at the top position by 2025, highlighting its increased exposure to phenomena such as cloudbursts and flash floods (see Figure 6.1). This escalation is driven by a combination of natural hazards including floods, droughts, and heatwaves and socioeconomic vulnerabilities like poverty and limited adaptive capacity, underscoring Pakistan's vulnerability to the new norm of climate change manifested through cloudbursts and flash floods that have occurred during the last five years.

Risk Reduction in Key Sectors Under

Figure:6.1

Pakistan Climate Risk Index in the Past and Present



Source: Germanwatch (2023)

Climate Stress

Risks in Agriculture and Livestock

Reducing agricultural production risks requires strategies that boost resilience and productivity. Water-smart practices like drip irrigation, deficit irrigation, and fertigation can raise yields by about 12 percent and increase water efficiency (Singh et al., 2020; Haruna et al., 2022). Soil-health measures such as mulching, cover crops, and organic amendments conserve moisture and enhance drought resistance (IPCC, 2022; Zhang et al., 2022). Climate-smart breeding to develop stress-tolerant crop varieties is vital as climate risks grow (FAO, 2021a), but adoption remains slow due to limited policy support and awareness.

In livestock systems, integrated approaches like silvopasture and rotational grazing improve forage, stabilize pastures, and store more soil carbon (FAO, 2021a; Nair et al., 2019), also benefiting biodiversity and drought resilience. Overall, combining soil conservation, water efficiency, and agroforestry is key for managing climate risks and supporting sustainable agriculture.

Environmental Risk Reduction

Reducing environmental risks in agriculture can be effectively achieved through regenerative agriculture practices such as no-till combined with cover crops, Alternate Wetting and Drying (AWD), and the System of Rice Intensification (SRI) (Linquist et al., 2015). These methods have demonstrated the potential to cut methane emissions by up to 85 percent, reduce irrigation water use by 25–50 percent, and increase rice yields by 40–100 percent, depending on agroecological conditions (Linquist et al., 2015; Nori, 2022). Verified regenerative agriculture programs in the United States have also generated over 160,000 carbon credits since 2019, channeling more than USD 12 million to participating farmers through carbon markets (FAO, 2021b). Developing low-carbon agriculture and water sectors is key to developing resilient and sustainable climate-neutral pathways.

Agroforestry systems—including alley cropping, hedgerows, and silvopasture—are another proven tool for mitigating environmental risks. Evidence shows these systems can sequester 30–45 percent more carbon than conventional monocultures while boosting farm productivity by around 15 percent (Kort & Turnock, 1999; FAO, 2019). For example, agroforestry projects in Canada reported that 100 km of hedgerows sequestered approximately 1,800 tons of CO_2 annually while diversifying income streams for farmers (Government of India, 2023). These approaches highlight the dual role of regenerative agriculture and agroforestry in reducing environmental impacts while enhancing resilience, sustainability, and profitability in farming systems.

Institutional Risk Reduction

Reducing institutional risks in agriculture requires tackling persistent market and credit challenges faced by smallholders, who often sell produce at distress prices due to inadequate storage and dependence on middlemen. In South Asia, 20–30 percent of grains are lost post-harvest, underscoring the need for improved storage and marketing systems. Cooperative storage and warehouse receipt models have shown promise in enhancing farmers' access to finance and strengthening their bargaining power (Greatrex et al., 2015).

Yet despite significant donor support, progress has been slow, leaving smallholders with limited credit and market access pressures now intensified by climate change. Crop insurance offers another crucial buffer, but design and implementation remain weak. India's Pradhan Mantri Fasal Bima Yojana (PMFBY), which now covers 41.9 million farmers, continues to face delays in payouts, highlighting flaws in indemnity-based models (Government of India, 2023). Properly designed and implemented index-based insurance schemes are therefore essential for building resilience among vulnerable farming communities (Greatrex et al., 2015; World Bank, 2019).

Institutional reforms must also extend to Disaster Risk Management (DRM), drawing on successful international models. Bangladesh's Cyclone Preparedness Program has dramatically reduced mortality through early warning systems and community mobilization (IFRC, 2019; Paul, 2009),

while India's decentralized disaster management authorities enhance localized response capacity. Ethiopia's satellite-triggered social protection scheme demonstrates how safety nets can be rapidly deployed during droughts (Carter et al., 2018). In the Caribbean, parametric insurance has delivered swift payouts after extreme events, and in Nepal, community DRM committees are embedded in local governance to strengthen grassroots preparedness (UNDRR, 2020). Together, these examples illustrate how institutional measures spanning credit, insurance, and DRM are central to building agricultural resilience and safeguarding smallholders against mounting climate and market risks.

Risks in Water Sectors

Floods in Pakistan's river basins including those in 2010, 2022, and the 2025 event have indicated that traditional top-down flood management strategies may not be sufficient for addressing current climate-related risks. Building back better requires rethinking water management through innovative technologies, resilient infrastructure, and ecosystem-based approaches that align with both adaptation and financing opportunities.

Investments in green water infrastructure such as wetlands, mangrove belts, urban green buffers, and floodplain restoration can complement conventional grey solutions like levees and embankments. Ecosystem-based strategies reduce hazard exposure and are often more cost-effective than engineered systems, with green infrastructure requiring 20–40 percent less capital investment and up to 25 percent lower maintenance (UNESCO, 2013a). Wetlands and floodplains help manage peak flows, boost infiltration, and provide benefits like biodiversity and groundwater recharge. In coastal Pakistan, mangrove restoration has lowered storm surge risks and increased blue carbon storage, supporting resilience and carbon credits (IUCN, 2021). Floodplain reforestation on the Indus River can decrease sedimentation, stabilize banks, and enhance agricultural water resources.

Community-based water recharge structures like ponds and small dams reduce flood risk and support water security by capturing rainwater and runoff, replenishing groundwater, and supplying water during dry periods (World Bank, 2021a). These

Figure:6.2

Risk Reduction in Water Sector

Source: Adapted from UNESCO (2013a); IUCN (2021); FAO (2017, 2018); Ramsar Convention Secretariat (2018); World Bank (2023)

affordable, decentralized systems are faster to implement and easier for local communities to manage than large dams, and when used widely in flood-prone areas, they boost agricultural productivity, resilience, biodiversity, and potential carbon credits (FAO, 2018).

Restoring and protecting wetlands further regulates water flow, lowers flood peaks, and filters pollutants, while also providing habitats for biodiversity and benefits like carbon sequestration and eco-tourism (Ramsar Convention Secretariat, 2018; UNESCO, 2013b). Mangrove forests defend coastal zones by absorbing storm surges, reducing wave energy, and preventing erosion. They store significant blue carbon, create climate finance opportunities, and support fisheries and livelihoods, strengthening community resilience to environmental and economic shocks (Alongi, 2015).

Agroforestry systems, including the integration of trees onto farms and along riverbanks, can improve water infiltration, soil stability, and reduce runoff (FAO, 2017). When combined with watershed reforestation, these approaches may positively affect microclimates, increase groundwater recharge, and enhance drought resilience. Additionally, agroforestry can provide various sources of revenue such as timber, fruit, and fodder—and contribute to carbon sequestration and landscape restoration (FAO, 2021a). Pakistan, which has the world's largest contiguous irrigation system, has made limited investments in agroforestry and watershed management.

Climate-smart irrigation methods like drip systems, deficit irrigation, and Alternate Wetting And Drying (AWD) can improve water-use efficiency by 20–30 percent and maintain or boost yields (Zhang et al., 2022). In Pakistan, widespread adoption of High-Efficiency Irrigation Systems (HEIS) is hampered by limited farmer motivation unless driven by cost incentives, profitable markets, or water scarcity (World Bank, 2023, Ahmad 2023) emphasizes that effective water pricing, demand management, and allocative efficiency are essential for encouraging uptake. Aligning technology transfer with market and incentive structures is crucial. These technologies also reduce pressure on water resources, lower methane emissions, and enable access to climate finance (World Bank, 2023).

Strategic Policy Reforms: Bringing Innovation

Financial Risk Reduction

Financial risk transfer mechanisms are increasingly seen as vital complements to adaptation. Index-based crop and livestock insurance, catastrophe bonds, and climate-resilience bonds can buffer communities and governments against shocks. Carbon markets, if transparently managed, can generate revenue streams for communities adopting regenerative practices, turning emissions reduction into financial opportunity. At the household level, microfinance and blended finance approaches have proven effective in enabling vulnerable groups to invest in climate-resilient technologies such as solar pumps or drought-tolerant seeds. The following sections highlight two instruments that can protect vulnerable farmers and others from financial risk: climate insurance and carbon credits.

Climate Insurance

Pakistan's agriculture sector is highly vulnerable to floods, droughts, and heatwaves, yet insurance coverage remains minimal. As highlighted earlier, the 2022 floods alone caused losses exceeding PKR 800 billion in crops, livestock, and fisheries, with most farmers lacking any financial safety net. Climate insurance is one option promoted as part of a layered risk management strategy—combined with climate-smart agriculture, carbon finance, and institutional reforms—it can become a cornerstone of climate resilience in Pakistan.

Pakistan's agricultural insurance remains narrow and inadequate, with the Crop Loan Insurance Scheme (CLIS) covering only loan values for five major crops and excluding non-borrowing smallholders, while livestock pilots suffer from low uptake. Key challenges include limited access, delayed payouts, low awareness, and compensation that rarely offsets actual losses. Emerging innovations—such as index-based pilots and micro-insurance for floods and crops—show promise if designed to be affordable and widely accessible. To

strengthen resilience, Pakistan needs to shift from credit-linked schemes to inclusive, index-based and community-level models, supported by public-private partnerships, premium subsidies, better climate data, and integration with social protection and climate finance.

Climate Finance

Transforming Pakistan's climate risks into economic opportunities requires institutional reform, strategic policy alignment, and stronger capacity to access climate finance (IEA, 2022a). By developing transparent carbon registries, aligning with international standards, and scaling projects in forestry, agriculture, and energy, Pakistan could unlock billions while enhancing resilience to floods and other climate shocks. Integrating carbon market development with flood resilience planning is crucial, allowing revenues from carbon projects to fund long-term adaptation rather than treating risks and opportunities separately. Success hinges on building institutional credibility, systematic project pipelines, and immediate action to avoid further exclusion from the global green economy.

million people and destroying over 2 million homes, with reconstruction needs estimated at USD 16.3 billion (UN DESA, 2022). Without a credible carbon market strategy, Pakistan risks not only recurring disaster losses but also the forfeiture of vital opportunities to finance resilience and sustainable growth.

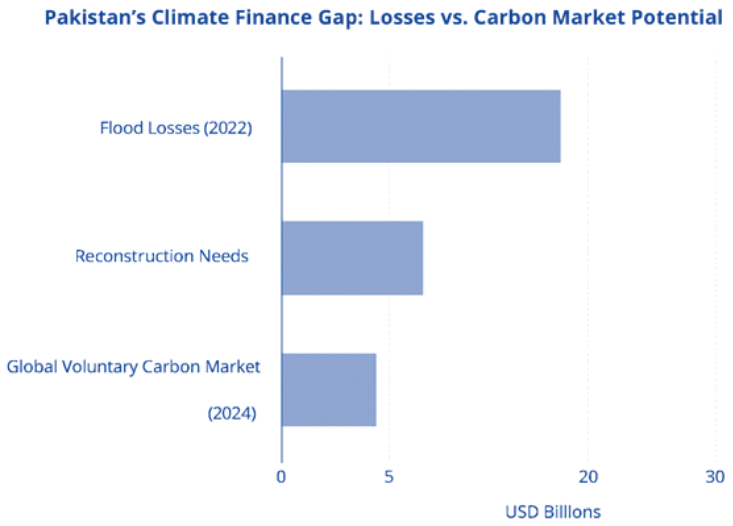
Challenges to Climate Resilience in Pakistan

The challenge for Pakistan is not only to confront climate change but to ensure that its response is equitable, sustainable, and inclusive. Progressing towards climate resilience requires addressing multiple, interconnected barriers that undermine effective action and escalate the costs of loss and damage (IEA, 2022a). These barriers span economic, demographic, technological, and policy dimensions, collectively slowing down the country's ability to adapt and transform.

Economic barriers remain a key factor. Pakistan's fiscal position is affected by increasing debt, with financial policies primarily oriented towards debt

Figure:6.3

Pakistan's Climate Finance Gap



Source: Adapted from IEA (2022a); UN DESA (2022); World Bank (2022)

The costs of inaction are already visible: the 2022 floods caused USD 15.2 billion in economic losses and USD 14.9 billion in damages, affecting 33

servicing rather than structural reforms or investments in resilience (UN DESA, 2022; Asian Development Bank, 2021a). The economy relies

significantly on climate-sensitive sectors such as agriculture and textiles, which raises exposure to related risks, and a reduction in manufacturing is linked to lower economic diversification (UN DESA, 2022). Limited investment in Research and Development (R&D) and innovation constrains the country's capacity to expand climate-smart solutions (Asian Development Bank, 2021a). As of July 2024, Pakistan's energy mix includes hydel (25.35 percent), thermal (45 percent), nuclear (18.19 percent), and renewable (3.26 percent) sources. Despite this diversity, fossil fuels—including coal, oil, and natural gas constitute approximately 70 percent of the mix, contributing to higher business costs (WMO, 2021a).

Demographic pressures exacerbate these risks. With a population growth rate of 2.4 percent, well above the regional average, Pakistan's population is projected to reach 338 million by 2050 (WMO, 2021b). Rapid and largely unplanned urbanization has placed enormous stress on infrastructure, consumed agricultural land, and worsened vulnerabilities linked to water scarcity, sanitation deficits, and urban flooding (CGIAR, 2022). At the same time, the concentration of people in coastal and flood-prone areas increases exposure to sea-level rise, cyclones, and riverine flooding (World Bank, 2022a).

Technological constraints continue to undermine resilience efforts. Limited investments in climate data infrastructure and weak hydro-meteorological forecasting capabilities impede effective preparedness (Government of Pakistan, 2021). Agricultural innovation is fragmented, with only a small proportion of farmers adopting technologies such as drip irrigation, drought-tolerant seed varieties, or solar-based energy solutions (Government of Pakistan, 2021). Additionally, institutions remain underfunded and reliant on external expertise including for carbon market design restricting Pakistan's capacity to achieve long-term self-sufficiency (Shah, 2025).

Furthermore, policy inaction perpetuates these challenges. National climate strategies frequently lack integration with fiscal and development planning, while overlapping mandates between federal and provincial authorities result in duplication and delays (IPCC, 2022b). Weak regulatory enforcement allows environmentally harmful practices, such as unchecked groundwater extraction and construction on riverbeds, to persist (Asian Development Bank, 2021b). The subsidy structure remains imbalanced, with ongoing fossil fuel subsidies and insufficient incentives for renewable energy, sustainable agriculture, and water efficiency. Moreover, the lack of a comprehensive carbon market framework constrains Pakistan from fully accessing climate finance opportunities.

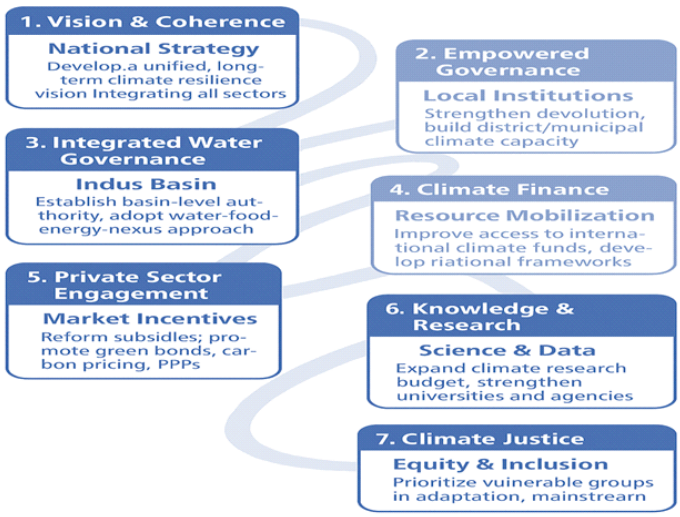
Addressing these challenges requires a coherent, nationally owned climate resilience vision that transcends donor-driven, fragmented efforts. Anchored in the Ministry of Climate Change but integrated across finance, agriculture, water, and energy sectors, such a strategy can align Pakistan's domestic priorities with international frameworks while embedding adaptation, equity, and sustainability into development planning (World Bank, 2021b). Building this coherence is the first of seven critical pathways Pakistan must pursue to transform climate risks into opportunities for resilience and equitable growth.

Strengthening governance, integrating water management, and addressing the climate finance gap are essential strategies for enhancing Pakistan's resilience. While climate adaptation necessitates local action, centralized decision-making has often left district and municipal governments under-resourced and unprepared (World Bank, 2021b; UNFCCC, 2022). Empowering local institutions through devolution and incorporating adaptation into local planning would greatly improve responsiveness. This is directly linked to the need for integrated water governance in the Indus Basin, which faces significant challenges due to climate change, population growth, and geopolitical stresses (UNFCCC, 2022; Ministry of Climate Change, Government of Pakistan, 2021). Establishing basin-level authorities with well-defined mandates, advanced monitoring systems, and effective conflict-resolution mechanisms is vital for managing uncertainty and reducing resource-related instability.

Pakistan faces a major climate finance gap, raising

Figure:6.4

Adaptation Blueprint – Pathways to Climate Resilience



Source: Adapted from World Bank (2021b); UNFCCC (2022); Ministry of Climate Change, Government of Pakistan (2021)

less than USD 1 billion annually versus a USD 348 billion need by 2030. Addressing this requires reforms to improve international fund access, ensure financial transparency, and diversify funding through green bonds, carbon pricing, and public-private partnerships. Fiscal policies should also promote renewable energy, sustainable agriculture, and resilient infrastructure.

Knowledge and justice are essential for resilience. Pakistan's climate research lacks funding and capacity in forecasting and policy development (World Bank, 2021b; Moazzam et al., 2025). Investing in local expertise through universities, think tanks, and agencies will strengthen adaptation strategies. Integrating climate justice into national policies ensures vulnerable groups—such as farmers, women, and the urban poor—are prioritized in adaptation efforts, helping to address inequality (Dawn, 2025a).

Advancing vision, governance, water management, finance, private sector engagement, knowledge, and justice can help Pakistan shift from reactive crisis management to proactive resilience. This strategy aligns domestic goals with global standards for a sustainable, climate-resilient future (World Bank, 2021b).

Linking Climate Risks to Governance and Development

The following case studies illustrate how Pakistan's climate risks, discussed earlier, translate into governance, environmental, and economic challenges. The Ravi River case demonstrates how weak enforcement of floodplain regulations, unchecked urban expansion, and inadequate disaster risk management transform natural hazards into human-induced crises. The Cholistan development initiative highlights how large-scale infrastructure projects, when misaligned with ecological and hydrological realities, can intensify environmental stress and interprovincial tensions. Together, these cases reinforce the chapter's core argument that Pakistan's climate vulnerability stems as much from governance and institutional shortcomings as from physical exposure, underscoring the need for integrated, transparent, and climate-resilient planning.

Case Study 1: Ravi River Encroachments, Flood Impacts, and Revival

The Ravi River in Pakistan presents a notable case for examining the multifaceted challenges associated with river basin management, especially in the

aftermath of recent flood events. The basin spans approximately 4.1 million hectares and includes 14 districts such as Sheikhupura, Kasur, Sialkot, and Lahore. Water flow in the Ravi River has experienced a dramatic decline from 7 million acre-feet in the 1960s to just 1.2 million acre-feet, attributable largely to the Indus Water Treaty—which allocated significant water rights to India—as well as intensified urbanization and infrastructural development along the river's path, resulting in diminished groundwater recharge capacity (The Express Tribune, 2025).

This reduction in river discharge has triggered considerable environmental and social ramifications. The decreased water levels have facilitated expanded residential growth along the riverbanks, including informal settlements and opportunistic land acquisitions by certain groups taking advantage of riverfront property. Additionally, limited flows have led to the transformation of sections of the riverbed into sites for urban waste disposal from cities such as Lahore, substantially undermining water quality. Pollution, notably from toxic metals, has severely damaged aquatic ecosystems and fisheries, with the extinction of 31 fish species over the past two decades, thereby impacting both biodiversity and community livelihoods reliant on fishing (RUDA, 2025).

Furthermore, degraded water quality poses critical public health concerns. Irrigation using contaminated river water has contributed to the increased prevalence of waterborne diseases—including hepatitis, cholera, and typhoid—across Punjab. The direct introduction of urban waste and hazardous substances into river channels amplifies health risks for local populations (Case Study, 2025).

The flood event of 2025 within the Ravi River basin underscored systemic institutional shortcomings related to uncontrolled urban development, unlawful housing projects, and inadequate enforcement of floodplain regulations, particularly in and around Lahore, Punjab, Pakistan. Despite regulations prohibiting construction on flood-prone land along the Ravi River, private housing schemes and informal settlements were still developed due to weak or inconsistent enforcement from RUDA and LDA. Developers claimed river training works and embankments would provide protection; however, these measures proved insufficient during flooding, resulting in significant damage to societies such as Park View City and New Metro City. Many developments lacked proper authorization and No Objection Certificates (NOCs) from the irrigation department (The Friday Times, 2025a; Eco-Business, 2025; Youlin Magazine, 2025; Case Study, 2025).

The flood amplified criticism of governance failures, including:

- Disparities between agencies in approval and enforcement of rules.
- Slow progress and limited scope of river training and flood protection infrastructure.
- Corruption and influence of land mafias pushing illegal developments.
- Lack of coordination among disaster management authorities at national, provincial, and district levels, leading to poor early warning dissemination, inadequate eviction or evacuation planning, and fragmented flood response.
- Failure to incorporate resilient, nature-based urban planning despite expert recommendations from earlier Ravi Riverfront studies.
- Policy and administrative slippages that allowed the conversion of sensitive river corridors and flood plains into urban sprawl, increasing runoff, blocking natural floodwater pathways, and diminishing river ecology.

The 2025 Ravi flood highlighted critical challenges related to property loss, the displacement of thousands, and widespread demands for institutional accountability. Observers assert that the event was exacerbated by human mismanagement and governance failures rather than being solely a natural disaster. In response, RUDA has intensified actions against illegal encroachments, initiated arrests of key land mafia members, and announced plans for enhanced flood embankments. These measures are accompanied by calls for comprehensive reform in transparent land use planning,

stringent enforcement of environmental regulations, and collaborative governance to ensure sustainable river management (Youlin Magazine, 2025; Case Study, 2025; Eco-Business, 2025).

Case Study 2: Cholistan Development – Does It Make Economic Sense?

The Special Investment Facilitation Council (SIFC) has brought renewed focus to Pakistan's water sector. Traditionally, the country has responded to challenges as they occur, rather than establishing comprehensive, long-term policies. The current initiative, which involves collaboration with the military, is intended to foster export-driven growth within the agricultural sector. The Cholistan region covers 6.65 million acres, comprising Smaller Cholistan (1.99 million acres) and Greater Cholistan (4.66 million acres). The project under consideration seeks to develop additional command areas by harnessing water from the Sutlej River along with seasonal flood resources.

Key Components

Key components of the proposed Cholistan Canal Project include:

- Construction of a 176 km Cholistan Canal (capacity: 4,120 cusecs).
- Remodeling of several link canals, including the Rasul–Qadirabad–Balloki–Sulemanki (RQBS) system.
- Phase I: Development of 455,000 acres at an estimated cost of Rs 211,340 billion.
- Phase II: Development of 744,000 acres, supported by a 120 km Marot Canal and 452 km of minor channels (Case Study, 2025).

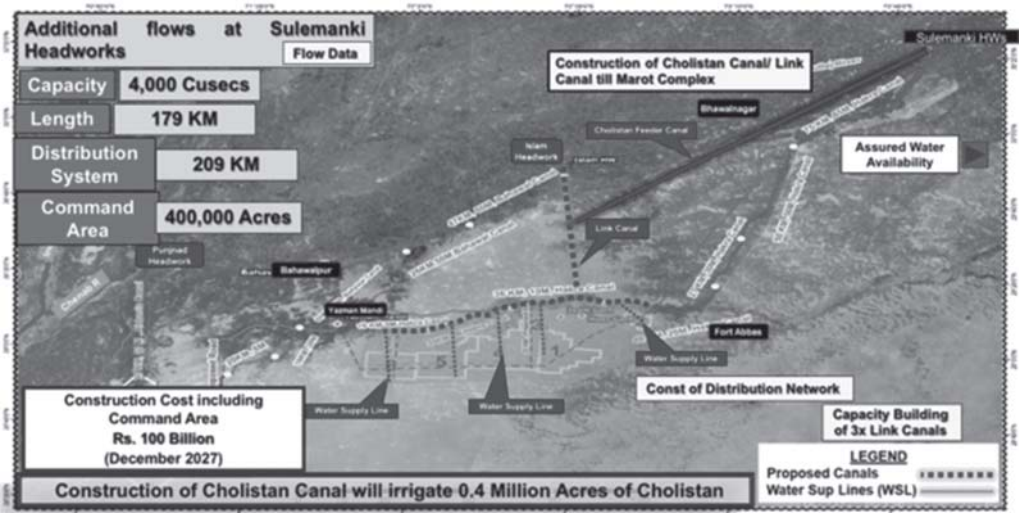
The design and implementation of this project prompt significant considerations regarding adherence to technical, economic, environmental, and social standards, as well as the potential efficacy of alternative funding approaches. In the context of agricultural and irrigation projects, access to reliable and high-quality water resources is essential. However, concerns have been expressed about the IFC's decision to allocate land prior to a comprehensive assessment of available water for expansion purposes. The feasibility study was limited in scope, predominantly referencing a WAPDA presentation, which estimated surplus water supply from the Bhasha and Mohmand dams on the Indus River for the Cholistan initiative. Notably, there has been insufficient analysis of the source of additional water, along with its associated environmental and economic impacts, and whether more sustainable solutions could be considered.

The Cholistan Canal project is stalled due to Sindh's concerns that Punjab's plans would divert water from its share under the Interprovincial Water Accord. Public protests and critics argue any extra water would come at Sindh's expense, while proponents believe surplus flows from the Mohmand Dam could help if link canals are upgraded. Uncertainties remain over whether water transfer would use gravity or pumping both costly options. The plan to expand by 455,000 acres at Rs 211,340 billion raises questions about whether all transfer costs are included (Case Study, 2025).

