Sindh Climate Finance Needs Assessment Investment Priorities, Financing Landscape and Pathways to 2035

PARTNERS IN DEVELOPMENT AND CONSULTANCY

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Executive Summary

Sindh is at the centre of Pakistan's climate vulnerability. Its exposure is shaped by its geography, dependence on climate-sensitive sectors, low-lying terrain, extensive irrigation network, long coastline and large rural and urban populations living with limited adaptive capacity. Floods, droughts, extreme heat, coastal erosion, sea-level rise and water stress are already affecting livelihoods, infrastructure, agriculture and ecosystems. At the same time, Sindh contributes relatively little to global greenhouse gas emissions. The scale and nature of these risks make climate finance an economic and development priority, rather than a standalone environmental concern.

The 2022 floods demonstrated the scale of this vulnerability. Sindh accounted for close to 70 percent of Pakistan's total flood damages and losses, with estimated reconstruction and recovery needs of US$7.9 billion (World Bank, 2022). Agriculture, infrastructure and housing were among the sectors most severely affected. However, the province's climate exposure extends beyond flooding. Droughts occur more frequently in Sindh than in other provinces, particularly during the Rabi season when irrigation availability is lower. Extreme heat is becoming more severe, with recorded temperatures exceeding 50°C in several districts. Along the coast, sea-level rise, saltwater intrusion, erosion and declining freshwater flows threaten the Indus Delta, agricultural land and coastal livelihoods. These hazards increasingly interact with existing poverty, weak infrastructure and limited access to essential services, amplifying their economic and social impacts.

The implications extend beyond rural and coastal areas. Climate-related displacement is increasingly contributing to movement from drought- and disaster-affected areas towards Karachi and other urban centres. In the absence of adequate employment opportunities and affordable housing, displaced and low-income populations are often absorbed into informal settlements and precarious, low-paid work. Climate vulnerability is therefore becoming an urban development issue as well as an agricultural, water and environmental one.

Despite the scale of these needs, Sindh does not currently have a consolidated assessment of its climate investment requirements. Climate-related investments are spread across provincial departments, federal programmes, multilateral development banks, international climate funds and bilateral partners. Existing projects also frequently cover more than one sector - for example, agriculture and irrigation - making it difficult to determine the precise amount of finance attributable to any single climate objective. This limits the province's ability to demonstrate the scale of its financing needs, identify underfunded priorities and build a coherent pipeline of projects for international climate finance.

This paper addresses this gap by developing an **indicator-based assessment of Sindh's priority climate investment requirements through 2035**. Rather than attempting to place a monetary value on every climate-related need, the analysis identifies a focused set of measurable indicators across priority sectors and estimates the additional investment associated with achieving defined 2035 targets. The indicators cover areas including climate-smart agriculture, irrigation and drainage, flood protection, high-efficiency irrigation, renewable energy and mangrove plantation.

For each indicator, the analysis establishes an evidence-based baseline using available provincial, national and project-level data; defines a 2035 target; calculates the additional physical or beneficiary-level requirement; and applies an indicative unit cost. Existing investments are reflected in the baseline wherever the available evidence allows. This is important because many ongoing programmes have

already created infrastructure, supported farmers or expanded climate-resilient practices. Existing climate finance is therefore **not mechanically subtracted from the resulting investment requirement.** Doing so would risk double-counting, particularly where a single project contributes to several indicators or where the outputs of existing investments are already reflected in the baseline.

The resulting figure should consequently be understood as **an indicative investment envelope required to achieve the selected 2035 targets,** rather than a residual international climate finance gap or a government budget requirement. The estimated investment could ultimately be financed through a combination of provincial and federal public expenditure, multilateral and bilateral development finance, international climate funds, private investment, blended finance, carbon markets and other mechanisms.

The analysis also maps existing climate finance flows to Sindh separately. This provides a picture of where external finance is currently concentrated and which sectors and interventions are already receiving support. Existing programmes demonstrate substantial activity in areas such as climate-smart agriculture, irrigation rehabilitation, disaster resilience, renewable energy and ecosystem restoration. However, the mapping also highlights fragmentation and gaps. Financing is often project-specific, time-bound and distributed across different institutions, while there is no single provincial mechanism that consolidates these flows against a common set of climate investment priorities.

This matters in the context of the changing global climate finance architecture. The Paris Agreement established developed countries' obligation to provide climate finance to developing countries, while the New Collective Quantified Goal agreed at COP29 established a target of at least US$300 billion per year by 2035 and called for the mobilisation of US$1.3 trillion annually from all sources. However, these headline figures should not be interpreted as US$1.3 trillion in grants or guaranteed public finance. Much climate finance remains loan-based, adaptation continues to receive a smaller share of international flows than mitigation, and access to international funds remains highly dependent on institutional capacity and the ability to develop credible, bankable projects.

For Sindh, the central challenge is therefore not only the availability of global climate finance, but the province's ability **to translate its climate risks and investment priorities into financeable programmes**. This requires stronger institutional coordination, improved data systems, better project preparation capacity and a clear financing strategy that matches different types of investments with appropriate sources of finance.

The paper identifies several priorities for strengthening Sindh's climate finance readiness:

1. **Establish a provincial climate finance coordination mechanism.**
2. **Develop a prioritised pipeline of bankable projects.**
3. **Improve provincial climate finance data.**
4. **Prioritise adaptation and resilience finance.**
5. **Use differentiated financing approaches.**
6. **Strengthen access to international climate funds.**

The central finding of this paper is that **Sindh's climate finance challenge is both a financing problem and a project-development problem.** The province faces substantial and increasingly measurable investment needs, but these needs will not automatically translate into international finance.

Demonstrating the scale of investment required is the first step. The next is to build the institutional systems, project pipeline and financing partnerships required to convert that need into actual investment.

The 2035 horizon provides a practical planning window. Global climate finance commitments are increasing, new financing mechanisms are emerging, and Pakistan is engaging with institutions including the IMF and multilateral development banks on resilience and climate-related investment. Sindh therefore has an opportunity to move from responding to individual climate disasters towards a more strategic approach that links climate risk, development planning and finance.

This paper provides a starting point for that process: a quantified set of priority investment requirements, a mapping of existing finance and a basis for identifying where additional financing and institutional action are needed. Its purpose is not to produce a single definitive financing figure, but to give Sindh a clearer basis for prioritising investments, engaging financing partners and building a climate finance strategy around measurable needs.

Section 1: Introduction

1.1 What Is Climate Finance?

Climate finance refers to the financial resources mobilised to support action on climate change - to reduce greenhouse gas emissions (mitigation), to help communities and systems adjust to the unavoidable impacts of a warming planet (adaptation), and increasingly to compensate for irreversible harm already caused by climate change (loss and damage). These three pillars form the foundation of the international climate finance architecture and of this paper.

Climate finance flows through a complex architecture of multilateral funds, development banks, bilateral donors, private investors, and carbon markets. It is channelled as grants, concessional loans, equity, and guarantees. In principle, it is meant to flow from those most responsible for historical emissions to those least responsible but most affected. In practice, the gap between what is pledged, what is disbursed, and what actually reaches the most vulnerable communities remains one of the defining failures of international climate governance.

Table 1: An Overview of Climate Finance

Climate Finance at a Glance	
Mitigation	Reducing or preventing greenhouse gas emissions - renewable energy, energy efficiency, forest protection, sustainable agriculture.
Adaptation	Adjusting systems, infrastructure, and livelihoods to cope with current and projected climate impacts - flood management, heat-resilient cities, drought-resistant agriculture, coastal protection.
Loss and Damage	Financing responses to climate-related losses that cannot be adapted to - disaster recovery, displacement support, non-economic losses including cultural heritage and ecosystem services.
Instruments	Grants (non-repayable), concessional loans (below-market rates), guarantees (risk-sharing), equity investment, and carbon market mechanisms.

Source: United Nations Framework Convention on Climate Change (UNFCC)

There is no single internationally agreed definition of climate finance. The UNFCCC Standing Committee on Finance (SCF) uses an operational definition encompassing all public and private finance, domestic and international, intended to support mitigation, adaptation, or loss and damage responses, regardless of geography. Under Article 9 of the Paris Agreement, developed countries bear a specific legal obligation to provide financial assistance to developing countries for both mitigation and adaptation.

The 2025 Advisory Opinion of the International Court of Justice confirmed that this obligation must be fulfilled at a level sufficient to achieve the temperature goals of the Paris Agreement - establishing a binding, not merely aspirational, standard.

A persistent challenge is that climate finance is notoriously difficult to quantify. Oxfam's Climate Finance Shadow Reports have consistently found that reported figures significantly overstate the real financial effort of provider countries. While developed countries officially reported US$115.9 billion in 2022,

Oxfam's Climate-Specific Net Assistance estimate, accounting for actual climate relevance and the grant-equivalent value of loans, stands at only US$28–35 billion (Oxfam, 2025). This gap between headline figures and real value is critical context for Sindh: the available resource pool is much smaller than official figures suggest.

1.2 Rationale: Why Sindh and Why Now?

Sindh is on the frontlines of the global climate crisis. It is one of the most climate-vulnerable provinces in one of the world's most climate-vulnerable countries. The 2022 super floods, documented as the worst in Pakistan's recorded history, submerged one-third of the province, destroyed 2.5 million hectares of cropland, killed hundreds, displaced millions, and caused an estimated US$7.9 billion in damages and losses: the highest reconstruction need of any province in Pakistan. Sindh bore close to 70 percent of the national total damage and losses from the 2022 floods alone (World Bank, 2022).

Yet Sindh, like Pakistan as a whole, contributes a negligible fraction of the emissions responsible for these disasters. Pakistan's share of global greenhouse gas emissions is less than one percent, approximately 0.8 to 0.9 percent, while it consistently ranks among the five most climate-vulnerable nations on earth. This stands to be the defining injustice of the climate crisis: those who contributed least to causing it are suffering its consequences most severely and receiving the least finance to respond.

Sindh's climate vulnerability is consequently not simply a function of experiencing one exceptionally severe disaster. It arises from the convergence of multiple hazards with structural exposure and development deficits. The province combines some of Pakistan's most drought-prone and heat-exposed areas with extensive floodplains, a highly vulnerable coastal delta and one of the country's largest urban concentrations. This combination creates a distinctive and persistent adaptation financing requirement, extending from climate-smart agriculture and water management to resilient infrastructure, coastal ecosystem protection and urban resilience.

At the same time, Sindh's capacity to access and strategically deploy international climate finance remains constrained. The province currently lacks a comprehensive climate-finance needs assessment and a consolidated provincial strategy for prioritising and financing climate investments. Institutional fragmentation, limited project-development capacity and the division of climate-finance functions across federal and provincial institutions further constrain the development of bankable projects and direct engagement with international climate-finance mechanisms. These constraints are particularly consequential given the scale and diversity of the province's climate risks.

This paper is therefore situated at a critical juncture. The international climate-finance architecture is undergoing significant change, including the implementation of the COP29 New Collective Quantified Goal (NCQG), the growing role of instruments such as the IMF's Resilience and Sustainability Facility (RSF), and the operationalisation of new arrangements for addressing loss and damage. For Sindh, the challenge is not simply to demonstrate that climate impacts are severe, but to translate its diverse and interconnected climate risks into quantified investment needs, credible priorities and finance-ready interventions. This paper seeks to provide that evidence base, enabling the Government of Sindh, civil society, development partners and other stakeholders to better position the province to access, coordinate and influence emerging climate-finance flows.

1.3 Purpose and Scope

This paper aims to provide an evidence-based overview of Sindh's climate finance needs and strengthen the province's case for greater access to national and international climate finance. The paper is intended primarily to support the Government of Sindh, development partners and other relevant stakeholders in identifying where climate finance is needed, at what approximate scale, and in which sectors and investment areas it should be prioritised.

The paper has three interlinked purposes. First, it documents Sindh's climate vulnerability and identifies the sectors and areas where climate-related investment needs are greatest. Second, it maps existing and emerging climate finance flows relevant to Sindh, including international, national and provincial sources, to identify where financing is already available and where significant gaps remain. Third, it develops indicative sector-level estimates of climate finance requirements for selected priority indicators in energy, agriculture, water and irrigation, and environment and coastal management. While urban resilience and extreme heat are significant vulnerabilities documented in this paper, they are not separately costed in the current phase due to limitations in available, sufficiently robust baseline and unit-cost data; these areas are identified as priorities for subsequent phases of the assessment. These estimates are intended to provide a practical basis for policy dialogue, investment prioritisation and engagement with potential financing partners.

The costing component does not seek to provide a comprehensive valuation of all climate finance needs in Sindh. Instead, it uses a bottom-up, indicator-based approach to estimate the investment required to move from selected current baseline conditions towards defined policy or planning targets. The estimates therefore represent an indicative financing envelope for the selected sectors and indicators, rather than a complete estimate of all public, private and international capital required for climate action in the province.

The paper covers three broad climate finance categories - mitigation, adaptation, and loss and damage - and applies these classifications at the level of individual indicators and investment activities. Particular attention is given to adaptation and mitigation given Sindh's high exposure to floods, heat, water stress, agricultural losses and coastal hazards.

The assessment focuses primarily on the 2026–2035 planning period, with 2035 used as the common target horizon for sectoral investment estimates. Where relevant, national commitments under Pakistan's NDC 3.0, the National Adaptation Plan, provincial policies and sectoral plans are used to inform target-setting. The paper also considers the wider policy and financing context, including Pakistan's IMF Resilience and Sustainability Facility and evolving international climate finance architecture.

The paper takes a focused approach to four sectors—energy, agriculture, water and irrigation, and environment and coastal management—where Sindh faces significant climate exposure and where sufficiently robust baseline, target and costing information could be established. This narrower approach is intended to provide a practical starting point for provincial investment planning rather than replicate the broader national NDC investment framework. Transport, industry, waste and other sectors should be considered in subsequent phases as provincial data and costing evidence improve.

The paper is designed as the first phase of a broader climate finance readiness process. Subject to the availability of resources and technical partnerships in subsequent phases, the assessment can be

expanded to include more detailed climate risk modelling, comprehensive mitigation investment requirements, detailed adaptation costing, economic and social impacts, human costs of climate change, and more granular valuation of loss and damage.

1.4 Methodology

The paper uses a combination of desk research, secondary data analysis, stakeholder consultations and bottom-up sectoral costing. The methodology was designed to produce practical, indicative estimates of Sindh's climate finance needs using available provincial and national data, while keeping the analysis sufficiently simple and transparent to allow the assumptions and calculations to be reviewed and validated by government and technical stakeholders.

The desk review covers relevant international climate finance literature and national and provincial policy frameworks, including Pakistan's NDC 3.0, National Adaptation Plan, National Climate Finance Strategy, IMF Country Report No. 25/109, and relevant Sindh sectoral policies and plans.

The sectoral assessment draws on the bottom-up costing approach used by the UNDP SDGs Support Unit Sindh for Costing SDG 7 (2023) and Pakistan's NDC costing approaches to create an adaptive costing method. Publicly available government, project and sectoral data are used to establish baselines and identify relevant targets and investment priorities.

Stakeholder consultations with relevant Government of Sindh departments, technical institutions, development partners and experts are used to validate indicators, baseline figures, targets, financing information and key assumptions.

The assessment focuses on four priority sectors - energy, agriculture, water and irrigation, and environment and coastal management - and considers mitigation and adaptation across relevant indicators. More details on the costing methodology are mentioned in Section 5.1. The resulting estimates are intended to provide an indicative sector-level picture of Sindh's climate investment needs, rather than a comprehensive economy-wide climate finance needs assessment.

Data validation and triangulation

All estimates are triangulated, where possible, using multiple sources, including government statistics, official sector reports, project documents, international development agencies, academic and technical literature, and stakeholder consultations. Where Sindh-specific data are unavailable, estimates based on national or other secondary sources are identified explicitly and treated as indicative rather than definitive.

The resulting estimates should therefore be interpreted as indicative sector-level investment requirements, designed to support government planning and climate finance advocacy rather than as final project appraisal or budget estimates.

1.5 Limitations

This assessment is intended as a first-phase, sector-level estimation of Sindh's climate finance needs and has several limitations.

First, data availability at the provincial level is uneven. Some indicators have regularly reported administrative data, while others require estimates based on secondary literature, national datasets or project-level information. Where Sindh-specific data are unavailable, proxy or estimated values are used and identified accordingly. These estimates should be updated as more recent administrative data become available.

Second, the costing is indicator-based rather than comprehensive. The analysis estimates investment requirements for a selected set of priority indicators within four sectors. It does not attempt to capture every climate-related investment required in Sindh. Consequently, the aggregated finance requirement should be interpreted as the cost of the selected interventions and indicators, rather than the total climate finance requirement of the province.

Third, target-setting is constrained by the availability of formal provincial targets. Where a published Sindh-specific target exists, it is used as the basis for the analysis. Where no formal target is available, a planning target is derived using national commitments, sector plans, existing project pipelines and expert consultation. Such targets are therefore analytical assumptions and should be revisited as provincial planning documents are updated.

