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Bridging Pakistan's Adaptation Financing Gap:

Developing Evidence-Based Climate Adaptation and Resilience Solutions

NOVEMBER 2024

Acknowledgements

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ABOUT GROWTH GATEWAY

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Growth Gateway is delivered by a joint public-private sector team from the UK Foreign Development and Commonwealth Office and the Department for Business and Trade, and the Boston Consulting Group-led consortium with Invest Africa, PA Consulting and Tetra Tech.

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Message from Federal Planning Minister

MESSAGE FROM FEDERAL PLANNING MINISTER

Guided by the 4RF (Resilient Recovery, Rehabilitation and Reconstruction Framework) and the 5Es Framework (Exports, Energy, Environment, E-Pakistan, and Equity & Empowerment), the Ministry of Planning, Development and Special Initiatives (MoPDSI) is undertaking a systematic review to mobilise more and better climate finance and private capital to build Pakistan's climate resilience. Together with the Ministry of Climate Change, are leading the development of the National Climate Finance Strategy . Our ministry is also leading the charge in climate finance with the Sustainable Finance Bureau (SFB) Project, which aims to transform the Public Sector Development Program to mobilise climate finance.

This FCDO study fills a critical knowledge gap.
It quantifies the cost of climate inaction and will help MoPDSI to prioritise adaptation and resilience actions based on social economic value and feasibility. Pakistan's federal and provincial governments, as well as the country's most at risk districts, all need to urgently adopt robust adaptation plans, based on data and analytics that quantify the cost of inaction and offer a quantified portfolio against which to mobilise finance and action to protect people, economies, and ecosystems. Evidence suggests that investment in adaptation and resilience solutions is around 15-20% of the projected future economic impact – acting now by investing in adaptation solutions will cost far less than the cost of climate inaction.

MoPDSI looks forward to integrating adaptation and resilience impacts and benefits into future investment decision-making, as well as embedding this analysis in the development of the National Climate Finance Strategy. We are also excited to take forward this workstream and collaborate with the UK Government on the key next steps identified by this project – putting this analysis into immediate action to build Pakistan's resilience.

PROFESSOR AHSAN IQBAL
Federal Minister

Ministry of Planning,
Development and Special Initiatives

Message from Chairman National Disaster Risk Management Fund

MESSAGE FROM CHAIRMAN NATIONAL DISASTER RISK MANAGEMENT FUND

Pakistan is a nation of diverse landscapes and climates. It is the world's 5th most populous country and is projected to be the fourth most populous nation by 2030. NDRMF has positioned itself as Pakistan's national investment fund for resilience building against disasters and long-term and adverse impacts of climate change. Its evolution is based on a track record of successful projects in a broad range of disaster risk reduction, disaster risk financing, and climate impact areas.

It is crucial to note that disaster and climate change risks are not gender neutral and affect women and girls disproportionately due to pre-existing socio-economic vulnerabilities. This report reinforces these findings. And while many of the conclusions of this work are quantitative, we must also be mindful of the less-quantifiable impacts of climate change on society.

We have seen that during periods of drought and heavy rainfall, women, as farmers, work harder to provide income and resources for their families. This puts additional pressure on girls to drop out of school to help their mothers cope with the increased burden of supporting the family. A lack of education also makes women more dependent on their families and communities and less employable. Women are more likely to stay on the land and tend to crops and livestock. They may have fewer opportunities to move away from the place they were born. They are therefore more vulnerable when sudden climate disasters occur. The need for gender inclusive disaster risk reduction and climate resilience action in Pakistan is critical at both the community and national levels.

Another conclusion of this report is the importance of leveraging the role of the private sector in building resilience. Given its proven institutional advantages and potential for high impact project interventions of NDRMF, I believe that it can provide an important investment vehicle to mobilise private sector capital.

It is clear from this project that the high vulnerability of much of Pakistan's population exacerbates the socio-economic impacts of climate induced disasters. This underscores the need to reduce vulnerabilities, strengthen Pakistan's climate resilience. NDRMF is very well positioned to continue to support this. I give my best wishes to the FCDO and NDRMF team for their efforts .

DR. MUHAMMAD JEHANZEB KHAN
Chairman

National Disaster
Risk Management Fund

NDRMF

Foreword

Pakistan's contribution to climate change has been negligible to date, and yet i t was the 8th most impacted country by climate-related disasters over the last two decades . Pakistan is also the 146th country least ready for climate impacts . I have seen across Pakistan communities which are unable to withstand repeated shocks, whose lives and livelihoods have been laid waste by climate-related disasters . These dangers are no longer distant risks. Real action is required now to build resilience for the people of Pakistan. The cost of inaction is far greater than the cost of prevention.

In November 2023, the UK-funded "Accelerating Green and Climate Resilient Financing in Pakistan" gave a clear diagnosis of the scale of Pakistan's financing problem and found two important conclusions. First, that despite Pakistan's severe climate vulnerabilities, there remains a significant adaptation and resilience financing gap - spend is only 6% of annual required funding. Second, that Pakistan can look to mobilise far more climate investment from the private sector. Our estimates suggest that Pakistan is only mobilising USD 4 billion in climate finance per tracked year, of which just 5% was domestic private finance.

This latest project has been delivered through our British Investment Partnerships 'Growth Gateway' programme . We have attempted to quantify the cost of climate inaction and prioritise adaptation and resilience actions based on social economic value and feasibility.

The figures do not make easy reading. By 2050, rice and cotton crop yields could fall by up to 50%, vast swathes of Pakistan are likely to become inhospitable for buffalo and cattle, and hundreds of millions of Pakistanis will be displaced.

What this work also shows are the opportunities we can take now to reduce these future impacts. This project has identified a large subset of priority and 'no-regret' resilience actions where commercial investment opportunities exist for public and private sectors. Alongside the Multilateral Development Banks, I believe the UK is well placed to work with and through our partners, including British International Investment, the Private Infrastructure Development Group, and the UK Centres of Expertise, to mobilise private investment for climate adaptation in Pakistan .

I hope that this project will contribute meaningfully to the implementation of Pakistan's National Adaptation Plan (NAP). Pakistan's federal government, provinces and districts will all need to come together through a whole of government approach to implement the NAP and, with support from the private sector, take forward the priority adaptation and resilience actions from this project. I give my special thanks to the Government of Pakistan and the Project Steering Committee members for stewarding this project to support Pakistan's future climate resilience.

JANE MARRIOTT
UK High Commissioner to Pakistan

British High
Commission Islamabad

UK International Development
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1. Global Climate Risk Index, average 2000-2019
2. ND Gain Index 2021

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List of Acronyms

A&R	Adaptation and Resilience
ADB	Asian Development Bank
BCG	Boston Consulting Group
CAPEX	Capital Expenditure
CID	Climate Impact Driver
COI	Cost of Inaction
GDP	Gross Domestic Product
GHG	Greenhouse Gas
GoP	Government of Pakistan
HEIS	High Efficiency Irrigation Systems
KP	Khyber Pakhtunkhwa
KPI	Key Performance Indicator
MoCC	Ministry of Climate Change
MoPDSI	Ministry of Planning, Development and Special Initiatives
NAP	National Adaptation Plan
NDRMF	National Disaster and Risk Management Fund
PCM	Phase Change Material
PDMA	Provincial Disaster Management Authority
R&D	Research and Development
RFID	Radio Frequency Identification
SIFC	Special Investment Facilitation Council
SLR	Sea Level Rise
SSP	Shared Socioeconomic Pathway
WRAP	Water Resource Accountability in Pakistan (FCDO Programme)

Glossary of Terms

Cost of Inaction: The estimated cost a country will incur from upcoming climate risks, should no action or intervention take place. In other terms, these calculations are based on an 'as is' baseline scenario, which does not factor in any adaptation and resilience actions.

Climate Impact Driver: Physical climate condition or climate risks that directly affects society or ecosystems.

Adaptation & Resilience: Changes in processes, practices, and structures to moderate potential damages or to benefit from opportunities associated with climate change.

Mitigation: Efforts to reduce or prevent emission of greenhouse gases by using new technologies and renewable energies, making older equipment more energy efficient, or changing management practices or consumer behaviour.

Shared Socioeconomic Pathway Scenarios: Climate change scenarios used to project and analyse the effects of socioeconomic factors on global changes up to 2100.

Shared Socioeconomic Pathway 2: “Middle of the Road” scenario representing a moderate path in terms of economic growth and environmental sustainability, without significant shifts towards either deterioration or aggressive mitigation of climate change.

Shared Socioeconomic Pathway 5: “Fossil-fuelled Development - Taking the Highway” scenario characterised by rapid economic growth driven by extensive use of fossil fuels, resulting in high energy demand and significant greenhouse gas emissions.

Build Actions: Technical actions or solutions such as the development of infrastructure and engineered solutions.

Enabling Actions: 'Soft actions' such as policy regulations, capacity building, and related strategies.

No Regret Actions: Actions identified as highly feasible and presenting high value.

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1 EXECUTIVE SUMMARY

1. Executive Summary

Context

Pakistan faces huge financing requirements to become climate resilient and make the transition to a low-carbon economy. According to the World Bank, the estimated cost to achieve these goals by 2030 is approximately USD 348 billion. Following Pakistan's 2022 floods, the impacts of climate change are now taken more seriously by the Government of Pakistan, but the planning and investment needed for climate resilience is lacking. Agriculture, business, and infrastructure all needs to shift to a new more resilient model. Millions of poor and marginalised people in Pakistan remain vulnerable with time ticking until the next disaster.

Private climate finance from domestic and international investors has lagged other countries and will be needed to close the financing gap. 2021 estimates suggest that Pakistan's domestic private sector contributed only 5% of total climate finance tracked. To compound this, this is a disproportionate focus on financing low-carbon mitigation projects, relative to Adaptation and Resilience (A&R) initiatives. The current spending in adaptation and resilience accounts for only 6% of the total annual required funding, resulting in a significant financing gap that is 16 times larger than current spending. Crucial investment in climate adaptation and resilience will both support Pakistan's long-term macroeconomic stability and protect development gains in Pakistan's social sectors.

When considering Pakistan's climate risks, the 2022 floods are still foremost in many people's thoughts. Pakistan endured devastating droughts and floods that destroyed assets, lives, and livelihoods on a country-wide scale. First, a severe heatwave, previously a 1-in-1000-year event, saw temperatures rise consistently above 45°C, resulting in crop losses, power outages, and forest fires. Then came the unprecedented monsoon rains, the heaviest and most concentrated ever recorded in Pakistan.

The 2022 floods caused over USD 30 billion in loss and damages, thousands of lives were lost, over 2 million houses were damaged or destroyed, millions were displaced, and more than 30 million people in desperate need of humanitarian need. Critical infrastructure such as roads and dams were washed away, 22,000 schools were damaged and forced to close, and for many, there was a near-complete loss of livestock and the summer (kharif) crops. According to researchers and public officials, an ineffective early-warning system for floods, poor disaster management, unregulated urban development, and poor water management likely compounded the devastation.

This project finds that the likelihood and frequency of these devastating climatic shocks continues to rise and could get increasingly worse in magnitude and persistence. The impact on the population of Pakistan and their livelihoods, on ecosystems, on physical assets, on the economy, and on poverty, will continue to grow.