Although prevailing plans prioritize extensive canal infrastructure intended to attract corporate agriculture, Cholistan presents viable alternatives through cost-effective, ecosystem-based approaches. Strategies such as managed aquifer recharge using floodwaters, wetland and grazing land restoration, and the adoption of drought-resilient agro-pastoral systems may deliver substantial benefits at significantly reduced capital costs. These nature-based solutions are consistent with global best practices in water and land management, advancing climate resilience and enhancing local livelihoods. The integration of water harvesting, rangeland rehabilitation, and sustainable farming could enable Cholistan's development to extend beyond large-scale investment projects, offering tangible advantages to local communities, pastoralists, and smallholder farmers who rely on the desert environment. This approach represents a transition from an exclusively capital-intensive model to one that harmonizes environmental restoration with inclusive rural progress.

Figure:6.5

Proposed Cholistan Canal Project Overview



Source: Case Study (2025); WAPDA presentations

Alternative Investment Pathways and Their Rationale

Research by the Climate Policy Research Unit at the Abdus Salam Forum is evaluating investment options for the Cholistan desert. Comparing canal irrigation to sustainable land management methods like silvopasture and silviculture, preliminary results show silviculture provides the best cost-benefit ratio (2.8–3.2) and internal rate of return (20–22 percent). Benefits include forest restoration, soil carbon improvement, biodiversity protection, and strong potential for carbon credits. Carbon markets further improve the financial viability of these flexible and scalable solutions over canal-based infrastructure.

The analysis of the Cholistan Canal Project yields several important conclusions and recommendations:

- The Cholistan Canal Project, in its current form, comes with financial, environmental, and social risks, including concerns about economic feasibility due to substantial costs, reduced river flows, and terrain-related challenges.
- There is a suggestion to consider prioritizing investment in nature-based, demand-driven, and technologically adaptable water management strategies, such as improved groundwater management with modern filtration and pumping technologies.
- Alternative approaches such as sustainable rangeland management, silvopasture, and silviculture are identified as methods that could support ecological restoration, livelihood diversification, carbon sequestration, and reduction of climate-related risks.
- Governance reforms have been proposed to promote equitable water distribution, transparent project evaluation, ongoing stakeholder engagement, and the integration of the water-energy-food nexus into planning processes.
- Focusing on demand management, water use efficiency, and ecosystem services is presented as an approach to sustainable agricultural development and climate resilience in the region, rather than relying solely on large-scale, capital-intensive canal projects.
- Policymakers and investors are advised to consider a cautious, phased strategy, which incorporates comprehensive feasibility and environmental assessments, innovative technol-

ogy adoption, and community-based natural resource management, aiming to improve investment returns and long-term sustainability for Cholistan's development.

Conclusions and Recommendations

Pakistan's escalating climate impacts reveal that vulnerability is as much institutional as environmental. The case studies of the Ravi River and Cholistan region highlight how weak governance, fragmented land and water management, and reactive planning have amplified disaster risks and ecological degradation. Despite multiple policy frameworks, enforcement remains inconsistent, while short-term, capital-intensive projects often substitute for evidence-based, ecologically balanced planning. Building genuine resilience requires shifting from project-based interventions to systemic reforms grounded in transparency, sustainability, and local participation.

Key Conclusions

Governance Failures Exacerbate Climate Risks: Unregulated urban expansion, weak environmental compliance, and overlapping mandates among planning authorities have intensified flood and water risks.

Ecological Degradation Undermines Resilience: Loss of wetlands, mangroves, and forest cover continues to heighten vulnerability to floods and droughts.

Planning without Ecological Assessment: Major infrastructure and irrigation projects often proceed without comprehensive environmental and hydrological evaluations, leading to long-term social and economic costs.

Institutional Fragmentation: Coordination gaps between provincial agencies, disaster management authorities, and urban planners have hindered integrated responses to climate hazards.

Policy Recommendations

Enforce Ecological Zoning and Floodplain Regulation: Strengthen legal enforcement to prevent construction and land conversion in flood-prone and ecologically sensitive zones. Introduce mandatory environmental impact audits for all major development schemes.

Establish River Basin and Watershed Authorities: Create integrated governance frameworks for major river systems (e.g., Ravi Basin Authority) to coordinate land use, water allocation, and flood management across jurisdictions.

Prioritize Nature-Based Urban and Rural Solutions: Promote wetland restoration, riparian buffer zones, and green flood infrastructure to complement engineered defenses, reducing runoff and enhancing natural water retention.

Reform Institutional Coordination Mechanisms: Mandate structured collaboration between NDMA, provincial disaster management authorities, irrigation departments, and urban development bodies, supported by shared data systems and early-warning platforms.

Integrate Environmental and Land Governance: Align planning authorities (e.g., LDA, RUDA) under a unified regulatory framework ensuring that land development complies with river ecology and climate resilience standards.

Adopt Evidence-Based Project Evaluation: Require all large-scale water and land projects (such as in Cholistan) to undergo independent hydrological and environmental appraisals before approval, ensuring alignment with sustainability and interprovincial equity principles.

Build Local Institutional Capacity: Empower local governments and community-based organizations to monitor land use, manage small-scale flood defenses, and implement early warning systems.

Strengthen Transparency and Public Accountability: Introduce public disclosure mechanisms for project approvals, environmental compliance, and enforcement actions to reduce corruption and promote civic oversight.

The Ravi and Cholistan cases collectively demonstrate that resilience cannot be engineered through

infrastructure alone. It must emerge from transparent governance, sound ecological management, and participatory institutions capable of enforcing laws and managing shared resources. Aligning land, water, and climate governance under an integrated national framework is therefore essential to prevent recurring disasters and to build a sustainable, climate-resilient Pakistan.

Chapter

7 Climate Smart Agriculture for Soil Health in Pakistan: Lessons from SAWiE

Climate Smart Agriculture for Soil Health in Pakistan: Lessons from SAWiE

Dr. Khalid Mahmood

Introduction

The agri-food system remains vital to Pakistan's economy and is the primary source of income for a significant portion of the rural population. The agriculture sector contributes 23 percent of the country's Gross Domestic Product (GDP) and its contribution has remained stable over the past three decades. The sector generates a quarter of total export earnings. Approximately 40 percent of Pakistan's labour force is still engaged in agriculture. More than 61 percent of Pakistan's people reside in rural areas and are largely dependent on crop and livestock productions. Overall, two out of three employed women work in the agri-food sector (Bank, 2023).

The majority of the farmers in Pakistan are smallholders whose subsistence livelihoods depend on agriculture, and the proper functioning and performance of the agriculture sector is linked with the overall well-being of small farmers (Shahbaz & Ata, 2014). Recent estimates suggest roughly 65 percentage of rural households are smallholder farmers. These farmers have fragmented landholdings, posing a significant barrier to efficient farming. Many smallholders operate non-contiguous plots, which hinders mechanization, increases production costs, and reduces overall productivity. This fragmentation is further compounded by the absence of land consolidation programs and modern cadastral mapping.

Another critical concern is the stark gender disparity in landownership. Despite women making up a substantial portion of the agricultural labour force, they own less than 5 percent of agricultural land in Sindh (FAO, 2022). Without formal ownership or inheritance rights, women are largely excluded from decision-making and credit access, limiting their contributions to agricultural development. (Brohi, 2025) Even though rural women in agriculture and the household sector all over Pakistan play an important and vital function in crop production and maintenance, food production and processing, feeding their families, and perform some other important and essential duties and responsibilities. It must be appreciated that they perform such type of responsibilities. Women make contributions to daily labour, are daily wage earners, and are other entrepreneurs. They are performing these duties honestly, but unfortunately, only 20 percentage land area of the total world land is owned by women still facing many obstacles and constraints in their way of work (Zahra, 2022).

In this context, Climate Smart Agriculture (CSA) has emerged as a pivotal framework to sustainably transform Pakistan's food systems. CSA aims to achieve three interlinked goals sustainably increase productivity, enhance resilience (adaptation), and reduce greenhouse gas emissions (mitigation) while promoting social inclusion and environmental stewardship (Lipper et al., 2014). Within Pakistan, the Soil Health pillar of CSA holds particular significance: poor soil organic matter, salinity, and

nutrient imbalance now limit productivity more than water in many regions.

To address this challenge, innovative organizations like Sustainable Agriculture Water & Intelligent (SAWiE) Ecosystems are driving a new generation of farmer-led climate-smart initiatives. Through regenerative agriculture clusters in rice and cotton systems, and the Climate Smart Village Initiative (CSVI) in collaboration with Bank Alfalah in Pakistan, SAWiE is demonstrating how meaningful engagement with farming communities at the grassroots level can foster the development and implementation of climate-smart agricultural practices. The CSV approach integrates social interactions, peer learning, farmer field schools, digital tools, soil health interventions, and local knowledge, working together to build climate-resilient livelihoods and empower farmers as agents of change.

This chapter explores the science and practice of CSA for improving soil health in Pakistan, situating SAWiE's work within national and global frameworks and offering lessons for scaling regenerative systems in arid and semi-arid environments.

The Climate Challenge and Soil Degradation in Pakistan

Pakistan's climate has warmed by approximately 0.6°C since the 1960s, with projections suggesting a further rise of 1.5–2°C by 2050 (IPCC, 2021). The frequency of droughts and floods has increased, particularly affecting the Indus Basin, the country's agricultural heartland. Meanwhile, unsustainable irrigation, excessive tillage, and chemical fertilizer misuse have accelerated soil degradation.

Soil erosion has been a major issue in Pakistan, which has a major impact on rainfed agriculture. Wind and water erosion affect over 76 percent of the total land mass of the country, with water erosion affecting some 36 percent of the area, and the land being affected by wind erosion is 40 percent. The issue of soil crusting is also very pernicious in the rainfed regions, leading to soil erosion and rendering crop husbandry and agronomic activities challenging to achieve. Low organic matter and high fine silt, sand and sodium content in the rainfed regions generally lead to the crusting of the surface soils. High ploughing and heavy, intense rains also increase the issue. Crusting and compaction of soil are known to impair the entry of water and raise the water runoff, and result in soil erosion among rainfed regions in Pakistan.

In rainfed areas soil is centuries old and as such, its fertility levels have reduced to a level that impacts negatively on the crop yields. Also, the farmers in rainfed areas are practicing low-input (low rates of fertilizers) agriculture as the risk is too high due to climatic uncertainties. Over-farming may result in destruction of the soil structure and due to this fact, soils cannot hold sufficient moisture to sustain the growing crops. At the national level, nearly 96 percent of the total soils that are put under the plough lack the ideal concentration of organic content in order to underpin good farming activities. The contents of organic matter of some 77 percent of soils are <0.80 percent and 4 percent of soils contain organic matter content >1.2 percent. The potential cause of low organic matter levels of soils might be explained by the existing climatic (arid to semiarid) and agricultural activities. The crop residues are reported to enhance the physical properties of the soils, and they are supposed to increase the contents of organic matter, but rather than introducing crop residues and animal wastes to the soils, they are largely utilized as fuel and fodder (Baig et al., 2013).

Land salinization has resulted in the loss of 5.7 million hectares of arable land. According to the Nuclear Institute of Agriculture and Biology (NIAB) in Pakistan, this number is increasing every year by 40,000 hectares. A high salt content in soil cannot support the growth of most crops, which makes fields appear like deserts, thus it has been a great threat to food security. Soil salinity may be natural, and it may be brought by the rise of sea level or any other environmental reasons. It may also be an implication of agricultural activities. In Pakistan, farmers have resorted to using ground water as a source of irrigation because of the unpredictable climatic conditions caused by the change in climate. Nevertheless, the salty groundwater water which has a high concentration of salt, worsens soil

salinization. (Evans, 2024).

Water logging and salinity are two major issues that threaten the sustainability of irrigated agriculture and are among those that affect the production of crops in Pakistan. Millions of hectares have been lost to the challenge of salinity, almost half of which is under the cultivation of irrigated agriculture. Indus Basin has experienced various efforts to control waterlogging and saltiness such as tube well usage, leaching of salt through over irrigation, the application of chemicals and biological and physical methods (Khan et al., 2022). However, to counter this, Sindh is actively exploring the possibility of saline agriculture and aqua-agriculture to adapt to environmental changes. But further research and more funding is required to improve this infrastructure. This in theory can reduce dependence on freshwater species and transition to a productive saline ecosystem.

The soil provides all the known essential nutrients of plants. Nonetheless, the continuous mining of the necessary plant nutrients of soil is a result of crop intensification and the cultivation of soils over the years. The available plant nutrients of most of the soils in Pakistan are in a poor state and they are unable to facilitate an optimum amount of crop productivity. The mining of the nutrients needed by plants is reducing the soil fertility. The nutrient availability can however, be enhanced through good tilth and the physical state of soil. (Ahmad, 2025)

According to the National Soil Survey of Pakistan (2020), more than 43 percent of cultivated land suffers from some form of degradation:

- **Salinity Affects** ~6 million hectares.
- **Waterlogging Impacts** ~2 million hectares.
- **Low Organic Matter (<0.5 percent)** is found in 70 percent of cropland soils.
- **Micronutrient Deficiencies** (especially zinc and boron) are widespread.

The decline in soil health undermines productivity and resilience. Degraded soils lose their capacity to store carbon, retain water, and support biological activity, amplifying vulnerability to drought and flood shocks.

Thus, soil health restoration is both a mitigation strategy (for carbon sequestration) and an adaptation imperative (for water efficiency and yield stability).

Climate Smart Agriculture (CSA): Framework and Relevance for Pakistan

The concept of climate-smart agriculture (CSA) depicts a desire to enhance the incorporation of agriculture responsiveness to climate and development. It aims to realize food security and greater development aspirations in the changing climate and rising food demand. CSA projects are sustainable to boost productivity. resilience, and mitigate/ eliminate Greenhouse Gases (GHGs), and need robust planning to deal with trade-offs and synergies among these three pillars: productivity, adaptation and mitigation. The priorities of various countries and reflexivity amongst the stakeholders is realized in pursuit of efficiency and effectiveness and food systems that solve difficulties in across the environmental, social, and economic dimensions of productive landscapes. Although the idea is fresh and yet changing, most of the practices that constitute CSA already serve the purpose of helping farmers all over the world in various production risks. Mainstreaming CSA requires a critical stocktaking of current and prospective promising practices of the future, and of institutional and financial facilitators of CSA adoption. The CSA approach, articulated by Food and Agriculture Organization (FAO), promotes an integrated management of soils, water, crops, and biodiversity to achieve triple wins: productivity, adaptation, and mitigation. Its operationalization requires context-specific adaptation tailored to local biophysical and socio-economic realities.

In Pakistan, CSA aligns with multiple policy frameworks:

- **Pakistan Vision 2030** emphasizes climate resilience and sustainable land use.

- **National Climate Change Policy (2021)** integrates CSA under adaptation priorities.

- **Punjab Climate Smart Agriculture Strategy (2023–2030)** promotes soil health, efficient irrigation, and climate-resilient cropping systems.

CSA in Pakistan is evolving beyond demonstration pilots to institutional partnerships, combining science, technology, and community-driven innovation. SAWiE exemplifies this transition, linking research, the private sector, and farming communities through digital, regenerative models.

Soil Health: Foundation of Climate Smart Agriculture

Healthy soils are living ecosystems that regulate water, nutrients, and carbon flows. CSA interventions increasingly focus on restoring soil organic carbon, enhancing microbial activity, and improving soil structure to buffer against climate shocks.

Key soil health principles underpinning CSA include:

- **Minimizing Soil Disturbance** (conservation tillage, direct seeding).

- **Maintaining Organic Cover** (crop residues, cover crops).

- **Diversifying Rotations** (legume integration, intercropping).

- **Optimizing Nutrient Cycling** (balanced fertilization, biofertilizers, compost).

- **Enhancing Water-Use Efficiency** (precision irrigation, alternate wetting and drying).

In Pakistan's Indus Basin, where soil salinity and declining fertility constrain yields, integrating these principles through localized knowledge and technologies is central to the regenerative transition.

Integrating Regenerative Agriculture

Approach

The use of a digital platform bridges the gap between scientific research, digital technology, and community engagement to promote climate-smart and regenerative farming. Built on a data-driven and participatory approach, the platform leverages satellite imagery, AI-based analytics, IoT sensors, and farmer-centric digital tools to deliver adaptive, evidence-based solutions that enhance productivity while conserving natural resources.

Beyond improving crop management, the digital platform places strong emphasis on gender inclusion, livestock integration, and rural enterprise development, ensuring that women farmers and entrepreneurs are actively engaged in regenerative value chains. By providing women with access to knowledge, technology, and financial opportunities, it strengthens their role as decision-makers and contributors to rural economies, helping create equitable and climate-resilient farming communities.

The regenerative agriculture clusters focus on four core objectives:

Improve Soil Health and Ecosystem Resilience

- Promote organic matter rehabilitation, cover cropping, composting, and residue recycling to restore soil vitality.

- Rebuild eroded soils, enhance carbon sequestration, and reinforce nutrient cycles critical for long-term fertility.

- Support biodiversity through agroforestry, crop rotation, and habitat restoration that improve pest control and soil structure.

Maximize Input Efficiency

- Conducting soil and water analysis for application of nutrients.

- Promote efficient irrigation management systems including sowing on ridges to reduce water consumption and energy needs.

- An early warning system for pests and diseases, enabling timely, cost-effective interventions.
-

Integrate Livestock for Circular Resource Use

- Encourage integrated crop–livestock systems that recycle nutrients, enhance soil organic matter, and reduce dependence on synthetic inputs.

- Promote climate-smart fodder management, rotational grazing, and manure composting to close nutrient loops and reduce methane emissions.

- Support small ruminant and dairy enterprises, particularly women-led livestock ventures, as a means of income diversification and food security.

Empower Smallholders and Strengthen Rural Enterprises

- Deliver localized farm advisory services through mobile applications, WhatsApp, and field extension teams using local languages.

- Facilitate traceability and certification systems that document sustainable practices, connecting farmers to premium markets and sustainability-driven brands.

- Support the growth of women-led micro enterprises in input supply, compost production, seed saving, value-added processing, and livestock-based products, enabling inclusive rural economic growth.

Case Study 1: SAWiE Regenerative Rice Cluster – Building Soil Carbon and Water Resilience

Location: Gujranwala, Punjab
Duration: Since 2023
Objective: Transition rice farmers from conventional flooded systems to regenerative, water-smart practices.

Rice is cultivated on nearly 162 million hectares across more than 100 countries, with an estimated annual value exceeding US $300 billion. It is a cornerstone of global food security, sustaining the livelihoods of over 3.5 billion people, particularly in Asia, where it serves as a vital source of nutrition, employment, and rural development.

In Pakistan, rice is grown on approximately 3.5 million hectares, making it the second major staple crop after wheat and a key contributor to export earnings of more than US$4 billion and rural livelihoods. However, conventional rice cultivation relies heavily on chemical fertilizers, pesticides, and water-intensive practices, leading to soil degradation, nutrient loss, and water pollution, while contributing to greenhouse gas emissions. The impacts of climate change, including rising temperatures, unpredictable rainfall, and extreme weather events, further threaten rice productivity and quality.

To address these challenges, SAWiE launched the Regenerative Agriculture Rice Cluster (RARC) in Pakistan in 2023. The initiative works closely with local farmers to transition towards regenerative rice systems that prioritize soil health, biodiversity restoration, and water conservation. Aligned with the UN Sustainable Development Goals (SDGs) and the Intergovernmental Panel on Climate Change (IPCC) carbon reduction objectives, RARC positions Pakistan as an emerging leader in climate-smart and sustainable rice production.

In Punjab, where rice farming is predominantly based on continuous flooding, traditional practices result in excessive methane emissions, soil compaction, and nutrient depletion. The Regenerative Rice Cluster demonstrates how the adoption of Alternate Wetting and Drying (AWD) and Integrated Pest Management (IPM) can maintain or even enhance yields while reducing water use, improving soil structure, and lowering environmental impacts.

By integrating digital monitoring tools, farmer field schools, and community-based learning, the RARC model offers a scalable approach for low-emission, resource-efficient, and climate-resilient rice farming, benefiting both the environment and farming communities across Pakistan's rice-

growing regions.

Key Interventions:

AWD Tubes (Alternate Wetting and Drying)

Sawie promoted AWD method with soil moisture sensors reduced irrigation frequency by 30–35 percentage also reducing GHGs emissions by up to 41 percentage and cuts water use by 40 percentage. AWD involves controlled irrigation cycles that allow rice fields to dry between watering stages, optimizing water use and nutrient uptake.

Mechanical Transplantation

Typically, rice is transplanted manually by farmers working under extreme weather conditions. SAWiE promoted the usage of mechanical transplanters to improve plant population and reduce water and nutrient loss.

Laser Land Leveling

- SAWIE encouraged farmers to execute laser land leveling. This helped to improve water distribution across rice fields, improving crop uniformity and reducing water wastage.

- IPM and Early-Warning Systems

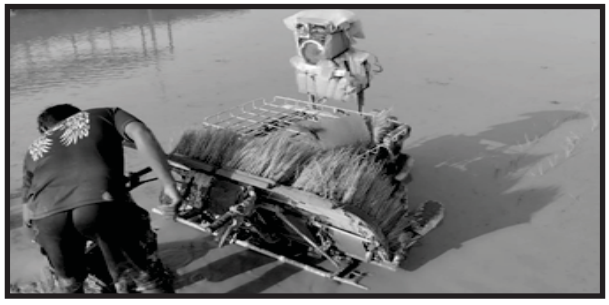
- SAWiE Advisory supported farmers in protecting crop health by helping them manage threats like rice stem borers and bacterial leaf blight. Farmer field schools and digital dashboards provided data on soil EC, pH, and carbon status.

Outcomes

- 40 percent reduction in water use.

- 15 percent yield stability under stress conditions.

- 50 percent reduction in GHG emissions



Case Study 2: SAWiE Regenerative Cotton Cluster – Soil, Carbon, and Supply Chain Integration

Location: Bahawalpur
Focus: Integrating soil health, reducing use of pesticides, protecting biodiversity, and traceability in cotton landscapes.

Cotton, one of the world's most important natural fibers, is cultivated on approximately 32.5 million hectares (80 million acres) across more than 75 countries. Valued at around US $50 billion annually, the crop supports the livelihoods of over 350 million people, including farmers, workers, and businesses along the textile value chain. It is a critical raw material for the global fashion and textile industry, particularly in developing countries, where it drives employment, rural income, and export earnings.

However, conventional cotton cultivation is highly resource-intensive, relying on chemical fertilizers, pesticides, and irrigation water, which leads to soil degradation, water pollution, and biodiversity loss. The sector is increasingly vulnerable to the climate crisis—with rising temperatures, prolonged droughts, flooding, and unpredictable rainfall patterns threatening yields, fiber quality, and farmer livelihoods.

At the same time, the fashion industry, which depends heavily on cotton, is facing growing scrutiny for its environmental footprint. Globally, the industry contributes up to 10 percent of total carbon emissions, consumes an estimated 93 billion cubic meters of water annually, and generates millions of tons of textile waste. Unsustainable sourcing and linear "take–make–waste" production models have exacerbated soil depletion, chemical contamination, and microfiber pollution, making the transition to more ethical and regenerative systems an urgent priority.

To address these challenges, SAWiE, in collaboration with a local ginning factory, launched the Regenerative Agriculture Cotton Cluster (RACC) in 2024. Partnering with local farmers, RACC is scaling up and introducing regenerative practices that restore soil health, enhance biodiversity, and improve water use efficiency while reducing reliance on agrochemicals. The initiative connects farm-level sustainability with responsible textile production, linking cotton growers directly with fashion brands committed to reducing their carbon footprint and meeting sustainability and traceability standards.

By integrating digital farm monitoring tools, soil health assessments, and capacity-building programs particularly for women and smallholders, the RACC initiative is helping to transform cotton cultivation into a climate-resilient, transparent, and inclusive system. This holistic approach not only mitigates climate impacts but also aligns with the UN Sustainable Development Goals (SDGs) and emerging EU Digital Product Passport (DPP) frameworks, setting a precedent for climate-smart cotton supply chains that benefit both people and the planet.

Key Interventions:

Raised Bed Planting (RBP)
SAWIE introduced Raised Bed Planting to reduce water usage for irrigation by up to 30 percent while enhancing root oxygenation and promoting healthier crop growth.

Crop Residue Composting
Through its training programs, farmers are now utilizing compost made from farm waste and livestock manure, significantly decreasing reliance on chemical fertilizers.

Integrated Pest Management (IPM)
RACC is implementing innovative pest control methods, such as pheromone and yellow sticky traps, enabling farmers to safe and responsible pesticide use to just three applications per season. This intervention has substantially lowered input costs while preserving crop health.

Leguminous Crop Rotation
By planting rotations and border crops such as Janter, attracting pollinators and beneficial insects, which has led to improved biodiversity and higher crop yields.

Livestock Integration

RACC approach integrates livestock for grazing, which naturally returns nutrients to the soil, enhancing soil fertility and supporting regenerative agriculture practices.

Outcomes

- Improved water use efficiency by +30 percent
- Improved soil health +0.25 percentage increase in soil organic matter over two years.
- Verified carbon sequestration through soil sampling and satellite monitoring.
- Strengthened farmer–buyer relationships through transparent sustainability metrics.

Case Study 3: SAWiE Climate Smart Village Initiative (CSVI)

SAWiE and Bank Alfalah have jointly pioneered three Climate Smart Villages (CSVs) across 3 major cropping systems in Pakistan: Rice-Wheat, Maize-Potato, and Cotton-Wheat. These CSVs serve as live demonstration hubs for regenerative practices, digital tools, and green finance integration. Since January 2025, the CSVI initiative has directly engaged 200 farmers, building capacity for sustainable production and improved market access. The framework is structured around 6 core pillars, with crop-specific interventions designed under each pillar. It combines community co-design, soil and water management, digital services, and local innovation.

Approach

- Villages are selected across diverse agro-ecological zones.
- Participatory soil testing and mapping identify constraints.
- Community irrigation scheduling, composting, and tree planting improve microclimates.
- Digital dashboards support farmers with real-time weather, irrigation, and pest advisories.
- Women and youth are trained as Climate Champions, ensuring inclusive adaptation.

Impact Highlights

- 15–20 percent improvement in soil structure and water retention.
- 30 percent reduction in fertilizer costs through nutrient management planning.
- Enhanced local biodiversity through agroforestry and cove.