Fourth, unit costs vary substantially across projects and locations. The estimates use available project-level and sectoral cost benchmarks rather than detailed engineering estimates for individual projects. Differences in technology, scale, location, procurement arrangements, inflation and implementation conditions may therefore result in actual costs differing from the estimates presented.

Fifth, existing climate finance cannot always be attributed to individual indicators. Many development programmes finance multiple activities simultaneously, while public budget documents do not always identify climate expenditure separately. Where an allocation cannot be reliably attributed to a specific indicator, financing is treated at the sector or investment-area level to avoid double counting or creating false precision.

Sixth, the current phase does not provide a full economic valuation of climate impacts. Loss and damage estimates currently focus primarily on measurable physical and economic indicators. Human costs, socioeconomic impacts, livelihood losses, distributional impacts and other indirect costs are not yet comprehensively valued.

These limitations are partly a function of the phased nature of the project. The current paper is intended to establish an initial evidence base for sectoral climate finance needs and institutional engagement. A subsequent phase, subject to resources and technical partnerships, can build on this work through more detailed climate risk assessments, regional and sector-specific valuation models, improved provincial data systems, comprehensive mitigation and adaptation costing, and more detailed assessment of human, socioeconomic and loss-and-damage impacts.

Section 2: Context: Climate Vulnerability and the Case for Finance

2.1 Pakistan's Overall Climate Vulnerability

Pakistan is one of the most climate-vulnerable countries in the world. According to the Notre Dame Global Adaptation Initiative (ND-GAIN) Country Index, Pakistan ranks among the top 50 most vulnerable nations globally, with a high vulnerability score combined with critically low readiness to adapt. The Global Climate Risk Index has consistently placed Pakistan in the five most affected countries by extreme weather events. Despite contributing less than one percent of global greenhouse gas emissions, approximately 0.8 to 0.9 percent, Pakistan faces climate impacts that are disproportionate to its share of the problem and catastrophic in their human and economic consequences.

Pakistan's climate threats are wide-ranging and intensifying. Glacial lake outburst floods (GLOFs) in the north threaten millions of people dependent on the Hindu Kush-Karakoram-Himalayan Mountain systems. Monsoon intensification is producing flood events of unprecedented scale, frequency, and geographic spread. Extreme heat events, including record temperatures exceeding 52°C in Mohenjo Daro in southern Sindh in May 2024, are becoming more frequent. Coastal areas face rising sea levels, increased cyclonic activity, and saltwater intrusion into agricultural land and freshwater systems. Water stress is worsening as glacial melt accelerates and competition for the Indus River's diminishing flows intensifies across sectors and provinces.

The 2022 floods took the lives of more than 1,700 people, one-third of them children. The total damage is estimated at US$14.9 billion, total loss at US$15.2 billion, and total needs at US$16.3 billion. Housing, Agriculture and Livestock, and Transport and Communications sectors suffered the most significant damage, at US$5.6 billion, US$3.7 billion, and US$3.3 billion, respectively. Sindh is the worst affected province with close to 70 percent of total damages and losses, followed by Balochistan, Khyber Pakhtunkhwa, and Punjab (World Bank, PDNA 2022).

Pakistan's climate vulnerability is amplified by structural factors: a large rural and agrarian population with limited adaptive capacity, weak early warning and detection systems outside major cities, chronic fiscal constraints that limit public investment in resilience, and an institutional architecture where federal-provincial coordination on climate issues remains inconsistent (IMF Country Report, 2025).

Through NDC3.0 (2025), Pakistan would like to voluntarily reduce its GHG emissions up to 50% by 2035. Of this, 17% will be achieved unconditionally through domestic resources and policy measures, while the remaining 33% is conditional on the provision of adequate mostly grant-based or concessional international climate finance, complemented by technology transfer and capacity building support. The estimated investment required to achieve these goals is USD 565.7 billion, a figure that sheds light on both the scale of the challenge and the magnitude of the financing gap.

2.2 Sindh's Climate Vulnerability: The Case for Finance

Overview of Climate-Induced Disasters

Sindh has experienced successive climate-induced disasters of increasing severity over the past two decades, each leaving cumulative damage that compounds the province's underlying vulnerability before the next event strikes. Sindh's climate vulnerability is not defined by a single hazard. Its exposure arises from the convergence of floods, drought, extreme heat, coastal erosion and sea-level rise,

compounded by high dependence on climate-sensitive livelihoods, widespread poverty and uneven access to basic services. This combination makes climate finance necessary not only for post-disaster recovery, but for reducing structural vulnerability before future shocks occur.

Table 2: Overview of climate induced disasters

Climate vulnerability indicator	Sindh Evidence	Climate-finance relevance
2022 flood exposure	2.8 million hectares of cropland inundated; Sindh accounted for approximately 70 percent of Pakistan's total flood damages and losses; provincial recovery and reconstruction needs estimated at US$7.9 billion. (World Bank/PDNA, 2022)	Demonstrates large-scale adaptation, resilient infrastructure and agricultural recovery needs.
Drought exposure	Around **3 million people in Sindh** were affected by moderate-to-severe drought in January 2019, when precipitation was 24.4 percent below expected levels**.** Large-scale droughts occur more frequently in Sindh than in Punjab, with particularly high exposure during the Rabi season when canal irrigation is less available. (World Bank, 2022)	Supports investment in water security, drought-resilient agriculture, water-efficient irrigation and livelihood resilience.
Extreme heat	Mohenjo Daro recorded 52.2°C in May 2024. Northern districts including Jacobabad and Shaheed Benazirabad, as well as Karachi and other southern areas, experience recurring heatwaves. Shaheed Benazirabad recorded 50.2°C in April 2018**.** (Reuters, 2024; Sayeed et al., 2024)	Creates needs for heat-health systems, urban cooling, resilient infrastructure, labour protection and early warning systems.
Long-term warming	Over approximately six decades, nighttime temperatures in Sindh increased by 2.4°C, while daytime temperatures increased by 1.6°C**.** (Sayeed et al., 2024)	Indicates that extreme heat is a structural and increasing risk rather than an isolated event.
Coastal erosion and sea-level rise	Sindh has approximately a 320-km coastline, with widespread coastal erosion. The highest average erosion rate identified along the coast reaches approximately 27.46 m/year in the Indus Delta region; relative sea-level rise has also increased along the coast. (Kanwal, 2022)	Supports investment in mangrove restoration, ecosystem-based adaptation, coastal protection and resilient coastal livelihoods.
Poverty and adaptive capacity	Approximately 37 percent of Sindh's rural population lives below the poverty line, with poverty reaching 40–60 percent in some districts**.** (World Bank, 2022)	Low household financial capacity limits autonomous adaptation and increases dependence on public and climate finance.
Basic-service vulnerability	Vulnerable districts face deficits in health, water and sanitation, schooling and electricity access. (World Bank, 2022)	Climate finance must address resilience of basic services alongside physical climate infrastructure.

Sources: World Bank, Reuters, International Growth Centre

A Multi-Hazard Vulnerability Profile

Sindh's coastal geography creates an additional and distinct layer of vulnerability. Its low-lying Indus Delta and coastal settlements are exposed to sea-level rise, coastal flooding, cyclones, erosion and

seawater intrusion. Reduced freshwater flows into the delta, alongside environmental degradation and rising sea levels, threaten ecosystems, agricultural land and coastal livelihoods. These risks are particularly significant because coastal ecosystems such as mangroves provide natural protection against coastal flooding and erosion while supporting fisheries and storing carbon. At the same time, rapid urbanisation, particularly in Karachi, creates another dimension of climate vulnerability. Existing infrastructure deficits in water, drainage, sanitation, waste management and housing increase the exposure of already vulnerable communities to extreme rainfall, urban flooding and heat. Karachi's infrastructure is itself considered highly vulnerable to climate-related disasters, with poorer communities disproportionately affected.

These overlapping risks matter because they intersect with Sindh's economic and social dependence on climate-sensitive sectors. Agriculture is central to provincial livelihoods and food security, while the province's irrigation system depends heavily on the Indus River and is already affected by water scarcity, inefficient water use, salinity and drainage problems. Approximately 77 percent of Sindh's agricultural land is irrigated, while an estimated 60–75 percent of water withdrawn for agriculture is lost through evaporation or seepage into saline groundwater (Sindh Irrigation Department). Climate impacts therefore have consequences beyond disaster losses: they threaten agricultural productivity, rural incomes, food security, water availability, coastal livelihoods, urban infrastructure and public health.

This creates a distinctive water-security challenge: Sindh must simultaneously manage **too much water during extreme rainfall and floods and too little water during drought periods**. The province's dependence on the Indus irrigation system further means that water availability, irrigation management and agricultural resilience are closely interconnected. The World Bank notes that agriculture already accounts for approximately **90 percent of water withdrawals in Sindh**, while water scarcity is particularly significant during the pre-monsoon summer period.

These hazards interact with Sindh's underlying socioeconomic vulnerability. Approximately **37 percent of the province's rural population lives below the poverty line**, with poverty reaching 40–60 percent in some districts. Flood-affected districts also experience some of the country's highest rates of stunting and face inadequate access to health, water and sanitation, education and electricity services (World Bank, 2022)

Disproportionate Burden on Vulnerable Communities

Climate impacts in Sindh are therefore not distributed evenly. Smallholder farmers, rural households, livestock-dependent communities, coastal fisherfolk, women and low-income urban populations have fewer financial and institutional buffers against climate shocks. The 2022 floods demonstrated this particularly clearly: rural households experienced severe livelihood losses because of their dependence on agriculture and limited access to infrastructure and social protection. (World Bank/PDNA, 2022)

Women face additional vulnerabilities because climate shocks affect both their livelihoods and their access to services and safety. Disasters have disproportionately affected women through losses in agriculture and livestock livelihoods, displacement and increased health and protection risks. The scale of these impacts is particularly significant in a province where a large share of the population depends directly or indirectly on climate-sensitive rural economic activity.

Climate change is not merely producing acute disasters in Sindh. It is systematically eroding the province's long-term development prospects. Infrastructure is repeatedly damaged before it can be rebuilt. Roads, bridges, irrigation infrastructure, and public buildings destroyed in the 2010 floods were only partially reconstructed before the 2022 floods struck. The same districts have been repeatedly flooded, raising the question of whether conventional reconstruction is appropriate or whether climate-resilient redesign, at significantly higher cost, is the only viable path. This cycle of damage and under-resourced reconstruction represents a growing drag on the province's economic and human development trajectory.

Public health is increasingly affected. Vector-borne diseases including malaria surge after floods, with the 2022 floods triggering over 69,123 confirmed malaria cases in Sindh by August 2022 (World Health Organization, 2022). Heat-related illness is increasing. Contaminated water sources following floods cause outbreaks of cholera and other waterborne diseases. The cumulative public health burden of climate change adds pressure to an already strained provincial health system.

Climate vulnerability is also increasingly connected to **population movement**. Repeated floods, drought, declining agricultural productivity, coastal degradation and loss of rural livelihoods can push households towards urban centres in search of income and services. Where migration occurs without corresponding economic opportunities, displaced and climate-affected households often enter low-paid and precarious employment and settle in already underserved areas. This transforms rural climate vulnerability into an **urban resilience challenge**, placing additional pressure on housing, drainage, water, electricity, transport, health and other basic services.

This dynamic is particularly important for Sindh because Karachi is both the province's largest urban centre and a major destination for internal migration. At the same time, Karachi itself faces significant climate exposure, including extreme heat, flooding and coastal degradation. Thus, climate finance investment for Sindh **is also required to manage the urban consequences of climate-induced displacement and to strengthen the resilience of rapidly growing settlements.**

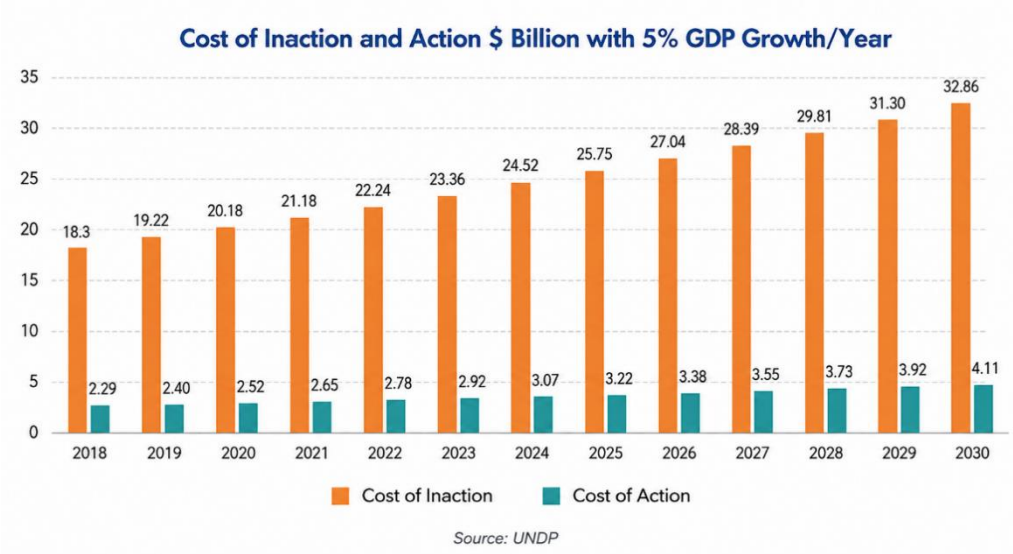
The Economic Cost of Climate Inaction

The economic argument for investing in Sindh's climate resilience is straightforward: the cost of inaction is already vastly outpacing the cost of proactive investment. IMF Country Report (2025) estimates that an additional one percent of GDP invested annually in climate adaptation and resilient infrastructure over five years would reduce the negative impact of natural disaster shocks on growth by approximately half, five years after the shock.

For Sindh specifically, a UNDP-supported Cost of Climate Inaction study (2018) estimated that climate inaction could cost the province approximately US$18.3 billion annually, equivalent to around 20 percent of provincial GDP. The study estimated that the cost of action would be approximately 2.5 percent of GDP, or US$2.29 billion annually. These estimates provide an important indication of the scale of the economic resources required to prevent climate impacts from becoming substantially more costly. The economic burden is distributed across the province’s major productive sectors. The same assessment estimated annual costs of inaction of approximately US$2.75 billion in agriculture, US$5.37 billion across industry, manufacturing and energy, and US$10.5 billion across services, including urban infrastructure, transport, retail and communications. The corresponding estimated costs of action were approximately US$0.34 billion, US$0.67 billion and US$1.31 billion, respectively (UNDP, 2018). This

reinforces the rationale for treating climate finance not simply as an environmental expenditure, but as an investment in protecting Sindh's productive capacity and development trajectory.

Figure 1: Cost of Climate Inaction and Action in Sindh



The scale of the financing challenge is also evident internationally. The World Bank's Pakistan Country Climate and Development Report (2022) estimated that Pakistan would require substantial investment to pursue a climate-resilient development pathway, warning that the combined effects of climate-related hazards, environmental degradation and air pollution could reduce national GDP by 18–20 percent by 2050 without significant action. More recently, UNEP's Adaptation Gap Report 2025 estimates that developing countries will require US$310–365 billion annually by 2035 for adaptation, compared with only US$26 billion in international public adaptation finance in 2023 - a financing gap of roughly 12–14 times current flows.

The alternative - continued climate inaction and under-investment in resilience - will keep resulting in compounding losses that undermine every development objective the province is pursuing.

Why This Creates a Distinct Case for Climate Finance

Sindh's case for climate finance therefore rests on the **interaction of multiple hazards and structural vulnerabilities**, rather than on the magnitude of any single disaster. The province simultaneously faces recurrent floods, relatively frequent droughts, intensifying heat, coastal erosion and sea-level rise, while large sections of its population depend on climate-sensitive agriculture, fisheries and informal livelihoods.

This creates three interconnected financing needs:

1. **Risk reduction and adaptation**: strengthening irrigation, drainage, flood protection, drought resilience, heat preparedness and coastal ecosystems before climate shocks occur.

2. **Resilient livelihoods and basic services**: protecting agriculture, fisheries, rural livelihoods and essential urban services on which vulnerable populations depend.
3. **Anticipatory and transformational investment**: addressing the longer-term consequences of climate change, including coastal degradation, water insecurity, heat exposure and climate-induced migration.

Section 3: Global Climate Finance: Commitments, Mechanisms, and Pakistan's Access

3.1 Climate Finance Commitments Under the Paris Agreement

The Paris Agreement of 2015 established the central international framework for climate finance. Article 9 requires developed country Parties to provide financial resources to assist developing countries in undertaking mitigation and adaptation action, while encouraging other Parties to provide or continue providing such support voluntarily. The Agreement also established that developed countries would continue their existing collective mobilisation goal of **US$100 billion annually through 2025**, while setting the basis for a new, higher quantified goal to be agreed before 2025.