Project Scope

Adaptation and resilience can be defined as the ability to reduce the impacts of, and prepare for, respond to, and recover from, climate-related shocks and stresses such as extreme weather events and shifts in climate and weather conditions. There is growing investment—including private investment—in a wide range of assets, technologies and services that offer climate adaptation and resilience solutions. However, to prioritise and scale up investment in adaptation and resilience, investors need to better understand the dimensions of adaptation and resilience, and how to accurately measure and report on the positive adaptation and resilience impacts of their investments.

This project aims to put in place the building blocks for prioritising, mobilising, and attracting adaptation and resilience financing in Pakistan. A rapid assessment of five of Pakistan's principal climate risks – including drought, extreme heat, flooding, storms, sea-level rise - has been undertaken. The Boston Consulting Group's (BCG) proprietary Climate Impact Artificial Intelligence tools have then been deployed to incorporate science-backed climate analytics and economic models, quantifying the dollar cost of climate inaction in US dollars. **This analytical work is the first of its kind in Pakistan.**

This technical risk analysis then allows for an informed quantitative prioritisation of adaptation and resilience actions based on social economic value and feasibility. The project team will develop an understanding of which districts and provinces are most at risk from specific impacts, before identifying the relevant sectors, subsectors, and priority resilience actions to take. These priority resilience actions can then be translated into specific investment archetypes and federal as well as provincial financing strategies. Some actions will require government or public sector financing, whilst other actions will have high potential for private sector investment.*[See detailed methodology & assumptions in Annex].*

Key Findings

Pakistan is consistently ranked as one of the most vulnerable countries to climate change in the world. This project attempts to quantitatively appraise Pakistan's climate risks across three dimensions: people, assets, and the economy. The people dimension is crucial to understand the impact of climate change on future temporary population displacement, permanent migration, and housing or settlement damage – particularly for vulnerable and marginalised groups. The assets dimension focuses the impact of climate change on critical infrastructure assets (for example, transportation, energy, education, and health facilities). The economic dimension focuses on future impacts to two critical sectors; textiles and agriculture, which both face stark and imminent climate risks.

A. Critical Climate Vulnerabilities

The analysis suggests that overall Pakistan faces nine critical climate vulnerabilities across the three dimensions of people, assets, and the economy. These vulnerabilities are largely driven by Extreme Heat and Drought, but also Flood and Sea-Level Rise risks:

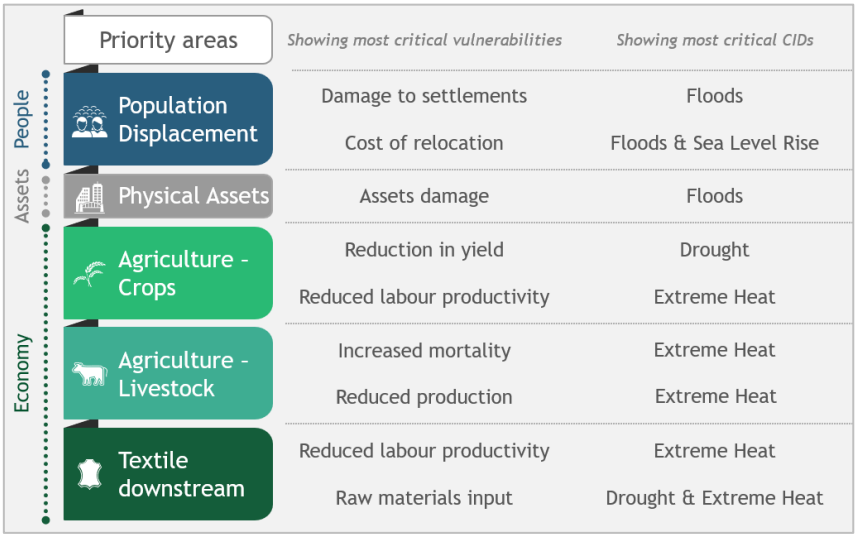


Figure 1 – Critical climate vulnerabilities in Pakistan

However, each Province in Pakistan has its own distinct risk profile, coping capacity and hazard exposure.

B. Quantifying the Cost of Climate Inaction

The project has attempted to quantify the cost of climate inaction in Pakistan.

> **Cost of Inaction Definition**
> The cost of inaction quantifies the economic, environmental, and social consequences of not addressing climate change, representing potential losses such as reduction in agricultural yields, reduced labour productivity, infrastructure damage, relocation costs, and livestock losses.

This concept assesses the consequences (see definition above) by breaking down the impacts into direct and indirect costs. Direct costs encompass immediate financial losses including asset destruction and diminished labour productivity, while indirect costs explore the broader economic and social effects stemming from sector-specific losses.

The projected total cost of climate inaction in Pakistan is estimated to be $250 billion by 2030 and $1.2 Trillion by 2050, equivalent to losses to priority sectors GDP of ~30% a year (max value in peak year).

People – Population Displacement:

- **The cumulative cost of inaction by 2050 is estimated at USD 80 billion for population displacement in Pakistan.**
- **Flooding is the primary catalyst for these costs**, expected to account for USD 60 billion, with Sea-Level Rise contributing USD 20 billion.
- **By 2050, flooding and sea-level rise could cumulatively displace approximately 400 million** people across Pakistan.
    - 320 million in the Punjab, 30 million in Sindh, and 45 million in Khyber Pakhtunkhwa (KP).
- **By 2030, 90 million people could be temporarily displaced.**

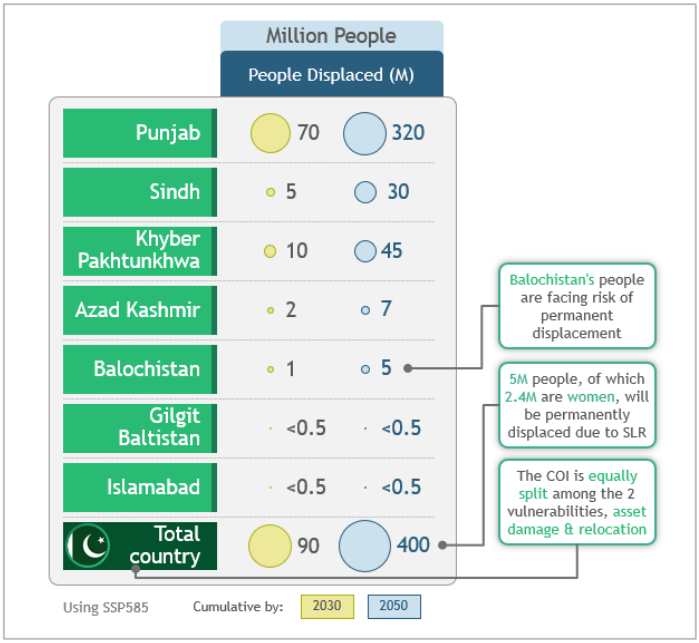


Figure 2 - Cost of Inaction, population displacement in Pakistan

Assets – Physical Asset Damage:

- **The cumulative cost of inaction by 2050 is estimated at USD 100 billion for physical asset damage.**
- Projections indicate that by 2050, costs associated with flooding could reach USD 90 billion, while sea level rise is expected to result in costs of USD 10 billion.
- **Floods will primarily affect essential transportation infrastructure**, with railways bearing 60% of the impact, requiring robust investment in resilient infrastructure to safeguard services and community well-being.

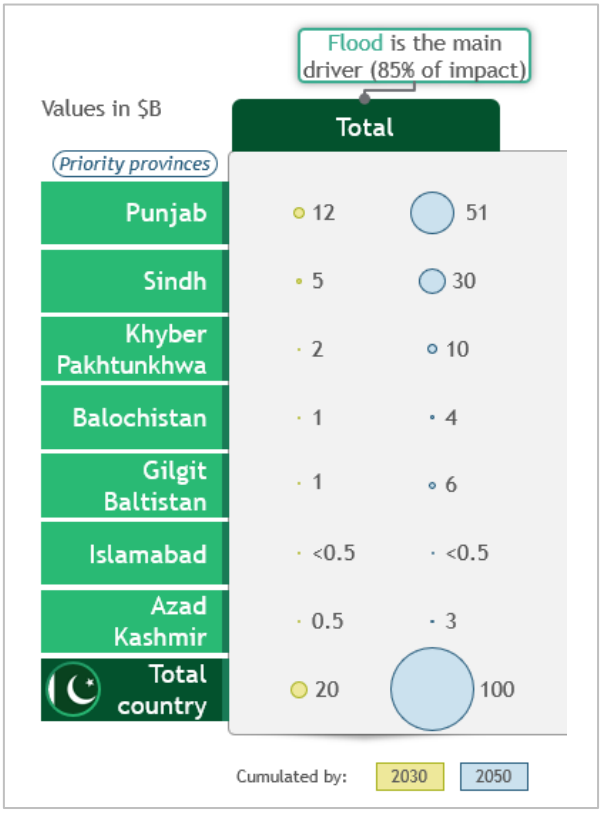


Figure 3 – Cost of Inaction, physical asset damage in Pakistan

Economy – Crop Cultivation:

- **The cumulative cost of inaction by 2050 is estimated at USD 200 billion for Pakistan's agricultural output and crop cultivation.**
- Drought and extreme heat will significantly reduce crop yields and agricultural labour productivity. Punjab and Sindh provinces are most exposed to these impacts.
- **Specifically, crop yield from drought and extreme heat could decrease by up to 47% by 2050**, with most of the production loss concentrated in the Punjab.
- **It is anticipated that these impacts will result in a 15% GDP loss per year** (approximately USD 5 billion) being at risk in peak year (2050), with rice and wheat being the most affected crops accounting for more than 80% of this sector's cost of inaction.
- **Even by 2030 drought and extreme heat will cause ~8% loss in agricultural crops GDP per year.**

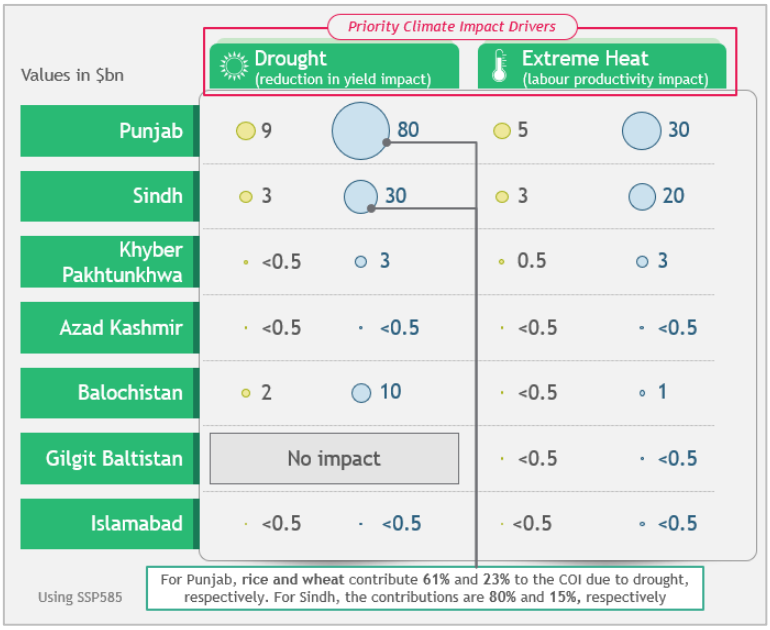


Figure 4 - Cost of Inaction, crop cultivation in Pakistan

Economy – Livestock:

- Livestock in Pakistan will be severely impacted by **climate risks such as extreme heat and floods, particularly in Punjab.**
- **The cumulative cost of inaction for the livestock sector will translate into USD 10 billion at risk annually** with cattle and buffaloes being the most at risk due to mortality from extreme heat.
- **It is possible that livestock farming as an activity could cease in many regions of Punjab and Sindh,** given the probability of high future livestock losses.[3]
- **These impacts are expected to result in 25% annual livestock GDP loss in 2050**, and could result in **~18% loss in GDP by 2030**.