Conclusion

Sustainable food systems are based on healthy soils. In Pakistan, where more than 80 percent of agricultural land is in the arid and semi-arid areas, climate resilience, food security, and rural livelihoods are determined by the restoration of soil health. Poor soils that are low in organic matter and imbalanced in their nutrients pose the challenge of low productivity and low water efficiency, and thus, soil regeneration is a national agenda, not a sectoral issue.

Climate Smart Agriculture (CSA) provides a practical approach to setting productivity, adaptation, and mitigation objectives. CSA meets the short and long-term climatic issues by increasing the efficiency of input, encouraging diversified cropping systems, and increasing the rate of carbon sequestration. A combination of regenerative agriculture with CSA principles opens a way of sustainable intensification - to produce more without damaging the ecology.

This transition is seen through the physical evidence of regenerative rice and cotton clusters in SAWiE. Farms have shown improvement in organic carbon of the soil, water retention, and the efficiency of the organic fertilizers through organic amendments, microbial inoculants, and precision management of inputs. These profits have been accompanied by social returns like better farmer income, involvement of women, and dependency on chemicals.

Moreover, the Climate Smart Village model is an illustration of how digital technology, community organization, and local innovation can result in bottom-up scaling of soil health projects. These villages are living laboratories, and farmers co-designed adaptive solutions, which are assisted by real-time digital advisory and satellite surveillance.

Chapter

8 Climate Injustice and Economic Extraction

Climate Injustice and Economic Extraction

Shahzad Shaukat

The Spiritual and Governance Failure

Pakistan stands at a crossroads, not just of climate vulnerability, but of moral accountability. The floods of 2022 and 2025 displaced tens of millions, yet policy silence continues to drown the poor. While ministries debate carbon pricing and donor frameworks, the less fortunate citizens burn rubber tyres and trees as fuel to survive, and bear the cost of decisions they never made.

Despite the escalating climate crisis, federal budget allocations remain grossly misaligned with environmental imperatives. Since 2018-19, for every Rs. 100,000 paid by the federal government, a mere Rs. 5 is directed toward environmental protection. This is an alarming ratio that exposes chronic underinvestment in ecological resilience.

This fiscal neglect is not just a budgeting oversight; it is a systemic misallocation with devastating consequences. Every sector, agriculture, health, energy, and urban infrastructure, and every citizen, pays the price through rising climate vulnerabilities, degraded natural assets, and mounting economic liabilities. These losses are compounded by the prioritization of interest-based financial policies, which divert critical resources away from regenerative, justice-oriented development.

The human and economic toll is staggering. Pakistan's chronic underinvestment in environmental protection has unleashed a cascade of preventable suffering. Each year, 128,000 lives are lost to air pollution, while 49 percent of the population lacks access to safe drinking water. By 2050, heat-related deaths are projected to quadruple, and millions will be displaced by floods, with no sovereign safety net to absorb the shock. Trillions of rupees in economic losses, silently borne by the poor and the vulnerable. These figures are not just statistics but they are a reflection of policy failure, moral abdication, and the urgent need for climate sovereignty.

When rulers neglect the environment, they violate both divine trust and economic logic. In a nation where over 200 million people face poverty, breathe polluted air, and drink contaminated water, environmental betrayal is not just a natural crisis - it is an existential one. Living in such conditions is like breathing inside a dying shell.

In Islam, the Earth is not a commodity - it is a trust.

"The Earth is green and beautiful, and Allah has appointed you His stewards over it." **Prophet Muhammad (SAW) (Sahih Muslim)**

The Qur'an reminds us that every creature and bird forms communities like ours (Al-An'am 6:38), and that humanity's role is stewardship, not ownership (Al-An'am 6:165). This divine trust demands restraint. Wastefulness is condemned as satanic ingratitude (Al-Isra 17:27), and even basic needs like food and water are to be consumed with

moderation (Al-A'raf 7:31). Water, in particular, is described as divinely measured and retractable if misused (Al-Mu'minun 23:18), a sacred resource with both economic and ecological value.

The Prophet lived this ethic. He performed ablution with less than a liter of water, planted trees as acts of perpetual charity (Sahih Bukhari), and taught that reviving barren land earns rightful ownership (Sunan Abu Dawood). His principle, "Do not cause harm or return harm" (Sunan Ibn Majah), extends to pollution, deforestation, and ecological degradation. Cleanliness, He said, is half of faith (Sahih Muslim), linking environmental hygiene directly to spiritual purity.

Islamic teachings are not just symbolic - they demand action from human beings. They call upon humanity to preserve the Earth, not degrade it. When governments fail in this duty, the consequences are not abstract. The poor are forced to survive by harming the very environment they depend on. This is not just "policy failure" - it is a betrayal of divine trust and public responsibility.

This chapter is a layman's manifesto. It speaks not to the technocrats, but to the people who live climate injustice every day. This includes not just the truck driver who's never heard of carbon emissions, yet inhales them with every breath to the small business owner who burns tyres and motor oil, not out of ignorance, but because electricity is either unaffordable or unavailable. Even the poor rickshaw driver who clogs traffic to slow down speed, not out of malice or to disrupt the steady flow of traffic but to earn his daily bread, unknowingly amplifies emissions. On the other hand, we have the policymakers caught in a moral bind, forced to choose between repaying foreign debt and planting trees for future generations.

This is not just a chapter, it's a mirror. A call to recognize that climate injustice is not theoretical. It's lived. It's local. And it demands a new language, one that ordinary people can understand, own, and act upon. This is not just a technical failure, it is a spiritual and economic betrayal. When the poor are punished for surviving, and the environment is exploited for fiscal gain, we must ask: *Is this extraction?*

We need to shift from donor dependency to ethical stewardship. Pakistan must not merely adapt to climate change; it must redefine the terms of adaptation as climate justice is not just about carbon, it is about integrity.

Adverse Climate Impacts

Negative Indicators by World Health Organization (WHO)

The Table 8.1 highlights the summary of negative indicators specifically linked to adverse climate impacts in Pakistan, extracted from the WHO Environmental Health Country Profile (2023):

The WHO indicators reveal a nation under siege, not by foreign powers, but by poisoned air, unsafe water, and climate-driven diseases. These are not abstract statistics; they are daily realities for millions of Pakistanis. When 43 percent of stroke and heart disease deaths stem from air pollution, and nearly half the population drinks unsafe water, the burden is not just medical, it is moral. Climate change has turned basic survival into a battleground. These figures demand more than policy tweaks; they call for a national awakening rooted in stewardship, equity, and ethical reform.

Negative Indicators by World Bank

The following Table 8.2 summarizes the adverse climate factors as mentioned in the World Bank document titled *"Pakistan: Country Climate and Development Report" (2022)*. These factors reflect the document's framing of climate risks to health, economy, infrastructure, and vulnerable populations.

The World Bank's climate risk matrix paints a sobering picture of Pakistan's future: rising temperatures, vanishing water, collapsing coastlines, and displaced communities. These are not distant projections; they are accelerating realities. From glacial floods in the north to heatwaves in urban slums, every region faces a unique threat, yet shares a common vulnerability. The data underscores that climate is not just an environmental issue; it is a developmental emergency. To protect lives, livelihoods, and dignity, Pakistan must move from reactive adaptation to proactive resilience, guided by justice, foresight, and inclusive planning.

Table: 8.1

Climate-Adverse Health & Environmental Indicators

Indicator	Value / Status	Climate Linkage	How This Was Calculated / Interpreted	Impact Summary
Annual deaths from ambient air pollution	128,000	Heatwaves, stagnant air, dust storms worsen $PM_{2·5}$/PM_{10}	WHO reports 58.2 deaths per 100,000; multiplied by 220M population = 128,040 deaths/year	Stroke, heart disease, lung illness
% of stroke and heart disease deaths caused by air pollution	43%	$PM_{2·5}$ exposure increases cardiovascular risk	Direct WHO attribution; nearly half of these deaths are pollution-linked	Preventable deaths with clean air
Annual deaths from unsafe WASH (Water, Sanitation, Hygiene)	40,000	Floods contaminate water; droughts reduce hygiene	WHO burden estimates based on diarrheal disease and exposure	High child mortality, especially rural
% of diarrhoea deaths caused by unsafe drinking water	69%	Contaminated water worsens during floods and droughts	WHO attribution from WASH section	Unsafe water is the leading cause of diarrhoea deaths
Population using polluting fuels for cooking	43%	Indoor smoke worsens respiratory illness; climate affects fuel access	Direct WHO figure; linked to household air pollution deaths	Women and children most exposed
Population without safe drinking water	49%	Climate variability affects groundwater and contamination	WHO reports only 51% have safe water; rest are exposed	Chronic disease, waterborne infections
Population without safe sanitation	25%	Floods destroy toilets; droughts limit hygiene	WHO reports 75% access to safe sanitation	Increases disease spread, especially in slums
Heat-related mortality risk (projected)	4× increase by 2050	More frequent and intense heatwaves	WHO projects 10 deaths/year (pre-1990) → 37 deaths/year (2050) in 65+ age group	Elderly most vulnerable to heat stress
Vector-borne disease vulnerability	High	Warmer, wetter climate expands mosquito zones	WHO flags dengue, malaria as climate-sensitive diseases	Urban outbreaks, rising hospital burden
Food insecurity due to climate shocks	20–30% affected during events	Floods and droughts damage crops and livestock	Based on national disaster data and food security assessments	Malnutrition, stunting, rural poverty
Displacement due to climate disasters	>1 million (2022 floods)	Direct result of extreme weather	Cited from 2022 flood impact reports	Loss of homes, jobs, education access
Health system vulnerability to climate stress	Moderate to high	Infrastructure damage, supply chain disruption	WHO assessment of system readiness and resilience	Slower emergency response, overwhelmed hospitals

Source: World Health Organization

Table: 8.2

Adverse Climate Factors - Pakistan

Climate Factor	Description / Impact	Affected Sectors / Populations
Rising Temperatures	Average temperature projected to rise by 2.5°C by 2050 under high emissions	Agriculture, labor productivity, elderly, outdoor workers
Heatwaves	Increased frequency and severity; major urban centers at risk	Health, energy demand, urban poor
Flooding (Riverine & Urban)	Pakistan among top 10 countries affected by riverine floods; 2022 floods displaced 8 million	Housing, agriculture, transport, health
Glacial Melt & GLOFs	Accelerated glacial melt increases risk of Glacial Lake Outburst Floods (GLOFs)	Northern regions, infrastructure, water supply
Water Scarcity	Per capita water availability projected to fall below 500 m^3 by 2040 (absolute scarcity threshold)	Agriculture, drinking water, sanitation
Droughts	Increasing frequency in arid zones; crop failures and livestock losses	Rural poor, food security
Sea Level Rise	Threatens coastal infrastructure and ecosystems, especially Karachi and Indus Delta	Urban infrastructure, fisheries, mangroves
Air Pollution (Climate-linked)	Climate-induced stagnation and dust storms worsen PM levels	Cardiovascular and respiratory health
Vector-Borne Diseases	Climate variability expands mosquito habitats (malaria, dengue)	Urban and peri-urban populations
Food Insecurity from Climate Shocks	Crop losses from floods, droughts, and heat stress	Farmers, low-income households
Energy System Stress	Higher cooling demand and flood damage to grid infrastructure	Power outages, economic productivity
Urban Vulnerability	Informal settlements face compounded risks: heat, floods, poor drainage	Slum dwellers, low-income urban families
Climate-Induced Migration	Displacement from floods, droughts, and coastal erosion	Rural poor, women, children

Source: *Country Climate and Development Report" (2022)*

Negative Indicators by United Nations

Table 8.3 presents comparison of key adverse climate and development indicators drawn directly from the three official sources. Each entry is grounded in the original reports, with no additions or extrapolations, designed for annexure inclusion or strategic narrative framing.

From economic losses exceeding USD 38 billion annually to a steep fall in human development rankings, the data expose a nation caught between environmental collapse and institutional inertia. The HDI dropped from 154 to 168, compounded by inequality-adjusted setbacks, and reflect not just climate stress but systemic neglect. Whether it's droughts choking rural livelihoods, floods displacing millions, or youth voicing despair, the message is clear, resilience cannot be built on fragmented efforts. Pakistan must now unify its climate, development, and justice agendas, or risk losing another generation to preventable suffering.

Negative Indicators by IMF

The IMF Country Report No. 25/109 marks a pivotal moment in Pakistan's climate and macroeconomic narrative. Chapter 5.2 states:

The total investment needs for a comprehensive response to Pakistan's climate and development challenges between 2023 and 2030 amount to around US$348 billion World Bank (2022).

For the first time, climate resilience is not treated as a peripheral concern but as a central pillar of fiscal stability and sovereign credibility. Through its Resilience and Sustainability Facility (RSF), the IMF acknowledges that Pakistan's exposure to floods, droughts, and heatwaves is not just environmental, it is economic, social, and existential. The Table 8.4 distills the report's key insights, revealing both the scale of the challenge and the contours of a possible recovery.

The IMF's endorsement of Pakistan's RSF arrangement signals a shift: climate resilience is now central to macroeconomic stability. However, the USD 1.4 billion RSF support is a fraction of the USD 200–348 billion needed it cannot bridge the climate finance gap, especially when governance fragmentation, debt stress, and donor conditionality persist. Without deep reforms in governance, energy pricing, and climate integration, Pakistan risks borrowing against its future, financing survival without securing sustainability.

The IMF report offers no room for ambiguity: climate resilience must be structurally embedded into Pakistan's fiscal framework, not merely echoed in policy language. Without enforceable commitments, transparent and traceable budget allocations, and cohesive institutional coordination, the RSF risks becoming another ceremonial deviation. Worse, it may compound Pakistan's debt exposure and interest obligations. With 85-90 percent of total demands for grants already consumed by debt servicing, and prior liabilities having inflicted substantial economic losses, the proposition of an additional $348 billion in climate finance, against a mere $1.4 billion RSF facility, exposes a stark asymmetry. What lies ahead demands more than external inflows; it calls for anticipatory governance, principled stewardship, and a unified national recalibration.

Consultative Process with the World Bank - Strategy by National Climate Finance Strategy (NCFS) of Pakistan - 2024

The National Climate Finance Strategy (NCFS) of Pakistan - 2024, based on the official document published by the Ministry of Climate Change & Environmental Coordination. NCFS is Pakistan's official framework to mobilize, manage, and deploy climate finance in alignment with national priorities and international commitments. Developed in consultation with the World Bank, it aims to transition Pakistan toward a low-carbon, climate-resilient economy by 2050. The following table summarizes the Strategic Targets of the NCFS:

The key features of the strategy:

- **Clear Targets and Timelines**: The strategy sets measurable goals and a review cycle.
- **Whole-of-Government Framing**: Attempts to unify fragmented governance.
- **Private Sector Engagement**: Opens doors to

Table: 8.3

Comparative Table of Adverse Indicators

S.No.	Indicator / Impact	UNDP Climate Focus Page UN Reports (2025)	UN Pakistan Media Update (May 2025)
1	Annual economic loss due to climate change	USD 38 billion/year (WB & ADB 2021)	Reaffirmed as ongoing vulnerability
2	Human Development Index (HDI) rank	154 out of 189 (2020) 168 out of 193 (2025)	Confirmed: HDI value 0.544, rank 168
3	HDI inequality-adjusted value		Drops to 0.364 (−33.1%) due to inequality
4	Multidimensional Poverty Index (MPI)		MPI remains at 0.198 (unchanged from 2023/24)
5	Gender Inequality Index (GII)	Gender gap flagged as critical Value: 0.536, Rank: 145/172 HDR 2025	Confirmed improvement, but still below global average
6	Climate vulnerability ranking	Pakistan ranks 8th globally	Reaffirmed vulnerability to climate shocks
7	Weather-related disasters	Frequent, intense, unpredictable	Linked to stalled development and displacement
8	Sea level rise risk	Threatens low-lying areas (Karachi, Indus Delta)	Reiterated as coastal threat
9	Severe droughts	Stifling rural livelihoods	Impacts food security and migration
10	Ecosystem fragmentation & species decline	Biodiversity loss and extinction threats	Confirmed stress on protected areas
11	Food insecurity	Climate variability disrupts crop cycles	Linked to rural poverty and displacement
12	Water scarcity	Per capita availability projected to fall below 500 m^3 by 2040	Reaffirmed as a national emergency
13	Climate-induced displacement	Not quantified	8 million displaced by 2022 floods (referenced)
14	Protected area stress	87,000 hectares reclaimed in Sindh	Biodiversity corridor under pressure (CKNP–DNP)
15	Youth vulnerability	18,000 youth voiced climate concerns	Youth seen as key to resilience building
16	Health access in GB (climate-affected)	19,487 people accessed services	Includes 1,385 women, 250 in extreme poverty

Source: *Reports on Pakistan: By United Nations Media, United Nations Human Development*

This tri-source comparison reveals a message:
"Pakistan's climate vulnerability is no longer a forecast - it is a lived reality".

Table: 8.4

Climate and Environmental Developments - IMF Report No. 25/109 (2025)

S.No.	Theme / Area	Key Insights from IMF Report	Financial Requirement / Status
1	Climate Vulnerability	Pakistan remains one of the most climate-vulnerable countries globally	Reiterated by IMF and CCDR references
2	2022 Flood Impact	USD 30 billion in damages; 33 million affected	Recovery needs remain unmet
3	Climate Finance Gap	Only USD 4 billion mobilized in 2021	Target by 2030: USD 200–348 billion
4	IMF RSF Arrangement	Pakistan approved for USD 1.4 billion under RSF	Supports climate resilience and disaster preparedness
5	Climate-Smart Investment Priority	IMF urges integration of climate goals into macroeconomic planning	Linked to concessional finance access
6	Debt Sustainability Warning	Without climate-smart reforms, debt trajectory may worsen	Climate finance must not deepen fiscal risk
7	Energy Sector Reform	IMF calls for improved energy pricing and reduced subsidies	Critical for climate mitigation and fiscal space
8	Institutional Coordination	Weak inter-ministerial alignment flagged	RSF requires governance reform and transparency
9	Public Investment Efficiency	IMF stresses need for climate-proofed infrastructure	Linked to RSF performance criteria
10	Monetary Policy Role	SBP's tight stance credited for inflation control	Must remain data-dependent amid climate shocks
11	Private Sector Mobilization	IMF encourages blended finance and green instruments	No binding commitments yet
12	Climate Policy Integration	RSF demands climate goals be embedded in fiscal and monetary frameworks	First review completed; next tied to performance benchmarks

Source: : Climate and Environmental Developments - IMF Report No. 25/109 (2025)

Table: 8.5

Strategic Targets of NCFS

Target Area	Goal / Action
Climate Finance Needs	Mobilize USD 200–348 billion by 2030 for NDCs and climate-resilient development
Domestic Revenue Mobilization	Leverage public investment to attract international climate finance
Whole-of-Government Approach	Align federal and provincial tiers for climate mainstreaming
Innovative Finance Mechanisms	Engage private sector, green bonds, blended finance, and carbon markets
Governance Framework	Establish 4 bodies: Steering Committee, Technical Committee, Provincial Committees, M&E Unit
Gender Responsiveness	Integrate gender equity into climate finance planning and execution
Research & Development	Advance tailored, State-of-the-art low-carbon solutions
Review Cycle	Strategy to be reviewed every 2 years; First review in FY27

Source: : Climate and Environmental Developments - IMF Report No. 25/109 (2025)

Table: 8.6

Admitted Facts in the Strategy

Admitted Reality	Details
Climate Vulnerability	Pakistan among top 10 most climate-affected countries for over a decade
2022 Flood Losses	USD 30 billion in damage; 33 million people affected
Current Climate Finance Flows	Only USD 4 billion invested in 2021 Far below needs
Institutional Fragmentation	Post-18th Amendment confusion over roles and mandates
Policy Misalignment	Sectoral policies not fully climate-proofed or integrated
Capacity Gaps	Weak understanding of global climate finance mechanisms
Monitoring Weaknesses	Need for robust M&E and performance tracking across ministries

Source: : Climate and Environmental Developments - IMF Report No. 25/109 (2025)

blended finance and innovation.

The key constraints of the strategy:

- **Massive Funding Gap**: USD 4B actual vs. USD 348B needed, a 98.8 percent shortfall.
- **Federal Revenue Limitations**: Pakistan's tax-to-GDP ratio remains under 10 percent, limiting fiscal space.
- **Donor Fatigue and Conditionality**: International climate finance is slow, competitive, and politically filtered.
- **Institutional Inactivity**: Post-18th Amendment confusion and weak provincial capacity persist.
- **No Binding Commitments**: Strategy is aspirational, not legally enforceable.

The NCFS is technically sound but financially fragile. Without radical reforms in revenue generation, debt restructuring, and climate diplomacy, it risks becoming a "hitman strategy" a well-written document that delays real action while deflecting accountability. Its success hinges on whether Pakistan can convert vision into enforceable policy and secure predictable finance, not just pledges. We can discuss adverse performances by federal government in next parts.

Adverse Financial Management - Table 11 of Budget Statement of Ministry of Finance

This information shows how poorly the Ministry of Finance has managed the country's money. Table 11 looks like it gives a full picture of government spending, but in reality, it only shows part of the story. The data is carefully chosen to make things look better than they are. It hides how much money is really going to pay off loans and interest, and how little is spent on the environment. If we take this data as true, it shows a serious lack of honesty and planning. It raises big questions about how transparent and responsible our financial leaders really are.

Despite Pakistan's rising climate vulnerability, federal spending on environment protection remains alarmingly low. Over a span of nine years, allocations have hovered between 0.005 percent and 0.04 percent of total government expenditure - barely a fraction of the national budget. In FY 2025–26, only PKR 3 billion was earmarked for environmental protection out of a total PKR 16,285 billion, translating to less than PKR 20 per PKR 100,000 spent. This chronic underinvestment signals a systemic neglect of climate resilience, where environmental priorities are consistently overshadowed by debt servicing, and administrative overhead. If this trend continues, Pakistan risks compounding its ecological losses with fiscal blindness, leaving future generations to pay the price for today's budgetary omissions. Whereas, we can review budget from different documents to assess how much federal government is serious about environment and other sectors.

Recent History – Budgets as Reported by Ministry of Finance

Pakistan's budget data from 2018 to 2026 reveals a persistent and worsening fiscal imbalance, where the overall deficit often exceeds net federal revenue. The government has policy to borrow not for development, but to cover interest and basic operational costs, creating a cycle of interest-based debt traps. With debt servicing consuming the majority of expenditures and revenue growth lagging behind politically driven spending, the fiscal framework reflects a breakdown in discipline, autonomy, and long-term planning.

In such a constrained environment, increasing the budget for environmental protection becomes nearly impossible. When over 85 percent of federal resources are absorbed by loan repayments and interest, and routine expenditures rely on borrowed funds, climate resilience is sidelined. The illusion of budgetary progress masks deeper structural weaknesses. Unless Pakistan restructures its fiscal architecture, shifting toward ethical, interest-free financing and performance-based budgeting, environmental priorities will remain underfunded, and long-term sustainability will remain out of reach. This picture is worse, if we review it from updated version of Pakistan's debt trap as approved under demands for grants.

Pakistan's Debt Traps & Demands for Grants Since 2018-19

In Pakistan's federal budget system, *Demands for Grants* are the official spending approvals that

Table: 8.7

Strategic Comparison: Table 11 of Budget Statements

FUNCTION-WISE EXPENDITURE										
TABLE – 11 of Annual Budget Statement										
(Rs in billions)			Rev			Rev				
Classification	2025-26	2024-25	2023-24	2023-24	2022-23	2021-22	2020-21	2019-20	2018-19	2017-18
General Public Service (salaries and expenses incurred by public authorities)	12,210	13,640	11,220	10,248	6,176	5,435	4,429	5,607	3,340	2,977
Defence Affairs and Services	2,558	2,129	1,859	1,809	1,527	1,373	1,293	1,153	1,100	999
Public Order and Safety Affairs	352	283.1	253.5	237.2	208.8	178.5	170	152.9	132.3	119.4
Economic Affairs	242	357.7	261.6	216.8	138.8	115.2	71.8	84.2	80.8	80.7
Environment Protection	3	7.3	1.1	1.2	0.7	0.4	0.4	0.5	1.3	1.2
Housing and Community Amenities	19	27.9	6.4	23	7.9	34.6	35.7	2.3	2.3	2.4
Health Affairs & Services	32	28.2	27.8	24.2	19.6	28.4	25.5	11.1	13.9	12.9
Recreation, Culture and Religion	22	18.5	18.3	17.1	11	10.4	9.8	9.8	9.2	11.9
Education Affairs and Services	113	103.8	103.7	97.1	90.6	92	83.4	77.3	97.4	90.8
Social Protection	734	608	480.3	465.1	370.1	255.3	230.9	190.6	2.4	2.3
TOTAL:	16,285	17,203	14,232	13,139	8,550	7,523	6,349	7,288	4,780	4,298
Environment Protection %age to total expenses	0.02%	0.04%	0.01%	0.01%	0.01%	0.01%	0.01%	0.01%	0.03%	0.03%

Source: Budget Documents – Ministry of Finance

Table: 8.8

Federal Budget Deficit – History (2019-2026)

FEDERAL BUDGET
Extracts from Table 1 & 2

For The Period Ended	25-26	24-25	23-24	23-24	23-24	22-23	22-23	21-22	20-21	19-20	19-20	18-19	18-19
….Amount in PKR Billion….			*Rev-2*	*Rev-1*		*Rev-1*				*Rev-1*		*Rev-1*	
FBR Revenue	14,131	12,970	*9,252*	*9,415*	9,200	*7,200*	7,470	5,829	4,963	*3,908*	5,555	*4,435*	4,150
Other Revenues	5,147	4,845	*2,947*	*2,963*	2,963	*1,618*	1,935	2,080	1,610	*1,596*	1,162	*1,226*	882
Gross Revenue	**19,278**	**17,815**	***12,199***	***12,378***	**12,163**	***8,818***	**9,405**	**7,909**	**6,573**	***5,504***	**6,717**	***5,661***	**5,032**
Less: Transfer to Provinces	-8,206	-7,438	*-5,427*	*-5,399*	-5,276	*-4,129*	-4,373	-3,412	-2,874	*-2,402*	-3,255	*-2,590*	-2,463
Net Revenue for Federal	**11,072**	**10,377**	***6,772***	***6,979***	**6,887**	***4,689***	**5,032**	**4,497**	**3,699**	***3,102***	**3,462**	***3,070***	**2,569**
Govt Expenditure	-17,573	-18,877	*-15,160*	*-14,485*	-14,460	*-11,090*	-9,579	-8,487	-7,137	*-6,830*	-7,022	*-5,071*	-5,156
Federal Budget Deficit	**-6,501**	**-8,500**	***-8,388***	***-7,506***	**-7,573**	***-6,400***	**-4,547**	**-3,990**	**-3,438**	***-3,728***	**-3,560**	***-2,001***	**-2,587**
Provincial Surplus		1,217	*539*	*600*	650	*459*	750	570	242	*-81*	423	*-850*	-700
Overall Budget Deficit	**-6,501**	**-7,283**	***-7,849***	***-6,906***	**-6,923**	***-5,941***	**-3,797**	**-3,420**	**-3,196**	***-3,809***	**-3,137**	***-2,851***	**-3,287**

Source: Budget Documents – Ministry of Finance

reveal how the government allocates its resources across debt, defense, governance, and development priorities. The following is the total of the last 8 years' payments approved under the demands for grants:

Over the past eight fiscal years, Pakistan's federal budget has operated under a deceptive fiscal architecture, one that prioritizes debt servicing over national development. The government has approved/paid PKR 289.5 trillion over eight years

Table: 8.9

Demands for Grants – Total Approved Payments (2019-2026)

Demands for Grants Approved		Eight Years Total	25-26	24-25	23-24	22-23	21-22	20-21	19-20	18-19
In Local Currency **PKR (billion)** **Net income of the Federal Government**										
Loans Repayments	68%	198,314	19,479	24,069	34,200	22,779	23,564	11,939	40,376	21,906
Interest Payments	14%	39,752	8,207	9,775	7,303	3,950	3,060	2,946	2,891	1,620
Loan and interest Payments	**82%**	**238,065**	**27,686**	**33,844**	**41,503**	**26,729**	**26,624**	**14,886**	**43,267**	**23,526**
Federal Government expenses	13%	37,116	7,603	7,463	5,522	5,161	3,885	2,738	2,649	2,095
Defence services	5%	14,305	2,565	2,131	1,809	1,532	1,371	1,290	1,807	1,800
TOTAL	**100%**	**289,487**	**37,855**	**43,439**	**48,834**	**33,422**	**31,880**	**18,914**	**47,723**	**27,421**
Enviornment Protection (EP)	**Rs. (Bil)**	14.911	3.17	7.252	1.142	0.749	0.436	0.431	0.47	1.261
Ratio of EP to Total Grants	**%**	0.01%	0.01%	0.02%	0.00%	0.00%	0.00%	0.00%	0.00%	0.01%
Allocation of EP per 100,000	**Rs.**	5.15	8.37	16.69	2.34	2.24	1.37	2.28	0.98	4.6

Source: Budget Documents – Ministry of Finance

Pakistan's fiscal architecture is caught in a rollover debt trap, old loans are recycled through new borrowings, while interest payments balloon and the principal remain untouched. With 85 percent of federal payments consumed by debt and interest, the budget has become a tool of illusion, masking insolvency behind inflated revenue projections and politically driven allocations. This debt-dominated framework serves external creditors more than the people, eroding economic sovereignty and sidelining national priorities. In this context, the federal allocation of merely PKR 14.9 billion over eight years (budget allocation is PKR 5 per PKR 100,000/= Government's spending) for environment protection is not just inadequate, it is tragic. Under the 18th Amendment, if provinces fail to invest and the federal government abdicates responsibility, the cost is not just fiscal, it is human. Pakistanis are left to pay with their lives, as climate disasters escalate and public resilience remains unfunded and undefined.