The US$100 billion goal was politically significant but structurally contested from the outset. It was not derived from an assessment of developing countries' actual climate finance needs, and it was not achieved by the original 2020 deadline. According to the OECD, developed countries first exceeded the target in 2022, providing and mobilising **US$115.9 billion** for developing countries, two years later than the original deadline. However, the headline figure includes both public finance and private finance mobilised through public interventions and therefore does not represent direct public transfers to developing countries. The composition of the finance also remains important: public climate finance has continued to rely heavily on loans, while adaptation has received a smaller share of total flows. In 2022, only **US$32.4 billion**, or approximately 28 percent of the US$115.9 billion total, was directed to adaptation, compared with US$69.9 billion for mitigation and US$13.6 billion for activities addressing both objectives (OECD, 2026).

This distinction matters for countries such as Pakistan. Much of the climate finance challenge is not simply a shortage of aggregate resources, but a mismatch between **where finance is needed and where it is easiest to invest.** Mitigation projects, particularly renewable energy and other infrastructure, are often more attractive to private investors because they can generate identifiable financial returns. Adaptation investments such as flood protection, drought resilience, drainage, ecosystem restoration and climate-resilient agriculture frequently produce substantial social and economic benefits without generating comparable financial returns. This makes adaptation more dependent on public, concessional and grant-based finance. The OECD's recent analysis similarly finds that private finance mobilisation remains much more limited for adaptation than for mitigation.

The New Collective Quantified Goal (NCQG): COP29, November 2024

Against this background, the **New Collective Quantified Goal on Climate Finance (NCQG)** was adopted at COP29 in Baku in November 2024. The outcome has two interconnected elements. First, developed countries are to **take the lead in mobilising at least US$300 billion per year for developing countries by 2035**, from public and private, bilateral and multilateral sources. Second, all actors are called upon to work together to enable the scaling-up of climate finance from **all public and private sources to at least US$1.3 trillion annually by 2035 (UNFCC).**

At face value, this represents a tripling of the previous US$100 billion goal. However, the structure of the NCQG is considerably more complicated than the headline suggests. **The US$300 billion is not**

equivalent to US$300 billion in new public grants or concessional resources from developed countries. The decision uses the broader concept of mobilisation and permits finance from a range of public and private sources and channels. The US$1.3 trillion figure is even broader: it represents a mobilisation ambition rather than a binding commitment by developed countries to transfer that amount to developing countries. Consequently, the gap between the headline figures and the volume of accessible, predictable and affordable finance available to governments remains substantial.

The negotiations also exposed a fundamental disagreement over **what constitutes an adequate climate finance goal.** Many developing countries had argued that the new goal should be based on their assessed needs rather than on what developed countries considered politically feasible. The final agreement instead established the US$300 billion target while placing the much larger US$1.3 trillion figure under a broader mobilisation framework. This distinction was a major source of dissatisfaction among developing countries, which argued that private finance cannot substitute for public finance where adaptation needs are greatest, particularly in poorer and highly vulnerable countries.

There are also unresolved questions around additionality, financial instruments and debt**.** Counting loans and other repayable instruments alongside grants can increase the volume of reported climate finance without necessarily providing equivalent fiscal support to recipient countries. This is particularly significant for climate-vulnerable developing countries already facing high debt burdens. The OECD's most recent data show that public climate finance remains predominantly loan-based: in 2024, loans accounted for approximately **67 percent of public climate finance,** compared with 29 percent provided as grants (OECD, 2026).

The adaptation dimension remains particularly concerning. Even after the adoption of the NCQG, adaptation finance continues to represent only around one quarter of international climate finance flows. In 2024, developed countries provided and mobilised **US$34.7 billion for adaptation**, while total climate finance reached US$136.7 billion. This is significant for Pakistan and Sindh, where the most urgent investment needs-including flood protection, irrigation and drainage rehabilitation, climate-smart agriculture, heat resilience, ecosystem protection and disaster preparedness-are predominantly adaptation-oriented.

The NCQG should therefore be understood as **both an opportunity and an unresolved financing challenge**. It creates a substantially larger political reference point for international climate finance and places a 2035 horizon around the scale-up of resources. Yet the agreement does not by itself guarantee that vulnerable subnational regions will receive finance commensurate with their needs, nor that such finance will arrive as grants or highly concessional resources. Access will depend on the ability of countries and subnational institutions to develop credible investment pipelines, meet fund-specific requirements, demonstrate climate additionality, and navigate increasingly complex channels of international finance.

For Sindh, this distinction is critical. **The existence of a larger global climate finance target does not automatically translate into finance for Sindh.** The province must compete within national and international allocation systems while addressing institutional constraints, limited project-development capacity and the absence of a consolidated assessment of its sectoral investment needs. The strategic question for Sindh is therefore not simply how much global climate finance has been promised, but how the province can position its priorities within the emerging NCQG architecture and convert global commitments into accessible, additional and appropriately structured finance.

3.2 International Climate Finance Mechanisms

The global climate finance architecture comprises a range of dedicated multilateral funds, each with different mandates, access requirements, and disbursement records. The following section provides a brief overview of the key funds relevant to Sindh, including their global scale and Pakistan's experience to date.

Table 3: Details of International Climate Financing Mechanisms

Fund / Mechanism	What It Finances	Global Scale	Pakistan Access
Green Climate Fund (GCF)	Mitigation and adaptation projects. Grants, concessional loans, guarantees, equity. Aims for 50:50 balance between mitigation and adaptation.	US$19.3 billion approved for 336+ projects across 133+countries (GCF 2024-27). US$2.5 billion committed in 2024 alone.	US$304.2 million portfolio across 10 approved projects. Pakistan's NDA is the Ministry of Climate Change (MoCC). Pakistan per capita access at US$0.16, one of the lowest among comparable countries.
Adaptation Fund (AF)	Concrete adaptation projects in particularly vulnerable countries. Focus on community-level action. Grants only.	US$1.4 billion approved across 200 projects in 110+ countries since inception. US$ 843.8 million disbursed as of June 2025. Country cap raised to US$ 40 million per project in April 2025.	Two projects totalling ~US$14 million: GLOF risk reduction in northern Pakistan (US$4.1 million) and SAFER Pakistan ecosystem restoration (US$10 million, approved 2024). No Sindh-specific projects to date.
Global Environment Facility (GEF)	Biodiversity, climate change mitigation, land degradation, chemicals and wastes, international waters. Grants and blended finance.	US$27+ billion in grants since 1991, mobilising US$155 billion in co-financing. 5,200+ projects across 186 countries. Current cycle: GEF-8 (US$ 5.33 billion, 2022-2026). GEF-9 (US$ 3.9 billion) starts July 2026.	US$80 million accessed by Pakistan to date across multiple focal areas including climate change mitigation, biodiversity and land degradation. GEF operates through 18 accredited agencies active in Pakistan including the UNDP and World Bank.
Fund for Responding to Loss and Damage (FRLD)	Economic and non-economic loss and damage in particularly vulnerable developing countries. Grants. Country-driven, bottom-up access.	US$822 million pledged as of March 2026 from 27 partners. Project cycle and eligibility criteria approved in late 2025; open submissions now ongoing through interim-accredited entities. Pledges represent less than 0.1% of the estimated US$ 400 billion needed annually	No Pakistan-specific projects yet. Project submission is now open - Pakistan can access funding through an interim-accredited national or multilateral entity. Pakistan ministers have spoken at FRLD board meetings; a formal application is urgent given Sindh's documented loss and damage

			record.

Sources: MoCC&EC, World Bank, GCF

Green Climate Fund - Pakistan and Sindh

The GCF is the world's largest dedicated multilateral climate fund and the most important single international climate finance mechanism for Pakistan (see Table 3). Its portfolio includes the landmark Recharge Pakistan programme (GCF contribution: US$66 million) - an ecosystem-based adaptation initiative covering the Indus Basin across KP, Sindh, and Balochistan – including Manchar Lake in Sindh, focused on integrated flood risk management through nature-based solutions.

However, Pakistan's GCF access record reveals a significant gap. The UNDP's CCA 2024 Climate Financing Policy Brief notes that Pakistan receives only US$0.16 in GCF finance per capita - one of the lowest rates among comparable climate-vulnerable countries. Bangladesh and Nepal, similarly, situated in terms of vulnerability, have accessed significantly more. The primary barriers include limited institutional capacity to develop GCF-quality project proposals, lack of accredited Direct Access Entities (DAEs) at the provincial level, and the federal gatekeeping of the NDA function through the MoCC.

For Sindh, the GCF represents the most significant unrealised climate finance opportunity. The province's reconstruction needs, renewable energy potential, coastal adaptation requirements, and agricultural transformation agenda all align with GCF thematic priorities. However, accessing GCF finance requires: a pipeline of bankable, GCF-ready project proposals; an accredited entity (either an international implementing partner or a DAE) to submit and manage the project; and NDA endorsement from the federal MoCC. All three require building Sindh's institutional readiness now.

Fund for Responding to Loss and Damage (FRLD)

The Fund for Responding to Loss and Damage (FRLD), agreed at COP27 (November 2022) and operationalised at COP28 in December 2023, represents the most directly relevant new mechanism for Sindh's climate finance case. The province's 2022 flood experience, resulting in US$ 7.9 billion in damages and losses and 70 percent of the national total (World Bank, 2022) is precisely the scenario the FRLD was designed to address.

As of March 2026, total pledges stand at US$ 822 million – less than 0.1 percent of the estimated US$ 400 billion needed annually by vulnerable countries. The FRLD's country-ownership model means a well-prepared application from Pakistan, grounded in Sindh's documented needs, can succeed.

3.3 Multilateral Development Banks

Beyond the dedicated climate funds, multilateral development banks (MDBs) are the largest single source of climate finance globally. In 2023, MDB climate finance to low and middle-income countries reached a record of approximately US$74.7 billion – up from US$ 60.9 billion in 2022 (MDB Joint Climate Finance Report, 2024). For Pakistan and Sindh, the three most relevant MDBs are:

World Bank Group

The World Bank is Pakistan's largest multilateral development partner for climate and disaster resilience. Its main engagement in Sindh includes: the US$100 million Sindh Solar Energy Project (SSEP); the Sindh Flood Emergency Rehabilitation Project (post-2022 floods); the Recharge Pakistan programme (co-financed with GCF and implemented primarily by the WWF); and the Variable Renewable Energy Locational Study which identified priority sites in Sindh for wind and solar development. The World

Bank's Country Partnership Framework for Pakistan (FY2026-2035) explicitly includes Sindh emergency housing reconstruction and flood-resilient infrastructure as forthcoming engagements. The World Bank is also developing Pakistan's green taxonomy (Reform Measure 8 under the RSF), which will directly affect how Sindh's RE and adaptation projects can be packaged for climate finance access.

Asian Development Bank (ADB)

The ADB is deeply engaged in Pakistan's climate and disaster risk management space. The ADB's Climate and Disaster Resilience Enhancement Programme (CDREP) — a US$ 500 million policy-based loan approved in October 2024 — is the primary external support for Pakistan's national DRM framework, strengthening NDMA capacity and federal-provincial disaster risk financing coordination (ADB, 2024). ADB-commissioned studies have identified 21 GW of commercially exploitable offshore wind potential within 50 km of Pakistan's Sindh coastline (ADB, 2023). A joint statement by MDBs at COP29 in Baku projected collective climate finance for low- and middle-income countries reaching US$ 120 billion annually by 2030, including US$ 42 billion for adaptation, alongside US$ 65 billion in mobilised private finance (MDB Joint Statement, COP29, 2024).

UN Agencies: UNDP, UNEP, IFAD, FAO

UN agencies play a critical implementing role in Pakistan's climate finance ecosystem. UNDP is the technical facilitator for Pakistan's NDC process and has supported the development of NDC 3.0. It manages the GEF Small Grants Programme in Pakistan, which has provided community-level adaptation support. UNEP's finance initiative is supporting Pakistan's sustainable finance framework development. IFAD is particularly relevant for Sindh given its mandate on rural agriculture and food security, both severely affected by climate change in the province. FAO has ongoing work on climate-smart agriculture in Pakistan's agricultural sector, directly relevant to Sindh's transformation needs.

3.4 Bilateral Donors

Several bilateral development finance agencies provide climate-relevant assistance to Pakistan, either directly or through multilateral channels:

- UK: FCDO (UK) is providing technical assistance on budget tagging capacities under the RSF reform agenda and has longstanding engagement on governance and social protection in Pakistan.
- Australia: DFAT Australia has provided climate and disaster response financing to Pakistan following recent flood events and has bilateral climate partnerships active in the region. Notably, Australia made no pledge to the FRLD at COP28, limiting its current role in loss and damage finance (Heinrich Böll Foundation, 2024).
- Germany: Germany (GIZ / BMZ) is advising NEPRA on the Prosumer Regulations 2025 and has technical engagement on Pakistan's energy transition. GIZ is actively involved in smart grid and prosumer framework development.
- Japan: Japan International Cooperation Agency (JICA) is engaged on disaster risk management and water management in Pakistan. Japan has pledged US$ 10 million to the FRLD and remains an active bilateral climate finance partner in Pakistan through JICA's disaster risk management and water management programmes (Heinrich Böll Foundation, 2024).

For Sindh, bilateral engagement is typically indirect - channelled through federal government agreements or multilateral programmes. Building direct relationships with bilateral development agencies operating in Pakistan, and positioning Sindh-specific projects within their programme priorities, is an underexplored opportunity.

3.5 Carbon Markets and Article 6

Article 6 of the Paris Agreement establishes the framework for international carbon markets: mechanisms through which countries can trade carbon credits, enabling one country's climate action to count toward another's NDC targets. COP29 completed the operationalisation of Article 6 rules, including Article 6.2 (bilateral trading agreements between countries) and Article 6.4 (the UN-supervised global carbon market).

Carbon markets represent a potentially significant revenue source for Sindh. The Sindh cabinet has already designated the Environment, Climate Change and Coastal Development Department as the lead authority for carbon markets and carbon financing under Pakistan's national policy framework. Projects that protect or restore mangroves in the Indus Delta, reforest degraded land, develop renewable energy, or adopt climate-smart agricultural practices can generate carbon credits that can be sold on international voluntary or compliance markets.

Pakistan's NDC 3.0 and the national green taxonomy (being developed under RSF RM8) are the institutional foundations for carbon market participation. For Sindh, the immediate steps are: developing an inventory of potential carbon offset projects aligned with Article 6 methodologies; building the technical capacity within the Environment Department to manage MRV (measurement, reporting, and verification) requirements; and engaging with the MoCC on Pakistan's Article 6 bilateral agreements to ensure Sindh-based projects are included.

Importantly, carbon markets are not a substitute for public climate finance. The revenues generated by carbon credits, even for substantial projects, are modest relative to Sindh's adaptation financing needs. Carbon markets should be treated as a complementary revenue stream and a signalling mechanism for private investment, not as the primary solution to Sindh's climate finance deficit.

4. Existing Policy and Institutional Landscape and Climate Finance Mobilisation

4.1 Federal and Provincial Institutional Framework

Pakistan's climate finance governance sits primarily at the federal level, managed through a set of institutions that were significantly restructured after the 2022 floods.

The Ministry of Climate Change and Environmental Coordination (MoCC&EC) is Pakistan's national designated authority (NDA) for international climate funds including the GCF and GEF, and the lead institution for climate policy, NDC implementation, and international climate negotiations. In November 2023, MoCC established a dedicated Climate Finance Wing to coordinate and mobilise climate finance across mitigation and adaptation (MoCC, 2023). This Wing manages Pakistan's interface with the GCF, Global Shield, FRLD, and bilateral climate finance partners.

Other federal institutions also control important climate-relevant financing channels. The National Disaster Risk Management Fund (NDRMF), established in 2017, provides financing for disaster risk reduction and resilience investments, while the Planning Commission manages the federal Public Sector Development Programme (PSDP), the country's principal public investment mechanism. Federal climate budget tagging was introduced in FY2023–24 and is being progressively expanded to cover development

expenditure, recurrent expenditure, subsidies and other budget categories (Government of Pakistan, Finance Division, 2026).

Pakistan's National Adaptation Plan (NAP 2023) is the country's first seven-year adaptation planning framework, covering 2023–2030. It sets out adaptation priorities across water, agriculture, health, coastal zones, and urban systems. Pakistan's adaptation financing needs under the NAP are estimated at US$ 7–14 billion per year through 2050 for infrastructure resilience and agricultural productivity alone (NAP 2023, cited in Migration Letters 2024). The NAP identifies GCF, NDRMF, and BISP as key financing vehicles but does not contain a province-disaggregated financing plan.

Pakistan National Climate Finance Strategy (NCFS 2024) was launched at COP29 in Baku in November 2024 by the Finance Minister and MoCC. It provides a roadmap for systematically accessing international climate finance and strengthening domestic financial systems for climate investment. (MoCC, 2024).