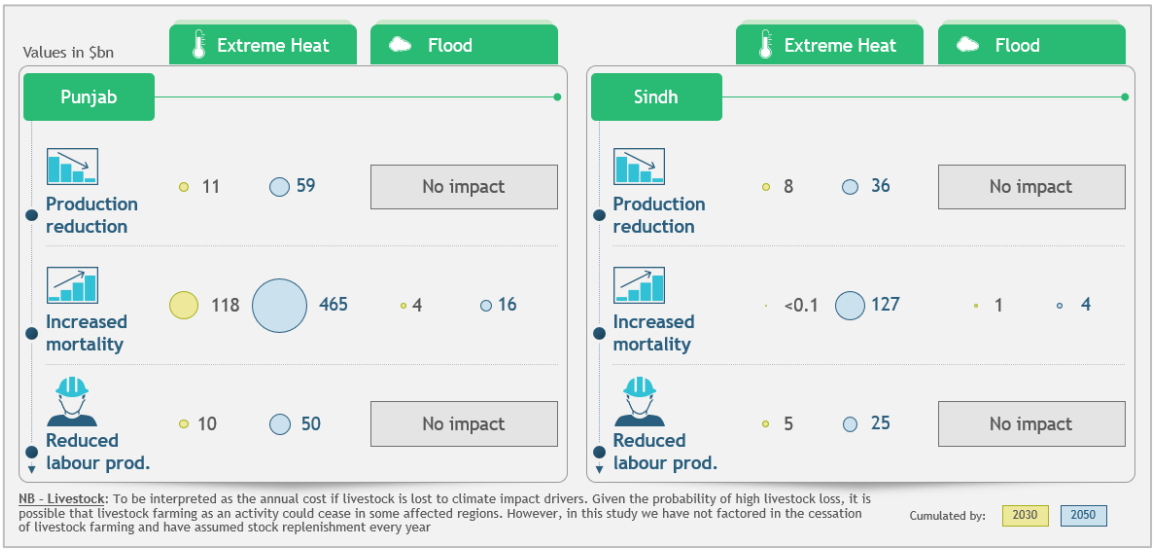


Figure 5 - Cost of Inaction, livestock in Pakistan

Economy – Textile Value Chain:

[3] The project team have not factored in the cessation of livestock farming and have assumed stock replenishment every year – hence the very high cost of inaction from extreme heat mortality.

- **The textile industry is exposed to the potential impacts of climate change all along its value chain**, from cotton production (upstream) to textile manufacturing and exportation (downstream).
- **Sindh and Punjab are the provinces most exposed to climate impacts** both upstream driven by drought, extreme heat, and flooding (disrupting cotton harvests) and downstream by extreme heat (reducing worker productivity).
- **In 2050, 70% annual GDP loss (USD 0.8 billion) is expected in upstream cotton production and 35% (USD**
- **10 billion) downstream** including the direct impact from cotton shortages.
- **More than 250,000 jobs are expected to be lost** in textiles due to the adverse effects of climate change.

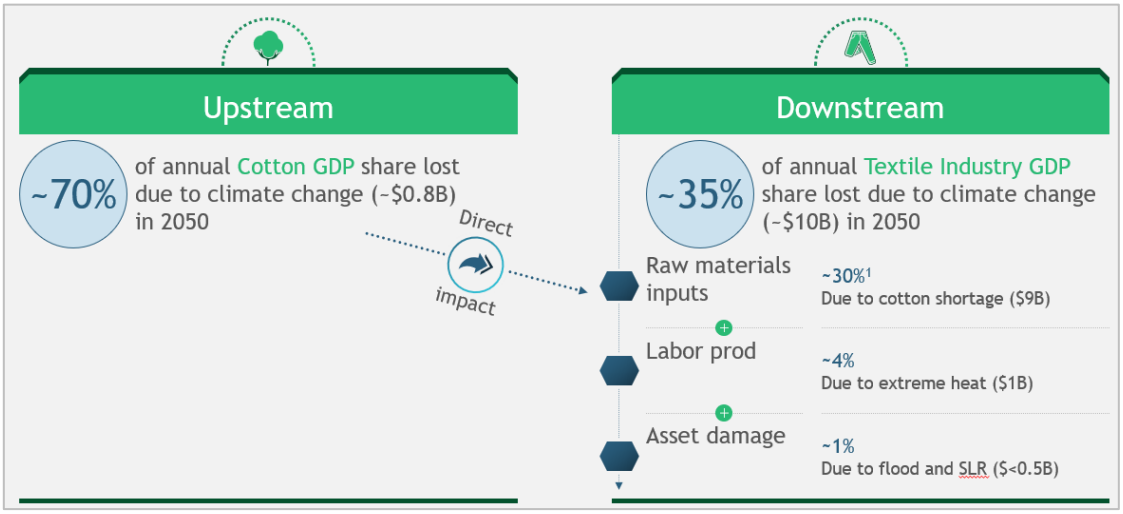


Figure 6 - Cost of Inaction, textile value chain in Pakistan

C. Marginalised and Vulnerable Groups

Within vulnerable populations, women are a key group significantly affected by climate hazards. 50% of Pakistan's female population is exposed to floods and sea-level rise, markedly increasing their risk of displacement. Permanent displacement projections estimate 2.4 million women to be displaced due to sea-level rise.

Evidence shows that climate change exacerbates existing inequities and vulnerabilities. Key factors that contribute to the highest levels of vulnerability include gender-based differences in time-use, access to assets and credits, treatment by formal institutions and the consequent strain on women's opportunities, limited access to policy discussions and decision-making, and a lack of sex-disaggregated data for policy change.

Pathway to Adaptation & Resilience

Targeted locally-led adaptation is essential to address the major risks of drought, heat, storms, sea-level rise and floods, with strategies customised for the specific needs of each Province and district. Empowering local stakeholders to lead in adaptation gives communities on the frontlines of climate change a voice in decisions that directly affect their lives and livelihoods.

The action prioritisation process employed by this project involves creating an action database for each priority sector using internal resources and benchmarks from national and provincial plans. The analysis outlines over 100 specific adaptation actions (*see Appendix*). Thirty of these actions are considered 'no regret' initiatives for timely implementation:

Priority area	Actions
People	Elevation of houses: Build houses on a higher level to increase resilience against moving water.
	Build emergency shelters: Create structures for evacuation during extreme weather events with adapted sanitation infrastructure
	Emergency operations centre: Establish facilities for coordinated emergency management.
	Local evacuation and response teams: Implement emergency response teams to execute plans.
	Local evacuation and response drills: Conduct drills to minimise impact post-extreme events.
	Anticipatory funding action: Support urban poor communities to anticipate risks and increase house resilience.
Assets	Transport network adaptation: Modify road and railway networks for climate resilience.
	Urban water absorption: Enhance water absorption through permeable surfaces and green infrastructure.
	Coastal ecosystem restoration: Construct natural barriers like reefs and wetlands to reduce flooding impacts.
	Flood defence construction: Build barriers or levees to protect against floods.
Economy Agriculture, Crops	Crop diversification: Rotate crops to mitigate species-specific climate impacts.
	Sowing/harvest rescheduling: Adjust planting and harvesting schedules to climate patterns.
	High Efficiency Irrigation Systems (HEIS): Use drip and sprinkler systems for efficient water use.
	Groundwater recharge: Implement groundwater recharge techniques.
	Disease surveillance: Strengthen disease control measures for crops.

Figure 7 - No regret actions (1 of 2)

Priority area	Actions
Economy Agriculture, Livestock	Genetic improvement: Develop climate-adaptive livestock varieties.
	Disease management: Enhance disease control and vaccination for livestock.
	Transportation optimisation: Use data to optimise transportation of livestock.
	Temperature regulation (shade and water): Provide shade and water to reduce heat stress.
	Temperature regulation (building design): Design buildings for optimal airflow.
	Temperature regulation (technologies): Implement temperature regulation technologies.
	Waterproofed buildings: Strengthen buildings to resist water intrusion.
	Relocation of livestock farms: Move farms to safer locations.
	Adapt modern reproductivity techniques: Use "Embryo Transfer Technology."
	Improve quality of feed: Produce high-quality livestock feed supplements.
Economy Textile Value Chain	Reduce raw material dependency: Increase use of recycled fibres.
	Insulate thermally: Use Phase Change Materials for thermal insulation.
	Use water-efficient machines: Implement advanced water-efficient washing machines.
	Strategic site selection: Choose low climate risk sites for construction.

Figure 8 - No regret actions (2 of 2)

Phase 1 Recommendations

If Pakistan is unable to adapt and build climate resilience this will likely have severe adverse implications for Pakistan's macroeconomic stability, regional security, settlement and displacement of population, and food security.

Urgent action is essential. It will require firm, clear decisions from the Government of Pakistan and the engagement of Pakistan's entire population. Pakistan's federal government, provinces and districts will need to come together effectively through a whole of government approach. Private sector initiatives will be required to take forward the priority A&R actions from this project.

This initial phase recommends 10 overarching enablers for the Government of Pakistan to successfully take forward the A&R initiatives identified through this project include:

1. Integrate A&R Impact into Development Project Decision-Making:

It is important to consider the cost of climate inaction and mainstream physical climate risk assessments to enable the identification of opportunities for building climate resilience. A&R investments often have limited revenue streams and are seen as 'unbankable'. However, these types of investments improve the climate resilience of people, the planet, or the economy, therefore it makes sense to assess and appraise their impact in terms of the social, environmental, and economic benefits that these investments confer. Cost of inaction analysis and pricing in A&R benefits can be used to screen investment opportunities in order to prioritise those with the highest impact and benefits (MoPDSI and NDRMF).

2. Develop the National Adaptation Plan (NAP) at the Provincial Level:

Prioritise actions within the National Adaptation Plan (NAP) based on these cost of inaction findings.[4] Cascade Pakistan's National Adaptation Plan into robust short-term provincial implementation plans and financing strategies which should include opportunities for private capital mobilisation (MoCC).

3. Develop District Adaptation Plans:

Establish district level adaptation plans for the most at risk districts within each province, devolving decision making to the lowest appropriate levels (provincial Planning and Development Boards, Provincial Disaster Management Authorities and District Disaster Management Authorities).

4. Encourage the Special Investment Facilitation Council to Prioritise A&R Investment:

Incorporate climate adaptation and resilience into the SIFC and Board of Investment project criteria and improve A&R progress tracking and coordination through the newly established Climate Change Authority (SIFC, BoI, MoCC).