(FY 2018-2026). To contextualize this, consider that in FY 2017-18, Pakistan's total public debt was reported at approximately PKR 25 trillion. Comparing this with the PKR 238 trillion paid over eight years, it becomes evident that the country has repaid nearly seven times its 2017-18 Public Debt, yet remains trapped in a cycle of rising liabilities. Yet, despite these massive outflows, the debt burden continues to grow, exposing a systemic failure in fiscal governance. Instead of decreasing, the public debt has increased to approximately PKR 94.197 trillion (June 2025). Hence there is no budget for Environment Protection because it has become a tool to ensure modern slavery and poverty.

Adverse Role of Policy Makers

Why have policymakers remained inactive for so long despite clear evidence of climate and health crises in Pakistan?

Answer: Policymakers have not been asleep -

they've been overwhelmed, distracted, and structurally constrained. But the cost of delay is now unbearable. The following are several factors that explain this prolonged inaction. These includes fragmented governance, reactive mindset, donor dependency, data neglect, short-term political gain and inaction on the funds allocated for the cause. But the evidence is now irrefutable:

- 128,000 deaths from air pollution
- 49 percent without safe drinking water
- 4× increase in heat deaths projected by 2050
- millions displaced by floods
- Trillions of dollars in economic losses

This is not just a policy failure, it is a moral failure. The time for silence has passed. What's needed now is ethical leadership, inter-ministerial unity, and a national climate justice framework rooted in stewardship, not survival. This fiscal neglect is not just a budgeting oversight; it is a systemic mis-allocation with far-reaching consequences. The following segments/econometrics outline the estimated value of economic losses and liabilities resulting from these mismatched priorities, offering a sobering reflection on the cost of inaction.

Climate-Related Vulnerability of Assets: Pakistan Vs Europe

According to a recent article in *Daily Times*, Pakistan earns as little as $2 to $5 per ton of CO_2 saved through carbon credit mechanisms due to the absence of a consistent policy or legal framework. In contrast, European carbon markets, particularly under the EU Emissions Trading System (ETS), have seen prices soar to around €85 per ton, reflecting far more mature regulatory frameworks and demand-driven pricing.

Impact of Climate Change on Asset Value

Carbon emissions are the invisibvle heat-trapping gases from fossil fuels. For ordinary citizens, it's like wrapping the planet in a suffocating blanket. Since 2010, Pakistan has incurred losses in climate damages. Stewardship, as emphasized in Islamic teachings, is not just spiritual; it's survival now. We need to save humanity from all sorts of losses. We can summarize the economic losses as below:

***Econometrics* Elucidation of Pakistan's Climate-Linked Losses (2010–2025)**

This section unpacks the rationale behind each estimated loss category, combining symbolic logic, sectoral data, and compounding effects to reveal the true scale of Pakistan's climate vulnerability. The following Table 8.10 summarize the losses.

Following are the elucidations, best judgment on the economic losses:

- ***Climate Disasters ($100–120 billion):*** Pakistan faces an average of $2 billion in annual direct losses from climate-related disasters, according to the Asian Development Bank. But this figure only scratches the surface. The 2022 floods alone caused over $30 billion in combined damages and productivity losses, underscoring how single events can exceed annual averages. Over 15 years, repeated floods, droughts, and heatwaves have compounded into systemic erosion, damaging infrastructure, displacing communities, and deepening poverty. The symbolic estimate of $100–120 billion reflects not just direct damages, but also recovery costs, lost livelihoods, and long-term development setbacks that ripple across generations.

- ***Energy Misgovernance ($150–200 billion):*** Pakistan's energy sector is plagued by circular debt, inefficiencies, and chronic mismanagement. With circular debt increased upto Rs 2.6 trillion and frequent bailouts draining public finances, the sector has become a persistent drag on economic growth. The missed opportunity to transition to renewables adds a hidden cost (lost investment, job creation, and energy security). This symbolic estimate of $150–200 billion aggregates direct financial losses, opportunity costs, and the economic consequences of delayed reforms. It reflects how energy misgovernance not only wastes resources but also undermines climate resilience and national sovereignty.

- ***Health Burden ($50–70 billion):*** Climate change is silently reshaping Pakistan's health landscape. Rising temperatures, water scarcity, and extreme weather events have triggered a surge in heat-related illnesses, malnutrition, and vector-borne diseases. These health impacts are not just medical, they're economic. Lost productivity, increased healthcare spending, and long-

Table: 8.10

Pakistan's Cumulative Economic Losses (2010–2025)

Loss Category	Estimated Range (USD)	Reference	Key Drivers & Notes
Climate Disasters	$100–120 billion	ADB Report	$2B/year losses; 2022 floods caused $30B+ in damages and productivity losses
Energy Misgovernance	$150–200 billion	IMF & ADB Energy Briefs	Circular debt, inefficiencies, missed transition; chronic sectoral losses
Health Burden	$50–70 billion	WHO & UNDP Climate-Health Nexus	Heat stress, malnutrition, waterborne diseases; rising climate-linked health costs
Agricultural Losses	$80–100 billion	Ministry of Finance – Climate Chapter	4M+ acres damaged in 2022 floods; yield volatility and food insecurity
GDP Erosion	$500–700 billion	Germanwatch Climate Risk Index	Ranked #1 climate-affected; growth stunted by shocks, debt, and energy crises
Missed Green Transition	$1.5–2 trillion	IEA & UNFCCC Opportunity Cost Benchmarks	Lost potential in renewables, green jobs, climate-resilient infrastructure
Debt Servicing	$300–400 billion	ADB Climate Loan 2024	Climate-linked borrowing, disaster recovery loans, rising external debt
Total Estimated Loss	**≈ $3 trillion**	Aggregated from above	Symbolic sum of systemic, avoidable losses

Source: : Econometrics as per working from (Pakistan Today, 2025), (Stratheia, n.d.), (Ministry of Finance, 2024), (UNDP Pakistan, 2025), (United Nations Pakistan, 2025) (World Bank, n.d.) (WHO, 2023), (IMF,2025)

term cognitive and nutritional deficits impose a heavy toll on families and the economy. The symbolic estimate of $50-70 billion captures both visible costs (hospitalization, treatment) and hidden burdens (lost earnings, stunted development), emphasizing the need for climate-adaptive health systems.

- ***Agricultural Losses ($80–100 billion):*** Agriculture is the backbone of Pakistan's economy, employing nearly 40 percent of the workforce and contributing around 20 percent to GDP. Yet climate volatility, floods, droughts, and erratic rainfall have repeatedly devastated crops and livestock. The 2022 floods alone damaged over 4 million acres of farmland. These shocks disrupt food supply chains, inflate prices, and push rural communities into poverty. The symbolic estimate of $80–100 billion reflects cumulative crop losses, livestock mortality, and the broader economic impact of declining agricultural productivity. It also accounts for the social cost of rural displacement and food insecurity.

- ***GDP Erosion ($500-700 Billion):*** Climate vulnerability, energy crises, and debt overhang have collectively stunted Pakistan's GDP growth. Each disaster, each policy failure, chips away at the country's economic potential. If Pakistan had maintained a stable growth trajectory, its GDP today would be significantly higher. The symbolic estimate of $500–700 billion models lost growth, missed investment inflows, and reduced productivity across sectors. It also reflects the intergenerational cost of poverty traps, where climate shocks prevent upward mobility and entrench economic stagnation.

- ***Missed Green Transition ($1.5-2 Trillion):*** Globally, countries that invest early in green infrastructure reap massive economic and social dividends. Pakistan, however, has lagged behind, missing opportunities to lead in renewables, climate-resilient infrastructure, and green job creation. The symbolic estimate of $1.5-2 trillion represents the opportunity cost of inaction: the investments not made, the jobs not created, the emissions not avoided. It's a vision of what could have been - a thriving, climate-smart economy, had Pakistan embraced the green transition with urgency and ambition.

- ***Debt & Debt Servicing ($300–400 billion):*** Pakistan's external debt has ballooned over the

past decade, with climate-linked borrowing adding to the burden. Loans for disaster recovery, adaptation, and infrastructure, while necessary, come with long-term repayment obligations. The symbolic estimate of $300-400 billion includes interest payments, emergency financing, and climate-related debt packages from institutions like the IMF and ADB. It reflects how climate vulnerability translates into financial dependency, eroding national sovereignty and limiting fiscal space for development. However, actual payments in this head remain US$1,243 billion since 2018, as per demands for grants approved by the Federal Government.

Econometrics Elucidation of Pakistan's Climate-Linked Losses (2010–2025)

Policy failure can be assessed from the following Table 8.11, where *Symbolic Economics, When Trees, Kilometers, and Wages Tell the Truth.* This isn't just a data table - it's a moral indictment -

Table: 8.11

Critical Comparison

Metric	Pakistan	Europe
Co_2offset per tree	8 km	25 km
Carbon credit value	$2–5/ton	€85/ton
Minimum wage	Rs 200/hour (Euro 0.59/Hour)	€10/hour

leading to ensure citizens as modern slaves to the system. In order to rescue the environment, we have to ensure Climate Justice by achieving the following targets:

Consultative Process: Climate Justice - Insights, Problem & Vision

Table 8.12 summarizes long debatable chapters, to initiate a consultative process.

Experts must now translate these one-liner insights into a comprehensive, actionable strategy, one that can rescue Pakistan from climate and economic collapse. Each line in the above table is not just a suggestion, but a call to restructure policy, reallocate budgets, and reclaim sovereignty. These symbolic directives must evolve into implementable plans rooted in justice, resilience, and national dignity:

- CPEC's carbon footprint demands 1 billion trees annually and 2 million acres for offset.
- Pakistan could have planted 10 billion trees with Rs 150B/year since 2015.
- Environmental budgets fund salaries-not solutions.
- One Pakistani truck emits 3× more CO_2 than a European-standard vehicle.
- Offsetting 100 km of travel requires 3-4 trees.
- A single tree absorbs only 21 kg CO_2/year-our transport system is a runaway carbon engine.
- Ministries operate in silos: climate is seen as cost, not crisis.
- Pakistan lacks a national emissions roadmap and freight-linked climate policy.
- Carbon credit colonialism sells our clean air for $2-5/ton while Europe pays €85.
- Pakistani workers earn less than the carbon they save-climate justice is economic justice.
- A laborer earns Rs 200/hour, yet one ton of CO_2 saved is worth €85-global markets reward speculation, not stewardship.
- Islamic finance offers ethical climate tools: Waqf Funds, Green Sukuk, and Zakat-backed microinsurance.
- Islamic ethics protect creation-not commodify it.
- Launching a Climate Justice Tribunal can rebuild trust and mandate accountability.
- Climate budgeting and a National Emissions Registry must be integrated into PSDP.
- Climate resilience is impossible without inter-ministerial coordination.
- Planning prioritizes GDP over GHG; Finance prioritizes debt over survival.
- Climate economics must be democratized-stripped of jargon and returned to the people.
- Symbolic tools like km-to-tree and wage-to-carbon ratios empower public understanding.
- Pakistan must reclaim its climate narrative from donor-driven templates.
- Indigenous knowledge and self-defined resilience metrics must replace conditionalities.
- Adaptation must evolve from bureaucratic checkbox to dignified self-respect.

- Islamic stewardship calls for care of creation, not carbon commodification.
- Pakistan should lead a South-South climate justice coalition grounded in equity.
- "Allah does not change the condition of a people until they change what is within themselves" (13:11).

Pakistan stands at a crossroads - not of technology, but of moral clarity. This chapter is not a policy paper; it is a people's covenant. A call to reclaim our climate narrative from donor dependency, interest-based debt traps, and extractive governance. Every rupee misallocated, every tree not planted, every ton of carbon sold for pennies is a betrayal of our future. We must now build a sovereign climate economy rooted in justice, faith, and indigenous wisdom. The poor must no longer pay the price for elite indecision. Let this be the moment we choose dignity over debt, resilience over rhetoric, and action over apathy.

Table: 8.12

Consultative Process: Climate Justice – Insights, Problem, & Vision

Chapter No.		One-Liner Insight	Problem Diagnosis	Visionary Target
1	Carbon for the Common Man	Carbon emissions cost Pakistan more than its development budget.	Climate damage is invisible yet economically devastating.	Make carbon visible in fiscal planning and public consciousness.
2	Kilometers vs Trees	Outdated trucks emit triple the CO_2 of European vehicles.	Our transport system is a runaway carbon engine.	Transition to low-emission freight and enforce green standards.
3	Invisible Smoke, Visible Costs	Pakistan's true carbon footprint is underestimated.	Informal fuel use and shrinking forests distort national metrics.	Build a verified, inclusive emissions registry.
4	The $60 Billion Corridor	CPEC risks becoming a carbon superhighway.	Infrastructure without greening multiplies emissions.	Integrate climate safeguards into corridor planning.
5	Highways to Heatwaves	Offsetting full CPEC emissions needs 1 billion trees annually.	Environmental budgets fall short by 90%.	Mandate corridor-linked climate budgeting.
6	Greening the Corridor	Environmental budgets fund salaries, not solutions.	Greening remains unfunded and symbolic.	Redirect funds to tree cover, clean energy, and climate resilience.
7	The Budget That Forgot the Earth	Less than 0.005% of Pakistan's budget goes to the environment.	Climate is treated as a cost, not a survival imperative.	Institutionalize climate spending across ministries.
8	What If We Had Acted?	Climate inaction has cost Pakistan billions and eroded GDP.	Reactive spending replaces proactive resilience.	Invest in green infrastructure to save lives and terrain.
9	Dirty Fuels, Dirty Decisions (I)	High energy costs push industries toward toxic fuels.	NEPRA's approvals lack climate foresight. NEPRA's adverse performances.	Reform energy policy to prioritize clean, affordable access.

Chapter No.		One-Liner Insight	Problem Diagnosis	Visionary Target
10	Dirty Fuels, Dirty Decisions (II)	Imported-fuel plants trigger pollution beyond control.	Energy desperation fuels environmental collapse.	Decentralize clean energy for SMEs and households.
11	XL Load, Extra Emissions	Truck load limits increased emissions and costs.	Policy solved road wear but worsened climate impact.	Model environmental outcomes before freight reforms.
12	Rail vs Road	Rail emits 80% less CO_2 than road freight.	Rail remains underutilized due to poor integration and lack of investments.	Shift freight to rail and link it to industrial zones.
13	Carbon Credit Colonialism	Pakistan earns pennies for carbon offsets; Europe pays euros.	Carbon credit colonialism exploits our clean air.	Demand fair pricing and reform global carbon markets.
14	Minimum Wage vs Maximum Exploitation	Pakistan's labor earns less than the carbon it saves.	Stewardship is undervalued; speculation is rewarded.	Link carbon value to ethical labor and national equity.
15	Islamic Finance for Climate Justice	Islamic finance protects creation, not commodifies it.	Carbon markets ignore moral and spiritual dimensions.	Scale Waqf, Sukuk, and Zakat for climate justice.
16	Who Let the Smoke In?	Policy failures have triggered environmental collapse.	Ministries act in isolation, ignoring climate risks.	Create a unified climate governance framework.
17	The Silence of the Ministries	Ministries treat climate as someone else's problem.	Silo thinking blocks resilience.	Mandate inter-ministerial climate coordination.
18	Audit the Air	Pakistan needs a Climate Justice Tribunal and emissions registry.	Accountability is missing from climate policy.	Audit the air to rebuild trust and protect the future.
19	Climate Sovereignty	Pakistan must reclaim its climate narrative.	Donor-driven templates erase indigenous resilience.	Define our own metrics rooted in justice and dignity.
20	From Donor Dependency to Divine Stewardship	Islamic stewardship offers a moral climate ethic.	Global finance commodifies nature.	Lead a South-South coalition grounded in faith and equity.
21	Democratizing Climate Economics	Climate economics must be democratized.	Jargon hides injustice from the public.	Build symbolic tools that empower citizens to act.

Chapter

9 Governing the Ungovernable: The Challenge of Coordinating Global Climate Action

Governing the Ungovernable: The Challenge of Coordinating Global Climate Action

Shahid Najam and Amna Amir

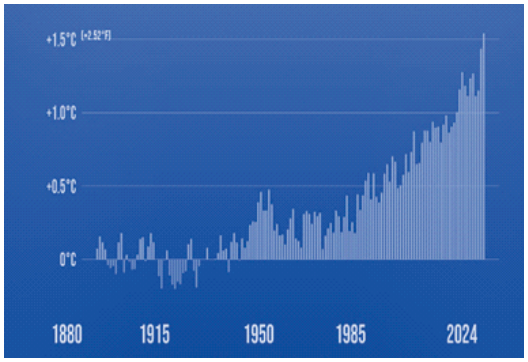
Introduction

The rapidity and severity of climate change have, over the years, assumed ominous proportions as is palpably evident from massive shifts in temperatures, weather patterns and levels of precipitation. The irresponsible and climate-insensitive human interventions are primarily responsible for aggravating Greenhouse Gas (GHG) emissions and consequent heat entrapment of the planet earth. The heavy and unseasonal rainfalls and cloud bursts, hurricanes, devastating floods and landslides, widespread wild fires, recurrent droughts and alarming rate of deglaciation have already started exacting hefty toll on the biolife of our planet, its biodiversity and ecosystems and its biomass i.e., the sum of all living organisms including plants, bacteria, animals and humans (World Meteorological Organization, 2025).

Environmental integrity of planet earth is under threat. It is ,crucial for sustaining life, driving the entire food web, providing clean air and water and equally importantly stabilizing climate for human survival and well-being. However, due to the alarming rate of GHG emissions and consequent rise of global temperatures, the earth's biomass and its ecosystems are under enormous stress. Figure 9.1 shows the historical trends of the global temperatures from 1880 to 2024, especially post 1985 meteoric rise (from 0.5ºC to 1.5ºC+) while Figure 9.2 indicates the GHG emissions trend from 1960 to 2024 manifesting the enormity of the climate change crisis, that the world is confronted with.

Figure: 9.1

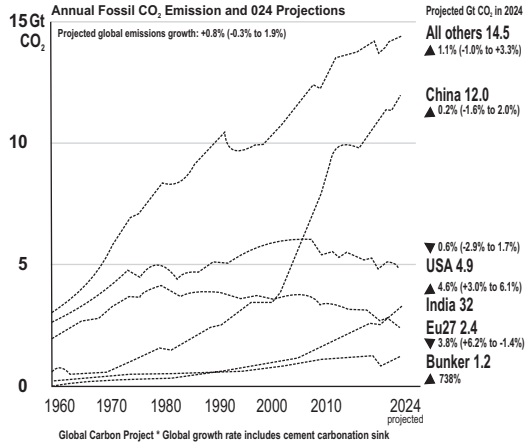
The Global Temperature Trend



Source: (Climate Central, 2025)

Figure: 9.2

GHG Emissions



Source: (Canadell et al., 2024)

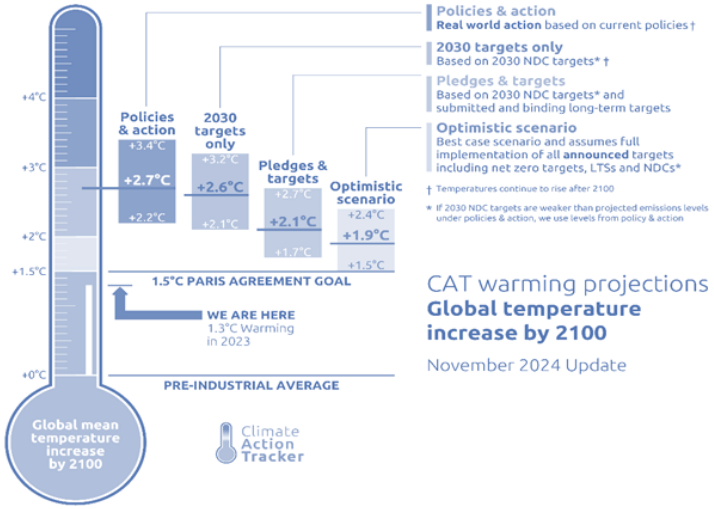
The consequent deleterious impact is being felt all over the world especially on the lives and livelihood assets of the poor who mostly reside in the coastal cities and fragile ecosystems besides fomenting intense inter-state conflicts and competition for accessing the diminishing natural resources.

The Future Projections of Global Warming

The future projection of global warming is also worrying if effective action to curb GHG emissions and rise in temperature is not globally taken to arrest and reverse this trend. Figure 9.3 shows four scenarios of global warming by end of 21st century (World Meteorological Organization, 2025).

Figure: 9.3

Global Warming Projections



Source: (Climate Action Tracker, 2024)

The first scenario based on current policies, projects a maximum temperature increase of 3.4ºC and an average of 2.4ºC; the second based on the Nationally Determined Contributions 2030 forecasts a potential rise of temperature up to 3.2ºC and average of 2.6ºC; the 3rd derived from the Pledges and Targets for 2030, could lead to increase of temperature up to a maximum of 2.7ºC and average of 2.1ºC; while the 4th scenario based on full implementation of targets including the Net-Zero targets, portrays an optimistic estimation of temperature hike by 2.4ºC maximum and 1.9ºC average. As is evident, if the current state of affairs continues, more than 3º C rise in temperature could cause catastrophic heat waves, extreme weather events, severe and prolonged droughts, increased frequency and severity of floods, hurricanes and storms, and other cascading effects including a rise of around half a meter of global sea level by the end of 2100. The seriousness of the impending crisis could well be gauged from the fact that the year 2024 was the hottest year in recorded history (mean temperatures rising 1.5°C+ above the pre-industrial average) with no indication of this trend abating (World Meteorological Organization, 2025). Globally, the climate change related events have already inflicted around $131 billion losses by the first half of 2025. Pakistan, among most climate-vulnerable country in the world (Germanwatch Climate Risk Index, 2025) is in the midst of confronting devastating floods, torrential rains and rapid deglaciation. The country has already suffered economic losses of around $30 billion, besides losing over 1,700 lives and extensive damage to homes and infrastructure. (Adam Smith International, 2024)

Consumption and Production Patterns

Lamentably, high-consumption and unsustainable productions patterns in the developed regions

including rapidly rising energy consumption continue to propel global warming and soaring carbon emissions up to 43 percent (United States (US) alone 20.3 percent). Even the developing countries like China (11.4 percent) Brazil (4.5 percent) and India (3.4 percent), in the wake of massive economic transformation, are encountering serious problems in managing the ecological footprints (IEA, 2022). With the size of their population and increase in per capita income, consumption especially of energy has grown phenomenally while eco-friendly conservation initiatives to regulate buildings, industry, transport and agriculture seem to have seriously trailed behind. The North America and European Union (EU) ideals of economic growth and development serve as reckless guide to their production and consumption patterns straining unsustainable pressure on planet earth and its resources.