At the provincial level, the Environment, Climate Change and Coastal Development Department is the lead institution for climate policy in Sindh. Other departments and agencies - including Planning & Development, Finance, Irrigation, Energy, Agriculture, the Sindh Irrigation and Drainage Authority (SIDA) and the Provincial Disaster Management Authority (PDMA) - control substantial climate-relevant programmes and expenditure. However, these flows are not currently consolidated within a single provincial climate finance framework. This institutional fragmentation matters because access to climate finance is not determined only by the availability of international funds. It also depends on whether provincial institutions can identify their needs, package projects, demonstrate domestic co-financing, meet fiduciary and safeguards requirements, and track results. Pakistan's National Climate Finance Strategy provides a national framework for mobilising finance, but it does not by itself create a province-level investment pipeline or a system for tracking climate finance received by Sindh (MoCC&EC, 2024).

4.2 Pakistan’s Domestic Climate Finance Window

The federal PSDP is an important domestic financing channel for climate-relevant investment. Climate budget tagging provides a mechanism for identifying expenditure with adaptation, mitigation and transition relevance, but the tagged amounts should not be treated as equivalent to dedicated climate finance. Climate relevance can arise within much larger sectoral programmes whose primary objectives are infrastructure, energy, agriculture, water or disaster management.

The FY2026–27 federal budget illustrates this distinction. The allocation for the Ministry of Climate Change and Environmental Coordination under the PSDP is approximately PKR 2.48 billion, of which 95 percent is allocated to the Green Pakistan Programme. At the broader budget level, reported mitigation allocations have fallen from PKR 603 billion to PKR 124 billion, while adaptation allocations have declined from PKR 85 billion to PKR 70 billion. Disaster-related financing has moved in the opposite direction, with PKR 19 billion allocated for reconstruction and PKR 21 billion for recovery and rehabilitation. These are separate budget categories and should not be treated as a single pool of dedicated climate finance (Dawn, 2026a; Dawn, 2026b).

For Sindh, the provincial Annual Development Programme (ADP) is the equivalent domestic financing window. The province's FY2026–27 development portfolio was reduced to approximately PKR 400 billion, compared with a provincial ADP allocation of PKR 520 billion in FY2025–26. Foreign Project

Assistance is expected to provide a further PKR 256 billion in FY2026–27, while approximately PKR 64.33 billion is expected through federal PSDP support (Government of Sindh, 2026; Dawn, 2026c).

Table 4: Relevant Climate Portfolio

Financing Window/Sector	FY2026–27 Allocation	What it Represents	Climate-finance relevance for Sindh
Sindh Annual Development Programme (ADP)	PKR 400 billion	Main provincial development financing envelope	Principal domestic window through which the province can finance climate-relevant infrastructure and sectoral investments
Foreign Project Assistance (FPA)	PKR 256 billion	External project financing incorporated into the development portfolio	Important channel for multilateral and bilateral climate-related projects implemented in Sindh
Federal PSDP support	PKR 64.3 billion	Federal development financing for projects in Sindh	Potential source of climate-relevant infrastructure and resilience investment, but not climate finance in its entirety
Irrigation	PKR 30.94 billion	ADP allocation for irrigation-sector development	Highly climate-relevant given Sindh's exposure to floods, drought, water scarcity, salinity and irrigation-system vulnerability; allocation is not exclusively climate finance
Agriculture, livestock & fisheries	PKR 6.3 billion	ADP allocation for these sectors	Relevant to climate-smart agriculture, livestock resilience and fisheries adaptation; allocation is not exclusively climate finance
Energy	PKR 5.18 billion	Provincial Programme allocation for Energy	Relevant to renewable-energy and energy-transition investments; not entirely climate finance
Environment, climate change and coastal development	PKR 0.54 billion	Provincial Programme allocation for the department	Most directly aligned with climate and environmental investment, but still represents a broader sectoral allocation rather than a dedicated climate-finance envelope

Sources: *Government of Sindh, FY2026–27 Annual Development Programme and budget documents (2026)*

Sindh therefore has several domestic and intergovernmental financing windows through which climate-relevant investments can be financed, but these should not be conflated with dedicated climate finance**.** The province's PKR 400 billion ADP is the principal domestic development window, while foreign project assistance and federal PSDP transfers provide additional financing for projects implemented in Sindh. Within the ADP, large allocations to irrigation, agriculture, energy and environment are particularly relevant to climate resilience. However, only a proportion of these allocations can reasonably be classified as climate expenditure. Without systematic climate budget tagging at the provincial level, it is not possible to determine that proportion with sufficient confidence.

This distinction is important for the climate finance needs assessment. The existence of a large provincial allocation to irrigation or agriculture does not mean that Sindh's climate adaptation needs in those sectors are already financed**.** Much of this expenditure supports routine development, service delivery and maintenance. Climate finance should instead refer to expenditure that directly addresses climate risks, reduces vulnerability, supports low-carbon transition, or enables climate resilience.

The current financing architecture therefore provides Sindh with potential domestic co-financing capacity, but not a transparent picture of the province's actual climate expenditure. Establishing a provincial climate budget-tagging system, supported by a CPEIR or equivalent expenditure review, would allow the Government of Sindh to identify how much of its existing ADP and sectoral spending contributes to adaptation, mitigation and loss-and-damage-related priorities. This would also strengthen the province's case for additional international climate finance by demonstrating both existing domestic effort and the residual financing requirement.

4.3 International Climate Finance Mobilized in Pakistan

Pakistan's international climate finance has expanded substantially following the 2022 floods, but available figures vary considerably depending on the definition of climate finance, the period covered and whether loans, grants, policy-based lending and private finance mobilised through public interventions are included. For this reason, this paper does not treat a single headline figure as Pakistan's total climate finance.

Available tracking indicates that in 2023, the ADB's loan and grant commitments to Pakistan alone amounted to approximately US$ 1.617 billion, comprising US$ 400 million in programme lending, US$ 1.2 billion in project lending and US$ 13.5 million in grants (Akhtar & Khawaja, 2025). Additional major commitments include the ADB's US$ 500 million policy-based loan for climate and disaster resilience approved in October 2024 (ADB, 2024) and the UK's £108 million Climate Investment Fund for Pakistan covering 2024–2031 (FCDO, 2024).

These figures should be interpreted carefully. A large proportion of Pakistan's climate-related external finance is provided as loans rather than grants. Loan-based development finance can be important for large-scale resilience infrastructure, but it increases public liabilities and is fundamentally different from grant-based adaptation finance. Similarly, post-disaster reconstruction finance should not automatically be treated as equivalent to longer-term adaptation finance: rebuilding infrastructure after a flood may incorporate resilience standards, but it does not necessarily address slower-onset risks such as drought, salinity, coastal erosion or heat stress.

The 2022 floods nevertheless produced a major increase in external financing directed towards Pakistan. Given Sindh's disproportionate share of national damages, a significant portion of post-flood reconstruction and recovery finance has been directed towards the province, including investments in housing, agriculture, irrigation, roads and disaster-resilient infrastructure. These flows are important, but they remain concentrated around recovery and reconstruction and therefore do not replace the need for predictable, multi-year adaptation finance.

To provide a more systematic picture, this paper uses the Renewable First database of climate-related foreign financing projects in Pakistan as a supplementary tracking source. The database identifies 1,512 foreign-financed projects across Pakistan and records information on financing source, amount, sector,

climate objective and other project characteristics. Because the database is project-based and captures identified financing flows rather than all climate-related expenditure in Pakistan, its figures should be understood as a tracked portfolio rather than a complete national climate finance account.

The portfolio is classified by the source database primarily into adaptation and mitigation. This distinction is retained in the analysis rather than imposing a new classification on the underlying data. Where projects have a clear relationship to climate-related disaster recovery, livelihood losses, displacement or reconstruction following climate shocks, they may be identified separately in the analysis as L&D-relevant. However, these projects are not counted as dedicated Loss and Damage finance unless the financing source itself explicitly identifies them as such. This distinction is important because disaster recovery, adaptation and Loss and Damage are related but not interchangeable categories.

The portfolio demonstrates an important feature of Pakistan's climate finance landscape: the volume and composition of finance do not necessarily correspond to the country's adaptation needs. Pakistan's climate vulnerability is overwhelmingly characterised by adaptation challenges - including floods, drought, heat, water insecurity, agricultural losses and coastal risks - yet international financing also contains substantial mitigation-oriented investment. This is not inherently problematic, particularly where mitigation investments also generate resilience or development benefits, but it reinforces the importance of tracking whether available finance corresponds to provincial climate risk and investment needs.

The sectoral distribution of the tracked portfolio is also relevant. Adaptation finance extends across areas such as water, agriculture, disaster risk management, infrastructure, forestry and urban resilience, while mitigation finance is concentrated more heavily in energy, transport, industry and other emissions-related sectors. A sector-level breakdown is therefore provided below to show where the tracked financing is concentrated rather than relying only on the aggregate adaptation–mitigation distinction.

Table 5: Distribution of tracked foreign climate-finance projects in Pakistan by sector and climate objective

Sector	Adaptation projects	Mitigation projects	Both	Total projects	Total financing (US$ million)
Agriculture	89	27	47	163	1,478.4
Water & irrigation	118	37	32	187	1,128.5
Energy	27	142	23	192	5,074.2
Forestry / land use	33	9	24	66	174.1
Disaster risk management	64	4	27	95	759.3

Infrastructure / urban	22	12	5	39	464.5
Transport	19	19	2	40	2,112.3
Industry	4	4	4	12	24.6
Other*	356	134	228	718	5,315.0
Total	**732**	**388**	**392**	**1,512**	**16,531.0**

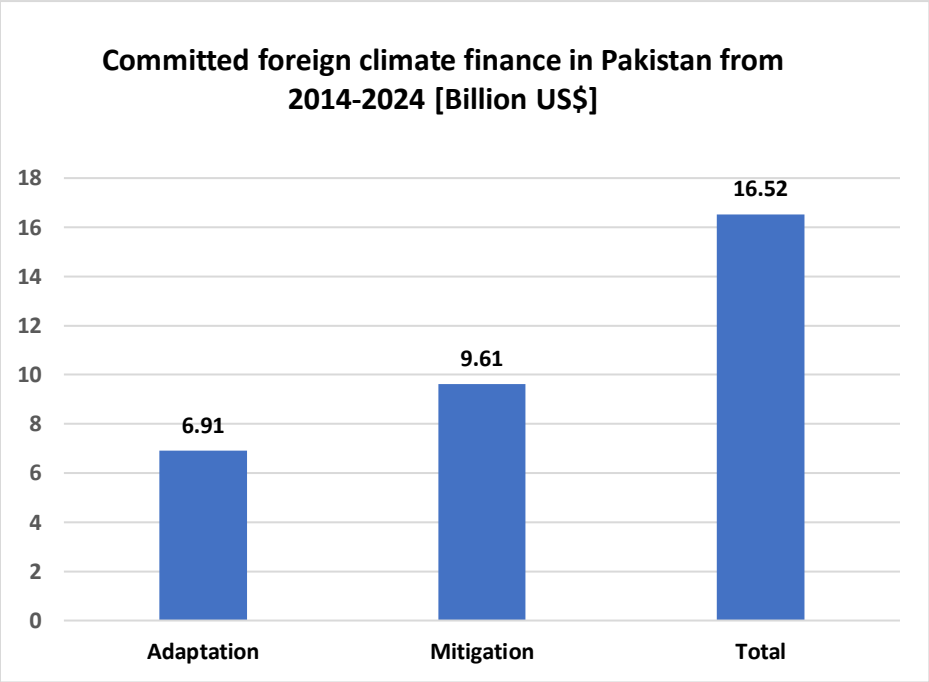
Note: Financing amounts in the source database are reported in thousand US$; converted here to US$ million. "Both" refers to project records with financing recorded under adaptation and mitigation.
**Other category contains sectors such as education, health, government/civil society, multisectoral projects, etc.*

The composition of climate finance matters as much as its total volume. Globally, mitigation accounted for approximately 60 percent of climate finance provided and mobilised by developed countries in 2022, while adaptation received a substantially smaller share (OECD, 2024). This matters for Sindh, where the financing needs identified in this paper are predominantly adaptation-focused, including flood resilience, climate-smart agriculture, water management, drought resilience and coastal protection.

A significant share of climate-relevant external finance in Pakistan and Sindh is also provided through loans rather than grants. Loan volumes therefore do not have the same fiscal value as equivalent grants, as they create future debt-service obligations, including principal and financing charges. This is particularly relevant for adaptation investments, where social and economic returns may be high but direct financial returns limited. Financing strategies should therefore distinguish between grants, concessional loans, commercial finance, private investment and blended finance, with grants and highly concessional resources prioritised for investments with primarily public or resilience-related returns.

Loss and Damage presents another distinct financing challenge. Reconstruction finance can address some consequences of climate disasters, but it is not equivalent to dedicated L&D finance; similarly, adaptation cannot substitute for L&D where climate impacts exceed the limits of adaptation. Because existing databases generally do not classify L&D consistently, this paper identifies L&D-relevant projects separately where the evidence supports it, without presenting them as dedicated L&D finance. The detailed database of identified international financing flows in Sindh (according to selected sector) is therefore presented separately in Table 5, including provider, financing instrument, amount, sector, geographic scope, climate objective and financing status.

Figure 2: Share of adaptation and mitigation within tracked climate finance projects in Pakistan, according to the database (2014-2024)



Overall, the issue for Sindh is therefore not simply the volume of finance entering Pakistan, but its composition, geographic distribution, financing terms and alignment with the province's climate risks and investment needs.

4.4 Who Receives Climate Finance - and Where Does It Go?

The principal weakness in Pakistan's climate finance architecture is not simply the overall volume of finance; it is the limited ability to trace that finance geographically and by climate objective.

International projects are frequently approved at the national level and implemented across several provinces. Project documents may specify the number of districts, beneficiaries or infrastructure assets in Sindh without reporting the corresponding financial allocation. Conversely, projects with broad climate objectives may contain substantial components that are development, disaster recovery or conventional infrastructure rather than additional climate investment.

For Sindh, this makes it difficult to answer three basic questions:

1. **How much climate finance has Sindh actually received?**
2. **What proportion was adaptation, mitigation, loss and damage, or mixed-purpose finance?**

3. **How much of the finance was actually disbursed and spent in Sindh?**

The UNDP NDC Investment Plan (2024) identifies US$ 7.2 million allocated to Sindh's industrial sector, US$ 26.6 million to agriculture, and US$ 5.3 million to land use and forestry in the 2022–23 Annual Development Plan. Against these allocations, the additional investment identified as needed for Sindh's NDC commitments is US$ 35 million for industry, US$ 55 million for climate-smart agriculture, and US$ 50 million for Land Use, Land-Use Change, and Forestry (LULUCF). These figures should be understood as identified NDC investment allocations rather than a comprehensive account of all climate finance flowing into Sindh (Shah et al., 2024).

This attribution problem is compounded by the absence of a province-wide climate expenditure tracking mechanism. As a result, Sindh's position in the national climate finance system is often that of an **implementation geography rather than a clearly identifiable financial recipient.**

4.5 The Financing Gap for Pakistan and Sindh

Pakistan's financing requirements remain far beyond current domestic and international flows. The World Bank's Country Climate and Development Report estimates approximately US$348 billion in climate-related investment requirements through 2030, including approximately US$152 billion for adaptation and resilience and US$196 billion for mitigation (World Bank, 2022).

At the same time, the federal budget illustrates the difficulty of maintaining climate investment under fiscal constraints. For FY2026–27, federal mitigation allocations were reported to have fallen from approximately PKR 603 billion to PKR 124 billion, while adaptation allocations declined from PKR 85 billion to approximately PKR 70 billion; disaster-management financing moved in the opposite direction (Dawn, 2026b). This reinforces the distinction between financing for prevention and resilience and financing mobilised after disasters occur.

For Sindh, the gap is sharper because the province combines high exposure to floods, drought, extreme heat, water stress and coastal change with substantial development deficits. The evidence points to four interconnected weaknesses in Sindh's current climate finance position:

Access. Sindh remains dependent on federal institutions and accredited international entities for access to many international climate funds. Provincial institutions therefore have limited control over the design and financing of projects addressing provincial priorities.

Attribution. There is no consolidated system through which Sindh can identify the total value of climate finance committed, approved or disbursed to the province. This makes it difficult to demonstrate the scale of existing investment or establish a credible additional-finance case.

Alignment. Existing projects are often organised around individual donor programmes or post-disaster priorities rather than a single provincial climate investment framework. This can produce fragmented interventions, short project cycles and gaps between major programmes.

Monitoring, reporting and verification. Weak and fragmented MRV systems make it difficult to track whether climate finance is producing measurable resilience outcomes, particularly across departments and local governments.