5. Introduce an A&R Project Preparation Facility:

Strengthen the enabling environment for project preparation for A&R investments at the federal level harnessing existing expertise and mandates (NDRMF, ADB, FCDO).

6. Provincial Level A&R Project Development:

Employ cost of inaction methodology and physical climate risk assessments to prioritise a shortlist of 5-10 priority adaptation projects within each province. Cost and screen these projects by investment archetypes and explore private finance mobilisation strategies (Chief Ministers, provincial P&D Boards).

[4] Pakistan launched its NAP in August 2023. The NAP needs to be cascaded into granular district level and provincial adaptation plans in order to facilitate short term implementation plans, track progress and prioritise development budget spending to climate vulnerable areas.

7. Adopt an evidence-based Resilience Taxonomy:

Within the ongoing 'Green Taxonomy' development, adopt an evidence-based approach that enables capital market issuers, investors, and other stakeholders to identify climate resilience investments, assets, and entities, and to facilitate the flow of capital.[5] This classification framework can then be implemented to form the basis for domestic budget tagging and financial disclosures. In turn this will improve the tracking of adaptation finance flows (MoF, SBP, MoCC, World Bank).

8. Integrate Climate Related Financial Risk into Supervisory Activities:

Seek to integrate climate-related risks in the prudential, financial, regulatory, and supervisory frameworks. Measuring and managing climate-related financial risks is critical for institutions across Pakistan's financial system (SBP, SECP, MoF).

9. Draw up Agriculture and Textile Resilience Roadmaps:

Consider provincial roadmaps in at-risk provinces to improve government coordination and build climate resilience within the agricultural and textile sectors to protect against future GDP loses (Chief Ministers, provincial P&D Boards, PPD fora).

10. Engage Textile, Agricultural and Livestock Corporations:

Engage domestic and multinational private sector corporations operating within climate vulnerable textile and agriculture value chains in Pakistan to increase awareness of future climate risks and explore financing opportunities (MoCC, SECP).

[5] A green taxonomy is a classification system that defines which economic activities and assets are "green" or environmentally sustainable. Taxonomies aim to increase investment in green activities or assets, and facilitate greenwashing detection. Pakistan's National Green Taxonomy is being developed by the World Bank with funding from the FCDO.

2

PAKISTAN'S CLIMATE RISKS

2. Pakistan's Climate Risks

Introduction

Ranked as the 8th most impacted country by climate-related disasters over the last two decades, Pakistan has faced significant socio-economic damage from recurrent, severe flooding. In 2022 alone, the country suffered USD 14.9 billion in infrastructure and property damages and USD 15.2 billion in economic losses, amounting to approximately 2.2% of its GDP. This catastrophic event displaced over 30 million people, resulted in more than 1,700 deaths, and led to the destruction of 2.2 million homes, over 4 million acres of arable land, and nearly 700,000 heads of livestock.

Such climate-related disasters are expected to continue impacting Pakistan's economic growth, potentially causing significant deviations from projected growth rates by 2050. Moreover, with the nation's population projected to nearly double to 403 million by 2050[6], its vulnerability is expected to increase significantly due to a complex interplay of socio-economic, demographic, and geopolitical factors. This report analyses the frequency and severity of climate events by 2030 and 2050, providing a deeper understanding of climate risks and their implication.

The UK Foreign Commonwealth and Development Office (FCDO) has worked closely with the Government of Pakistan and its key development partners to quantify the country's climate finance gap, and take tangible steps to address it. This evidence-based Climate Adaptation and Resilience Solutions Project in Pakistan, has been delivered in partnership with the FCDO Growth Gateway Programme, delivered by the Boston Consulting Group (BCG)-led consortium and picks up on the key initiatives and enablers identified in the Growth Gateway-led intervention on Accelerating Green and Climate Resilient Financing in Pakistan delivered in 2023. Specifically, it picks up on the strategic actions that must be prioritised to strengthen the country's resilience against anticipated climate risks given the estimate that Pakistan requires 16 times more funding than current flows to address the Adaptation and Resilience (A&R) needs[7].

The stark exposure to climate threats coupled with insufficient A&R funding underscores the urgent need for a robust pipeline of actions and projects. This pipeline, guided by a rigorous, data-driven approach that includes analyses of vulnerability and the costs of inaction, will identify the most pressing climate risks and the areas most vulnerable to these threats. This approach marks the initial step toward developing targeted, location-specific projects that will appeal to potential financiers, helping to bridge the A&R financing gap and facilitate better informed decision-making.

Risk Dimensions

Aligned with the National Adaptation Plan (NAP) sector mapping, three dimensions have been critically evaluated to address Pakistan's vulnerability to climate change: People, Assets, and Economy. Each dimension has been analysed to identify where interventions could mitigate the most significant impacts.

The analysis of the **People dimension** is crucial for addressing widespread displacement and the direct effects of climate change on vulnerable groups across the country. In the **Assets dimension**, the focus is on assets covering up to 80% of critical infrastructure (transportation, energy, education, health facilities). The **Economic dimension** focuses on two critical sectors – Agriculture, including livestock and Textiles -

[6] UNFPA Pakistan

7 Growth Gateway Project: Accelerating Green and Climate Resilient Financing in Pakistan, November 2023

that together account for 30% of Pakistan's GDP. These sectors are both significantly exposed to climate risks, making them pivotal areas for targeted resilience actions.

For the remaining sectors, including Natural Capital, and social-related topics such as Youth, Vulnerable Groups, and Cultural Sites, specific Key Performance Indicators (KPIs) have been established to highlight their vulnerabilities to climate change. The analysis integrates two critical elements: vulnerability assessments and the Cost of Inaction (CoI) and has been conducted across two Shared Socioeconomic Pathway scenarios (SSP 2-4.5 and SSP 5-8.5 - see box below), for the years 2030 and 2050. The CoI focuses on the direct impacts of climate inaction, highlighting the tangible repercussions of failing to address climate risks. Meanwhile, the vulnerability assessments provide heatmaps at the national level to identify areas most at risk.

SSP Scenarios

The SSP scenarios originate from a collaborative effort involving researchers from various institutions around the world, coordinated by organizations like the Intergovernmental Panel on Climate Change (IPCC) and the International Institute for Applied Systems Analysis (IIASA).

Socioeconomic Pathway Scenarios: Climate change scenarios used to project and analyse the effects of socioeconomic factors on global changes up to 2100.

Socioeconomic Pathway 2: "Middle of the Road" scenario representing a moderate path in terms of economic growth and environmental sustainability, without significant shifts towards either deterioration or aggressive mitigation of climate change.

Socioeconomic Pathway 5: "Fossil-fuelled Development – Taking the Highway" scenario characterised by rapid economic growth driven by extensive use of fossil fuels, resulting in high energy demand and significant greenhouse gas emissions (GHG's).

For each priority sector, the analysis follows a six-step methodology to outline Pakistan's pathway to resilience:

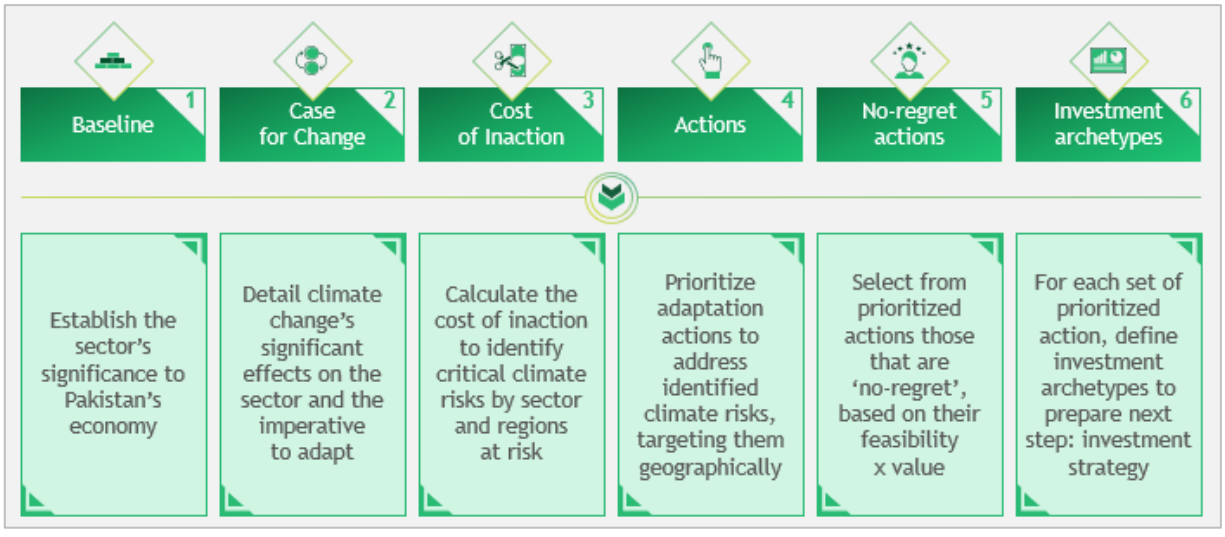


Figure 9 - Six-step methodology to outline Pakistan's pathway to resilience

Climate Vulnerabilities by Sector

Pakistan's diverse topology, including its extensive river basins, arid deserts, and mountainous regions, makes it highly vulnerable to the impacts of climate change. The glacial melt from the Himalayas and Karakoram mountains significantly affects river flows, while the monsoon variability impacts the Indus River basin, crucial for agriculture and water resources. Additionally, the arid deserts, such as the Thar Desert, are particularly prone to extreme heatwaves, severe droughts, and sandstorms, which exacerbate water scarcity and impact agriculture and livelihoods. Four key sectors and challenges have emerged as priorities for this analysis due to their extensive impact across three significant dimensions: economy, people wellbeing, and infrastructure.

i. **People** - Population Displacement and Housing / Settlement Damage

Population Displacement has been identified as requiring urgent action, given Pakistan's significant challenges related to human mobility and climate change pressures. Being the 5th largest host of refugees globally and experiencing the most internal displacements in 2021, Pakistan confronts ongoing social and economic pressures from these population shifts. This includes an outflow of around 600,000 people each year seeking employment abroad, highlighting the urgency of addressing population displacement. Key vulnerabilities include those identified in figure 10.