Population Growth

To add to the gravity of situation, the world population growth particularly in the developing countries poses a daunting climate challenge. It is already around 8.2 billion in 2025 and expected to increase to 9.8 billion by 2050 mostly to be concentrated in developing countries (Barbi et al., 2016). Population growth has a complex bidirectional and dynamic relationship with climate change and ecosystem-bio-capacity of earth as it engenders increased demand and pressure on resources for food, water, fiber, shelter and energy and leads to deforestation, loss of habitat and bio-diversity, pollution and contamination of air and water, waste generation, soil degradation etc. This invariably drives climate change which in turn detrimentally affects mortality rates, accentuates food insecurity and exacerbates existing social and economic inequalities. (Earth.Org, 2022)

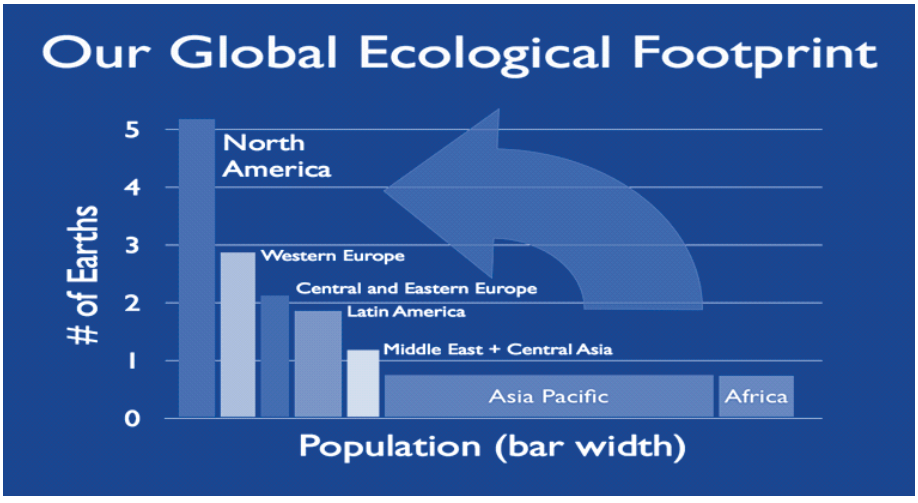
The Ecological Footprints

Cumulatively, the unsustainable consumption-production patterns, population growth, and ensuing climate change lead to high levels of ecological foot prints exerting colossal stress on the earth's resource endowment environment. Figure 9.4 below derived from Global Footprint Network data, shows the contribution of various regions to the global ecological footprints (width of bar proportional to population in associated region) (Global Environment Facility, 2024).

It is abundantly evident that the developed nations are already consuming beyond Earth's capacity while the developing nations are moving up the consumption curve in the quest to espouse North-

Figure: 9.4

Population and Consumption Patterns*



*Humanity would require carrying bio-capacity equivalent to more than 5 Earths to sustain

Source: (Kimball, 2011; Countercurrents)

American lifestyle.

Climate Change - Governance Odyssey

A major breakthrough was however, achieved in 2015 through adoption of the Paris Agreement, by 195 Parties at the United Nations (UN) Climate Change Conference (COP21) which entered into force on 4 November 2016 to further legally bind all the members to hold "the increase in the global average temperature to well below 2°C above pre-industrial levels" and pursue efforts "to limit the temperature increase to 1.5°C above pre-industrial levels" by the end of this century (IPCC, 2023). Further, by 2030, GHG emissions were to be reduced up to approximately 45 percent from 2010 levels, or to be halved compared to 1990 levels. The agreement refined the principle of Common but Differentiated Responsibilities & Respective Capabilities (CBDRRC) to include "Self Determination" and invited all countries to submit voluntary national targets for emissions reduction i.e., Nationally Appropriate Programs of Action on Mitigation and Adaptation, known as 'NAMAS' and 'NAPAS' to be reviewed every 5 years at the Global Stocktake. As of 2020, countries submit their national climate action plans, called "Nationally Determined Contributions" (NDCs) to reflect their efforts for limiting the revised global warming target to 1.5°C as agreed at COP27. The Paris Agreement also provides for financial, technical, and capacity-building support to countries that need it.

Annex A presents a snapshot of the historical evolution and recognition of climate change as a global challenge.

The Architecture of Global Climate Governance (GCGS)

The international climate framework and governance system has evolved incrementally over the past few decades to combat climate change (Jagers & Stripple, 2003) as a highly complex and fragmented hybrid architecture to promote collective policy actions and programs by state and non-state actors. Principles of sustainability and equity with major focus on sectors like energy, transportation, industry and agriculture constitute the kernel of the system. Its major components are as follows:

International Institutions

These include:

- **United Nations Framework Convention on Climate Change (UNFCCC)**

The UNFCCC architecture derives from the three interlinked mechanisms: (1) research and knowledge based scientific truth and intergovernmental negotiation processes; (2) framework alignment with these regimes; and (3) UN institutional path dependence recognizing sovereignty and territoriality of states (Bäckstrand, Kuyper, & Lövbrand, 2017). Adopted in 1992, it commits 198 Parties to limit their impact on environment as per the agreed NDCs targets. The Parties are divided into Annex I (43 countries primarily industrialized and countries with economies in transition) and Non-Annex I (155 mostly developing countries) based on their state of economic development, with a higher burden of reducing emissions on Annex 1 countries. Its supreme decision-making body is the Conference of the Parties (COP), which meets annually. Decisions are adopted by consensus through procrastinated pre-COP negotiations and mediated by regional blocs (AOSIS, African Group), economic profile (G20, G77), or issue specific stance (OPEC, EU).

Its Bureau is responsible for electing the Chair of COP to facilitate its sessions and comprises representatives from five regions: Africa, Asia, Central and Eastern Europe, Latin America and the Caribbean, and Western Europe. Additionally, there is representation from other countries such as Australia, Iceland, Canada, Norway, Switzerland, New Zealand, and the United States.

Its subsidiaries like the Subsidiary Body for Scientific and Technological Advice (SBSTA) reviews the latest climate-science findings and provides technical advice, while the Subsidiary Body for Implementation (SBI), monitors how Parties

convert pledges and commitments into positive action.

There are several constitutional bodies like Adaptation Committee (AC), Standing Committee on Finance (SCF), Executive Committee for Loss and Damage (WIM excom), Paris Committee on Capacity-Building (PCCB), Adaptation Fund Board, Clean Development Mechanism Executive Board (CDM EB) etc., to foster dialogue on various issues and serve as implementation of tools.

- **Intergovernmental Panel on Climate Change (IPCC)**

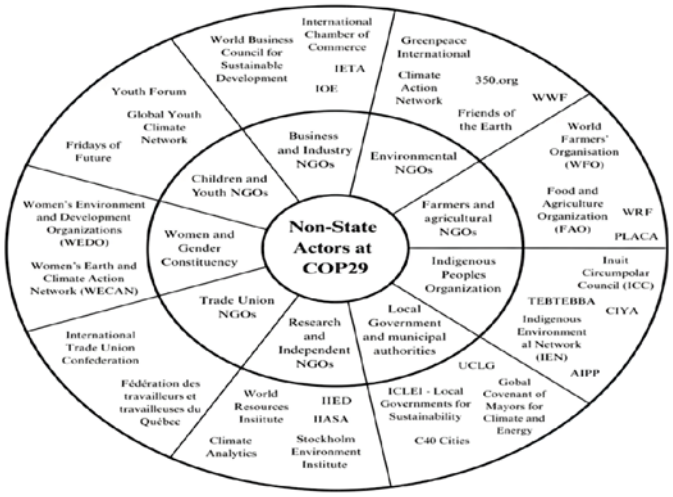
Intergovernmental Panel on Climate Change (IPCC), was created in 1988 by the United Nations Environmental Program (UNEP) and the World Meteorological Organization (WMO) as a research and knowledge hub to provide governments with world-wide scientific information, analysis and assessment to help develop climate policies. It comprises three Working Groups and a Task Force on National Greenhouse Gas Inventories. Working Group 1 deals with the physical science basis of climate change; Group 2 deals with impacts, adaptation, and vulnerability, and Group 3 addresses mitigation. The Task Force works simultaneously to develop methods of measuring and reporting greenhouse gas emissions. Based on their findings, the IPCC produces Assessment Reports (ARs) that are reviewed by experts and governments which form primary evidence for negotiations and climate discussions. These Reports constitute the basis for galvanizing universal consensus regarding the deleterious impact of anthropogenic activities on climate.

- **Non-State Actors (NSAs)**

The role of civil society including Non Governmental Organization (NGOs) in stewarding the climate governance system is considerably significant. NGOs are particularly active in IPCC deliberations and the annual COPs negotiations e.g., out of over 56,000 accredited attendees in the Baku COP29, around 3,956 were NGO observers including, youth groups, indigenous movements, businesses, and trade unions extensively engaged in shaping and monitoring climate policy (Bäckstrand, Kuyper, & Lövbrand, 2017) holding governments and corporations accountable and galvanizing public awareness, inclusivity and capacity building programs especially for vulnerable people at the gross roots level. For example, organizations like *Greenpeace* and *350.org* have launched global campaigns to reduce

Figure: 9.5

UN and Non-State Actors Linkages



Source: (UNFCCC, 2024a & UNFCCC, 2024)

fossil fuel use and promote renewable energy (Haider, Ferheen, & Shah, 2025). Many firms make climate pledges, disclose emissions, invest in clean technologies, and join programs like the *Race to Zero* initiative to reach net-zero emissions by 2050. Greenpeace, World Resources Institute, and Friends of the Earth are also influential actors in various UN forums to lobby for issues like climate justice and transparency.

Within the UN system, NGOs are organized into nine official constituencies: Business and Industry NGOs (BINGO); Environmental NGOs (ENGO); Farmers: Farmers and Agricultural NGOs (FANGO); Indigenous Peoples Organizations (IPO); Local Government and Municipal Authorities (LGMA); Research and Independent NGOs (RINGO); Trade Union NGOS (TUNGO); Women and Gender Constituency (WGC); and Children and Youth NGOs (YOUNGO). Figure 9.5 captures the network of the climate related non-state actors and the UN agencies.

- ***Climate Finance Mechanisms:***

Following are the multiple channels created by UNFCCC for the developed countries to provide financial support to the developing countries:

a) Global Environment Facility (GEF) to provide grants through four-year cycles to meet the objectives of international environmental treaties. Over the past 3 decades, GEF has provided more than US $26 billion in financing and mobilized another $153 billion for country-driven projects (GEF, 2024);

b) Green Climate Fund (GCF) established in 2010, as the world's largest dedicated climate fund has thus far approved projects worth more than $66 billion;

c) The Special Climate Change Fund (SCCF) established in 2001 finances projects relating to adaptation, technology transfer, and capacity building;

d) Least Developed Countries (LDC) Fund assists the LDCs to carry out their National Adaptation Programs of Action (NAPAs); and.

e) Fund for Responding to Loss and Damage assists countries that are particularly vulnerable to climate change in responding to loss and damage caused by extreme weather events.

Figure 9.6 presents the major actors and entities of multi-layered and multi-faceted institutional framework under the UN system for climate governance.

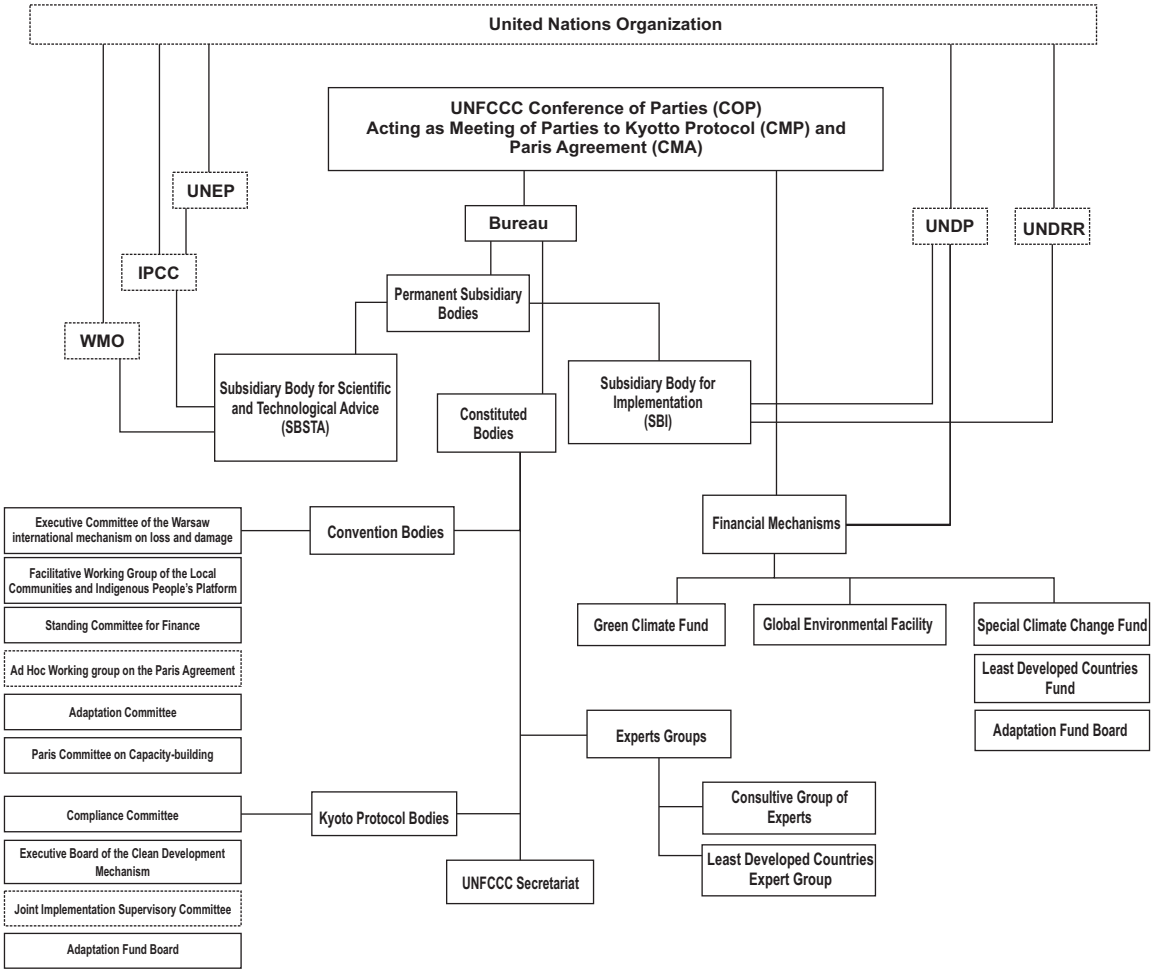
Barriers to Effective Climate Governance

The current GCGS and climate action plans/NDCs have though made some progress in limiting the increase in average global temperatures they lag far short of global warming target of 1.5°C set for end 21st century. To stay within that limit, global greenhouse gas emissions in 2030 must fall by 42 percent relative to current projections. The major weaknesses and barriers encountered by the system include:

a) The Design Paradox: The disjuncture and complexity of dynamics between the apolitical techno-scientific basis of climate crisis and the state-centric approach as defined by UN/UNFCCC poses the major governance challenge to achieve climate goals for 2030 the UN Race to Zero campaign. The system tends to, on the one hand reinforce the logic of state sovereignty as enshrined in the UN Charter, on the other, institutionalize and perpetuate enduring asymmetries, power differentials, and skewed burden of responsibility between the Global North and South. This is further compounded by the paradox of immediacy of "domestic decision space" vs the remoteness of the "internationalized interstate commitments" based on universality of climate science establishing climate change as a planetary phenomenon. While the GHGs emissions are inherently territory specific, the predicament is that these emissions have global atmospheric repercussions. The supremacy of the state sovereignty principle and the national interest over the climate science truth thwarts any attempt to formulate and implement just ecological responses to climate threats and indeed accentuates the discord between Global South and Global North.

Figure: 9.6

UN and Non-State Actors Linkages



Source: Self computation inspired from (Haigh, 2012)

b) Lack of Collective Will for Enforcement: The current GCGS operates without binding enforcement mechanisms and relies on good faith and soft instruments e.g., pledges and recommendations. The Paris Agreement, for instance, does not embody legal sanctions to compel the states to meet emission targets. Instead, it requires them to submit, update, and report on their NDCs as procedural obligations. In the absence of accountability mechanism, collective national efforts often fall short of the agreed targets and are merely reduced to performative actions of setting climate goals without implementation. According to the most recent UN emissions gap report, virtually all countries remain off track for meeting the Paris goals (Dunne, 2025)**.** By the 10 February 2025 deadline to publish climate pledges, just 13 of 195 Parties (see Figure 9.7) had done so (Dunne, 2025) with no penalty for the delay. Enforcement is indeed *the Achilles' heel of international law;* state sovereignty supersedes the writ of global institutions (Moscalewsky, 2022). There is no "climate police" or sanctions regime to discipline non-compliant states.

Then the myopic pursuit of "national interest" and the short-term electoral gains through quick-fix disaster solutions by most of the countries dilute the will for long-term strategic collective action to meet NDCs and financing targets for ensuring environmental integrity and preserving the ecosystem

Figure: 9.7

Status of Paris Goals Compliance

Source: *Self computation, data taken from (Dunne, 2025) (Climate Action Tracker, n.d.)*

(Atwood, 2015). The policy instability and politically articulated issues like energy shortages, rising debt, poverty, interest lobbies etc., prompt the states to opt for low-cost short-term actions for coping with the climate induced disasters instead of striving for strategic and long-term environmental goals (Shaikh, 2024). The shifting political stances on climate change especially in case of the United States, the world's largest historical emitter further diminishes the effectiveness of global climate governance. United States of America (USA) signed the Kyoto Protocol under the Clinton Administration, but never ratified it. President Bush formally rejected the protocol in 2001. It joined the Paris Agreement under President Obama in 2016, withdrew under President Trump, and rejoined under President Biden. In 2025, President Trump withdrew from the Agreement again.

c) Lack of Nexus between Population, Environmental Degradation and Climate Change: The complexity and inextricable connect of population, environmental degradation and climate change does not seem to have been adequately recognized as integral and innate structural part of the climate governance framework. UNFCCC and the NDCs, rarely if at all, lay down explicit targets envisaging the mutual symbiosis, cumulative impact and the tri-directional kinetics between the three at all levels and across all sectors. This dynamic relationship represented by demography, regional consumption and production patterns, and income levels, with associated potential for increased CO2 emissions must be captured by GCGS to address both direct and indirect effects on achieving climate goal and sustainable development (Roesch & Nobre, 2021).

d) Competency and Data Deficit: Many countries grossly suffer from lack of the institutional capacity, resources, or technical expertise to reliably monitor and report their emission and need for climate finance. This is further exacerbated by issue of data accuracy, inoperability, and transparency, though the Paris Agreement introduced the Enhanced Transparency Framework to allow member states' data access. Even the data presented on IMF's Climate Change Indicators Dashboard which provides information on climate and weather, climate finance, transition to low carbon economy, GHG emissions and actions for bridging the data gap on climate change does not fully capture reliable and credible data from all the countries (UNFCCC, 2024)

e) Coordination Dysfunction and Institutional Logics: Lack of nexus between the enormity and scale of climate crisis and the state-centric approach of UNFCCC, complicates the coordination function

among the diverse entities and institutions. This dysfunction perpetuates the fundamental tension and traction in global climate governance and defies pursuit of climate justice .

The consensus rule further jeopardizes the fast and ambitious action needed to combat the severity of climate change (Roesch & Nobre, 2021). It prevents effective integration and resolution of the concerns of the Global South in GCGS and its framework agreements e.g., "climate debt, historical responsibility, binding GHG reduction of industrial emissions, non-conditionality in climate finance, right to development and sovereignty over natural resources etc." (Weinger, 2023; Marquardt et al., 2023).

Then within the United Nations System, coordination between different bodies like the United Nations Development Programme (UNDP), United Nations Environment Programme (UNEP), and United Nations Office for Disaster Risk Reduction (UNDRR) is also a serious problem. The existing mechanism to facilitate collaboration between different bodies, such as the Development Coordination Office and the Chief Executive Board for Coordination, does not comprehensively address significant disconnect and overlap between high-level ambitions and on-ground implementation by the individual Agencies (Dupont & Skjold, 2022).

f) Inter-Disciplinary Leadership Dysfunction: The global climate forums often operate in silos and "climate bubbles". UNFCCC negotiations are dominated by environment ministries and diplomats (Roesch & Nobre, 2021) to the general exclusion of major entities and issues, like trade regime, alignment of global financial markets to climate policies, population and environment etc. Such fragmentation is mirrored at the national level, with little coordination between climate change departments and other key ministries. At the national process level, countries themselves do not benefit from the input of local authorities, civil society or private sector in designing and implementing NDCs and national climate policies (Roesch & Nobre, 2021) to bridge the gap between national policies and local realities.

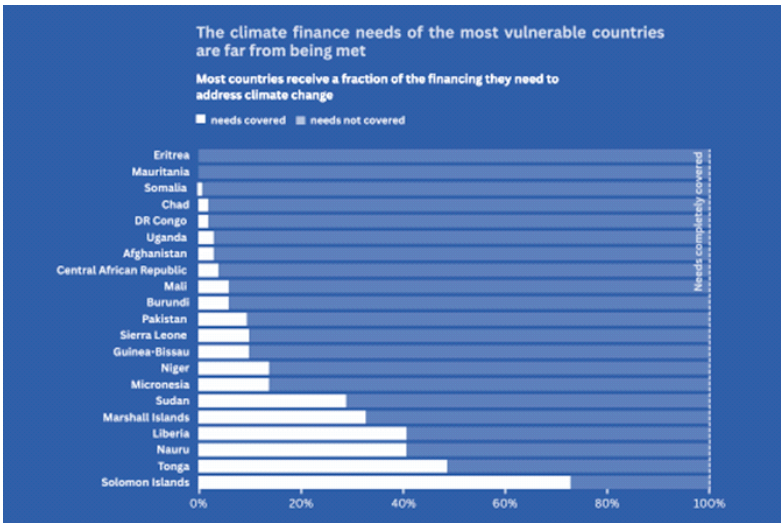
g) Inadequate Climate Financing: Climate finance, being the core of climate governance, serves as means for developed countries, which are responsible for more than 60 percent of cumulative carbon dioxide emissions, to compensate developing countries for the historical injustice and pursue low-carbon development pathways. The total annual climate financing including contribution by both the developed and the developing countries is estimated between $6.3-$6.7 trillion by 2030 and $7-$8.1 trillion by 2035 to meet climate targets. The developed countries and emerging economies are obliged to provide major contribution. However, in 2023, it could reach $1.9 trillion and in 2024 exceeded $2 trillion which significantly fell short of the current requirements (Cao, 2025). The Paris Agreement also envisaged the developed countries to mobilize at least $100 billion annually by 2020 for climate action in developing countries which goal was met two years later in 2022. COP29, thereafter established a higher level of at least $300 billion annually with emphasis on a balance between adaptation and mitigation finance (UNFCCC, 2024).

However, financial short falls and lack of timely access to quality finance worsens the climate-vulnerability of many developing countries. The complex application processes and procedures, rigid conditions, risk aversion, loan rather than grant nature etc., add to their distress besides pushing these already debt-ridden countries to further global climate inequalities (Cao, 2025). Figure 9.8 depicts the climate financing needs of the most vulnerable countries

h) Fossil-Fuel-Driven Growth Model: The historical coal and gas-carbon intensive model of economic growth of the developed countries inspires the developing countries to follow the same path to deal with the immensity of their development challenges. Clean energy or eco-friendly development models as ordained by climate goals require huge investments and gestation time to yield dividends to already resource poor developing countries. It also accentuates sense of injustice among the latter to constrain their development and growth. China, in particular, has stood staunchly against binding reduction requirements on developing states and only committed to cap its CO2 output by 2030 after a joint deal with the USA, in which

Figure: 9.8

Climate Financing Needs of the Most Vulnerable Countries



Source: (Kraus, 2024)

President Obama agreed to cut carbon pollution by 26-28 percent below 2005 levels by 2025.

The strong lobbying by the fossil fuel industry and their opposition to carbon pricing and the removal of subsidies for fossil fuels adds to the discordance and departure from fossil-fuel-dependent growth models. In COP28 alone, 2456 fossil fuel lobbyists were granted access to the negotiations, more than every country delegation except two (Lakhani, 2023).

A Sustainable Way Forward

The foregoing analysis amply demonstrates the constraints and ineffectiveness of the current GCGS to comprehensively address the climate change challenges and to meet the NDCs, the Paris Agreement goals and climate financing commitments. It needs to be reshaped as a matter of urgency to save the planet earth and its inhabitants especially the poor from survival consequences.

A multifaceted-inclusive approach involving governments, non-government entities and private sector seems to be the only way forward to redesign the GCGS in order to sustain earth's bio-life and its environmental integrity. The following salient recommendations may be considered to reconstruct the new GCGS:

a) Science led Apolitical Recognition of Climate Change as a Present Crisis: The first step forward would be to develop a firm apolitical international consensus based on the scientific evidence, to declare climate change as a proximate, immediate and existential problem of a global nature. This consensus must transcend the North-South divide or geopolitical power asymmetry and firmly discard the belief that climate change is not *"an urgent issue for all"* (Roesch & Nobre, 2021). An overall commitment of governments, the UN system and non-state players etc., generated through media, public awareness, education curricula, at all levels and across all sectors is sine qua non to ensure effective operability of the GCGS.

b) Reform of the International Institutions: The current GCGS, including UNFCCC and COP processes should be radically reformed to address its fragmentation and multi-centralization by:

(i) accepting supremacy of techno-scientific determination and decision making on climate issues;

(ii) replacement of the rule of consensus by 2/3 majority voting in case of failure of COP

negotiations;

(iii) introducing a smaller yet frequent meeting schedule catering to specific deliverables that would encourage better monitoring and greater accountability (Dixson-Declève, 2024);

(iv) making UNFCCC more inclusive by multi-sectoral leadership to cater for composite consideration of major issues like economics and defense (Roesch & Nobre, 2021), population and environmental degradation. The incorporation of non-state actors and stakeholders would further ensure that climate negotiations take a holistic approach to find integrated and inclusive solutions to the global problem;

(v) establishing a specially designated Global UN Board on Climate for more effective coordination, clearer assignment of roles among UN/international institutions and the member states and overall oversight to reduce overlap and achieve enhanced impact of climate initiatives;

(vi) making the achievements of GHG emissions agreed targets legally binding and enforceable and holding deviant states and other entities accountable through sanctions and penalizing mechanism by 2/3 majority rule;

(vii) integrating alternative frameworks, such as the Law of the Atmosphere and World People's Conference on Climate Change, the Rights of Mother Earth etc., to ensure a more justice-oriented planetary governance- driven by ecological consideration and self-determination.

c) Revamping Global Climate Finance: The climate finance system must be reformed to make it easily accessible which a prior, entails timely, adequate and non-loan based financing by the developed countries to help developing countries build their institutional capacity and action programs for transition to low carbon economy. UN should play a key role in tracking pledges and the use of climate funds and rationalizing the finance system to be less *burdensome, slow, and disempowering*. At the same time, financial commitments should be scaled up since the world needs approximately five times the current annual amount of climate financing to limit global warming to 1.5 °C by end of 21st century (Samar, 2025).