The strategic priority for Sindh is therefore not simply to attract more projects. It is to establish a provincial climate finance system capable of **tracking existing expenditure, identifying investment gaps, developing a bankable pipeline and demonstrating measurable results.** This would allow the province to move from being primarily an implementing geography for externally financed programmes towards becoming a more active actor in defining and mobilising its own climate investment priorities.

The international climate finance database presented in Table 5 above provides the first layer of this exercise by identifying existing flows in Pakistan. The sectoral investment assessment that follows provides the second: an estimate of what Sindh would require by 2035 to address a defined set of priority climate risks. Together, these two components allow the paper to distinguish between **finance already mobilised, finance potentially available, and additional investment required** rather than treating all three as the same financing gap.

5. Climate Finance Needs Assessment

5.1 Approach and Methodology Breakdown

The assessment aims to develop an indicative, sector-level climate finance costing model for Sindh, drawing on established and similar bottom-up costing approaches. It is informed particularly by the UNDP SDGs Unit Sindh's SDG 7 costing assessment, Pakistan's NDCs, and the National Adaptation Plan. These approaches share the principle of linking measurable targets to investment requirements but differ in their application. The model therefore adapts this common approach to Sindh's available data, sectoral priorities and financing context, providing a transparent and replicable basis for estimating indicative investment needs.

The costing follows a common framework across the four sectors:

Baseline → Target → Gap → Unit Cost → Gross Investment Need → Existing Finance Mapping

Selection and Classification of Indicators

Indicators were selected based on four considerations: relevance to Sindh's climate risks and development priorities, availability of measurable baseline data, the existence of a meaningful policy or planning target, and the availability of a reasonable basis for estimating investment costs.
Each indicator is classified according to its primary climate objective:

Mitigation: activities that reduce or avoid greenhouse gas emissions, such as renewable energy capacity.

Adaptation: activities that reduce exposure or vulnerability to climate impacts, such as climate-resilient agriculture and efficient irrigation.

Some indicators are designated as primary indicators and are directly costed. Supporting indicators are used to provide additional context, assess progress or validate the direction of investment needs, but are not separately costed where a reliable unit-cost basis or independent financing allocation is not available. At this stage of the analysis, the indicators are kept broad in regards to the sectors, in a way that they are able to capture the main costing estimates required.

Baseline and Target: For each primary indicator, the most recent reliable Sindh-specific baseline is established using government statistics, sector reports, project-level information and other credible sources. Where a comparable quantitative figure is unavailable, an estimate or proxy is used where possible and clearly identified. Where prior interventions are documented but cannot be reliably quantified in the indicator's unit, the baseline is retained as 0 for costing purposes and the data limitation is noted. A zero baseline therefore reflects a data limitation, not an absence of prior investment.

A target is then established for the 2035 planning horizon. Published provincial or national policy targets are used where available. Where no formal target exists, an indicative planning target is derived from relevant sector plans, national commitments, existing investment pipelines and stakeholder consultations.

The physical financing gap is calculated as: **Physical Gap = Target Level – Current Baseline**

Unit Cost and Gross Investment: The physical gap is converted into an indicative investment requirement using a unit investment cost appropriate to the indicator. Unit costs are drawn, where available, from government and development-partner project documents, sector studies, project-level investment data and comparable national or international benchmarks.

Where costs vary substantially between projects or assumptions are uncertain, low, central and high-cost estimates are presented. The central estimate is used for the main assessment, while the range demonstrates the sensitivity of the financing requirement to variations in investment costs. A single value is used only where the cost comes from an approved, recently-tendered project budget line; all other unit costs use a +/-20-30 percent range.

The gross investment requirement is calculated as:

Gross Investment Need = Physical Gap × Unit Cost

The resulting figure represents the additional estimated investment required to reach the selected target. It should not be interpreted as a project budget or final government expenditure requirement.

The analysis separately maps existing and pipeline financing relevant to the selected sector and investment areas. This includes identifiable financing from the Government of Sindh and federal government, multilateral and bilateral development partners, international climate funds and other relevant financing mechanisms.

Where a financing programme supports multiple indicators and a reliable indicator-specific allocation is not available, the financing is not divided artificially between indicators. Instead, it is considered at the relevant sector or investment-area level to avoid double counting and false precision.

After the costings of each sector, a set of potentially bankable project ideas are also mentioned. They are illustrative pathways for translating the investment priorities identified in this assessment into financeable interventions. They are not intended to constitute fully developed project proposals or imply that new projects should be prioritised over existing programmes.

Sindh Climate Finance Needs Assessment

Purpose: to develop an evidence-based estimate of CF required to enable Sindh to respond to climate change over the period 2025–2035.

Bottom-up sectoral costing
Forward mitigation & adaptation needs

↓

Data sources (three avenues)

Government statistics	International databases	Peer literature
PBS, NEPRA, SIDA, ADP	WB, IRENA, FAO, EM-DAT, GCF, OECD CRS	Project Reports, IPCC AR6, NDC 3.0

↓

Calculation Process

1. Identify relevant indicators under each sector	2. Establish baseline values	3. Identify target by 2035 (planning scenario where applicable)	4. Gap: Target – Baseline	5. Derive a unit cost for selected indicator	6. Gross investment required = Gap × Unit cost

↓

Four focal sectors and their indicators

Energy	Agriculture	Water & Irrigation	Environment
Indicators	**Indicators**	**Indicators**	**Indicators**
Installed utility-scale solar and wind energy capacity	Area under Climate Resilient Agriculture	Agricultural drainage systems	Mangroves restored
Decentralised solar HH	Farmers adopting CSA	Farms under efficient systems	Supporting: Carbon credits
		Flood embankments	

↓

Key assumptions & validation

Assumptions	Triangulation & Validation
Price base: Constant 2024 US$[1]	≥2 independent sources per unit cost
Exchange rate: PKR 278/US$ (SBP Q4 2024)[2]	Expert sector validation log
	Low / Central / High range (where applicable)
	All [E] estimates flagged

[1] All investment estimates in this paper are expressed in real 2024 US$ and therefore do not incorporate future inflation or nominal price escalation through 2035. They represent the constant-price investment requirement and should not be interpreted as a nominal 2026–2035 budget allocation.

[2] PKR-denominated unit costs have been converted using a single 2024 exchange rate for consistency. Given historical exchange-rate volatility, the resulting US$ estimates should be interpreted as indicative planning estimates; changes in the PKR/US$ rate would proportionately affect the US$ value of PKR-denominated costs.

5.2 Assessment

Sector: Energy

Context: Pakistan's energy sector remains heavily dependent on fossil fuels, yet renewable energy has emerged as a strategic priority for improving energy security, reducing import dependence, and meeting the country's climate commitments. As of June 2025, the total installed energy capacity stands at 41,121 MW. Out of this, renewable energy (wind, solar and bagasse) accounts for approximately 2,867 MW, or 6.9 percent of Pakistan's total installed electricity generation capacity (State of the Industry Report, 2025). Under the Alternative and Renewable Energy (ARE) Policy 2019 and Pakistan's Nationally Determined Contribution (NDC 2021), the country aims to increase the share of electricity generation capacity from wind and solar to 30 percent by 2030 as part of its broader commitment to reduce projected greenhouse gas emissions by 50 percent by 2030, including a 15 percent unconditional reduction from domestic resources and a 35 percent conditional reduction subject to international climate finance. The NDC also targets 60 percent renewable energy generation and 30 percent electric vehicles by 2030, highlighting the central role of renewable energy in Pakistan's long-term decarbonisation strategy.

Despite these national commitments, Pakistan has experienced a largely consumer-led solar transition. Independent estimates suggest that Sindh alone has approximately 5.255 GW of distributed solar capacity installed across residential, commercial, industrial and agricultural users (TransitionZero & Policy Research Institute for Equitable Development, 2025). While this demonstrates strong market demand for clean energy, most of this investment has been privately financed and therefore falls outside the scope of this climate finance assessment. This analysis focuses specifically on government-supported utility-scale renewable energy infrastructure**,** which remains critical for expanding clean electricity generation, improving grid reliability, and enabling equitable energy access.

Sindh is well positioned to lead Pakistan's renewable energy transition due to its exceptional solar irradiation and wind resources. The province hosts the **Jhimpir–Gharo wind corridor**, with an economically viable wind potential of approximately **11 GW**, while earlier technical assessments estimate an exploitable potential of up to **50 GW** (Alliance for Climate Justice and Clean Energy, 2024). A World Bank renewable energy zoning assessment further estimated that Sindh could accommodate approximately 10,035 MW of renewable energy by 2030 after accounting for resource availability, environmental and social constraints, and existing transmission infrastructure (World Bank, 2021).
As of June 2025, Sindh had approximately 2,088 MW of commissioned utility-scale renewable energy capacity, comprising 1,838 MW of wind power **and** 250 MW of solar power**, representing over** 70% of Pakistan's utility-scale renewable energy capacity (State of the Industry Report, 2025). Wind development has expanded rapidly over the past decade, with 36 operational wind farms located primarily in the Jhimpir–Gharo corridor. Major projects include the Foundation Wind Energy**,** China Three Gorges**, and** Sapphire–Tricon wind farms. The State of the Industry Report (2024) previously recorded 2,485 MW of wind projects issued Letters of Intent, of which 1,875 MW had been commissioned, indicating that additional approved projects remain to be developed. According to the Global Wind Tracker (February 2026), Sindh also has an additional 700 MW of wind projects in the development pipeline (200 MW announced and 500 MW in pre-construction).

Utility-scale solar development remains comparatively limited. As of 2025, Sindh hosts five commissioned utility-scale solar projects with a combined installed capacity of approximately 250 MW**,**

including three projects connected to the CPPA-G system in Sukkur and two K-Electric projects in Thatta (State of the Industry Report, 2025). However, the project pipeline indicates significant future growth, with approximately 1,100 MW of additional solar capacity either announced or in pre-construction (Global Energy Monitor, 2026).

Although renewable energy currently represents only a small share of Sindh's overall electricity mix, the province has one of Pakistan's largest pipelines of future renewable energy projects. Based on the Global Integrated Power Tracker (March 2026)**,** approximately 31.9 percent of Sindh's prospective generation pipeline is solar, 20.3 percent is wind, and 47.8 percent is coal, indicating continued opportunities to increase renewable generation if adequate financing can be mobilised.

Investment in renewable energy also generates wider economic and social benefits beyond emissions reduction. Under the Sindh Solar Energy Project (SSEP)**,** the World Bank estimated that the project's 28 solar PV schemes generated approximately 817 job-years during design, construction, operation and maintenance, while long-term operation and maintenance activities are expected to create an additional 1,137 job-years. A job-year represents one full-time job sustained for one year; therefore, the figures capture the total employment generated over the duration of project activities rather than the number of individual people employed. These findings demonstrate that renewable energy investments can simultaneously support employment generation, local economic development and improved energy access, reinforcing the case for scaling up climate finance in Sindh (World Bank & ESMAP, 2023).
Scaling up renewable energy investment can simultaneously reduce emissions, improve energy security, diversify the electricity mix, reduce dependence on imported fuels, and generate employment.

Primary Indicator: Installed Utility-scale Renewable Energy Capacity (Solar and Wind)
Classification: Mitigation[3]

Rationale: Installed renewable energy capacity has been selected as the primary indicator because it directly represents the infrastructure that requires public investment and climate finance support. Solar and wind have been combined into a single indicator as both technologies contribute towards the same renewable energy objective and are financed through similar public investment mechanisms.

Baseline: As of June 2025, Sindh has 39 commissioned utility-scale renewable energy projects, consisting of:

Technology	No. of Operating Projects	Installed Capacity
Solar (CPPA-G)	3	150 MW
Solar (K-Electric)	2	100 MW
Wind	36	1,838 MW
Total	41	2,088 MW

Source: State of Industry Report 2025

The baseline includes commissioned utility-scale renewable projects connected to both the CPPA-G (Central Power Purchasing Agency) /NTDC (National Transmission and Despatch Company) and K-Electric systems, as the objective of this analysis is to estimate total government-supported renewable

[3] Expansion of solar capacity reduces reliance on fossil fuel-based electricity generation and contributes directly to greenhouse gas emissions reductions, making it a mitigation investment.

generation capacity within Sindh.

Target and Gap: Pakistan's Alternative and Renewable Energy Policy and Nationally Determined Contributions (NDCs) aim to increase the share of wind and solar in the national electricity mix to 30% by 2030. At the provincial level, Sindh's NDC 3.0 Policy Recommendations (2025)[4] establish a target of achieving a 25% renewable energy mix by 2030. As no official provincial renewable energy target exists beyond 2030 or specifies installed renewable capacity (MW), this assessment derives a planning target of 30% renewable energy mix by 2035 for the purpose of estimating climate finance needs. This represents a modest progression beyond Sindh's 2030 target while remaining aligned with Pakistan's long-term renewable energy transition objectives.

Using the State of the Industry Report (2025) as the baseline, Sindh's total installed generation capacity is 13,851 MW, of which 2,067 MW comprises operational wind and solar capacity. To estimate the 2035 requirement, the derived target is converted into installed capacity by applying the 30% renewable energy mix to the province's total installed generation capacity:

13,851 MW × 30% = 4,155 MW

Accordingly, Sindh would require approximately 4,155 MW of installed renewable energy capacity by 2035 to meet the target.

Methodological note*: The 30% renewable energy mix adopted for 2035 is a derived planning assumption used solely for estimating Sindh's climate finance needs. It does not represent an official Government of Sindh target but extends the province's existing 2030 policy ambition over the paper's 2035 assessment horizon.*

Step	Calculation
Total installed capacity (2025)	13,851 MW
Derived 2035 RE target	30%
Required RE capacity	13,851 × 30% = 4,155 MW
Existing RE capacity	2,088 MW
Gap / Additional capacity required	**4,155 – 2,088 = 2,067 MW**

Unit Cost: A blended capital investment cost is applied because the indicator combines utility-scale solar PV and onshore wind technologies. The blended cost is derived using the global average total installed costs (CAPEX) reported in International Renewable Energy Agency's (IRENA) report, Renewable Power Generation Costs in 2024 with utility-scale solar PV costing US$0.691 million/MW and onshore wind costing US$1.041 million/MW. A localisation factor of 0.9[5] is applied to reflect relatively lower domestic

[4] The NDC 3.0 Policy Recommendations – Sindh (Final Report, August 2025) is used in this paper as a technical policy-recommendations document informing Sindh's NDC 3.0 process. Its proposed targets and priorities are therefore treated as policy recommendations and planning references.

[5] A localisation factor of 0.9 is applied to international CAPEX benchmarks to reflect comparatively lower local engineering, civil works and labour costs in Pakistan. Imported components such as PV modules, wind turbines and electrical equipment continue to be priced at international market rates; therefore, only a modest adjustment is applied.

engineering, civil works and labour costs in Pakistan, while recognising that major equipment continues to be imported.

Scenario	Unit Cost (US$/MW)
Low	0.65 million
Central	0.78 million
High	0.90 million

Capital expenditure (CAPEX) per MW is used rather than electricity tariffs (US$/kWh or PKR/kWh), as the objective is to estimate the upfront infrastructure investment required to expand renewable energy capacity, rather than the lifetime cost of electricity generation.

Gross Investment Requirement: Gap = 2,067 MW

Scenario	Investment Need
Low	**US$1.34 billion**
Central	**US$1.61 billion**
High	**US$1.86 billion**

The above range reflects uncertainty in technology mix, procurement costs, exchange-rate fluctuations and project implementation costs. The blended CAPEX approach is adopted because the analysis estimates overall renewable energy investment requirements rather than technology-specific financing needs.

The central estimate of **US$1.61 billion** represents the indicative investment required to expand Sindh's commissioned utility-scale renewable energy capacity from **2,088 MW** to **4, 155 MW,** meeting the 2035 target.

Supporting Indicator: Households with decentralized solar access in rural and off-grid areas
Classification: Adaptation[6]

This indicator is included because decentralized solar deployment[7] is one of the most cost-effective and climate-resilient pathways for expanding energy access in Sindh, particularly in rural, remote, and off-grid communities where grid extension remains technically and financially challenging. It directly contributes to climate mitigation by reducing reliance on fossil fuel-based electricity while improving energy security and resilience at the household level.

The indicator is also policy-driven. It is explicitly identified in the Sindh NDC 3.0 Policy Recommendations (2025) under "Promote Decentralized Renewable Energy Systems in Rural and Off-grid Areas," with a target of 200,000 rural households powered by off-grid solutions (2025–2028)**.** This assessment

[6] Decentralized solar systems improve resilience to grid disruptions, extreme heat, and climate-related shocks, particularly in vulnerable and underserved areas, and are therefore classified as adaptation investments.
[7] Decentralized renewable energy systems are small-scale, distributed energy systems - primarily solar home systems, mini-grids, and off-grid solar PV installations - that generate electricity close to the point of use, particularly in rural and off-grid areas.

therefore adopts decentralized solar households as a primary indicator because it aligns with the province's stated policy priorities and provides a measurable basis for estimating climate finance requirements.