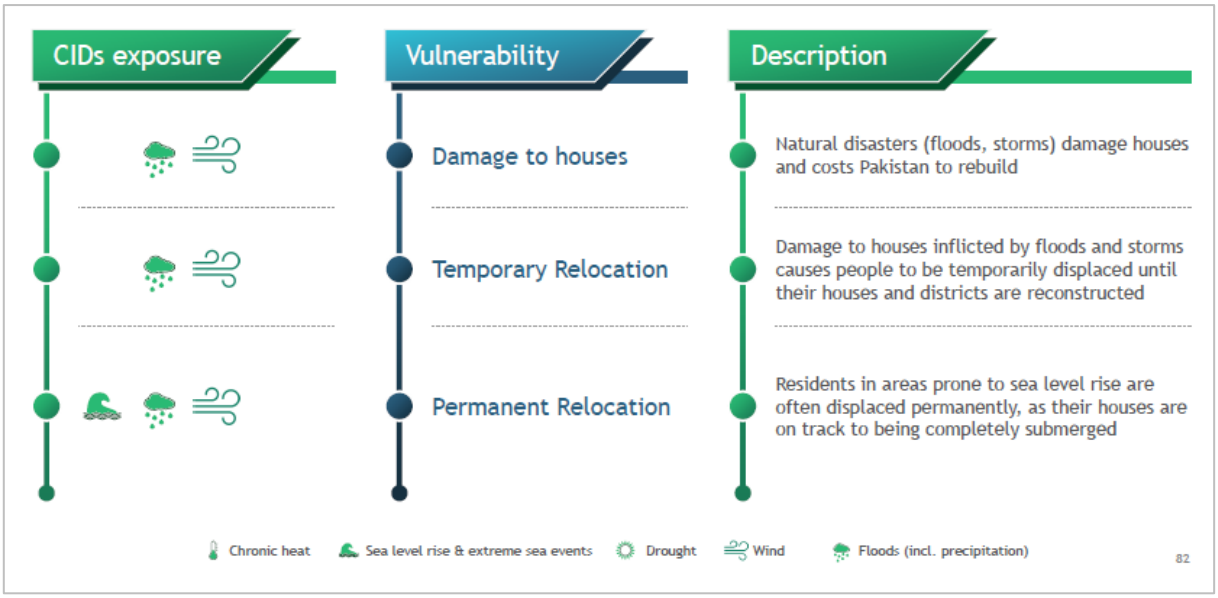


Figure 10 – Population Displacement Vulnerabilities

ii. **Assets** - Physical Asset Damage

Physical Assets have been highlighted as a critical area due to the extensive infrastructural and economic losses from the catastrophic floods in 2022. This includes a total infrastructural damage cost of USD 14.9 billion, an overall economic loss of USD 15.2 billion, equating to 2.2% of the GDP, and the damage of more than 2,000km of roadways. These figures underscore the severe impact of climate events on the country's physical infrastructure and economic stability. Key vulnerabilities include:

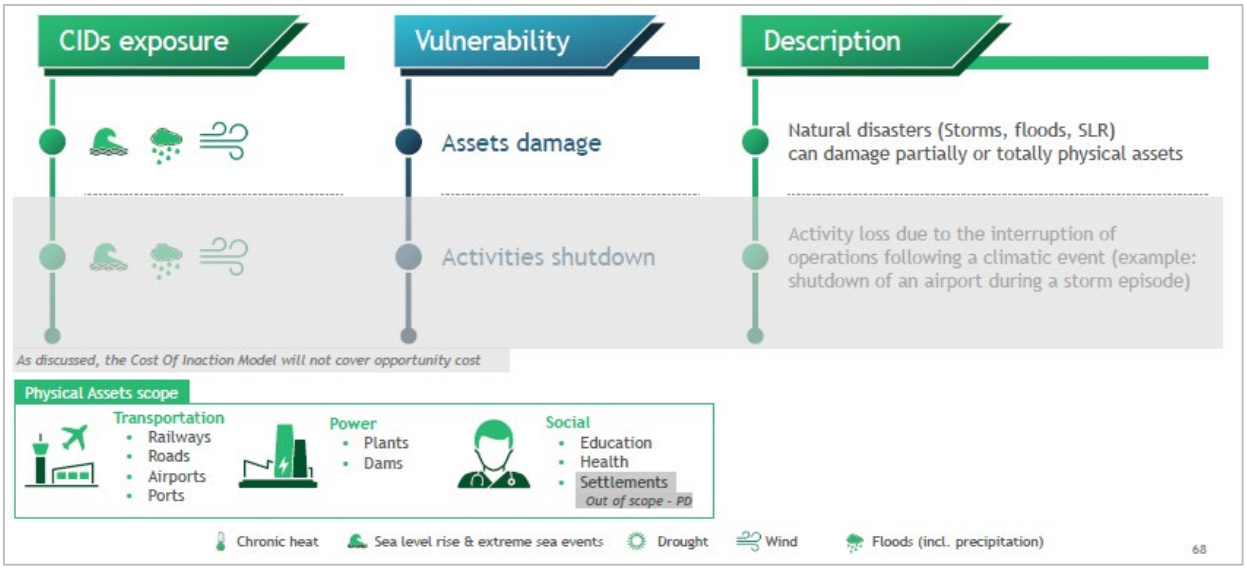


Figure 11 - Physical Asset Damage Vulnerabilities

iii. **Economy** – Agriculture, Crops and Livestock

Pakistan is still primarily an agrarian society with 42% labour force in this sector. 75% of women and girls in employment also work in this sector. Agriculture contributes to 25% of GDP and produces over 75% of export revenue. Millions of people owe livelihoods to this sector, and it is closely tied up to Pakistan's human development. However, Pakistan's agricultural sector is currently highly inefficient, and practices and management are vulnerable to climate change. Key climate vulnerabilities include those identified in figures 12 & 13.

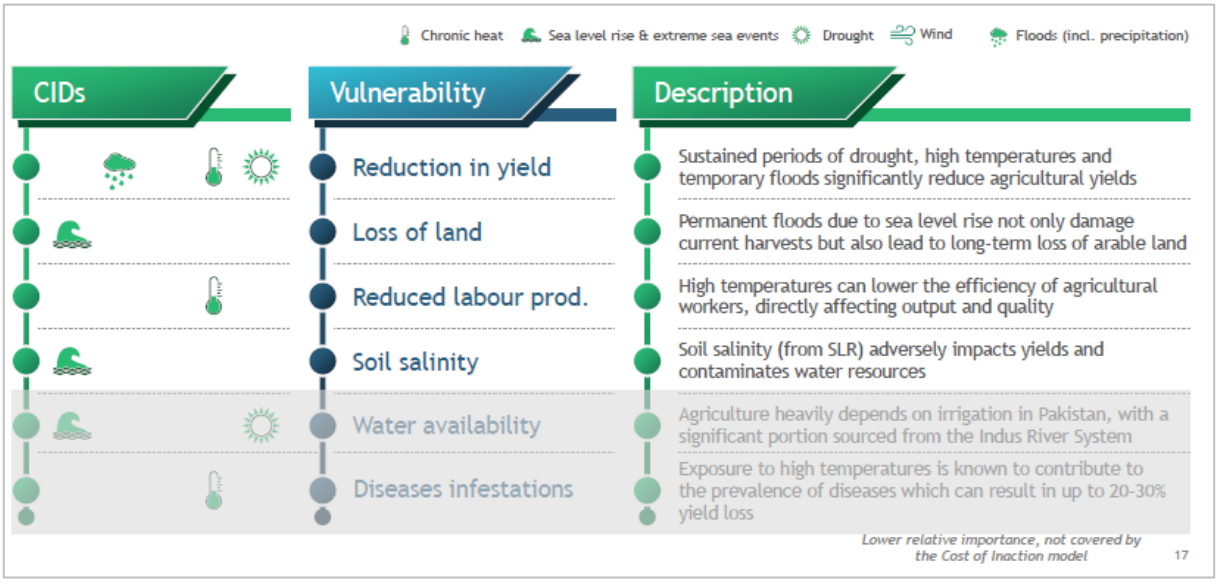


Figure 12 – Crop cultivation Vulnerabilities

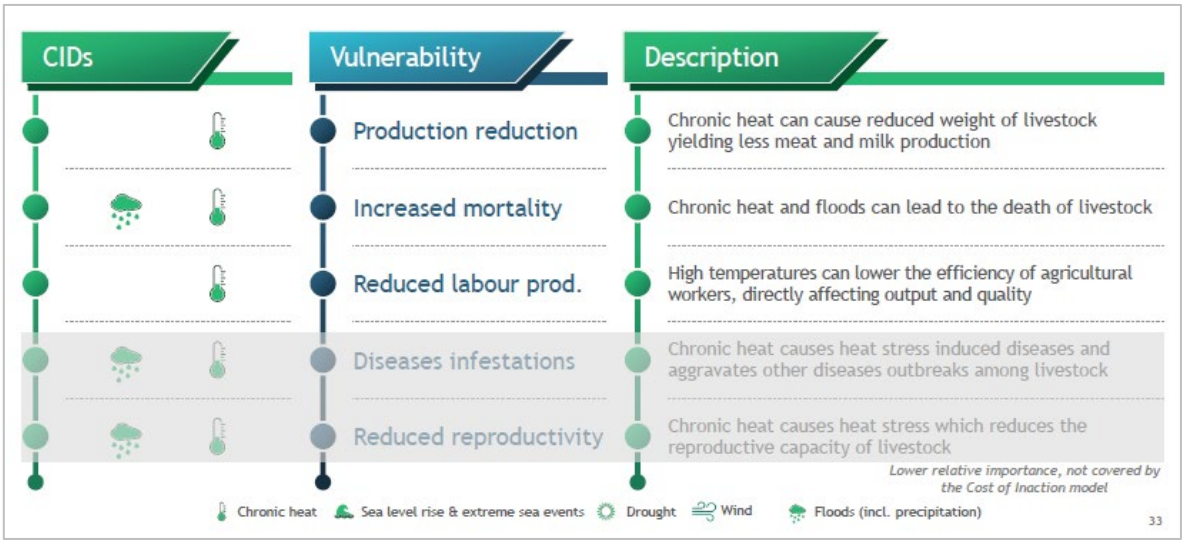


Figure 13 – Livestock Vulnerabilities

As noted in Pakistan's National Adaptation Plan, many agro-ecological areas are identified as having significant exposure and sensitivity to the adverse impacts of climate change as well as low adaptive capacity. Agriculture is therefore a key focus for building climate resilience from livelihoods, food and water security and economic growth perspectives.

iv. **Economy -** Textile Value Chain

The textile sector, which contributes to 10% of GDP, and 60% of the nation's exports, is a crucial economic pillar for Pakistan. With 40% of its workforce being women, the sector's role in sustaining livelihoods is clear. Globally, as the 9th largest exporter of textiles, any significant production disruptions, particularly those stemming from cotton shortages, are predicted to cause a 35% reduction in the sector's GDP contribution. This is especially critical for textile-centric districts such as Lahore and Faisalabad in the Punjab province. Key vulnerabilities include:

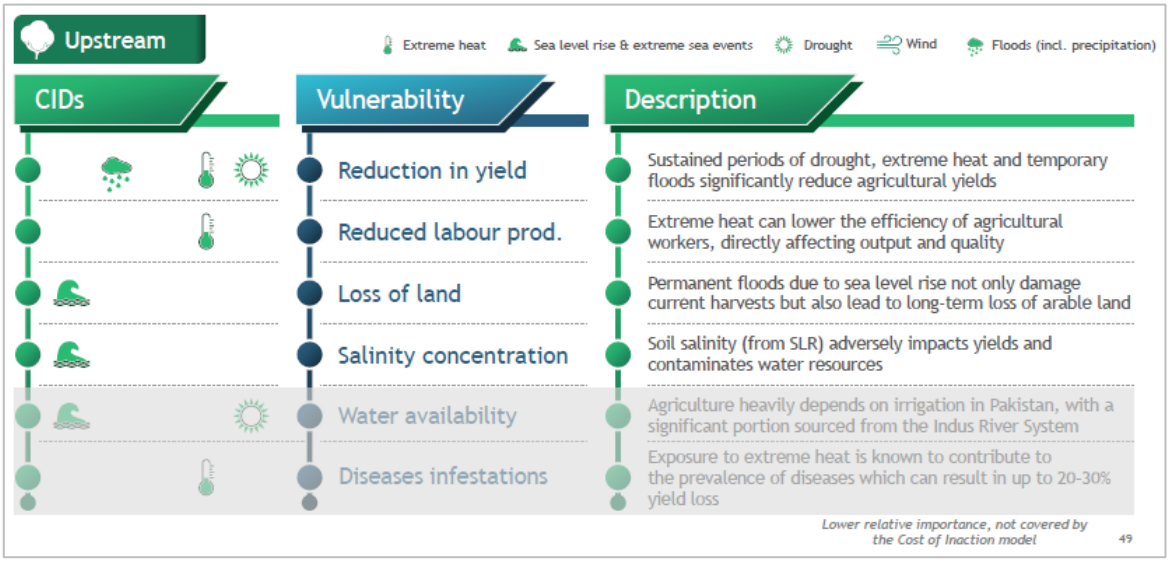


Figure 14 - Textile Upstream Vulnerabilities

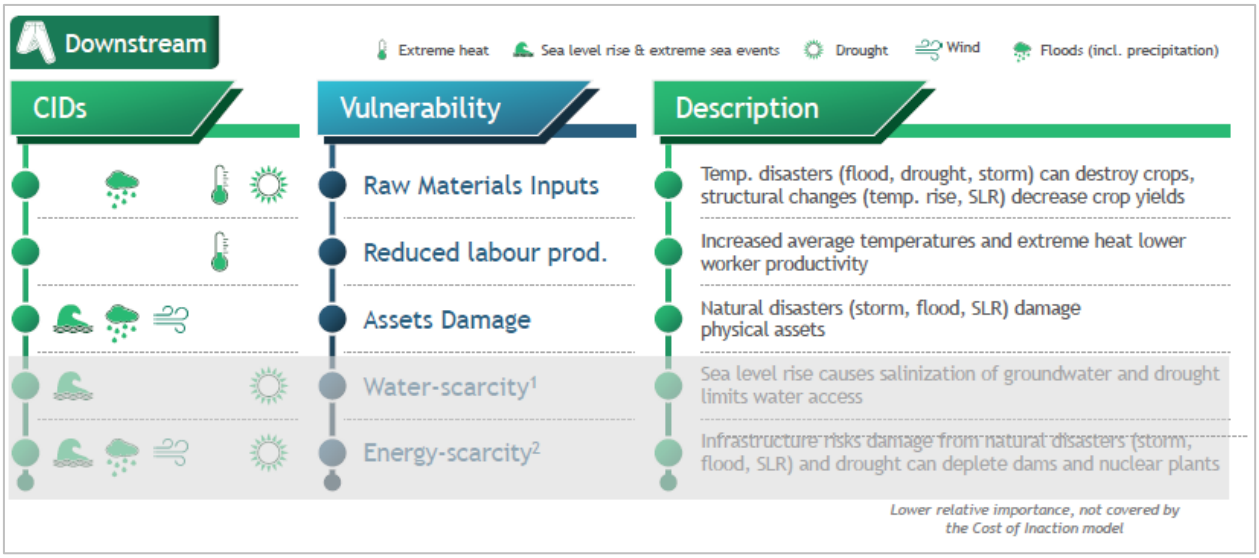
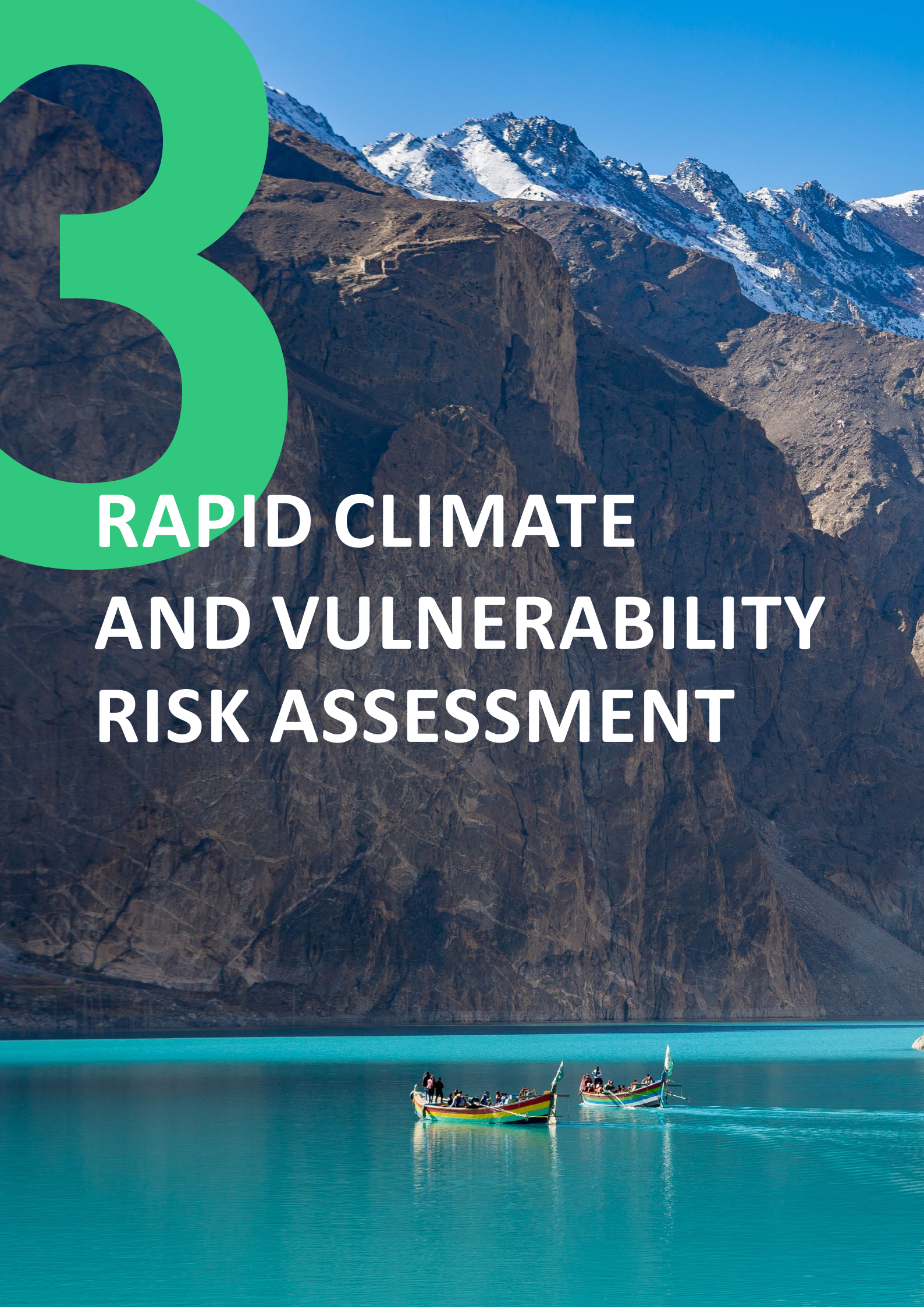


Figure 15 - Textile Downstream Vulnerabilities

3

RAPID CLIMATE AND VULNERABILITY RISK ASSESSMENT



3. Rapid Climate and Vulnerability Risk Assessment

Methodology

The rapid climate and vulnerability risk assessment looks at multiple factors to provide a comprehensive view of each district's susceptibility to specific climate risks. By combining the intensity of climate hazards with economic and societal vulnerabilities, the assessment offers a strong perspective on the multifaceted nature of regional vulnerabilities.

Climate risks across Pakistan's provinces exhibit considerable variation due to distinct geographical and socio-economic factors. At the national level, two CIDs - drought and heat - have the most substantial impacts across the country, affecting multiple districts with high exposure rates. This understanding allows for targeted interventions that address the specific vulnerabilities of each province, ensuring that mitigation efforts are both effective and appropriately scaled.

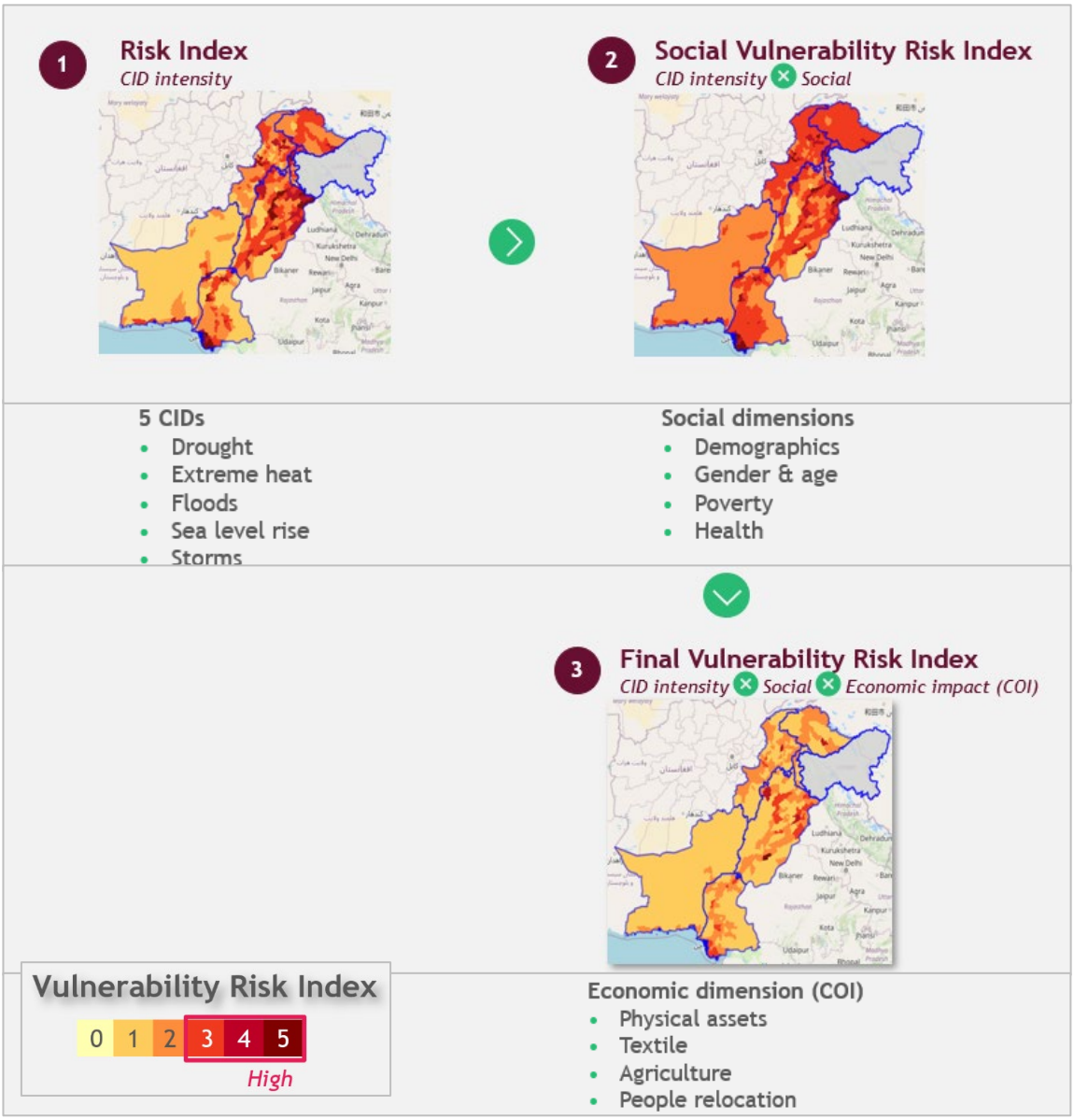


Figure 16 – Vulnerability Risk Index Construction

Risk index *(Climate risk exposure)*

The two scenarios, SSP 2-4.5 and SSP 5-8.5, provide balanced perspectives on the potential future development of climate risks in Pakistan. Spanning from moderate to high emission trajectories, these scenarios enable a thorough assessment of future climate conditions and the need for resilience against severe climate change impacts.