- ***Align Trade and Economic Policy with Climate Goals*:** Economic growth should be closely linked to climate action through progressive phasing out of the fossil-fuel-driven model. Aligning trade and economic policy with environmental goals will incentivize the accomplishment of mutual climate goals and penalize the ones which fail to comply with the emissions targets. The multilateral trade deal between New Zealand, Costa Rica, Iceland, and Switzerland, signed in November 2024, already sets a precedent to eliminate tariffs on the export of environmental goods and restricts fossil fuel subsidies (Tipping, et al., 2024). A similar trade deal between New Zealand and the European Union also includes provisions for trade sanctions in case of material breaches of the Paris Agreement. These trade-based approaches should be complemented by economic instruments e.g., cost on carbon-intensive activities, cap-and-trade system to decarbonize industries etc. The EU's Carbon Border Adjustment Mechanism which envisages a levy on goods imported to the EU based on their carbon footprint serves as viable trade model. The revenues generated through such mechanisms could be utilized for investments in clean technology, social protection, and skill development programs to facilitate a just transition to a clean economy e.g., part of the revenue generated by the European Union Emissions Trading System is allocated to the Social Climate Fund to support vulnerable households (LSE, 2024).

- Technical and financial assistance for transition to low-carbon economy. The reduction of GHG emissions and meeting NDCs, should be made a condition precedent for the developing countries to access technical and financial assistance from various climate finance mechanisms.

d) Reform of the National Climate Governance Mechanisms Within Countries: The states, while pursuing the sovereignty principle, must ensure that international climate related commitments, NDCs, climate financing, etc., are strictly complied with

and enforced. For the purpose, following specific steps should be taken:

- Legally Binding Climate Laws should be enacted to integrate state specific climate goals into all relevant national laws to address climate disasters, set out long-term net-zero targets and time-bound legally obligated detailed implementation roadmaps. The Climate Change Act 2008 in the United Kingdom (UK) and the Climate Change Response Act 2021 in New Zealand, already provide the template for intervention by the state judiciary and parliament in case of non-compliance. Climate laws serve as a tool to override executive policy decisions or actions, ensure long-term policy stability and incentivize industries to innovate and adopt climate-friendly technologies.

- Independent Statutory Climate Commissions should be established to remove the possibility of aberrations or instability in case of national leadership changes. These Commissions should comprise experts and techno-professionals and operate solely to advance climate goals, monitor government progress in meeting national goals, ensure transparency by publishing regular reports and hold government accountable for any lapses or gaps. The UK's Committee on Climate Change sets an example to ensure government's adherence to the carbon budgets. Such Commissions in the developing countries should be assisted by the international organizations/United Nations to facilitate accurate data-generation and sharing and building capacity for their effective operation.

- Interdepartmental Executive Boards should be set up to ensure a holistic approach in development planning and programming and horizontal and vertical coordination, between different levels of government from international to local, and across ministries and sectors. The existing Planning Commissions or coordination mechanisms should be strengthened by including heads of all main government departments/ministries and representatives of private sector, academia and expert bodies to, inter alia, align and coordinate budgets and climate strategies across sectors like energy, agriculture, industry etc., and help deliver on cross-departmental initiatives. These Boards should be chaired by the Head of States to ensure highest level commitment for achieving climate goals and avoiding contradictory policies (Roesch & Nobre, 2021).

- **Inclusive Decision Making:** Participation and contributions from locals, indigenous people, and NGOs in enacting laws and climate change strategies etc., needs to be ensured at the national and international levels through, for example, climate assemblies that bring together representatives of all relevant stakeholders to discuss environmental goals. In 2020, the UK held its first Climate Assembly, where 108 people discussed and provided detailed recommendations how the UK could meet its 2050 net zero target. Similarly, indigenous climate leadership programs of Canada incorporated indigenous knowledge of the land use and climate into long-term climate policies. These experiences should be suitably replicated as standard for effectively dealing with climate change.

Conclusion

The enormity and severity of climate crisis afflicting planet earth and its bio-life has been repeatedly brought to the fore by a plethora of scientific studies and predictive models at the international forums and. At the same time, the demand for reforming the climate governance system is being intensely articulated especially by the Global South to establish a robust GCGS with strengthened and systemic role of UNFCCC that is capable of (a) equitably mediating the inextricable connect between the techno-scientific universalism of climate truth and the state sovereignty dynamics which at present is grossly susceptible to the whims and discretion of handful of the developed countries; (b) inclusively formulating, implementing and monitoring, the universally agreed targets through innovative processes for deliberations and by leveraging and vertically integrating government, non-government and private sector players from local to national levels; and (c) effectively enforcing legally binding climate action plans, NDCs and financial commitments that transcend the short term

state specific political exigencies or interest driven exceptionalities.

Climate change is not a remote threat; it is the defining crisis of our times, with massive potential to severely disrupt Earth's ecosystem, extinguish biodiversity, mitigate resilience and aggravate vulnerability especially of the poor, and above all foment wars and conflicts in the quest to control the ever-denuding natural resources .

In the wake of changing global order and especially reservations of President Trump regarding climate change, green economy and renewable energy vociferously expressed in his address to the UN General Assembly on 23 September 2025, Pakistan should seize the opportunity to engage actively at the global (UN, COPs and other international conferences and deliberations on climate change) and regional forums (Shanghai Cooperation Organization, Economic Cooperation Organization, Organization of Islamic Cooperation etc.) to reform GCGS and dispel and falsify obstinate misconceptions of handful of countries to relegate the climate threat to periphery in pursuit of their "national interests" to the great detriment of the Global South. At the national level, the country has to streamline its climate governance framework, which largely reflects the broader international stalemate and inertia. It presented third NDCs recently in September 2025 and quantified the climate finance need of $565.7 billion though failed to implement the previous two NDCs of 2016 and 2021. There is a need to streamline fragmented policies, institutional and planning and programming frameworks to be able to effectively address the immensity of climate crises. More specifically,

- There has to be a national political will beyond the federal provincial political economy divergence to accord highest priority to combating climate change.
- The preparation of NDCs document should follow a bottom-up approach as climate change related sectors e.g., agriculture, water, irrigation, forestry, disaster management, transport etc., are the provincial subject as per the 18th Amendment to the Constitution.
- The Provinces should also be enjoined to prepare their own time-bound and Key Performance Indicator (KPI)-based NDCs and implementation strategies and ensure that their development portfolios and associated budgetary outlays fully incorporate the NDCs commitments and climate actions.
- The institutional capacity of the provincial government especially in the planning and development department and climate related departments should be strengthened to ensure NDCs sensitive planning, programming and budgeting.
- At the Federal level, the Planning Commission together with the Pakistan Climate Change Council should ensure that the PDSPs are climate-sensitive, reflect the adaptation and mitigation strategic priorities and vertically integrate the provincial NDCs to represent composite and coherent national NDCs framework.

Pakistan must join the world in unison to move rapidly towards low carbon economy to restrict global warming to 1.5°C by end of the century and reduce GHG emissions by 43-45% (or halved by 2030 for the Race to Zero) below 1990 levels for sustaining life on Planet Earth.

Annex A: Evolution of Climate Governance System*

Table 9.1: Global Climate Governance Timeline.

1945	UN Charter	Formalized the principle of the sovereign equality of UN member states.
1961	UN GA Resolution 1721	Advanced atmospheric science and established WMO programs.
1972	Stockholm Declaration (UN Conference on the Human Environment)	Established Principle 21 on state sovereignty and environmental responsibility.
1974	UN study of climate change	Prompted by WMO and UN resolutions.

1979	First World Climate Conference	Sponsored by the WMO to gather four working groups on climate science.
1979–1980	World Climate Programme/World Climate Research Programme	Sponsored by the WMO, UNEP, UNESCO, and ICSU to coordinate global climate research.
1982	UN Convention on the Law of the Sea	Applied the common heritage doctrine beyond national jurisdictions.
1985	Villach Conference	Scientific consensus on the threats of anthropogenic climate change and establishment of the Advisory Group on Greenhouse Gases in 1986, a key group in the leadup to the IPCC.
1987	Montreal Protocol	Model for inter-state environmental cooperation on ozone depletion.
1988	Establishment of IPCC	Created to assess climate change and support negotiations.
1988	Toronto Conference	WMO/IPCC meeting that called for a global action plan and Framework Convention.
1988	Malta Resolution A/43/241	Declared climate part of the common heritage of mankind.
1988	UN GA Resolution 43/53	Recognized climate change as a global concern and endorsed IPCC.
1989	UN GA Resolution 44/207	Urged urgent global collaboration and preparation for a Framework Convention.
1990	IPCC First Assessment Report	The report provided key scientific input for the INC and future UNFCCC negotiations.
1990	Second World Climate Conference	Held in Geneva to discuss te results of the first decade of work under the World Climate Programme.
1990	UN GA Resolution 45/212	Formally established the INC process under UN auspices.
1991–1992	Intergovernmental Negotiating Committee	The five sessions of the Intergovernmental Negotiating Committee meet.
1992	United Nations Conference on Environment and Development	The Framework Convention on Climate Change was adopted alongside the Convention on Biological Diversity and the creation of the INC for the UN Convention to Combat Desertification.
1992	UNFCCC opened for signature	Formalization of the Framework Convention at the Rio Earth Summit.
1997	Kyoto Protocol	Follow-up binding emission reduction agreement for Annex I parties under the UNFCCC.
2015	Paris Agreement	Established Nationally Determined Contributions and a goal of limiting warming to well below 2 °C above pre-industrial levels.

Chapter

10 AI Vision for Water Security and Governance in Pakistan: A Pathway to Climate Resilience

AI Vision for Water Security and Governance in Pakistan: A Pathway to Climate Resilience

Rahamat Ullah Gill & Masham-e-Zahra

Introduction

The climate crisis is intensifying globally, leading to unprecedented environmental, social, and economic disruptions. According to Germanwatch's Global Climate Risk Index 2025, over 9,400 extreme weather events occurred worldwide between 1993 and 2022, resulting in approximately 765,000 deaths and nearly US $4.2 trillion in direct economic losses. These events, comprising storms, floods, droughts and heatwaves, have grown in both frequency and severity. Storms alone accounted for around 35 percent of fatalities and 56 percent of total economic losses, making them the most destructive category of weather-related disasters (Germanwatch, 2025).

The World Meteorological Organisation (WMO) confirms that the Earth's average near-surface temperature has already reached 1.45–1.55 °C above pre-industrial levels, making 2024 the warmest year on record (WMO, 2025a). Projections indicate that the global mean temperature between 2025 and 2029 will range from 1.2 °C to 1.9 °C above the 1850–1900 baseline, with an 86 percent probability that at least one of these years will exceed the critical 1.5 °C threshold. These figures demonstrate that climate change is no longer a distant threat but a lived reality across all regions.

As global temperatures rise, the severity of heatwaves, flash floods, droughts, glacial melt, and sea-level rise continues to intensify. These phenomena collectively threaten food and water security, human health, and economic stability worldwide. In many countries, including Pakistan, these risks are exacerbated by weak governance, institutional inefficiencies, and political instability, which hinder timely adaptation and effective resource management. The United Nations warns that the long-term cost of inaction on climate adaptation and water governance will far exceed the cost of immediate and coordinated responses (United Nations, n.d.).

Pakistan, however, is at the forefront of this crisis. Consistently ranked among the most climate-vulnerable countries, Pakistan regularly appears in the Global Climate Risk Index as one of the world's worst-affected nations (Germanwatch, 2025). In 2022, catastrophic floods submerged one-third of the country, displaced over 33 million people, and caused economic losses exceeding $30 billion (Ministry of Planning, Development & Special Initiatives, n.d.). The country's vulnerability was again underscored in July 2025, when 230 mm of rainfall inundated Rawalpindi within 24 hours, overwhelming drainage systems, flooding homes, and forcing evacuations along the Lai Nullah (Arab News, 2025). On 3 August 2025, more than 300 people died when their houses collapsed, and 1,600 homes were destroyed. These tragedies occurred only two years after the historic 2022 floods, highlighting Pakistan's exposure to recurring extreme events driven by insufficient infrastructure, ineffective warning systems, and limited disaster preparedness (World Weather Attribution, n.d.).

Addressing these weaknesses requires a paradigm shift toward robust early warning mechanisms, AI-

enabled climate surveillance, and data-driven disaster management. Pakistan's dependence on the Indus Basin, coupled with accelerated glacier melt, ageing water infrastructure, deforestation, and low adaptive capacity, makes climate resilience not only a development priority but a strategic necessity. The adoption of AI-supported observation systems, investment in water-smart infrastructure, and strengthened water governance can transform how the country manages its most critical resource – water– thereby protecting lives, livelihoods, and ecosystems (EBSCO Research Starters, n.d.).

Within this context, integrating Artificial Intelligence (AI) into Pakistan's water governance framework offers a transformative pathway toward climate resilience. AI-driven analytics can improve data accuracy, real-time monitoring, and predictive modelling of hydrological trends, while enhancing institutional coordination, transparency, and public accountability. AI vision can redefine water security and governance in Pakistan by leveraging digital innovation for anticipatory action, resource optimisation, and policy coherence, contributing to a climate-resilient and sustainable future.

Threats to Water Supply

Transboundary rivers and aquifers pose a major challenge to global water security, as they require international cooperation. While shared resources should foster collaboration, the lack of equitable agreements or enforcement often turns them into sources of vulnerability. Geopolitical friction, environmental deterioration, and incompetent governance intensify pressure on water security (EBSCO, 2024). Non-consumptive uses such as biodiversity conservation and ecosystem preservation are often undervalued in water policies, despite their critical role in maintaining ecological balance (Bergkamp et al., 2006).

In South Asia, the Indus Waters Treaty (IWT), signed between Pakistan and India in 1960, remains a critical framework for transboundary water management. Although the Indus Waters Treaty allocates about 80 percent of the Indus Basin's water to Pakistan, India has often been accused of manipulating upstream flows, releasing excess water during monsoon seasons, which increases flood risks, and restricting flows during dry periods, thereby intensifying drought conditions in downstream regions (Baloch, 2025). Such actions undermine both the treaty and Pakistan's hydrological and geopolitical security. Pakistan is ill-prepared due to the lack of storage infrastructure that can buffer sudden surges or shortages. These threats require strengthened transboundary governance, enhanced monitoring, and proactive diplomacy, in addition to domestic measures to improve storage capacity, data systems, and adaptive water management. India's temporary suspension of the Indus Water Treaty (IWT) following the 2025 Pahalgam attack reflects both geopolitical manoeuvring and deep-seated frustrations over the treaty's constraints. Yet, lasting water security in the region depends on renewed cooperation through either amendments to treaty terms or the establishment of a new, more comprehensive framework for shared management (Von Lossow, 2025).

Water Management and Its Significance

Water is essential for human survival, economic growth, and ecosystem stability, yet it is becoming increasingly scarce due to population growth, urbanisation, and climate change. When discussing water management, it refers to the–planning, development, allocation, and sustainable use of water resources to meet the needs of agriculture, industry, households, and ecosystems (Planet Smart City, n.d.). Effective water management systems include infrastructure and processes such as treatment plants, pipelines, reservoirs, monitoring technologies, and wastewater recycling facilities. Such systems control water distribution, reduce wastage, and ensure fair allocation. They manage rivers, lakes, and aquifers; maintain distribution networks; recycle wastewater and store water during dry seasons.

Modern water management leverages Internet of Things (IoT) technologies such as smart sensors and real-time analytics to monitor and optimise water use with greater efficiency. This approach conserves water, reduces operational costs, and strengthens resilience to climate shocks. Moreover, smart water management enhances environmental sustainability by minimising leaks, conserving resources, and enabling precise distribution. It offers a durable, cost-effective, and sustainable response to one of humanity's most pressing challenges (Planet Smart

City, n.d.).

Artificial Intelligence and Digital Transformation in Water Monitoring

The digital revolution has accelerated the adoption of smart water systems. These systems continuously monitor water sources at high resolution using IoT, machine learning, AI, and geospatial big data. IoT sensors collect real-time data on water quality, temperature, flow rates, and usage. AI algorithms detect anomalies such as contamination or leakages, enabling timely interventions and predictive maintenance.

Remote sensing, satellite instruments like Moderate Resolution Imaging Spectroradiometer (MODIS), provides real-time data on snow cover, surface water dynamics during drought and flood situations, and changes in water levels (Hall et al., 2002). Unmanned Aerial Vehicles (UAVs) offer high precision in monitoring flood mapping and damage assessment. (Perea-Moreno et al., 2016). These datasets are processed and analysed within Geographic Information Systems (GIS), which-support scenario planning, flood forecasting, and drought analysis.

Gridded Surface Subsurface Hydrologic Analysis (GSSHA), a hydrological model, storm runoff, urban flooding, and riverine flows across various intensities, providing vital information to-decision-makers. Flood forecasting during extreme events is accelerated and disseminated through the combination of data-driven models with physically based modelling (Ogden et al., 2003). The integration of AI, IoT, GIS, and hydrological modelling is replacing the previously passive approach to water

Table: 10.1

Remote Sensing Applications for Hydrological Monitoring and Assessment

Application Fields	Specific Contents	Examples of Sensors or Satellites
Water Resources	Snow	AVHRR, Terra/Aqua MODIS, Landsat, SSM/I, AMSR E, Cryosat, etc.
	Glaciers	Landsat, ASTER, SPOT, ICESat, SRTM, etc.
	Soil moisture	SSM/I, AMSR E, SMAP, SMOS, etc.
	Groundwater	GRACE
	Lakes, reservoirs, rivers, and wetlands	MODIS, Landsat, SPOT, ICESat, GRACE, SRTM, etc.
Hydrological Fluxes	Precipitation	NEXRAD, TRMM, GPM, etc.
	Evapotranspiration	MODIS, Landsat, GRACE, etc.
	River, reservoir or lake discharge	MODIS, ENVISAT, Landsat, SRTM, ICESat, etc.
Drought and Flooding	Drought and flooding	MODIS, Landsat, GRACE, UAV, AMSR E, SMAP, SMOS, ENVISAT, ASAR, Sentinel 1A/2A, etc.

Source: Resource Labs

management with an active, proactive one. This paradigm relies on early detection, rapid response, and data-driven decision-making to address water challenges-exacerbated by climate change.

Global Approaches to Water Management

Globally, countries are increasingly adopting a mix of infrastructure, robust policy frameworks, and advanced digital technologies to ensure efficient and sustainable water management. Artificial Intelligence (AI) has emerged as a key enabler in this transformation, allowing governments and utilities to move from reactive to predictive management of water resources. These international examples offer valuable lessons for strengthening Pakistan's own water governance and resilience.

- **Singapore:** The city-state's *WaterNet* system demonstrates how AI can revolutionise urban water management. Using machine learning algorithms, the system continuously monitors flow rates, consumption patterns, and leakages across the city's water network to ensure optimal distribution and prevent losses. AI-driven predictive maintenance has enabled Singapore to reduce Non-Revenue Water (NRW) levels to below 5 percent, one of the lowest in the world (Dai et al., 2025). This success stems from strong institutional coordination between PUB (Singapore's National Water Agency) and technology partners, supported by clear policies on data governance and digital infrastructure. Pakistan could draw from this example to modernise its urban water utilities and reduce its high leakage and inefficiency rates.

- **Netherlands:** The Netherlands integrates AI with sophisticated hydrological and meteorological models to support early flood warning systems and adaptive water control. Machine learning helps analyse vast datasets from sensors, satellites, and river gauges to predict flood risks and adjust water levels in real time (Pengel et al., 2011). This system not only protects vulnerable areas but also optimises water storage and drainage for agriculture and urban zones. The Dutch model illustrates how combining AI with strong institutional planning and community engagement can enhance climate resilience, an approach that Pakistan could adopt for managing flood-prone regions, particularly in Sindh and southern Punjab.

- **Kenya:** In semi-arid regions, Kenya has successfully used AI to anticipate groundwater demand and availability. By merging ground sensor data with satellite imagery and machine learning models, researchers were able to predict periods of high groundwater stress before dry seasons (Fankhauser et al., 2022). This enabled timely interventions for water allocation and drought preparedness. The Kenyan experience underscores the importance of integrating low-cost sensors and open-source AI tools to support data-driven decision-making in rural and water-scarce areas, a strategy highly relevant for Pakistan's drought-prone districts in Balochistan and Tharparkar.

These examples highlight that AI, when embedded within sound governance structures and supported by reliable data ecosystems, can transform water-stressed regions into resilient and adaptive systems. For Pakistan, replicating such models would require investing in digital water infrastructure, establishing strong data-sharing mechanisms among federal and provincial authorities, and fostering public-private partnerships to scale up innovation in water management.

Global Significance of Water Management in Drought Mitigation

Drought is among the world's most devastating natural hazards, affecting an estimated 55 million people each year and threatening livelihoods, ecosystems, and national economies (World Health Organisation, n.d.). With the intensification of climate change, prolonged dry spells and unpredictable rainfall patterns are becoming more frequent and severe, posing a growing challenge to global water and food security. Effective water management has therefore become a cornerstone of climate adaptation and drought mitigation strategies worldwide.

A comprehensive water management approach integrates technological, infrastructural, and governance-based measures to enhance resilience. Practices such as groundwater recharge, rainwater harvesting, efficient irrigation systems, and drought-resilient cropping patterns help maintain water availability and reduce vulnerability during dry periods. For instance, Managed Aquifer Recharge (MAR) has been successfully implemented in countries such as India and Australia to store excess

monsoon water underground for use during droughts. Similarly, drip and sprinkler irrigation technologies, widely adopted across Israel and Spain, maximise water-use efficiency in agriculture, enabling higher productivity with minimal water input.

Equally important are early warning systems and water allocation frameworks that allow governments to anticipate drought conditions and manage resources proactively. AI-assisted drought forecasting models, satellite-based soil moisture monitoring, and integrated hydrological databases now play a vital role in providing timely alerts to farmers and policymakers. Countries such as the United States and South Africa have developed multi-tiered drought monitoring systems that link meteorological data with agricultural advisories, ensuring coordinated response and mitigation efforts.

Global experience underscores that effective water management is not just a technical endeavour but a governance challenge. It requires coordinated policy frameworks, institutional capacity, and community participation to ensure equitable water access and sustainable use. For drought-prone countries like Pakistan, integrating these lessons, particularly in areas of groundwater governance, demand-side management, and early warning systems, can significantly strengthen national resilience against climate-induced water stress.

Supporting Evidence & Examples

Australia's Murray Darling Basin provides one of the world's most successful examples of institutionalised water governance under climate stress. The introduction of a basin-wide water allocation framework, guided by scientific modelling and economic analysis, enabled the government to regulate withdrawals, maintain environmental flows, and safeguard agricultural productivity during extended drought periods. These reforms reduced conflict among users, enhanced transparency in water trading, and demonstrated that well-designed governance mechanisms can mediate both economic and ecological crises (Mallawaarachchi et al., 2020).

Across Sub-Saharan Africa and South Asia, the widespread adoption of rainwater harvesting, micro-irrigation, and soil moisture conservation technologies has strengthened water security in drought-prone landscapes. By capturing and storing rainfall, communities have improved agricultural resilience, stabilised food production, and reduced dependence on erratic surface water flows. These interventions, often community-driven and low-cost, illustrate how decentralised water management systems can effectively support livelihoods under changing climatic conditions (Amede et al., 2014).

The integration of drought-resistant crop varieties with Integrated Water Resource Management (IWRM) principles has proven vital in enhancing adaptive capacity across semi-arid regions of Africa and Asia. IWRM emphasises the coordinated use of land and water to maximise social and economic welfare without compromising ecosystem sustainability. Field studies across the Limpopo Basin have shown that combining crop diversification, efficient irrigation scheduling, and community-led water governance significantly reduces vulnerability to water scarcity and climate variability (Ncube et al., 2008).

Pakistan's Strategic Water Reservoirs

Water issues in Pakistan extend beyond environmental sustainability; they are deeply tied to national security and economic resilience. Per capita water availability has plummeted, falling to about 1,000 cubic metres per year, making Pakistan one of the most water-stressed countries in the world today, compared to approximately 5,600–6,000 cubic metres in the 1950s (Rana et al., 2025). Pakistan's total storage capacity has declined from over 25 Million Acre-Feet (MAF) to just 13.7 MAF, sufficient for only 30 days of national demand, compared to a global average of 1,000 days.

Principal resources, Tarbela, Mangla, Chashma, and the under-construction Diamer Bhasha Dam are indispensable for irrigation, flood control, and drinking water supply. Their performance demands strict monitoring and periodic evaluation, as they are critical to downstream ecosystems and socio-economic stability. High-risk zones prone to Glacier Lake Outburst Floods (GLOFs), including Hunza, Passu, Skardu (Shigar), and Chitra, urgently need early warning systems to detect and alert authorities to potential glacial bursts. Deploying AI-powered vision systems and satellite-based radiometric

monitoring in these locations would enable timely alerts, improving disaster risk management and water allocation. Table 10.2 outlines the strategic contributions of major dams to Pakistan's water management.

Water and Ecosystems

Water influences biomes, supports biodiversity, and regulates ecological processes. The provisioning (food and water), regulating (climate and disease control), supporting (nutrient cycles and pollination), and cultural (spiritual and recreational) services are closely tied to the quantity and quality of water resources. However, population growth, poor management, and climate change have placed immense pressure on these systems.

Over the past century, more than 50 percent of global wetlands have been lost, largely due to human activities and inadequate water management (Intergovernmental Panel on Climate Change, 2019). Overexploitation of surface and groundwater, combined with pollution and unsustainable practices, has worsened the crisis. Desertification is now one of the most urgent environmental challenges worldwide (United Nations Convention to Combat Desertification, 2020).