Baseline: According to the Sindh Energy Department, approximately 1.039 million rural households currently use decentralized solar systems. This figure is adopted as the baseline because the indicator specifically measures decentralized solar access in rural and off-grid areas, consistent with the Sindh NDC 3.0 Policy Recommendations (2025).

Target: The Sindh Energy Department estimates that approximately 2.6 million households remain off-grid across the province. As no official target exists beyond the interim NDC objective of 200,000 rural households (2025–2028), this assessment adopts a planning scenario whereby all currently off-grid households gain access to decentralized solar systems by 2035.

Gap:

Baseline	Target	Gap
1.039 million households	2.6 million households	1.56 million households

This represents households that remain vulnerable to energy disruptions and lack reliable electricity access.

Unit Cost: Based on the Government of Sindh's Solar Home Systems (SHS) Program benchmark, the central unit cost is derived from the average cost of a singular solar home system (SHS), which comes to around PKR 50,000 per household ≈ US$180 per household. As this estimate is derived from an existing provincial implementation programme, no additional localization factor or scenario analysis is applied. Exact costs may vary depending on system size, battery specifications, transport requirements and installation location.

Gross Investment Requirement: 1.56 million households x US$180/household = **US$280.8 million**
This estimate suggests that US$280.8 million is the investment required to provide decentralized solar access to 1.56 million rural and/or off grid households in Sindh.

Investment Summary:

Indicator	Category	Baseline	Target	Gap	Unit Cost	Gross Investment Required
Installed utility-scale renewable energy capacity (Solar + Wind)	Mitigation	2,088 MW	4,155 MW	2,067 MW	US$0.78 million/MW	US$1.61 billion
Decentralized solar access to rural/off-grid households	Adaptation	1.03 mil households	2.6 mil households	1.56 mil households	US$180/ household	US$280.8 million
Total gross investment need						**US$1.89 billion**

Potential Financing Pathways and Existing Program Scale-up Opportunities

- Renewable energy and grid integration: Develop a financing programme for additional renewable capacity alongside priority grid and storage investments needed to improve integration of wind and solar generation in Sindh.
- Scale-up of decentralised solar: Expand the Sindh Solar Home System model through concessional, results-based or blended finance to support phased deployment in underserved and off-grid communities.
-

Sector: Agriculture

Context: Sindh accounts for 18 percent of Pakistan's land area, 16 percent of the country's cultivated area, and contributes approximately 23 percent of national agricultural value added. Agriculture is the backbone of Sindh's economy, contributing around 28 percent of provincial GDP and employing approximately 43 percent of the provincial workforce (Pakistan Economic Survey 2024–25; PBS Agricultural Census 2024). Agricultural GDP is estimated at approximately PKR 1,600 billion (US$15.5 billion). The Sindh Agriculture Policy (2018) estimates that achieving a sustained annual agricultural growth rate of 5 percent would require approximately PKR 320 billion (US$ 3 billion) in annual public and private investment.

According to the Agricultural Census 2024, Sindh has approximately 8.11 million acres of cultivated land, with a total cropped area of around 13.10 million acres. Agricultural production is dominated by four major crops: wheat (30 percent), rice (22 percent), cotton (17 percent), and sugarcane (9 percent) (SWAT, 2022). Nearly 75 percent of cultivated land is irrigated through the Indus Basin irrigation system, making agricultural productivity highly dependent on the province's barrages, canals, and drainage infrastructure (FAO, 2019).

Climate change is already imposing substantial economic losses on the sector. The 2022 floods caused an estimated US$1.30 billion in direct losses across Sindh's three principal crops, including US$543 million in rice, US$485 million in cotton, and US$273 million in sugarcane, alongside an additional US$374 million in vegetable crop losses (World Bank SWAT Project, 2022). More broadly, approximately 4.4 million acres of agricultural land were damaged and around 0.8 million livestock perished during the disaster, with Sindh accounting for approximately 72 percent of the country's agricultural damage and losses (World Bank, 2022). Looking ahead, wheat yields are projected to decline by 15–25 percent by 2050 under moderate warming scenarios (CGIAR/CIMMYT Pakistan), while recent modelling suggests that, in the absence of adaptation investments, climate change could reduce agricultural value added by approximately 5.1 percent and household incomes by around 2 percent (Begum, 2026). Crop yield losses and livestock mortality therefore serve as important indicators of climate vulnerability, reflecting the socioeconomic consequences of increasing climate hazards. While these outcome indicators are not independently costed in this assessment, they provide the underlying justification for prioritising investments in climate-resilient agriculture, as reducing crop losses and protecting livestock ultimately depend on expanding Climate-Smart Agriculture, strengthening farmer capacity, improving water management, and increasing the resilience of agricultural production systems.

To estimate climate finance needs, this assessment therefore focuses on two primary adaptation investment indicators: (i) area under Climate-Smart Agriculture (CSA) and (ii) farmers supported to adopt CSA practices. Together, these indicators capture both the physical expansion of climate-resilient agricultural practices and the institutional and human capacity required for their successful adoption.

Primary Indicator: Area under Climate Smart Agriculture (CSA)
Category: Adaptation

Rationale: Transitioning farmland to climate-resilient practices, drought-tolerant varieties, water-efficient irrigation, improved soil management, and flood-adaptive cropping systems is the most direct adaptation investment available to Sindh's agriculture sector. It directly protects rural livelihoods, provincial food security, and GDP. Despite causing one third of global greenhouse gas emissions, agrifood systems receive 4 percent of climate finance, with only a fifth of this going to smallholders. Current financial flows need to be realigned in order to support a sustainable agrifood system transformation (World Bank, 2024).

This indicator is identified as a priority adaptation measure under the Sindh NDC 3.0 Policy Recommendations, which call for financial, technical and capacity-building support to scale climate-resilient agricultural practices across the province. Climate-smart agriculture is treated as an integrated package comprising improved seed, efficient irrigation, soil management, water conservation, climate information services and improved agronomic practices therefore for the purpose of this analysis, costing individual interventions separately would risk double-counting investments delivered through integrated programmes.

Baseline: At present, Sindh does not maintain a province-wide inventory of agricultural land under Climate-Smart Agriculture (CSA) but ongoing programmes demonstrate that implementation has commenced at a pilot and demonstration scale. However, the total area currently under CSA has not been formally documented. Accordingly, the baseline for this assessment is taken as 0 hectares of documented CSA coverage, reflecting a monitoring gap rather than the absence of CSA interventions. Under the Sindh Water and Agriculture Transformation (SWAT) Project funded by the World Bank, CSA has been promoted through demonstration plots and replication activities[8]. To date, SWAT has established demonstration plots of 30 acres each for wheat, rice and cotton, trained 750 farmers in CSA practices, and aims to support approximately 80,000 acres of water-thrifty crops and 110,000 acres under improved on-farm water management during the project period (SWAT, 2026). At Khorwah Minor in Badin, wheat has been planted using a zero-tillage technique, which uses residual moisture after rice harvesting, saving costs, water, and labour while benefiting the environment (Express Tribune, 2025). Under the Green Climate Fund (GCF) funded project, Transforming the Indus Basin with Climate Resilient Agriculture and Climate Smart Water Management, during 2024, **80 adaptive research plots** were established across **Badin, Sanghar, and Umerkot** to test locally appropriate climate-resilient farming practices. In addition, **60 Climate-Resilient Agriculture (CRA) demonstration plots** were established during the Kharif 2024 season. Across the Kharif and Rabi seasons combined, the project established **120 CRA demonstration plots and 120 control plots**, benefiting approximately **1,500 registered farmers**. These demonstration sites promoted practices such as ridge sowing, raised-bed sowing, zero tillage, intercropping, alternate wetting and drying (AWD), direct-seeded rice (DSR), and improved multiple cropping systems.

Target: In the absence of an official provincial target, this assessment adopts a planning scenario of bringing 50 percent of Sindh's cultivated area under Climate-Smart Agriculture by 2035. According to the

[8] Demonstration plots are pilot fields established to showcase climate-smart farming practices and serve as practical training sites for farmers. Replication activities refer to the subsequent adoption of these practices by participating farmers on their own farms following training and technical support.

Agricultural Census 2024 (Sindh Report, 2026), Sindh has 8,108,200 acres of cultivated land. Achieving CSA across 50 percent of this area would therefore require:

Target = 4,054,100 acres (1,640,636 hectares) under CSA by 2035

For consistency with the other land-based indicators in this assessment, the target is also expressed in hectares, although the underlying agricultural land statistics and CSA unit costs are reported in acres.

Baseline	Target	Gap
0 ha	1,640,636 ha	1,640,636 ha

Unit Cost: Based on cost estimates provided by the SWAT Project, establishing Climate-Smart Agriculture demonstration plots costs approximately PKR 50,000 per acre, while replication activities - where trained farmers adopt CSA practices on their own farms - cost approximately PKR 25,000 per acre. Since large-scale provincial expansion would primarily involve replication rather than establishing new demonstration sites, the replication cost is applied as the representative unit cost for scaling CSA. Unit Cost: PKR 25,000 per acre (≈ US$ 89 per acre).

Gross Investment Requirement: 4,054,100 acres × US$89/acre = **US$361 million**

This represents the estimated investment required to expand Climate-Smart Agriculture across 50 percent of Sindh's cultivated land by 2035. The estimate covers the replication of CSA practices at farm level and is intended as a planning estimate for climate finance purposes rather than a detailed project cost.

Primary Indicator: Smallholder farmers supported to adopt Climate Smart Agriculture
Category: Adaptation

Rationale: Farmer adoption of CSA practices determines whether investments translate into improved resilience. This indicator captures households adopting integrated CSA packages rather than individual technologies. The successful adoption of Climate-Smart Agriculture depends not only on infrastructure and technology but also on farmers' knowledge, skills, and capacity to implement climate-resilient practices. Training and extension support enable farmers to adopt improved crop varieties, water-efficient irrigation, soil and nutrient management, climate information services, and sustainable agronomic practices. This indicator complements the previous indicator on area under CSA, as expanding climate-smart agriculture requires farmers to be equipped with the knowledge and technical assistance necessary for effective implementation. Capacity building for farmers is also identified as a priority under the Sindh NDC 3.0 Policy Recommendations, which emphasise technical assistance, demonstration activities, and field-level support to promote climate-resilient agriculture.

Baseline: There is currently no consolidated provincial database recording the number of farmers supported to adopt Climate-Smart Agriculture across Sindh. Therefore, the baseline is derived from verified beneficiaries of major ongoing programmes. Under the Sindh Water and Agriculture Transformation (SWAT) Project, 750 farmers have been trained in CSA practices through demonstration plots and replication activities. In addition, the GCF funded project, Transforming the Indus Basin with Climate Resilient Agriculture and Climate Smart Water Management, has provided training in advanced and climate-smart cultivation practices to 10,000 farmers across Sindh where they specifically learn low-

water cultivation, row planting, balanced fertilizer use, and zero-tillage methods. In 2024, the project established 77 Climate-Based Farmer Schools (CBFS) with 1,925 enrolled farmers, conducted 16 field days reaching 1,248 farmers, and delivered financial literacy sessions to 570 farmers to improve access to finance for adopting climate-resilient agriculture and on-farm water management practices. Together, these programmes provide a minimum verified baseline of 10,750 farmers supported in the adoption of CSA practices (GCF Project Report, 2025).

Target: As of 2021, approximately 90 percent of Pakistan's 7.4 million farmers are classified as smallholders, cultivating less than 5 hectares (12.5 acres) (IFAD, 2021). Smallholder farmers are particularly vulnerable to climate risks due to limited access to finance, technology, and extension services, making them the primary beneficiaries of CSA interventions. In line with the target of expanding Climate-Smart Agriculture to 50 percent of Sindh's cultivated land by 2035, this assessment recognises that large-scale farmer capacity-building will be essential. Accordingly, support to smallholder farmers is treated as a complementary implementation indicator for achieving the CSA area target rather than as an independent investment target.

Baseline	Target
10,750 farmers	To be determined through expansion of CSA to 50 percent of cultivated land

Costing Approach: This indicator is not independently costed. Under the SWAT Project, farmer training, demonstration plots, extension services, smart subsidies, technical assistance, and field-level support are delivered as an integrated Climate-Smart Agriculture package, rather than as standalone activities. Consequently, the costs associated with farmer capacity-building are already embedded within the per-acre implementation cost used for Indicator 1 (Area under Climate-Smart Agriculture). Estimating a separate investment requirement for farmer training would therefore risk double counting the same expenditure. Accordingly, this indicator is retained as a performance and implementation indicator to monitor the scale of farmer outreach and adoption, while the associated financial requirements are incorporated within the overall CSA investment estimate.

Investment Summary:

Indicator	Category	Baseline	Target	Gap	Unit Cost	Gross Investment Required
Area under Climate-smart Agriculture	Adaptation	0 acres (no documented provincial CSA coverage)	4.05 million acres (50 percent of cultivated land)	4.05 million acres	PKR 25,000/acre	US$361 million
Farmers supported to adopt CSA practices	Adaptation + Capacity building	10,750 farmers	Scaled in line with CSA expansion	-	Not separately costed	Costs embedded within CSA implementation
Total gross investment need						**US$361 million**

Note: The second indicator is retained as an implementation and monitoring indicator. Costs associated with farmer training, extension services, demonstration plots, technical assistance and smart subsidies are integrated within the per-acre Climate-Smart Agriculture investment estimate to avoid double counting.

Potential Financing Pathways and Existing Program Scale-up Opportunities

- **Scale-up of climate-smart agriculture:** Expand existing climate-smart agriculture programmes through a combination of smart subsidies, extension support and concessional finance, with particular attention to smallholders and climate-vulnerable production systems.

- **Climate-risk insurance:** Pilot index-based agricultural insurance for flood-, drought- and heat-exposed crops, supported by public risk-sharing and weather or remote-sensing data.

- **Integrated HEIS and solar irrigation:** Scale water-efficient irrigation alongside solar-powered pumping where technically and economically appropriate, linking farm-level efficiency improvements with lower energy costs and improved climate resilience.

Sector: Irrigation and Water Resources

Context: Sindh's agricultural economy depends almost entirely on irrigation, with over 90 percent of crop production reliant on the Indus Basin Irrigation System (IBIS), the largest contiguous irrigation network in the world. Climate change is intensifying water scarcity through rising temperatures, erratic monsoon rainfall, declining river flows and more frequent droughts; while recurring floods continue to damage irrigation infrastructure and reduce agricultural productivity. Waterlogging, salinity and groundwater depletion further constrain agricultural resilience, highlighting the need for sustained investment in efficient irrigation and integrated water resource management. Sindh's irrigation system supports over 14.1 million acres of cultivated land but is increasingly vulnerable to climate change through more frequent floods, prolonged droughts, waterlogging and salinity.

Irrigated agriculture is the backbone of Sindh’s rural economy - 77 percent of the net area sown in Sindh is irrigated - but low agricultural water productivity leads to inefficient use of limited water resources. Sindh is facing significant water scarcity problems, particularly during the summer months before the monsoon. Agricultural water use, which already accounts for around 90% of water withdrawals, is projected to significantly increase if current irrigation and cropping practices are not changed (Sindh Agriculture Policy, 2018). Furthermore, current agricultural water use is inefficient, and an estimated 60 to 75 percent of the water withdrawn lost either to surface water evaporation or seepage into saline groundwater (The Irrigation Management Strategy for Irrigated Agriculture of Sindh). Sindh’s multipurpose canal network depends entirely on the Indus River. It serves agricultural, industrial, urban, and rural users through three large barrages that divert approximately 48 million acre-feet (59 billion cubic meters of water), 90 percent of which is used to irrigate a gross command area of roughly 14.3 million acres (5.8 million hectares) (Sindh Irrigation and Drainage Authority, 2012). The Sindh NDC 3.0 Policy Recommendations identify rehabilitation of embankments, river training works, flood-water management, rainwater harvesting and construction of small and large reservoirs as priority adaptation measures. The NDC also notes that 685 water supply and drainage schemes have already been rehabilitated, demonstrating ongoing provincial investment but highlighting the need for further expansion.

Primary Indicator: Agricultural Drainage Infrastructure Rehabilitated
Category: Adaptation

Rationale: Agricultural drainage infrastructure comprises the network of surface drains, subsurface drains, associated hydraulic structures, and pumping systems that remove excess rainfall and irrigation water from agricultural land. Unlike irrigation canals and watercourses, which deliver water to farms, drainage systems evacuate excess water, reducing waterlogging, salinity, and crop losses while maintaining agricultural productivity.

The indicator aligns with Sindh's NDC 3.0 priority of improving irrigation and water management. It is selected as a proxy for irrigation system resilience because comprehensive provincial data on reservoir infrastructure are currently unavailable, whereas verified information exists for the province's drainage network and associated rehabilitation costs.