The analysis, anchored in the 2030 and 2050 timelines, respectively, delivers projections of CID's and their effects in the coming decades, integrating three critical layers: the global evolution of climate change, its physical impacts on Pakistan, and the translation of these impacts into socioeconomic metrics. This multi-layered approach aims to understand the potential effects on Pakistan's population and economy.

The focus is on five specific CIDs: increased temperature, drought, sea level rise, flooding, and intense wind/ storms, including tropical cyclones. Historical evidence demonstrates the significant impact of these CIDs on Pakistan, a trend that is expected to persist if mitigation actions are not implemented. By assuming no proactive measures are taken, the model projects the potential impacts across physical, social, and economic domains.

A specialised model was developed to map the risk exposure of each region in Pakistan to the identified CIDs. This model explains the vulnerability of different areas to climate impacts, serving as a foundation for formulating targeted adaptation and mitigation strategies.

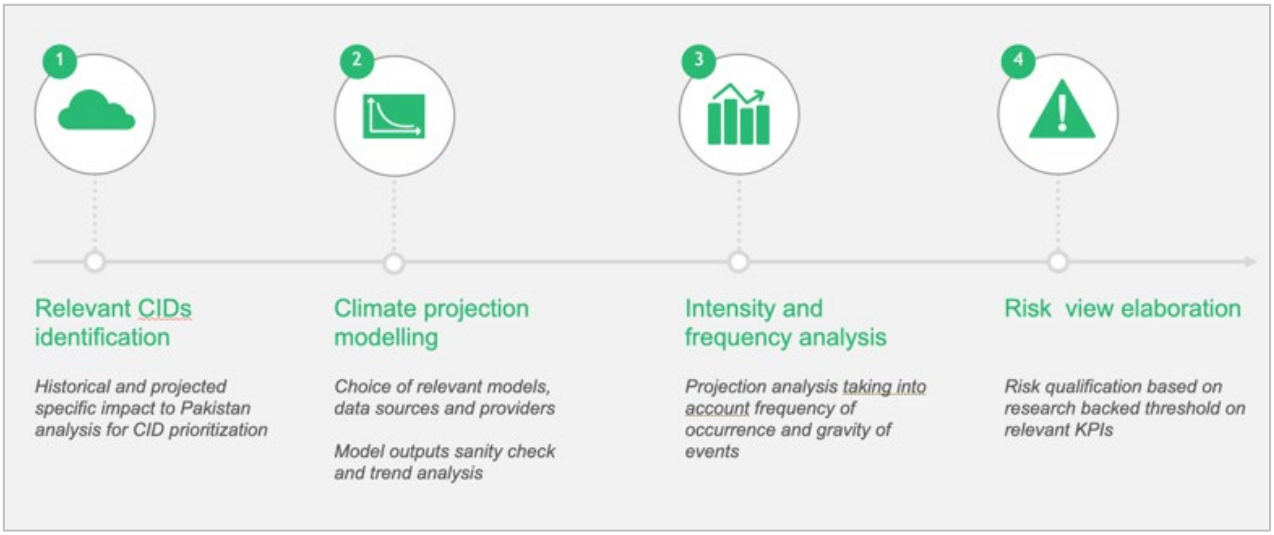


Figure 17 - Methodology of building Pakistan's climate risk profile

The methodology for aligning climate projections with Pakistan's historical trends follows a three-step process. It begins with the selection of climate models that best match historical climate patterns in Pakistan. Following this, the projections define climate hazards by their intensity and frequency. A risk threshold is then established, combining these indicators, and standardising them against the Jupiter-Intel risk scale and relevant literature for hazards such as drought, extreme heat, and the highest risk quantiles for storm, flooding, and SLR.

Social vulnerability risk index *(Vulnerability assessment)*

Risk exposure metrics identify the potential impacts of climate change for each location, focusing on specific CIDs. However, these metrics traditionally do not account for broader aspects beyond the immediate intensity of climate hazards. To address this, the project team have developed a thorough model that

amalgamates climate hazard intensity with both the economic and societal vulnerabilities of each region. This integrated approach offers a nuanced view, illustrating the vulnerability of regions and districts to each CID.

The model incorporates a socioeconomic vulnerability index, drawing inspiration from academic research, to pinpoint areas most susceptible to each hazard and climate driver. This index evaluates vulnerability through three primary dimensions: the intensity of the climate hazard, the potential economic costs, and the societal impacts, thereby offering a multidimensional assessment of risk. The following factors are included in the model:

- **Hazard Intensity Factor:** Assesses the hazard's risk level, adjusting for the potential impact of each specific climate hazard.
- **Economic factor:** Derived from the CoI analysis, including damages to Points of Interest, labour productivity losses, and impacts on agriculture.
- **Social factor:** Encompasses four subcategories to capture the broader societal implications[8]:
    - **Demographics**: Focuses on the population density at risk from specific hazards.
    - **Gender & Age**: Targets the impact on women, children, <= 14 years, the elderly (extreme ages), >= 65 years, and youth ages 14-25, emphasizing vulnerabilities across different age groups.
    - **Household Income**: Concentrates on populations below the poverty line[9], with low income, or facing unemployment or illiteracy.
    - **Health**: Addresses vulnerabilities related to disabled[10] individuals and the prevalence of underweight and stunted children.

Each of these dimensions contributes a specific weight to the overall societal factor and the overall vulnerability index. The weighting system is derived from a detailed vulnerability analysis, academic literature, and expertise from BCG.

[8] Data sources such as Worldometers, 2021; National Database of the Pakistani Citizens, 2021; and Pakistan's Bureau of Statistics (pbs) (2020-21) were used to build this view.
[9] Population in multidimensional poverty based on United Nations, Department of Economics and Social Affairs, Population Division (2017 survey)
[10] Including blind, deaf & dumb, physical disability and mentally retarded from National Database of the Pakistani Citizens (2021)

Results

Drought

High vulnerability to drought affects 35 districts in Pakistan, all located in Sindh, Balochistan, and the Punjab. Drought severely affects 15% of the country's total area, impacting 50 million people incl. 24 million women, posing significant threats to food security and productivity.

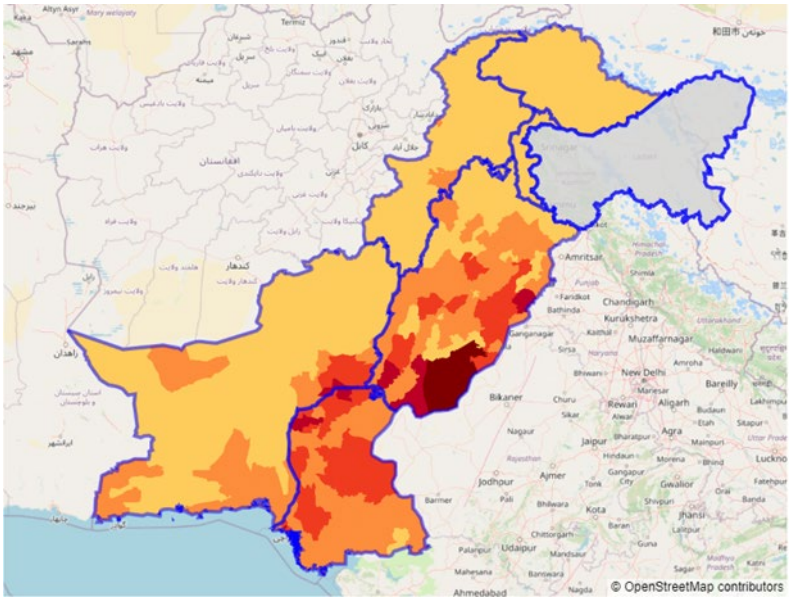


Figure 18 - Drought Vulnerability Map

Extreme Heat

Extreme heat highly impacts 45 districts across the Punjab and Sindh provinces, with Okara and Ghotki being particularly vulnerable. Around 105 million people are affected by extreme heat, including 40 million who are of extreme ages and 50 million women. The high risk extends over 17% of Pakistan's land area.

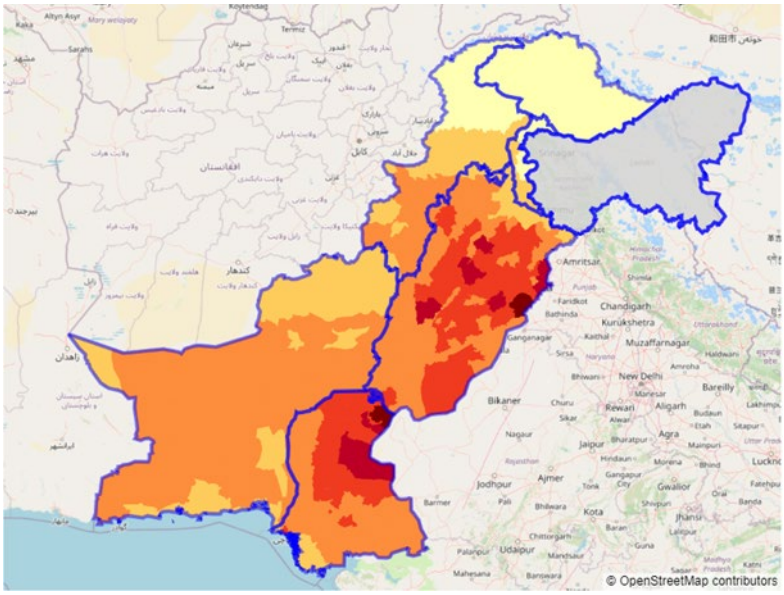


Figure 19 – Extreme Heat Vulnerability Map

Floods

Out of 160 districts exposed to floods in Pakistan, a total of 29 districts are located in Khyber Pakhtunkhwa (KP), the Punjab, and Sindh are highly vulnerable (vulnerability risk score >= 3), impacting about 33 million

people, including 11 million children and 16 million women. Certain districts in the Punjab have a lower risk in comparison to the climate risk index due to lesser social exposure, but the risk is amplified in some areas due to a high CoI.