Proper water management is key to restoring degraded habitats by mimicking natural hydrological regimes, improving water quality, and enhancing ecosystem resilience. Controlled reservoir releases

Table: 10.2

Major Dams and Their Strategic Contributions to Water Management in Pakistan

Site	River	Province	Strategic Role
Tarbela Dam	Indus	Khyber Pakhtunkhwa	Largest dam (~13.7 MAF); flood and irrigation control
Mangla Dam	Jhelum	Azad Jammu and Kashmir	2nd largest reservoir; Punjab irrigation
Diamer Bhasha Dam	Indus (Upper)	Gilgit Baltistan/ Khyber Pakhtunkhwa	Future water security and silt control
Chashma Barrage	Indus	Punjab	Balances flow between provinces
Warsak Dam	Kabul	Peshawar	Irrigation and flood overflow
Hub Dam	Hub River	Sindh/Balochistan	Karachi's water supply
Rawal Dam	Korang	Islamabad	Drinking water for twin cities
Marala, Sulemanki, Islam Headworks	Chenab, Sutlej	Punjab	Early flood detection from cross border flows
Rawal Dam	Korang	Islamabad	Drinking water for twin cities
Marala, Sulemanki, Islam Headworks	Chenab, Sutlej	Punjab	Early flood detection from cross border flows

Source: Gill, 2025

and regulated flows can rehabilitate wetlands and create suitable breeding grounds for aquatic species critical in areas like the Indus Delta, where reduced flows have degraded mangroves and fisheries (Hafeez & Qayoom, 2025; Dawn, 2025). Cleaner water through improved treatment, reduced runoff, and controlled sewerage discharges enables native species to recolonise and supports ecosystem recovery (Dawn, 2021). Prudent water use also boosts groundwater recharge and soil moisture, aiding the recovery of floodplains, forests, and arid zones (Business Recorder, 2022).

By integrating AI and real-time monitoring, restoration efforts can be executed with precision and adaptability, ensuring habitats receive water at the right time and in the right amount. Smart and sustainable water management restores rivers, wetlands, and forests, thereby preserving biodiversity, protecting communities from climate impacts, and strengthening natural systems vital to society (Verra, 2023). Thus, conserving water-based ecosystems is not just ecological stewardship; it is central to environmental health and climate resilience. Concerted, policy-driven, and interdisciplinary action is essential to protect these habitats for future generations.

Governance and Institutional Role

Weak governance remains one of the most persistent and systemic barriers in Pakistan's water sector. The country's water governance landscape is characterised by institutional fragmentation, overlapping mandates, and siloed data systems that impede coherent planning and evidence-based decision-making. Multiple agencies at the federal, provincial, and local levels operate with limited coordination, resulting in inconsistent policies, duplication of efforts, and inefficient allocation of resources. These challenges are further compounded by outdated regulatory frameworks, limited data transparency, and inadequate capacity for long-term water planning.

Integrating Artificial Intelligence (AI) and digital governance tools into administrative processes offers a transformative opportunity to address these institutional bottlenecks. Through AI-enabled data integration and real-time analytics, key agencies such as the Irrigation Development & Regulation Authority (IDRA), the Water and Power Development Authority (WAPDA), and provincial irrigation departments can gain access to interactive dashboards that visualise real-time water flows, reservoir levels, and demand forecasts. Such systems can support data-driven decision-making, allowing institutions to anticipate shortages, optimise water allocations, and detect anomalies or leakages instantly. Moreover, digital transparency tools can strengthen accountability by making water data publicly accessible, fostering trust among stakeholders, and reducing the risk of mismanagement or political influence.

The success of this transformation depends heavily on institutional collaboration and policy coherence. Organisations such as the Urban Unit, the Pakistan Council of Research in Water Resources (PCRWR), and provincial planning and development departments are strategically positioned to lead this shift. These entities can play a catalytic role by developing open-data ecosystems, promoting standardised data-sharing protocols, and creating platforms for Public–Private Partnerships (PPPs) in water innovation. Engaging universities, startups, and private tech firms in applied research on AI-driven hydrological modelling, groundwater mapping, and demand forecasting can accelerate the adoption of new technologies and foster local innovation.

Ultimately, strengthening governance in Pakistan's water sector requires a dual approach: institutional reform and technological integration. Establishing a unified National Water Information System (NWIS), guided by principles of transparency, interoperability, and inclusivity, could serve as a foundational step toward cohesive water governance. When paired with AI-based monitoring and predictive tools, such reforms can transform Pakistan's water institutions from reactive administrators into proactive stewards of water security and climate resilience.

Policy Inputs and the Way Forward

To secure its water future, Pakistan must move beyond reactive management toward a proactive, digitally empowered, and climate-resilient governance model. Water scarcity, transboundary pressures, and extreme weather events demand a

national transformation anchored in policy coherence, institutional reform, and technological integration. The way forward lies in embedding Artificial Intelligence (AI) and digital technologies across the water management chain from data collection and planning to implementation and monitoring, while ensuring inclusivity, transparency, and accountability.

Develop a National Water–AI Integration Strategy

Pakistan needs a unified national framework that defines institutional mandates and responsibilities for integrating AI into water management. This strategy should outline clear standards for data collection, interoperability, and ethical AI use, ensuring consistency across provinces. It must also address capacity building to train technical staff and policymakers in digital tools, fostering a new generation of AI-literate water professionals.

Establish a National Water Data Governance Framework

Current water data in Pakistan is fragmented across departments and often inaccessible for analysis. A centralised National Water Information System (NWIS) linking WAPDA, PCRWR, the PMD, NDMA, and provincial irrigation departments should be established to consolidate datasets, monitor flows, and share information in real time. This will enhance policy coherence, transparency, and accountability, aligning national water management with the Sustainable Development Goals (SDGs) and the National Adaptation Plan.

Deploy AI-Driven Hydrological Mapping and Forecasting

Machine learning models that integrate satellite imagery, climate data, and IoT-based ground sensors can revolutionise flood and drought forecasting. Predictive modelling can inform water allocation, optimise reservoir operations, and improve preparedness for GLOF-prone areas like Hunza and Skardu. Linking these systems with NDMA's disaster response platforms will ensure rapid and evidence-based decision-making.

Invest in Smart Infrastructure and Innovation Ecosystems

Modernising Pakistan's ageing irrigation and storage infrastructure with AI-enabled leak detection, smart metering, and predictive maintenance systems can minimise losses and improve efficiency. Establishing innovation hubs jointly managed by the Urban Unit, PCRWR, and academic partners can encourage research-industry collaboration to pilot scalable technologies. Incentives such as tax breaks, research grants, and climate finance (e.g., GCF, Adaptation Fund) can further catalyse private-sector investment in AI solutions.

Strengthen Institutional Coordination and Governance Reform

Governance transformation is key to technology adoption. Establishing an Inter-Provincial Water Innovation Council (IPWIC) could harmonise policies, oversee AI integration, and resolve data-sharing conflicts between jurisdictions. Decentralised decision-making, backed by transparent data systems, will empower local authorities to respond more effectively to water crises.

Promote Community Engagement and Climate Awareness

Technological innovation must be inclusive. Public participation, gender-sensitive approaches, and awareness campaigns are essential to ensure local ownership and trust. Communities should be trained to interpret early warnings, adopt water-saving practices, and co-manage local resources through participatory digital platforms.

Through this multi-dimensional strategy, Pakistan can position itself as a regional leader in AI-enabled water resilience, setting benchmarks for data-driven governance and sustainable resource management.

Conclusion

Water management is no longer a peripheral policy issue; it is central to Pakistan's survival, stability, and socioeconomic future. The convergence of climate change, population growth, and governance deficit has turned water scarcity into a multifaceted crisis that poses a threat to food security, public health, and national security. In this context, artificial intelligence offers a transformative framework for rethinking how Pakistan perceives,

plans, and governs its water resources.

Embedding AI within Pakistan's water architecture can shift the paradigm from crisis response to anticipatory action, enabling real-time decision-making, predictive forecasting, and efficient resource allocation. Yet, technology alone cannot succeed without institutional commitment, inter-agency collaboration, and long-term investment in data infrastructure and human capital. Governance reform anchored in transparency, accountability, and decentralisation remains the backbone of sustainable water security.

True resilience will emerge when digital innovation and institutional reform converge, when data informs every decision, ecosystems are protected as public assets, and local communities participate as partners in stewardship. By pursuing an AI-driven water governance vision, Pakistan can move beyond managing scarcity toward building abundance through intelligence, ensuring that water becomes not a source of crisis but a foundation for climate-resilient growth and human security.

Chapter

11 Analyzing Hyphenated Climate and Gender Challenge

Analyzing Hyphenated Climate and Gender Challenge

Muhammad Firas Shams

Introduction

The world has transitioned from a time when climate change was deemed a "hoax". However, it can now be defined as one of the most pressing existential crises of today. In the last two decades, roughly between the years 2000 to 2019, extreme weather conditions fueled by climate change killed over 475,000 people and caused economic losses of $2.56 trillion. Experts claim that by 2030, heat stress alone can cause an anticipated economic loss of $2.4 trillion globally, resulting in approximately 136 million job losses in sectors such as construction and agriculture. (Begum, 2025) It goes without saying how Climate change is effectively jeopardizing all the headways made in areas such as sustainable development and gender equality. In the case of the latter, it threatens safety, livelihoods, security and health for women and girls the world over. Experts state that women and girls are disproportionately impacted by climate change because of unequal access to resources and other societal inequalities. To put it simply, women and girls' climate change experience isn't similar to that of men due to structural and historical gender inequalities.

Due to implicit as well as explicit laws and social norms, differentiated roles, responsibilities and powers have been imposed on both men and women in various areas of life. Females, especially the Global South population, have an inequitable burden of finding and securing water, energy and food in addition to taking care of both the elderly and the young in the family. This fact increases their vulnerability to climate change. For instance, women of all ages are on the receiving end of droughts, heat waves and severe storms to a greater degree, as they face mental health and physical issues due to extreme climate events. They have to fulfill the responsibility of traversing long distances in order to secure already scarce water, food and firewood. Moreover, they are left behind in disaster-struck or disaster-prone regions to take care of the vulnerable.

Furthermore, women and girls haven't been encouraged or allowed to fully and fairly participate in the climate action movement at the global level. They confront gender-driven harassment due to their participation in climate activism. Women and girls continue to remain underrepresented in climate negotiations; thus, their authentic point of view and solutions are monumentally under-resourced. These inequalities impact women and girls' ability of decision making, to take action, to lead and to find solutions to fight climate change. Becoming cognizant to climate-gender nexus can enable better policy action for climate solutions since including female voices in climate action leads to leveraging of women and girls' local knowledge as well as their leadership in sustainability, creating a much more people-centric, inclusive and informed policy-making. There needs to be an across the board realization that females are at the forefront of climate-related solutions. The Beijing Platform for

Action demands that women be made an equal stakeholder and leader in the climate debate and action.

Latest Gender Snapshot

If the current trajectory of gender inequality lingers on, by 2030, an estimated 351 million females will dwell in extreme poverty, missing out on Sustainable Development Goal -5 (SDG 5) of Gender Equality. Conversely, if investment is done in just one concrete action vis-à-vis the gender digital divide, approximately million women and girls can receive the gender dividend, as 30 million females can be alleviated from poverty and generating around $1.5 trillion windfall in global GDP by 2030. The discourse and action around gender parity since the Beijing +30 - the Beijing Platform for Action that served as a blueprint for equal rights for women was adopted 30 years ago at a watershed juncture. Unfortunately, hasn't progressed desirably; in other words, it has conspicuously fallen short. Countries exist that put curbs on women's civil liberties, along with imposing legal restrictions vis-à-vis employment and marriage. Additionally, women's access to economic dividends still remains limited.

Notwithstanding progress in political participation, unfortunately, gender parity remains an exception instead of being part and parcel of the social fabric. Securing gender equality isn't a far-fetched dream or a mirage, however, it requires concerted bids that factor in a comprehensive, intersectional, gender-responsive and integrated policy plan, strategies, and action that can not only fortify legal frameworks but also shatter deeply entrenched structural roadblocks entailing discriminatory social norms and economic stumbling blocks and ramp up investments in all areas.

On the bright side, an estimated 99 positive legislative reforms helped to eliminate discriminatory laws from 2019 to 2024 and simultaneously set up gender equality frameworks. However, data originating from 131 states in 2024 still reflect considerable stumbling blocks as countries are yet to secure exemplary scores across four dimensions measured, such as 1) violence against women 2) legal frameworks and public life 3) marriage and family 4) employment and economic benefits. Moreover, it is estimated that over 51 percent countries have gaps in the aforementioned areas. For instance, in almost 47 percent countries, which turn out to be 61 countries, at least one restriction precludes women and girls from performing the same job as men and boys. Additionally, in 29 percent countries, which turns out to be 38 countries, fix 18 years as the minimum marriage age without factoring in exceptions. More alarmingly, in 48 percent of the countries, that is around 63 countries, have rape laws grounded on the lack of consent. Globally, 1 in 8 women and girls aged 15 to 49 has been a victim of physical/sexual violence by a current or former intimate partner in the last 12 months, which comes out as 12.5 percent. What is more critical is the fact that in Oceania (excluding New Zealand and Australia), 1 in 4 women coming out as 28.6 percent faced the aforementioned violence, while in sub-Saharan Africa, 20.4 percent encountered such violence. (Women & DESA, 2025)

Furthermore, currently 1 in 5 women aged 20 to 24 was first married or is in a matrimonial union before turning 18, which in fact reveals a minimal but noteworthy decrease to 19 percent when compared to 22 percent in 2014. Shockingly, in this day and age, globally, 230 million females have experienced genital mutilation, out of which 63 percent cases originate from Africa, 35 percent from Asia, while 3 percent from the Middle East. It is estimated that every year, 4 million women and girls go through genital mutilation known as female circumcision, and egregiously 2 million of them are under the age of 5. Notwithstanding "global bids", only 56.3 percent of women aged 15-49 who enter marriage or a union have complete decision-making autonomy over their reproductive and sexual health as well as rights. This data originates from 78 countries. (Women & DESA, 2025)

As a matter of fact, females of all ages still continue to bear an asymmetrical, disproportionate share of unpaid domestic work, including care work for the family unit. Approximately, on an average basis, women are evidenced to devote over twofold (2.5x precisely) times as many hours a day to tasks as men. Moreover, women and girls in Western Asia and

Northern Africa are reported to spend over four times as many hours as men. Whereas, in Oceania (excluding New Zealand and Australia, North America and Europe), women are engaged in estimated two times as many hours as men spend on tasks. Conversely, data suggests that gender ratios in time engaged in care and unpaid domestic work have reduced in countries like Germany, Colombia, the Dominican Republic, Mexico, the United States, Japan, the United Kingdom and Mongolia. However, the gender ratio vis-à-vis unpaid domestic and care work considerably remained unchanged in states like Switzerland, Canada and Guatemala. (Women & DESA, 2025)

Furthermore, women and girls confronting intersecting and multiple inequalities have been impacted the most. An estimated 33 percent of women aged 60 and above faced an increase in childcare during COVID-19, as compared to 62 percent women with disabilities. Apart from this, as of the first month of 2025, women occupied 27.2 percent of the seats in the national parliaments, an improvement of 4.9 percent from 2015. Moreover, the number of countries with 50 percent or more female political representation in lower chambers/house have witnessed a twofold increase from 3 to 6 between the years 2015 and 2025. The underlying phenomenon for this success is women's quotas. It is worth mentioning here that there are still 102 states which have never had a women Head of the Government or State, including the United States of America. Apart from this, women's participation as well as representation in the most basic tier of the government, the local government, saw no improvement. It is frozen at 35.5 percent in the years 2023 and 2024, following an average yearly increase of 0.4 percent since 2020. The world over, women only occupy 30 percent of managerial titles, increased of merely 2.4 percent between the years 2015 and 2023. With the current pace, it will require at least 100 years to secure gender equality in the domain of management. (Women) & (DESA), 2025)

In addition, data available from approximately 80 countries suggested that less than half of women and girls have ownership/ rights to agricultural land. In virtually 50 percent of these countries, men and boys are two times more likely to own land at least compared to women and girls. Moreover, since the year 2021, the gender gulf in mobile phone ownership has contracted from 9.4 percent to 7 percent in 2024. With this, Gender gaps in mobile money account ownership have also notably shrunk. In terms of fleshed out systems of tracking resource allocation for gender parity, only 26 percent of the 121 countries had implemented it, which remains the same as 2021. This lack of progress underscores chronic capacity gaps in domains such as spending, costing and allocating funds. This makes it hard to plan, strategize and legislate gender equality.

How are Gender Inequalities and Climate Change Intertwined?

Climate crisis cannot be described as "gender neutral", rather, it aggravates the already existing gender inequalities, as females are mostly on the receiving end of its impact. In other words, what drives the climate crisis also drives gender inequalities. Currently, it is estimated that 47.8 million more women experience hunger and food insecurity than men. Based on the findings of the Gender Snapshot 2024 report, by 2050, 158 million more females of all ages may plunge into poverty by virtue of climate change, that is, in fact, 16 million more than the cumulative sum of men in a similar situation. (Women, 2025)

In several regions around the world, the onus of finding and securing water, fuel and food for their families disproportionately falls on the shoulders of females. Add the layer of Climate Change in this scenario, as due to scarcity of resources caused by Climate Change, women and young girls are forced to work much harder and traverse long distances to fetch basic necessities. This, in turn, can force girls to drop out of school to share their mother's burden. Bolivian environmental journalist, Miriam Jemio, is of the opinion that females are on the vanguard of the fight against Climate Change. However, their role is not grasped by the community, nor is it made visible. Take the example of indigenous women and girls in Bolivia's eastern region Chiquitania, where women and girls are tasked with securing water for their families as part of traditional care responsibilities. (Women, 2025) Due to Climate Change, there is an increasing water scarcity in the aforementioned

region; therefore, women and young girls, at times, have to travel to another community or the nearest city to fetch water.

It is also noteworthy that Climate Change leads to an increase in Gender-based violence. Based on the findings of a UN Spotlight brief published in 2025, Climate Change is described as amplifying economic and social maladies that trigger an increase in violence against women and girls. This statement is corroborated by one of the studies in the aforementioned brief, citing a 28 percent surge in femicide during the heat wave season. (Women, 2025) What is more worrisome is how climate change may be connected to one in every ten cases of violence occurring in an intimate relationship by the end of the century. The shockwaves of gender-based violence will be experienced the hardest in places where deep-rooted inequalities already exist.

Moreover, regions that are rendered fragile by conflicts are susceptible to gender-based violence. They also tend to experience aggravated political, economic and social tensions by virtue of climate change. Take the example of a rural economic set-up, a flash flood or continuous drought can devastate the revenue stream generated by agriculture, along with making access to clean water and food difficult; in turn, it can augment existing political turmoil. This is substantiated by research which reflects directly proportional relationship between instability as well as poverty caused by climate change-related conflict. The cases of human trafficking, child marriages and sexual violence grounded in conflict also snowball (Women, 2025).

Certainly, climate change is leading to unpredictable weather patterns and natural-anthropogenic disasters. In the event of a disaster, women face disproportionate consequences as they are to a greater degree likely to find themselves injured because of deep-rooted gender inequalities that have enabled disparities vis-à-vis mobility, access to information, training and resources, and autonomy in making decisions. In the wake of a disaster, women's access to assistance and relief is limited, which in turn jeopardizes their recovery,well-being and livelihood. Both reproductive health and maternal health are impacted negatively by climate change, as disasters and conflicts limit access to healthcare services. Research shows that spells of extreme heat ramp up the incidence of birth defects and stillbirth. As global temperature rises, rainfall and humidity are linked to the spread of vector-borne illnesses like dengue fever, Zika virus and malaria that can cause anemia, miscarriages and premature births amongst pregnant women. Experts claim that women in general are less likely to survive natural hazards. (Women, 2025) Moreover, according to the Intergovernmental Panel on Climate Change (IPCC) report of 2022, women and girls are at a higher risk of food insecurity as compared to men. In addition, women are more likely to die in extreme weather and have a greater tendency to have their mental health suffer due to climate change. (Zack, 2022)

Furthermore, the impact of climate change on females is disproportionate, while the effects aren't uniform. Climate change has to be analyzed by factoring in intersectional feminism. In other words, different layers of inequality converge and aggravate one another. For instance, climate change poses a greater threat to women and girls with disabilities, those, residing in remote, conflict and disaster-prone regions and rural areas. According to Matcha Phorn-in, a feminist human rights defender from Thailand, if certain segments in society are invisible in everyday affairs of life, their needs won't come up in thought or discussion, much less be addressed, especially in situations of crises. Phorn-in opines that humanitarian programmes have the tendency of reinstating patriarchal structures of society, particularly when gender and sexual diversity aren't factored in. Therefore, a structural change is required for equality across genders. (Women, 2025)

According to the World Bank's 2021 Groundswell report, by 2050, approximately 216 million people could be forced to move within their countries due to climate change. Decision-making vis-à-vis migration is tied to gender responsibilities and roles. Women and girls often have to confront stumbling blocks to leave areas that are vulnerable to natural/anthropogenic disasters and climate change because they are expected to be caregivers. Yet they lack financial assets, while having almost no rights

to property and land. When women are allowed to migrate, they still face hazards such as human trafficking, gender-based violence and child marriage.

Apart from this, it is a generational phenomenon how women and girls globally have displayed leadership and absolute resilience when it came to safeguarding their land, natural resources, livelihoods and communities. However, female environmentalists continue to experience gender-based violence, which is disproportionately high due to their ecological crusade; as a result, threats grounded in gender are employed to stifle female environmentalists. Women and girls suffer harassment, verbal, sexual abuse, intimidation and exclusion at the hands of those who want to undermine the urgency and reality of environmental movements.

Notwithstanding undeniable role of women and girls in international and national climate movements and their glorious history of resilience and leadership in the arena of environmentalism, men continue to occupy 67 percent of climate-related decision-making roles, while women's representation both nationally and internationally as environmental defenders in climate negotiating organizations is below 30 percent. Leadership and participation to a much greater degree in the climate movement is indispensable and harnessing women and girls' knowledge of ground realities is critical if we are to design responsive and sustainable solution to the climate emergency that factor in differentiated needs of women and girls. In the same vein, according to the Generation Equality Action Coalition on Feminist Action for Climate Justice, it is imperative to include women in any discourse about sustainable solutions to climate change and its impact. Ironically, only 3 percent of philanthropic funding goes into supporting their activism. Usually, climate fund providers invest in large-scale projects starting at $10 million, which puts female-led climate organizations at a disadvantage since they are small and have difficulty accessing climate funds. (Zack, 2022)

Apart from this, women and girls need to be viewed as at the forefront of climate change and their local knowledge and expertise harnessed to find region specific, gender-responsive, intersectional solutions to the devastation of climate change. For instance, the "conchera" or the shell women and girls of Tumaco, Colombia, have been harvesting piangu (mollusk) for generations as a source of income and food. They became cognizant of climate change with the destruction of local mangrove forests which in turn was adversely impacting piangu. Consequently, these females united to create a project for the conservation and replantation of mangroves. This project will aid in the preservation of the local harvest through the protection and replantation of mangroves. In addition, the mangroves will preserve the coastline, filter water and sequester carbon. (Women, 2025)

Monsoon on Steroids: The Impact of Climate Change in Pakistan

The ongoing floods of 2025 have submerged a major land mass mostly in Punjab and Khyber Pakhtunkhwa (KPK), displaced millions and wreaked unprecedented magnitude of devastation. Since 26 June, the countrywide deluge has caused 1,006 deaths, including 275 children, destroyed over 12,500 housing units and displaced a colossal 3 million people, with approximately 150,000 taking refuge in makeshift shelters. Moreover, according to KPK's Rapid Needs Assessment (RNA), over 1.57 million have been negatively impacted with alarming gaps in the areas of education, water, nutrition, hygiene and sanitation services. According to Punjab's RNA, over 4.2 million have been adversely affected, 2.8 million displaced in 18 different districts. (Web, 2025) In Punjab alone an estimated 2.5 million acres of farmland have been inundated by Chenab, Sutlej and Ravi rivers. (Ashraff, 2025)

Based on UNICEF's services, it has delivered oral rehydration salts, insecticide treated nets and essential medicines, covering over 650,000 flood-affected affected. Moreover, 136,000 children, along with pregnant and lactating mothers, have been covered through nutrition treatment and screening. Along with this sanitation facilities, hygiene kits and safe drinking water have all been provisioned to an estimated 130,000 flood-affected

affected in Punjab and KPK. Furthermore, UNICIF is also engaged in education continuity for 30,000 children in KPK and has built 33 makeshift learning centers in Punjab. Preparedness and protective measures are operational in Sindh and Gilgit-Baltistan to protect learning paraphernalia and school infrastructure. (Web, 2025)

Not least for women, the deluge of 2025 has brought a plethora of formidable challenges. The floods have damaged doors and walls, causing homes to become unsafe. There is a lack of secure shelters, privacy and clean toilets. This acts as a compounded problem for females of all ages. Since women are traditionally labelled as caregivers, they find themselves in a dire predicament due to lack of access to proper sewerage and sanitation, food, clean water and healthcare. Expectant and young mothers find it extremely difficult to access nutrition and medical attention. The coming winter and the scarcity of resources compound their problems. In addition, girls also who already have to grapple with societal pressures are at a higher risk of dropping out of school in order to lend a hand to their family to manage household affairs in the aftermath of the floods. For flood victims, basic necessities have become elusive for women such as sanitary items. These people have lost all their savings, including emergency grain supplies, and in many cases, small grocery shops as their sole source of income is also losing marginal financial autonomy in the devastation. Additionally, 67 percent of Pakistan's female population is associated with the agriculture sector, often exploited or underpaid, which has been overwhelmed by the current deluge. (Begum, 2025) This in turn, creates a cycle of food insecurity and acute poverty for the various already impoverished agriculture dependent households.

During the floods of 2022, the United Nations Population Fund (UNPF) estimated that virtually 650,000 pregnant women in flood-impacted districts required maternal healthcare services for safe and healthy pregnancy, while upwards of 73,000 women were expected to deliver in the coming month, which urgently required newborn care and skilled birth attendants/doulas/midwives. Back UNPF reported that women and girls are at an increased risk of harassment and Gender-Based Violence (GBV) since 1 million houses were destroyed. (Pakistan, 2022) This time around, the situation is far worse than the deluge of 2022, with women particularly suffering and adapting as well as making difficult choices for themselves and their families.

Policy Recommendations

- There needs to be a widespread understanding amongst all stakeholders, especially policy-makers and that females, especially those originating from indigenous and rural communities, bear the brunt of climate change. Their participation is also critical in providing solutions.