The importance of rehabilitating drainage infrastructure was further highlighted during the 2022 floods, when 234 drainage systems and approximately 7,300 km of irrigation canals were damaged, while around 90 flood protection structures were washed away, disrupting irrigation services and exposing agricultural land to prolonged flooding. These impacts underscore the need for sustained investment in resilient irrigation and drainage systems (World Bank, 2022).

Baseline: Sindh's agricultural drainage network consists of 13 surface drainage systems with an aggregate length of approximately 4,800 km, serving more than 6.2 million acres of agricultural land, together with two subsurface drainage systems serving an additional 0.1 million acres (SIDA & World Bank, 2006).

According to the SWAT project team, the drainage network requires continuous rehabilitation and maintenance because it is largely composed of earthen canals that deteriorate due to weathering, flooding, sedimentation, and other natural processes. The team estimates annual maintenance requirements of approximately PKR 5,987 million for drainage systems, including drains and saline and freshwater tube wells, in addition to annual operational costs for electromechanical equipment. Under the Sindh Flood Emergency Rehabilitation (SFER) Project by the World Bank, approximately **512 water supply and drainage schemes** have been rehabilitated across **11 districts** (World Bank, 2026). However, no consolidated provincial inventory reports the corresponding length (km) of drainage infrastructure rehabilitated. Consequently, the existing rehabilitation effort is acknowledged qualitatively, while the investment analysis adopts the full 4,800 km drainage network as the planning horizon for long-term rehabilitation by 2035.

Target: As no formal provincial rehabilitation target exists, this assessment adopts a planning scenario in which **the entire existing 4,800 km surface drainage network** is rehabilitated by **2035** to improve climate resilience, reduce waterlogging and salinity, and strengthen agricultural water management.

Baseline	Target	Gap
0 km rehabilitated*	4,800 km rehabilitated	4,800 km

Note*: The baseline reflects the absence of a consolidated provincial inventory of rehabilitated drainage infrastructure rather than the absence of the drainage network itself.

Unit Cost: The SWAT project team estimates that rehabilitation of agricultural drainage infrastructure typically costs between PKR 1.5 million and PKR 3.5 million per kilometre (approximately US$ 5,400–12,500 per km), depending on earthworks, reconstruction of hydraulic structures, and the size of the canal or drain.

Scenario	Unit Cost (US$/km)
Low	5,400
Central	8,950
High	12,500

Gross Investment Requirement:

Scenario	Investment Need
Low	**US$25.92 million**
Central	**US$42.96 million**
High	**US$60.0 million**

Rehabilitating Sindh's agricultural drainage infrastructure would require an estimated **US$42.96 million** under the central scenario.

Primary Indicator: Flood Embankments Rehabilitated
Category: Adaptation

Rationale: Flood embankments (also referred to as river bunds, loop bunds and extension bunds) are engineered earthen or reinforced barriers constructed along rivers to protect settlements, agricultural land, and critical infrastructure from riverine flooding. They are designed to prevent floodwaters from overtopping riverbanks and inundating surrounding areas. In Sindh, where agriculture, settlements, and transport infrastructure are concentrated along the Indus River, embankments form the first line of defence against increasingly frequent and intense flood events. Strengthening and rehabilitating these structures is therefore a critical climate adaptation investment that reduces disaster risk, protects livelihoods, and enhances long-term resilience to climate change. The indicator aligns with Sindh's NDC 3.0 objective of strengthening climate-resilient water infrastructure and flood management systems. Baseline: Sindh's flood protection network comprises approximately **875 miles (1,408 km)** of main river embankments and an additional **450 miles (724 km)** of loop and extension bunds, giving a total embankment network of approximately **2,132 km** (SWAT, 2026). These structures protect extensive agricultural areas, settlements, and infrastructure along the Indus River.

The 2022 floods highlighted the vulnerability of this infrastructure, with approximately **90 flood protection structures** reported as washed away or severely damaged. Rehabilitation efforts are already underway through provincial and development partner programmes. Under the World Bank-supported Sindh Flood Emergency Rehabilitation Project (SFERP), 201 km of embankments have been restored and reinforced using climate-resilient designs, protecting approximately 156,753 hectares of agricultural land and benefiting more than 3.61 million people, including 1.73 million women (World Bank, 2025). However, the Irrigation Department does not maintain a consolidated provincial inventory of embankments requiring rehabilitation, as strengthening works are generally undertaken on an emergency or need basis following flood events.

The 201 km reflects embankments rehabilitated under the SFERP and does not necessarily represent all rehabilitation undertaken province wide. It is therefore used as the minimum verified rehabilitation baseline available.

Target: As no provincial rehabilitation target exists, this assessment adopts a planning scenario whereby the entire existing flood embankment network (2,132 km) is rehabilitated to climate-resilient standards by 2035. This assumption is adopted solely for estimating long-term climate finance requirements and does not represent an official Government of Sindh target.

Baseline	Target	Gap
201 km rehabilitated	2,132 km rehabilitated	1,931 km

Unit Cost: The SWAT project team estimates the indicative cost of embankment rehabilitation at approximately **PKR 240 million per kilometre** of bund rehabilitation (SWAT, 2026). This equivalent to approximately **US$0.86 million per kilometre**. As this estimate is provided directly by relevant project teams, a single unit cost is adopted rather than developing low, central, and high scenarios.

Gross Investment Requirement = 1,931 km × US$0.86 million/km **= US$1.66 billion**
Rehabilitating the remaining flood embankment network is estimated to require approximately **US$1.66 billion**.

Primary Indicator: Area under High-Efficiency Irrigation Systems (HEIS)
Category: Adaptation

Rationale: High-Efficiency Irrigation Systems (HEIS), including drip and sprinkler irrigation technologies, improve water-use efficiency by delivering water directly to crops while reducing evaporation, seepage, and runoff losses. As agriculture accounts for the overwhelming majority of freshwater withdrawals in Sindh, expanding HEIS is one of the most effective adaptation measures for addressing increasing water scarcity, drought, and climate variability. Beyond reducing irrigation water demand, HEIS also improves crop productivity, lowers energy consumption for pumping, and strengthens the resilience of farming systems. HEIS is costed separately as a dedicated irrigation-infrastructure intervention. Its investment requirement may overlap with land receiving broader CSA support, since efficient irrigation can form part of the CSA package; the two indicators should therefore not be interpreted as mutually exclusive areas.

Baseline: Under the Sindh Irrigated Agriculture Productivity Enhancement Project (SIAPEP), High-Efficiency Irrigation Systems have been installed across 4,934 hectares. The programme has additionally supported 707 farmers with HEIS installations (approximately 9 percent women beneficiaries), provided 15,100 households with HEIS-supported kitchen gardens, and established 48 demonstration farms to showcase water-efficient irrigation technologies.

Despite these achievements, adoption remains extremely limited. Nationally, high-efficiency irrigation systems cover only around 0.1 percent of Pakistan's irrigated agricultural area, reflecting barriers such as high upfront investment costs, maintenance requirements, and concerns regarding theft of irrigation equipment (Dawn, 2024).
Note: *No* consolidated *provincial inventory of efficient irrigation systems currently exists. The baseline is*

derived from documented implementation under SIAPEP and therefore represents a conservative minimum estimate.

Target: According to the Pakistan Agricultural Census 2024, Sindh has approximately 8.11 million acres of cultivated land, of which around 77 percent is irrigated, equivalent to approximately 6.24 million acres (2.53 million hectares).

As no provincial HEIS adoption target exists beyond current programmes, this assessment adopts a planning target of expanding HEIS coverage to 30 percent of irrigated agricultural land by 2035, equivalent to approximately 756,700 hectares. This represents an ambitious but achievable long-term adoption pathway for estimating climate finance needs and does not constitute an official Government of Sindh target.

Gap Analysis

Baseline	Target	Gap
4,934 ha	756,700 ha	751,766 ha

Unit Cost: Based on SIAPEP implementation costs approved in 2015, the estimated cost of installing HEIS is approximately **PKR 285,753 per acre** including storage tanks, irrigation equipment, pipelines, fittings, and associated accessories.

This is equivalent to approximately: **PKR 706,000 per hectare**
≈ US$2,540 per hectare (using PKR 278/US$)

751,766 ha × US$2,540/ha = US$1.91 billion

Achieving the proposed target would require approximately **US$1.91 billion** in adaptation investment, primarily for installation of efficient irrigation systems, supporting infrastructure and farmer adoption.

Investment Summary

Indicator	Category	Baseline	Target	Gap	Unit Cost	Gross Investment Required
Agricultural Drainage Infrastructure Rehabilitated	Adaptation	0 km rehabilitated*	4,800 km rehabilitated	4,800 km	US$8,950/km	US$42.9 million
Flood Embankments Rehabilitated	Adaptation	201 km rehabilitated	2,132 km rehabilitated	1,931 km	US$0.86 mil/km	US$1.66 billion
Area under HEIS	Adaptation	4,934 ha	756,700 ha	751,766 ha	US$2540/ha	US$1.91 billion
Total gross investment need						**US$3.61**

	billion

Potential Financing Pathways and Existing Program Scale-up Opportunities

- Climate-resilient irrigation and drainage programme: Prioritise rehabilitation and upgrading of irrigation, drainage and water-management infrastructure in areas exposed to waterlogging, salinity and flood risk, building on existing programmes and identified infrastructure gaps.
- Flood protection and embankment resilience: Develop a multi-year pipeline for rehabilitation and climate-resilient upgrading of priority flood embankments, shifting from primarily post-disaster repair towards planned risk reduction.
- Multi-hazard early warning and anticipatory action: Strengthen hydrometeorological monitoring, early-warning dissemination and pre-arranged financing for early action in flood-, drought- and heat-prone districts.

Sector: Environment and Coastal Sector

Context: The Indus Delta is a major ecological and economic asset for Sindh. It covers approximately 600,000 hectares, extends along roughly 250 km of coastline, and contains 17 major creeks, numerous smaller creeks and extensive mudflats. The delta supports approximately 129,000 hectares of mangrove forests, making it one of Pakistan's most important coastal ecosystems (WWF, 2021).

Mangroves provide both significant ecological and economic benefits. They serve as breeding and nursery grounds for commercially important fish, shrimp, lobster and crab species. According to the Sindh Forest Department, these fisheries generate approximately US$100 million in annual export earnings and provide employment and livelihoods to more than 100,000 people associated with the fishing industry. Mangroves therefore function not only as a climate adaptation asset but also as an important source of coastal livelihoods and foreign-exchange earnings. However, the ecosystem remains under significant pressure. Mangroves in the Indus Delta are threatened by reduced freshwater flows downstream of Kotri Barrage, pollution, deforestation, overfishing, urbanisation, sea-level rise and climate change.

At the same time, more recent interventions demonstrate that mangrove cover can be restored and expanded. WWF-Pakistan reports that mangrove cover in the Indus Delta increased from approximately 86,000 hectares in 2005 to more than 130,000 hectares in 2021, reflecting sustained efforts by government agencies, NGOs and private-sector actors. WWF also reports that approximately 14,000 hectares were rehabilitated through various projects over the preceding decade, including more than 3,000 hectares under its own restoration programme.

The scale of current interventions is further demonstrated by the Delta Blue Carbon Project, a public-private initiative involving Indus Delta Capital Ltd. and the Government of Sindh's Forest Department. According to the project's monitoring information, the project encompasses 350,000 hectares under conservation and aims to restore/plant approximately 220,000 hectares of mangroves over its 60-year lifetime. The project estimates that its activities will generate 128.5 million carbon credits and sequester approximately 142 million tonnes of CO_2 over its lifetime. Its activities currently benefit approximately 42,000 people in 60 coastal villages, while the project values non-carbon benefits to local communities at approximately US$134 per tonne of CO_2-equivalent. The project area also contains 11 species listed as vulnerable or threatened on the IUCN Red List (Delta Blue Carbon Project).

Recognising this potential, the Government of Sindh has also designated the Environment, Climate Change and Coastal Development Department as the lead authority for implementing carbon market initiatives under Article 6 of the Paris Agreement and developed a Directorate of Climate Change and Carbon Finance under this department.

To estimate climate finance needs, the analysis focuses on one priority indicator representing direct adaptation (and mitigation) investments.

Primary Indicator: Area under mangrove plantation
Category: Adaptation + Mitigation

Rationale: Mangrove plantation is a nature-based adaptation measure that can reduce exposure to coastal erosion, storm surges, cyclones and sea-level rise while protecting fisheries and coastal livelihoods. It also provides significant carbon-sequestration and blue-carbon benefits, creating potential access to mitigation and carbon-market finance.

Baseline: For this indicator, the baseline measures cumulative area that has actually been planted/afforested, rather than the total area of naturally existing mangrove forest. This distinction is important because existing mangrove forests represent an ecosystem asset, whereas the indicator is intended to capture the scale of plantation investment already undertaken and the additional area requiring investment.

The Delta Blue Carbon monitoring data reports 108,024 hectares of mangroves planted, while the World Bank-funded Pakistan Hydromet and Climate Services Project implemented through NDRMF completed afforestation of 55,000 acres (22,258 hectares) of blank and de-vegetated mangrove areas in the Indus Delta.

Baseline = 108,024 ha + 22,258 ha = 130,282 ha
2024 baseline: 130,282 hectares of mangrove area planted/afforested

The baseline deliberately excludes the approximately 125,000 hectares of existing protected mangrove forests, because these represent existing forest rather than plantation investment. This distinction also avoids conflating existing ecosystem extent, protected forest and newly planted area, which are different measures.

Target: Since no consolidated provincial 2035 plantation target exists, and project-specific targets such as Delta Blue Carbon's 220,000-ha lifetime target extend over a 60-year period, the assessment adopts a planning target of 200,000 hectares by 2035.

The target represents a 53.5 percent increase over the documented plantation baseline and requires an average of approximately 7,700 additional hectares per year through 2035. It should be treated as a planning assumption for climate-finance estimation rather than an officially adopted provincial target.

Baseline planted area	2035 planning target	Additional plantation required
130,282 ha	200,000 ha restored and planted	**69,718 ha**

Unit Cost: A Sindh-specific plantation cost could not be established from the reviewed project documentation. The assessment therefore applies the global evidence from Goto et al. (2025), which draws on nearly 250 mangrove restoration projects and estimates a global median implementation cost of US$8,143 per hectare. The study finds substantial variation in costs depending on site conditions and restoration requirements.

Rather than treating the global median as a precise Sindh cost, the assessment uses it as the central planning estimate and applies a low/high range to reflect uncertainty.

Scenario	Unit Cost/ha	Basis
Low	US$6,000	Lower-cost implementation conditions
Central	US$8,143	Global median
High	US$12,000	Higher-cost sites requiring more intensive implementation

Gross Investment Requirement

Scenario	Investment Need
Low	**US$418.3 million**
Central	**US$567.7 million**
High	**US$836.6 million**

Thus, the estimated gross investment requirement is approximately US$568 million under the central scenario, with a planning range of approximately US$418–837 million.

Note: The estimate should be refined through site-specific costing because mangrove plantation costs vary substantially according to hydrology, site condition, accessibility, nursery requirements, labour, community engagement and post-planting maintenance. The global benchmark is therefore used because a sufficiently robust Sindh-specific unit cost was not available, rather than applying an unsupported localisation factor.

Potential Financing Pathways and Existing Program Scale-up Opportunities

- Integrated mangrove restoration and coastal resilience: Scale mangrove restoration and protection in degraded coastal areas while supporting community-based conservation, nursery development and coastal livelihoods. Carbon revenues could provide a complementary financing stream where verified revenues are available.
- Mangrove protection + community livelihoods**:** Combine mangrove plantation with community-based protection, nursery development and livelihood activities, particularly for coastal households and women engaged in mangrove-related enterprises.

Urban and Transport Sector:

- Urban drainage and flood-resilience programme**:** Develop priority drainage rehabilitation and retention infrastructure for flood-prone urban areas, combining conventional drainage upgrades with nature-based solutions.
- Wastewater treatment and reuse**:** Develop decentralised wastewater treatment/reuse schemes for major urban and peri-urban areas, with potential climate and water-security co-benefits.
- Urban green infrastructure**:** Establish green corridors, urban forests and heat-reduction interventions in high-heat neighbourhoods, potentially combining municipal finance with carbon-market or results-based financing where the methodology supports it.
- Energy-efficient public infrastructure: Solar-street lighting, efficient public buildings and municipal solar systems could be packaged as smaller blended-finance projects rather than treated as standalone infrastructure investments.
- Electric public transport / EV transition: Develop a phased financing facility for electric buses and supporting charging infrastructure in Karachi and other major urban centres, combining concessional finance with municipal/private-sector participation.
- Climate-resilient transport corridors: Upgrade priority roads and transport links exposed to flooding and extreme heat using climate-resilient design standards.

Section 6: Existing Finance Landscape

Sindh has already attracted a range of climate-relevant financing linked to the indicators assessed in this study, including international development finance and provincial support for decentralised solar. However, these flows remain limited relative to the investment requirements identified for 2035. The main identified financing flows relevant to the selected indicators are outlined below.

Table 6: Major existing and committed financing flows

Funding Agency	Programme	Sector	Instrument	Pillars	Value (US$)	Status
World Bank (96.5 percent) and Govt of Sindh (3.43 percent)	Sindh Solar Energy Project (SSEP)	Energy	Grant	Mitigation; Renewable energy	100 million	2019-ongoing
Govt of Sindh	Solar Home Systems (SHS) Distribution Programme	Solar Energy	Public subsidy/distribution	Mitigation; Renewable energy	34 million	2024-ongoing
Core International Inc (USA)	200 mw solar and 100 mw wind power project in Jamshoro-Thatta region	Solar energy	Grant	Mitigation; Renewable energy	12.25 thousand	2016
International Finance Corporation (IFC), World Bank	Sapphire -Tricon Wind Power Project	Wind energy	Grant	Mitigation; Renewable energy	66 million	2017
US AID	PPSE	Renewable Energy	Private sector investment		8 million	2021-2024
State Bank	Financing Scheme for RE	Renewable Energy	Concessional financing (2	Renewable energy	Not applicab	2016-ongoing

Funding Agency	Programme	Sector	Instrument	Pillars	Value (US$)	Status
			percent interest rate)	investment	le	
World Bank (91.2 percent) and Govt of Sindh (8.8 percent)	Sindh Water & Agriculture Transformation (SWAT)	Agriculture + Irrigation	Loan	Agricultural water productivity Restoring crop production Promoting climate-smart agriculture	320 million	2022-ongoing
World Bank	Sindh Resilience Project (SRP)	Agriculture + Irrigation	Loan	Construction of rainwater-fed recharge dams Disaster preparedness	120 million	2016-2022
World Bank	Sindh Agriculture Growth Project (SAGP)	Agriculture	Loan	Capacity building Strategic planning for the agricultural sector Modernisation of services	88.7 million	2014-2019
World Bank	Sindh Irrigated Agriculture Productivity Enhancement Programme (SIAPEP)	Agriculture + Irrigation	Loan	Community water infrastructure High Efficiency Irrigation Systems Improved agricultural practices	242.2 million	2015-2023
Germany	Promoting Socio-Political Engagement of Smallholder Farmers and More Sustainable Agriculture in Khairpur, Sindh, Pakistan	Agriculture	Loan	Sustainable agricultural practices	135.6 thousand	2022 - ongoing
Global Environmental Facility (GEF)	Sustainable Land Management Programme to Combat Desertification in Pakistan	Agriculture	Grant	Promotion of arid agriculture and water resource management	20.4 million	2013-2018
Green Climate Fund (GCF)	Transforming the Indus Basin with Climate Resilient	Agriculture	Grant	Promoting climate-smart agriculture,	Approx. 47 million	2019-ongoing

Funding Agency	Programme	Sector	Instrument	Pillars	Value (US$)	Status
	Agriculture and Climate Smart Water Management			farmer capacity building and on-farm resilience		
World Bank	Sindh Water Sector Improvement Project Phase I (SWSIP)	Irrigation	Loan	Improvement of irrigation water distribution	175 million	2007-2019
Asian Development Bank (ADB)	National Disaster Risk Management Fund (NDRMF)	Irrigation	Loan	Disaster risk management Disaster financing	200 million	2019
World Bank	Sindh Flood Emergency Rehabilitation Project (SFERP)	Irrigation	Loan	Rehabilitation of Irrigation and Flood Control Infrastructure Livelihoods support Strengthening government capacity	650 million	2022-ongoing
Germany	Supporting Communities for Flood Rehabilitation, Sindh, Pakistan	Irrigation	Loan	Flood rehabilitation Community support	427 thousand	2022
Delta + Government of Sindh	Delta Blue Carbon	Environment and Coastal Protection	Public private partnership	Adaptation + Mitigation; Large scale mangrove plantation; Coastal resilience; Blue carbon	Not publicly disclosed	2015-2075
International Union for Conservation of Nature (IUCN) /WWF	Mangrove Conservation, Replanting and Sustainable Management	Environment and Coastal Protection	Grant	Ecosystem restoration; Coastal resilience; Community-based conservation	2965 thousand	Project based
NDRMF under World Bank funded project	Restoration of Riverine, Inland, Dry-land & Urban Ecosystems of Sindh Province	Environment and Coastal Protection	Grant	Restoration and afforestation Improvement of ecosystem Livelihood improvement	7.6 million	2021-2024
United Nations Environment Program (UNEP)	Green Pakistan Program -Ten Billion Trees Tsunami	Environment and Coastal Protection	Grant	Adaptation + Mitigation; Afforestation;	10.86 million	2019-2024

Funding Agency	Programme	Sector	Instrument	Pillars	Value (US$)	Status
and MOCC, GoP	Program, Phase I			Ecosystem restoration; Carbon sequestration		
ADB + GCF	Sindh Coastal Resilience Project	Environment and Coastal Protection	Grant	Adaptation + Mitigation: Agriculture, natural resources and rural development for coastal protection and resilience	154 million	2025-Ongoing

Sources: Green Climate Fund, World Bank, Global Environmental Facility, Sindh Forest Department, CPEC Secretariat, State Bank, US AID, State of Industry Report 2025

Table-6 summarises major existing and committed financing flows that are directly relevant to the climate investment indicators identified in this paper. The table focuses on programmes with a clear connection to Sindh's priority needs in renewable energy, climate-smart agriculture, water and irrigation management, disaster resilience, and coastal and ecosystem restoration. Where financing values were not available from the identified sources, these are reported as not available rather than estimated. The table therefore represents a portfolio of relevant financing flows rather than a comprehensive accounting of all climate finance entering Sindh.

Indicative Climate Finance Gap

Existing finance is deducted at the **sector level** rather than allocated across individual technologies for example, most renewable energy programmes (e.g., the Sindh Solar Energy Project) support multiple activities, including utility-scale generation, distributed solar access and enabling infrastructure, and do not report technology-specific financial allocations. Therefore, finance flows are aggregated and deducted from total sectoral investment requirements for all sectors.

The analysis distinguishes between the *investment requirement* associated with achieving the identified 2035 sectoral targets and the *existing climate finance flows* supporting Sindh. Existing investments are not mechanically deducted from the indicative investment requirement. This is because the baseline values used to establish each indicator already incorporate infrastructure, beneficiaries, areas or other outputs achieved through ongoing and completed programmes. Deducting the full value of existing project financing from the resulting investment requirement would therefore risk double-counting existing investments, particularly where projects are multi-sectoral or finance multiple indicators simultaneously.

Instead, existing climate relevant financing flows are mapped separately to demonstrate the current financing landscape, identify areas already receiving support, and assess the extent to which existing programmes contribute toward the identified sectoral priorities. The resulting investment figures therefore represent the **additional indicative investment associated with achieving the defined 2035 targets from the established baseline,** rather than a residual financing gap obtained by subtracting all

existing climate finance from total investment needs. It is also important to note that the finance mapping covers projects with a substantive climate relevance regardless of the year in which they were initiated. This should not be interpreted as meaning that all projects were formally classified through Pakistan's climate budget-tagging system, which was introduced subsequently.

This approach also recognises that the identified investment requirement may be met through a combination of international climate finance, domestic public expenditure, development finance, private investment, blended finance and other financing mechanisms. The analysis therefore does not assume that the entire requirement must be financed through international climate funds.

Investment Summary

Table 7: Summary of Required Indicative Investment

Sector	Indicator	Indicative Investment Required (US$)
Energy	Installed utility-scale renewable energy capacity (Solar + Wind)	1.61 billion
	Decentralized solar access to rural/off-grid households	280.8 million
	Total	1.89 billion
Agriculture	Area under Climate-smart Agriculture (CSA)	361 million
	Farmers equipped to adopt CSA	
	Total	361 million
Water and Irrigation	Agricultural drainage infrastructure rehabilitated	42.96 million
	Flood embankments rehabilitated	1.66 billion
	Area under High-Efficiency Irrigation Systems (HEIS)	1.91 billion
	Total	3.61 billion
Environment and Coastal	Area under mangrove plantation	568 million

Potential Financing Pathways and Pipeline

Sindh has several existing and emerging financing opportunities that could help translate the identified investment needs into actual climate finance. These include projects already under implementation or preparation, provincial co-financing mechanisms, private-sector investment, and carbon-market opportunities.

1. Flood resilience and resilient infrastructure

The Government of Sindh has estimated a requirement of approximately US$966 million to restore critical flood protection infrastructure and road networks to pre-flood levels, with additional resources required where infrastructure is reconstructed to higher, climate-resilient standards (World Bank, 2025). The ongoing Sindh Flood Emergency Rehabilitation Project (SFERP) also provides an important financing channel for this sector, with an additional US$150 million World Bank credit approved under the project's additional financing. These resources provide a potential pathway for financing flood embankment rehabilitation, drainage and other resilient infrastructure, although the extent to which the financing corresponds directly to the investment requirements identified in this paper would need to be established project by project.

2. Private-sector investment in renewable energy
Sindh is also beginning to create opportunities for private investment in renewable energy. The Government of Sindh has allocated 300 acres of land in Jhimpir to Moro Power Company (MPC) for a proposed 100 MW hybrid wind-solar project, described as the province's first business-to-business (B2B) electricity venture under its own provincial regulatory framework (Dawn, 2025). Such initiatives demonstrate the potential for private capital to contribute to Sindh's renewable-energy transition, reducing the extent to which utility-scale renewable investment needs must be financed entirely through public or concessional climate finance.

3. Blended financing for high-efficiency irrigation
The existing financing model for High-Efficiency Irrigation Systems (HEIS) provides a useful example of how public and private finance can be combined to overcome adoption barriers. The Government of Sindh provides a 60 percent capital subsidy**,** while farmers contribute the remaining 40 percent. Financial institutions such as MCB Bank can finance up to 80 percent of the farmer's contribution, allowing farmers to access HEIS without bearing the full upfront cost. This type of blended financing could be expanded to increase adoption of water-efficient irrigation technologies, particularly where high upfront costs and maintenance expenses discourage farmers from investing in HEIS.

4. Carbon and private finance for mangrove plantations
Sindh's existing programmes demonstrate the feasibility of mobilising finance at scale for mangrove plantation. The Pakistan Hydromet and Climate Services Project, implemented through the National Disaster Risk Management Fund, included afforestation of blank and de-vegetated mangrove areas across 22,258 hectares in the Indus Delta. At a much larger scale, Delta Blue Carbon demonstrates the potential of combining mangrove plantation, ecosystem conservation and carbon-market finance. Its long-term carbon-credit potential provides a basis for attracting private and results-based finance alongside public climate finance.

Sindh is increasingly positioning carbon markets as a source of private climate finance, particularly through mangrove restoration. The Delta Blue Carbon programme has already generated US$40 million from the sale of 3.1 million carbon credits, while its expanded projects are projected to generate substantial additional carbon revenues. The Sindh government has also promoted large-scale mangrove plantation as a means of attracting private investment alongside climate and coastal-resilience benefits (Arab News, 2023).

For Sindh, carbon finance can therefore complement public climate finance by funding investments that simultaneously support coastal protection, livelihoods, biodiversity and carbon removal. However, projected carbon revenues should not be treated as guaranteed finance: they depend on carbon prices, verification and future market demand. Carbon-market revenues should nevertheless be treated as a **potential future financing stream rather than guaranteed funding.** Expected carbon revenues should not be deducted from the gross investment requirement unless there is sufficient evidence regarding credit issuance, price assumptions, revenue allocation and the timing and certainty of those revenues. This is particularly important when using carbon finance to support long-term restoration investments.

5. Leveraging existing financing structures
These examples suggest that Sindh's financing strategy should not rely on a single source of climate finance. Instead, different investment needs can be matched with the financing instruments most appropriate to them: concessional public finance for flood protection and drainage; blended finance and

commercial lending for agricultural technologies; private investment for renewable energy; and carbon or results-based finance for ecosystem restoration and other interventions with measurable mitigation outcomes.

Section 7. Recommendations

Scale and de-risk climate-smart agriculture

Scale smart subsidies for climate-smart agriculture (CSA). Existing subsidy and cost-sharing mechanisms should be expanded to reduce the upfront cost of adopting water-efficient and climate-resilient technologies, particularly for small and resource-constrained farmers.

Expand agricultural extension and farmer awareness. Greater investment is needed in extension services, demonstration plots, farmer field schools and locally appropriate information to increase awareness of CSA practices and address farmers' concerns around costs, risks and uncertain returns.

Develop agricultural risk-financing mechanisms. Index-based crop insurance and other weather- and climate-linked insurance products should be piloted and scaled. Forecast-based financing should also be explored to release funds before anticipated extreme events, enabling farmers and local institutions to undertake early preparedness rather than relying primarily on post-disaster assistance.

Integrate solar energy into agricultural water management. HEIS and agricultural pumping should be linked with solar and other renewable-energy systems to reduce operating costs and improve the long-term viability of efficient irrigation.

Build a stronger provincial climate-finance system

Improve access to and autonomy over climate finance. Sindh needs simpler and more predictable pathways for accessing climate finance, alongside greater provincial capacity to identify, prioritise and implement projects. The developing Sindh Climate Change Fund provides an emerging institutional mechanism for mobilising and directing climate resources; its effectiveness will depend on clear governance, transparent allocation and adequate technical capacity.

Develop sustained and coordinated adaptation finance. Existing financing remains fragmented across departments, projects and funding cycles. Sindh should maintain a consolidated pipeline of priority adaptation investments that can be taken systematically to the GCF, MDBs, bilateral partners and other financing institutions.

Strengthen co-financing arrangements. Project design should account for Sindh's capacity to provide counterpart financing and avoid unrealistic co-financing requirements that can disrupt implementation, staffing and achievement of targets.

Build government capacity for climate finance. Dedicated technical training should be provided to provincial and district officials on project preparation, climate-fund requirements, financial structuring, safeguards, procurement, carbon markets, MRV and results frameworks. This should move beyond one-off workshops towards a sustained institutional capacity-building programme.

Strengthen climate finance tracking, MRV and decision-making

Establish a provincial climate-finance MRV system to track finance received and spent, project outputs, beneficiaries and climate outcomes across departments and programmes.

Mainstream climate risk into development planning so that resilience is incorporated into infrastructure, agriculture, water, energy and urban planning from the outset.

Strengthen and regulate carbon-market finance

Develop a clear Sindh carbon-market framework. Sindh is developing a growing pipeline of carbon-finance and carbon-trading initiatives, but projects currently operate within Pakistan's federal carbon-market framework rather than a comprehensive set of Sindh-specific procedures.

Expand carbon and results-based finance. Carbon finance should be pursued particularly for mangrove and riverine forestation, renewable energy, waste management and other interventions with measurable mitigation outcomes. Sindh is already exploring carbon finance for its Solar Home Systems programme, including project registration, MRV, verification and monetisation of credits.

Ensure carbon revenues support adaptation and local benefits. Carbon finance should complement, rather than substitute for, public adaptation finance. Revenue-sharing arrangements should ensure that communities and ecosystems generating carbon benefits receive appropriate long-term benefits.

Reframe the climate-action narrative

Pakistan's low contribution to global emissions remains an important **climate-justice argument**, but it should not become the dominant framing of climate action. Low historical emissions do not remove the responsibility to reduce emissions domestically or improve the environmental quality of development.

For Sindh, climate policy should therefore connect **adaptation, mitigation and development** rather than treating them as competing agendas. Renewable energy, for example, should be framed not only as a response to climate change but also in terms of energy access, affordability, energy security, jobs and consumer benefits. Similarly, Karachi's continued expansion of carbon-intensive, car-oriented and concrete-heavy urban development demonstrates the need to integrate climate considerations into land use, transport, housing, waste and infrastructure decisions. Climate responsibility exists across government, corporations and households, alongside the need for international support for adaptation and loss and damage.

Put vulnerable communities at the centre of climate-finance decisions

Climate-finance decisions should incorporate the lived experiences and priorities of coastal communities, smallholder farmers, women, low-income urban residents and climate-affected migrants. Participation should inform project design, implementation and monitoring, particularly where adaptation could otherwise shift risks rather than reduce them.

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About PIDC

Partners in Development and Consultancy (PIDC) is a Pakistan-based research and development consultancy working to advance evidence-driven, inclusive, and climate-resilient policy across the country, with a core presence in Karachi.

PIDC conducts multi-disciplinary research and policy analysis; designs and manages development programs from concept note through evaluation; builds institutional and human capacity for public, private, and civil-society partners; and implements innovative, donor-funded initiatives focused on poverty reduction, gender equality, youth leadership, and climate resilience.

This working paper was prepared as part of PIDC's ongoing engagement on energy governance and climate finance in Sindh, undertaken in consultation with provincial institutions, regulators, and civil society.

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