- The Beijing Platform for Action is a watershed moment and a visionary plan for gender equality, conceived around 3 decades ago. In light of the aforementioned plan, women's proactive role in climate action is critical; their rights and leadership need to be prioritized when it comes to climate action. In this vein, female leadership for climate needs to be cultivated at the grassroots level. This has to be done at the most basic tier of the government and all the way to the state legislature. Women must be integrated into climate strategies, policies and plans.

- Young women and girls who could be leaders of tomorrow need to be encouraged to take part in the climate crusade and fulfill their civic responsibility as concerned citizens. Obviously, their place in the climate spectrum can only be ensured if men participate in the struggle to help them.

- It is key to encompass youth and even adolescent girls in bids to save the planet and fight climate change with the help of climate education and climate action, as well as debate spearheaded by the female youth. The female youth must be utilized and included in crafting of Nationally Determined Contributions (NDCs), an exercise already pioneered by the Marshall Islands, Ecuador and Lesotho for successful and participatory design and implementation of NDCs.

- There needs to be an increase in the number of

women working and leading climate negotiating bodies across the globe as opposed to the asymmetrical representation dominated by men. In other words, more women and girls need to be in decision-making roles, calling the shots, especially from the Global South, particularly rural and indigenous communities.

- Due to their societally determined caregiving responsibilities, women possess a deep and incisive understanding, as well as a comprehensive local profundity of resources and natural environment. Regardless of the dollar worth of their projects, funding women and girls-led climate projects, financing their vision and ideas for environmental sustainability, is instrumental for mitigation and adaptation vis-à-vis climate change.

- Regional councils need to be made in regions prone to anthropogenic and natural disasters, with inclusion of indigenous and rural women, so that not only their localized knowledge and participation in decision-making is leveraged, but also to alleviate the plight of women and girls in the event of a disaster. In the same vein, governments must espouse legislative and normative reform that buttress climate justice, by expediting women's participation and engagement at all tiers of decision-making, making sure equal rights to land, tenure security and resources.

- It is absolutely essential that gender budgeting, in general, especially in relation to health and education, and more relevantly for climate change, must be prioritized. More women need to be made part of the budgeting process so that the budget is responsive to the needs and neglected state of women and girls; adding the lens of intersectionality to the budget will only make it more impactful and targeted.

Participation alone of women in climate debate and action wouldn't suffice, as it may not invariably lead to more gender-responsive climate policies. Climate Change has inappropriately affected underprivileged women. It is worth mentioning that women of African descent or black females in Western countries and those living in Africa have had a profound impact in almost all walks of life; from social and economic burden, to livelihood and food security, and last but not least, health and safety, as discussed earlier, this has also happened in our country.

In terms of Climate Justice, there is an urgent need to prioritize women and girls' rights, especially from rural and indigenous segments of the marginalized and intersecting social fabric, in order to move to biodiversity and environmental sustainability.

Statistical Appendix
Key Indicators

Statistical Appendix
Key Indicators

Table A-1
Level of Pattern of Growth
(Base year 2015-16)

	GDP Growth Rate (%)	Incremental Capital Output Ratio	Volatility of Growth% a	Extent of Balanced Growth b	Growth Rate of Labor Intensive Sector c
2000/01	3.1	8.0	-2.2	6.3	0.8
2001/02	4.7	4.9	-0.2	4.4	0.9
2002/03	7.5	3.3	1.4	4.1	1.1
2003/04	9.0	1.9	3.9	10.2	0.6
2004/05	5.8	1.6	4.8	11.6	0.9
2005/06	5.5	2.8	0.6	17.4	0.7
2006/07	5.0	2.8	-0.5	3.4	0.9
2007/08	0.4	3.1	-1.5	5.4	0.8
2008/09	1.1	38.9	-6.2	5.6	3.9
2009/10	2.3	5.0	-2.6	3.8	1.1
2010/11	3.2	3.2	-0.2	8.6	1.0
2011/12	3.2	3.0	0.4	3.2	1.1
2012/13	3.9	3.1	0.6	4.4	1.2
2013/14	3.6	2.8	1.3	6.6	1.0
2014/15	3.8	3.1	0.5	4.7	0.9
2015/16	4.1	2.8	0.7	**7.1**	1.0
2016/17	4.6	0.3	1.2	5.7	1.1
2017/18	6.1	2.8	1.2	5.7	1.3
2018/19	3.1	4.7	-2.6	5.5	0.9
2019/20	-0.9	-13.9	-4.6	5.2	-0.3
2020/21	5.8	2.4	2.4	5.2	1.0
2021/22	6.2	2.2	2.4	4.8	0.9
2022/23	-0.2	-50.7	-4.3	4.7	1.2
2023/24	2.5	4.2	-0.4	4.5	1.5
2024/25	2.7	4.3	0.0	4.2	0.7
Average	**3.8**	**1.9**	**-0.2**	**6.1**	**1.0**

Note: The base year of all calculations has been changed from 1999-00 to 2005-06. The values before 2005-06 will differ compare to previous reports.

n.c. = not computed

Source: Pakistan Economic Survey (various issues)

a Difference in the growth rate of GDP during a year minus the trend growth rate (as approximated by the average growth rate during the previous five years)

b Computed as the weighted (share of value added in 2005-06) standard deviation of the growth rates of individual sectors during a particular year. The larger the magnitude of this indicator the less the extent of balanced growth

c Labor-intensive sectors of the economy are identified as agriculture, small scale manufacturing, construction, whole sale and retail trade, public administration and defence and social services

Table A-2
Level and Pattern of Investment
(Base Year 2015-16)

	Gross Domestic Capital Formation (%of GDP)	National Savings as % of Investment	Private Investment as % of Total Fixed Investment	Share of Private Investment in Labor Intensive Sectors (%)
2000/01	17.2	95.8	64.6	54.8
2001/02	16.8	110.7	72.9	47.7
2002/03	16.9	123.1	73.9	45.7
2003/04	16.6	107.8	72.7	46.5
2004/05	19.1	91.5	74.9	51.0
2005/06	19.3	78.8	76.3	41.4
2006/07	18.8	74.5	73.3	42.7
2007/08	19.2	57.3	72.7	42.0
2008/09	17.5	68.6	73.6	46.5
2009/10	15.8	86.1	73.9	52.4
2010/11	14.1	100.7	74.4	56.5
2011/12	15.1	86.1	71.9	57.7
2012/13	15	92.7	73.1	58.0
2013/14	14.6	91.8	72.6	57.0
2014/15	15.7	93.6	73.8	53.0
2015/16	15.7	88.5	73.0	51.4
2016/17	16.2	74.1	69.2	54.0
2017/18	16.70	62.3	68.2	53.3
2018/19	13.19	65.3	66.9	45.2
2019/20	13.1	69.2	75.0	46.3
2020/21	12.8	94.4	76.8	47.1
2021/22	14	**69.9**	75.8	46.2
2022/23	13.6	93.6	75.6	48.5
2023/24	11.9	96.2	78.9	48.7
2024/25	13.8	102.2	75.8	49.5
Average	**15.7**	**87.0**	**73.2**	**49.7**

Source: Pakistan Economic Survey (various issues) SBP, annual Report (various Issues)

Table A-3
Agricultural Growth and Profitability
(Base Year 2015-16)

	Growth Rate (%)	Share of Growth in Crop Sector (%)	Volatility in Agriculture Growth	Change in of Output Prices to Fertilizer Prices (%)	Change in Agriculture Terms of Trade with Manufacturing (%)
2000/01	-2.2	n.c	-7.1	-3.8	4.6
2001/02	0.1	n.c	-2	-5.4	0
2002/03	4.1	57.8	2	-0.3	-0.8
2003/04	2.4	42.4	0.4	-0.3	0.2
2004/05	6.5	90.9	4.4	-4.8	-2.1
2005/06	6.3	n.c	4.1	-4.1	-6.7
2006/07	3.4	55.8	-0.5	10.2	4.2
2007/08	1.8	n.c	-2.7	-20.6	-4.2
2008/09	3.5	62.5	-0.6	-10	9.6
2009/10	0.2	n.c	-4.1	17.3	1
2010/11	2	20.8	-1.1	-4.9	3.3
2011/12	3.2	36.3	1.4	-48.3	-9
2012/13	3.1	23.2	0.5	7.8	6.2
2013/14	2.4	47.8	0.1	10.6	3.1
2014/15	1.8	14.1	-0.1	4.7	7.9
2015/16	0.4	**n.c**	-2.4	6.9	6.6
2016/17	2.2	16.5	0.0	30.9	3.1
2017/18	3.9	37.1	2.1	0.0	-0.5
2018/19	0.9	n.c	-1.6	-19.4	-7.7
2019/20	3.9	42.8	-2.7	-44.3	-9.3
2020/21	3.5	64.2	2.7	-5.8	-14.9
2021/22	4.2	67.5	1.6	-28.6	-11.3
2022/23	2.2	70.2	2.0	-4.3	-2.6
2023/24	6.4	54.4	6.4	-13.8	2.1
2024/25	0.6	n.c	-2.5	-3.3	-2.0
Average	**2.7**	**47.3**	**0.0**	**-5.3**	**-0.8**

n.c. = not computed, n.a. = not available

Source: Pakistan Economic Survey (various issues)

Table A-4
Level of Pattern of Manufacturing Growth
(Base Year 2015-16)

	Manufacturing Growth Rate (%)	Large Scale Manufacturing Growth(%)	Small Scale Manufacturing Growth (%)	Share of Growth in Large Manufacturing (%)	Manufactured Goods Exports Growth(%)
2000/01	9.3	11	6.2	76.3	21.3
2001/02	4.5	3.5	6.3	52	7.7
2002/03	6.9	7.2	6.3	68.2	21.3
2003/04	14	18.1	-20	84.6	8.9
2004/05	15.5	19.9	7.5	87	21.7
2005/06	8.7	8.3	-20	75.2	13.5
2006/07	9	8.7	7.5	74.3	3.5
2007/08	6.1	4	8.7	58.9	13.2
2008/09	-4.2	-8.1	8.1	n.c.	14.5
2009/10	1.4	4.8	7.5	24.9	12.8
2010/11	2.5	1.1	7.5	54.8	26.7
2011/12	2.1	1.13	7.5	44.5	1.2
2012/13	4.9	4.46	8.28	74.9	8.4
2013/14	5.7	5.46	8.29	78.3	11.3
2014/15	3.9	3.28	8.21	68.2	-8.4
2015/16	3.7	**2.98**	**8.19**	65.0	-5.3
2016/17	5.8	5.64	8.15	77.2	0.3
2017/18	5.4	**5.12**	**8.17**	75.2	14.9
2018/19	**-0.7**	-2.6	**8.2**	n.c.	25.6
2019/20	-7.8	-11.3	1.37	24.1	9.1
2020/21	10.5	111.5	8.97	12.4	27.3
2021/22	10.9	11.9	8.9	8.1	40.0
2022/23	-5.3	-9.9	9.2	-5.4	21.3
2023/24	3	0.94	9.1	0.3	-12.9
2024/25	1.3	-1.53	8.8	-0.5	10.4
Average	**4.7**	**8.2**	**5.5**	**51.2**	**12.3**

n.c. = not computed

Source: Pakistan Economic Survey (various issues)
SBP, Annual Report (various issues)

Table A-5
Inflationary Trends

	Rate of Inflation (Consumer Prices) (%)	Rate of Inflation (Food Prices) (%)	Core Rate of Inflation (Non-Food Non-Energy) (%)	Rate of Inflation in Import Prices (%)	Rate of Monetary Expansion less GDP Growth (%)
2000/01	4.4	3.6	n.a	15.2	7.0
2001/02	3.5	2.5	n.a	0.0	12.3
2002/03	3.1	2.8	n.a	3.7	13.3
2003/04	4.6	6.0	3.9	14.8	12.1
2004/05	9.3	12.5	8.8	10.4	10.3
2005/06	7.9	6.9	7.0	17.3	9.4
2006/07	7.8	10.3	6.9	7.6	13.8
2007/08	12.0	17.6	10.2	27.7	10.3
2008/09	17.0	23.5	11.4	25.1	9.2
2009/10	10.1	12.6	7.6	6.2	9.9
2010/11	13.7	18.3	9.4	20.7	12.2
2011/12	11.0	11.0	10.6	21.8	9.8
2012/13	7.4	7.1	9.6	7.8	12.3
2013/14	8.6	9.0	8.3	4.3	8.5
2014/15	4.5	3.5	6.5	1.3	9.0
2015/16	2.9	2.1	4.2	-13.5	9.0
2016/17	4.1	3.9	5.2	-1.3	8.4
2017/18	3.8	2.0	5.4	5.2	3.9
2018/19	7.3	4.6	7.9	8.1	8.0
2019/20	10.7	14.9	8.2	5.9	18.4
2020/21	8.9	12.9	6.0	30.0	10.4
2021/22	12.1	13.4	8.1	47.4	7.4
2022/23	29.2	39.0	16.2	-1.3	14.4
2023/24	23.4	20.8	16.1	14.5	13.6
2024/25	4.73	-0.2	10.2	5.7	11.0
Average	**9.5**	**10.4**	**8.5**	**11.6**	**10.5**

n.c = notcomputed
Source: Pakistan Economic Survey (various issues)
SBP, Annual Report (various issues)
IMF

Table A-6
Fiscal Policy
(Percentage of GDP)

	Revenue	Expenditure	Non-Interest Current Expenditure	Budget Balanced	Revenue Deficit/ Surpluse
	a	b	c	d	e
2000/01	13.1	17.1	9.4	4.0	-2.2
2001/02	14	18.6	9.6	4.6	-1.7
2002/03	14.8	18.4	11.4	3.6	-1.5
2003/04	14.1	16.9	9.8	2.8	0.3
2004/05	13.8	17.2	9.7	3.4	0.5
2005/06	14	17.1	9.7	4	-0.5
2006/07	14.9	18.1	10.9	4.1	-0.8
2007/08	14.1	21.4	12.8	7.3	-3.3
2008/09	14	19.2	10.7	5.2	-1.4
2009/10	14	20.2	11.7	5.2	-2.1
2010/11	12.3	18.9	12.1	6.5	-3.5
2011/12	12.8	21.6	12.9	8.8	-4.5
2012/13	13.3	21.5	12	8.2	-3
2013/14	14.5	20	11.3	5.5	-1.5
2014/15	14.3	19.6	11.3	5.3	-1.8
2015/16	13.6	17.7	10.4	4.1	-0.8
2016/17	13.9	19.1	10.8	5.2	-0.7
2017/18	13.3	19.1	11.1	5.8	-1.6
2018/19	11.2	19.1	11.4	7.9	-5
2019/20	13.2	20.3	12.4	7.1	-4.8
2020/21	12.4	18.5	11.4	6.1	-3.9
2021/22	12.1	20	12.5	7.9	-5.2
2022/23	11.5	19.3	10.4	7.8	-5.7
2023/24	12.6	19.5	10	6.9	-4.2
2024/25	15.2	21.1	10.5	2.6	-1
Average	**13.41**	**19.10**	**11.05**	**5.60**	**-2.40**

Source: Pakistan Economic Survey (various issues)

SBP, Annual Reports (various issues)

MoF, Fiscal Operations

a Total revenues of federal and provincial governments

b Revenue and development expenditure of federal and provincial governments

c Current expenditure minus interest payments

d Total revenue minus total expenditure

e Revenue receipts minus current expenditure of federal and provincial governments

Table A- 7
Fiscal Policy
(Base Year 2015/2016)

	Primary Balance (% of GDP) a	Total Government Debt (% of GDP) b	Effective Interest Rate on Domestic Debt % c	% of Deficit Financed by Bank Borrowing %
2000/01	1.3	82.4	11.3	-18.4
2001/02	0.1	73.1	12.4	7.4
2002/03	0.4	68.9	10.2	-30.5
2003/04	1.1	62.3	9.4	47.4
2004/05	0.3	58	8.5	27.7
2005/06	-1.1	53.1	10.2	21.8
2006/07	-0.1	52.1	13.8	37.5
2007/08	-2.7	56.8	13.7	80.5
2008/09	-0.3	57.8	12.9	54.2
2009/10	-1.9	59.9	12.4	32.8
2010/11	-2.7	58.9	10.5	51.5
2011/12	-4.3	54.3	10.7	52
2012/13	-3.8	59.3	9.7	79.5
2013/14	-1	60.2	9.5	23.3
2014/15	-0.6	58.1	9.3	61.2
2015/16	-0.3	58.3	8.1	58.3
2016/17	-1.4	61.3	8.2	55.7
2017/18	-1.9	61.5	8.1	49.57
2018/19	-1.3	77.7	8.8	65.7
2019/20	-1.6	80.0	9.9	57.5
2020/21	-1.4	63.9	9.6	54.9
2021/22	-3.1	66.6	9.1	59.0
2022/23	-1.0	68.8	14.6	56.3
2023/24	0.9	61.5	15.2	99.9
2024/25	3.0	70.1	12.1	74.0
Average	**-0.94**	**63.40**	**10.67**	**45.20**

Source: Pakistan Economic Survey (various issues)
SBP, Annual Reports (various issues)
Ministry of Finance, Fiscal Operations
Ministry of Finance, Debt Policy Statements

a Estimated as revenue receipts minus total expenditure net of interest payments

b Includes domestic and external debt

c Defined as the ratio of domestic interest payment to outstanding domestic debt

Table A- 8
Monetary Policy

	Net Foreign Assets a (% Change of broad money) a	Net Assets a (% Change of broad money)	Private Credit Growth % b	Interest on Six Treasury Bill (%)	Broad Money Growth (%)	Spread Interest Rate c
2000/01	5.1	3.9	4.0	10.4	9.0	8.3
2001/02	13.4	2.0	4.8	8.2	15.4	9.6
2002/03	17.5	0.5	18.9	4.1	18.0	7.8
2003/04	2.1	17.5	29.8	1.7	19.6	6.3
2004/05	2.2	17.1	33.2	4.7	19.3	7.4
2005/06	2.5	12.4	23.2	8.5	14.9	8.7
2006/07	8.1	11.3	17.2	8.9	19.3	9.0
2007/08	-7.8	23.2	16.4	11.5	15.3	8.4
2008/09	-3.2	12.8	0.7	12.0	9.6	9.8
2009/10	-6.9	0.8	3.9	12.3	12.5	9.3
2010/11	23.5	-2.4	4.0	13.7	15.9	9.0
2011/12	-40.2	5.3	7.5	11.9	14.1	8.3
2012/13	-55.8	4.1	-0.6	8.9	15.9	7.0
2013/14	97.9	-3.1	9.1	9.7	12.5	7.3
2014/15	20.5	-1.3	11.7	8.0	13.2	5.6
2015/16	9.1	-0.7	11.1	5.9	13.8	5.7
2016/17	-8235.6	26.5	11.6	12.7	11.3	5.9
2017/18	-961.2	11.9	2.1	7.5	17.5	6.3
2018/19	-8235.6	26.5	11.6	12.7	11.3	5.9
2019/20	-70.8	-5.5	2.9	7.5	17.5	6.3
2020/21	-220.8	-5.3	11.2	7.6	16.2	4.6
2021/22	-191.5	5.9	21.1	14.8	13.6	3.4
2022/23	214.9	19.0	-0.8	21.9	14.2	6.4
2023/24	-45.4	-2.5	6.1	19.9	16.1	7.1
2024/25	-157.8	-4.8	12.2	10.9	13.7	5.3
Average	**-735.8**	**7.5**	**10.9**	**10.2**	**14.8**	**7.2**

Source: State Bank of Pakistan, Annual Report (various issues)

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a Growth rate of net foreign assets/broad money ratio

b Growth rate of net domestic assets/broad money ratio

c Difference between the interest rate on advances and deposits

Table A- 9
Effective Tax Rates
(Tax Revenues as percentage of Tax Basea)

	Income Tax (%)	Customs Duty (%)	Excise Duty (%)	Sales Tax (%)	Total FBR Taxes (%)
2000/01	4.2	17.8	4.7	13.1	9.3
2001/02	4.5	12.0	4.3	14.1	9.1
2002/03	4.4	14.8	3.6	14.8	9.4
2003/04	4.0	14.3	3.1	12.7	9.2
2004/05	3.8	11.2	2.9	10.0	9.1
2005/06	3.9	12.1	2.4	10.3	9.4
2006/07	5.0	10.5	2.7	9.9	9.7
2007/08	4.9	7.6	2.9	10.0	9.8
2008/09	4.6	5.7	5.7	10.0	9.1
2009/10	4.8	5.7	5.0	10.1	8.9
2010/11	4.4	5.6	4.3	10.3	8.6
2011/12	4.6	5.6	3.3	11.0	9.1
2012/13	4.3	5.5	4.1	11.4	9.5
2013/14	4.6	5.2	4.3	12.6	10.1
2014/15	4.9	6.6	5.3	13.9	11.0
2015/16	5.3	8.7	5.6	16.1	12.4
2016/17	5.5	8.8	5.4	14.0	12.5
2017/18	5.2	10.0	5.1	14.4	10.7
2018/19	4.8	8.6	5.3	13.3	9.6
2019/20	4.8	8.8	4.9	13.9	10.0
2020/21	4.0	8.8	4.2	13.0	8.5
2021/22	4.4	7.9	3.6	11.7	9.2
2022/23	5.4	6.8	3.2	10.3	9.0
2023/24	5.6	7.1	4.2	10.6	8.8
2024/25	7.2	7.8	5.2	12.6	11.0
Average	**4.7**	**9.0**	**4.2**	**12.1**	**9.7**

Source: SBP, Annual Reports (various issues)
Pakistan Economic Survey (various issues)
FBR (various issues)
a Tax bases for various taxes are as follows:
Income tax: Non-agricultural GDP
Custom Duty: Value of imports
Excise Duty: Value of manufacturing
Sales Tax: Value of Imports plus value of manufacturing

Table A-10
Balance of Payments

	Current Account Balance (% of GDP)	External Debt as a % of Exports of Goods and Services	Net Reserves (US $ Million)	Gross Reserves (In months of next year's import of goods and services)	Change in Value of Pakistani Rupee per US $ (%)	Change in Real Effective Exchange Rate (%)
1999/2000	-1.6	322.1	908	0.9	3	-0.6
2000/01	-2.7	309.4	1679	1.7	12.8	-2.5
2001/02	3.9	282	4337	3.7	5.1	-2.6
2002/03	4.9	229	9529	6.5	-4.7	-0.1
2003/04	1.8	209.5	10564	5	-1.5	-1.8
2004/05	-1.4	183.7	9805	3.5	3.1	0.3
2005/06	-3.9	167.2	10760	3.7	0.8	5.3
2006/07	-4.8	169.2	13345	4.5	1.3	0.5
2007/08	-8.4	169.7	8577	2.7	3.2	-1.12
2008/09	-5.5	212.9	9118	2.8	25.5	-1
2009/10	-2.3	218.9	12958	2.9	6.8	1
2010/11	0.1	204.9	14784	3.6	2	6.5
2011/12	-2.1	212.2	10803	2.9	4.4	3.1
2012/13	-1.0	182.3	6008	1.5	8.4	-1.3
2013/14	-1.3	204.1	9098	2.7	6.3	7.3
2014/15	-0.8	204.9	13532	3.9	-1.5	5.4
2015/16	-1.8	250.9	18130	9	2.9	4.6
2016/17	-4.0	284.6	16242	4.4	0.5	3.5
2017/18	-6.1	317.2	9765	1.7	4.9	-11.2
2018/19	-4.8	368.4	7,285	3.3	24.0	-15.4
2019/20	-1.1	387.3	12,132	3.9	16.1	2.3
2020/21	-0.8	301.3	17,299	4.6	1.3	7.2
2021/22	-4.7	253.6	9,816	2.2	10.9	-6.1
2022/23	-0.7	350.3	4,445	0.7	39.8	-7.5
2023/24	-0.6	254.1	9,390	3.0	14.1	14.1
2024/25	0.5	254.6	14,506	4.1	-1.3	-2.1
Average	**-2.0**	**250.0**	**10012.4**	**3.4**	**7.6**	**0.4**

Source: SBP, Annual Report (various issues)
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Table A- 11
Level and Pattern of Trade

	Merchandise Export Growth (US $; %)	Extent of Product Diversification of Exports (a)	Extent of Market Diversification of Exports (a)	Merchandise Import Growth (US $; %)	Change in Terms of Trade %	Share of Essential Imports (a) %
1999/2000	11.2	0.801	0.23	13.1	-15.3	39.3
2000/01	12.5	0.798	0.221	14.3	-7.1	39.3
2001/02	2.3	0.786	0.221	-7.5	-0.2	36.7
2002/03	20.1	0.791	0.223	20.1	-9.6	35
2003/04	13.5	0.782	0.232	21.2	-4.1	28.8
2004/05	16.2	0.778	0.218	38.3	-6.5	25
2005/06	14.3	0.769	0.229	31.7	-11.7	30.7
2006/07	3.2	0.737	0.228	8	-3.7	29.1
2007/08	16.5	0.722	0.21	31.2	-11.5	38.9
2008/09	-6.4	0.709	0.202	-10.3	2.8	41.9
2009/10	2.9	0.717	0.199	-1.7	0	42.3
2010/11	28.9	0.697	0.184	14.9	2.8	42.7
2011/12	-2.6	0.722	0.183	12.8	-5.9	45.8
2012/13	0.4	0.719	0.189	-0.6	-2.4	42.9
2013/14	1.1	0.745	0.193	3.8	0.9	40.8
2014/15	-3.9	0.767	0.202	-0.9	-0.4	33.8
2015/16	-12.2	0.768	0.214	-2.5	4.2	25.5
2016/17	-1.7	0.764	0.210	18.5	1.5	24.5
2018-19	-2.2	0.769	0.207	-7.4	1.5	40.3
2019/20	-7.1	0.764	0.211	-15.9	3.7	50.1
2020/21	13.7	0.756	0.206	23.3	1.4	50.0
2021/22	25.6	0.731	0.193	42.1	-2.4	55.4
2022/23	-12.7	n.a	n.a	-31.0	n.a	52.3
2023/24	10.6	n.a	n.a	-0.8	10.2	49.7
2024/25	4.5	n.a	n.a	10.2	-2.2	n.a
Average	**5.9**	**0.8**	**0.2**	**9.0**	**-2.3**	**39.2**

Source: Pakistan Economic Survey (Various issues)
United Nations Conference on Trade and Development
State Bank of Pakistan, Annual Report (various issues)

a This is estimated by UNCTAD as the Herfindahl Index, which ranges from a value of 0 to 1.
The greater the extent of diversification the lower the value of the index
Essential imports are of wheat, edible oil, fertilizers, medicines and POL products

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