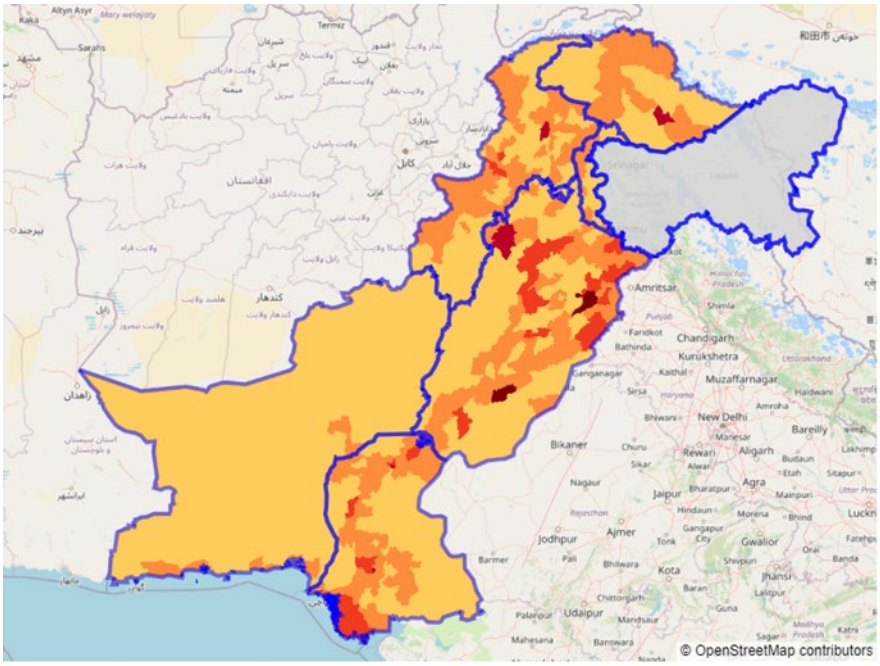


Figure 20 – Flooding Vulnerability Map

Sea Level Rise[11]

26 districts in the coastal regions of Pakistan are exposed to this climate risk. Districts such as Badin, Korangi, Lyari, and Saddar in Sindh face significant risk. Sea Level Rise (SLR) affects 13 million people, with 6 million women highly vulnerable to SLR and 4 million children living in precarious conditions, and over half (52%) are in extreme poverty.

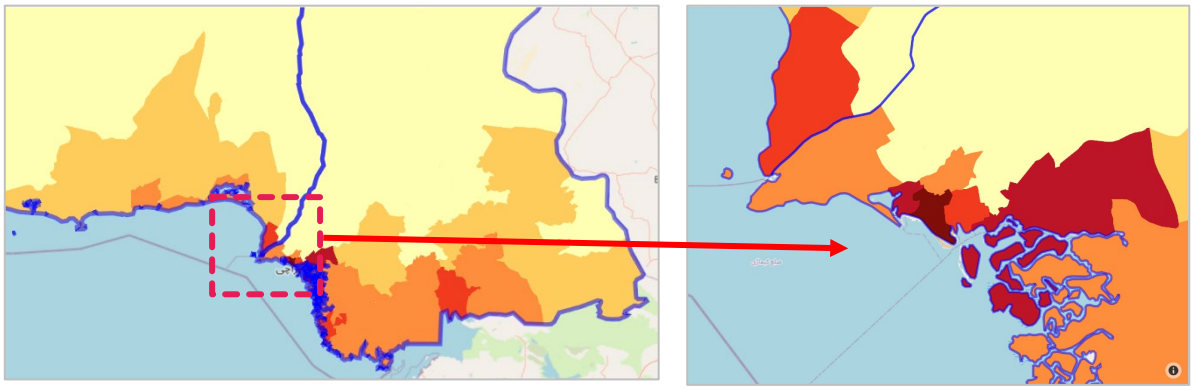


Figure 21 – Sea Level Rise Vulnerability Map

Storms

Out of Pakistan's 72 districts exposed to storms, 62 are in Sindh and Balochistan, with a significant concentration in the southern divisions, especially Karachi, due to its economic importance. The 8 highly impacted districts (vulnerability risk score >= 3) are located in Sindh. They account for approximately 18

[11] SLR is based on SSP 2-4.5

million people affected by storms in the province, which includes around 5 million children and 9 million women.

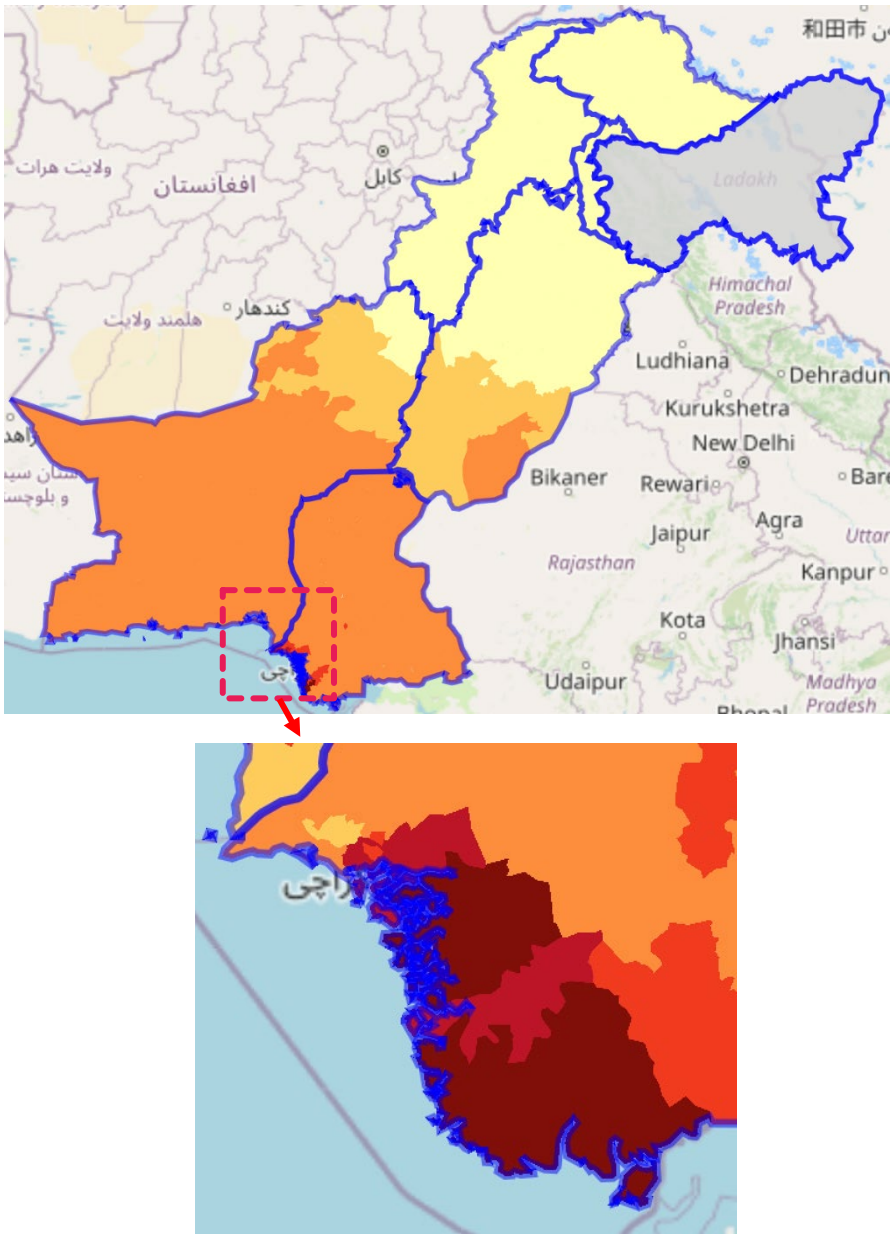


Figure 22 - Storm Vulnerability Map

4

QUANTIFYING PAKISTAN'S COST OF CLIMATE INACTION

4. Quantifying the Cost of Climate Inaction

Results by Priority Dimension

The CoI quantifies the economic, environmental, and social consequences of not addressing climate change, representing potential losses such as reduced productivity, infrastructure damage, health costs, and biodiversity loss. This concept assesses the repercussions across three main dimensions: people, assets and the economy, breaking down the impacts into direct and indirect costs. Direct costs encompass immediate financial losses including asset destruction and diminished labour productivity, while indirect costs explore the broader economic and social effects stemming from sector-specific losses, affecting trade dynamics and community well-being. [Technical methodology available in the Annex]

Cost of Inaction Principles

1. Scope of Risks: The climate risk model encompasses all critical CID's that are relevant to Pakistan, with the exception of Glacial Lake Outburst Floods. Additionally, the CoI modelling specifically focuses on dimensions of socio-economic vulnerability that are most significant to the country.

2. CoI Logic: The CoI estimates have been calculated cumulatively, looking ahead to the years 2030 and 2050. These calculations are based on an 'as is' baseline scenario, which does not factor in population or GDP growth. It also does not consider adaptation and resilience actions, effectively making it a 'no action' scenario.

3. Economic Indicators: The economic impact indicators utilise marginal economic impact proxies. These are derived from multipliers within Pakistan's social accounting matrix, and GDP impact is thus referenced against variations in gross added value under an 'as is' baseline scenario.

4. Timelines and Scenarios: The modelling incorporates two distinct timeframes and considers two SSPs - scenario SSP 2-4.5 and SSP 5-8.5, for year 2030 and 2050, respectively, with the SSP5-8.5 scenario considered a 'worst-case' scenario.

5. Risk Aggregation: While the CoI model was initially developed to evaluate each individual risk independently, for the sake of clear communication, the impacts across all risks have been aggregated. However, it is crucial to note that climate risks are not exclusive. It has been assumed that positive and negative synergies across various risks can offset each other.

i. People

People displacements caused by climate impacts are increasing in frequency and this underscores the urgent need for proactive measures [detailed list of measures in next section and annex]. In recent years, devastating events such as the 2022 floods have displaced 8.2 million people, plunging millions into poverty and food insecurity. By 2030, it is expected that there will be 90 million displacements of people due to the impacts of climate change in Pakistan.

Looking ahead to 2050, it is projected that floods and SLR will cumulatively displace approximately 400 million people across Pakistan: about 300 million in the Punjab, 30 million in Sindh, and 40-50 million in KP, i.e. i.e., this figure represents the total number of displacement events over time. The cumulative cost of inaction by 2050 is estimated at USD 80 billion for population displacement, predominantly borne by the Punjab, KP, and Sindh. Flooding is the primary catalyst for these costs, expected to account for USD 60 billion. Significant financial impacts are anticipated, including flood-induced housing damage in the Punjab potentially costing USD 30 billion. Imminent SLR in Sindh will require strategic and efficient population relocation strategies, which are projected to cost USD20 billion. KP can also expect major costs associated with housing damage and temporary relocation. All provinces will need focused mitigation and adaptation strategies to manage and reduce the risks and impacts of climate displacement effectively.

Figure 23 - People CoI x Vulnerability Dimension

ii. Assets

The CoI model emphasises the substantial impacts of climate disasters on Pakistan's physical assets, focusing on transportation, power, and social infrastructure including health and education facilities. The devastating floods of 2022 illustrated the severe economic and societal repercussions, with damages to roads and railways alone surpassing USD 2.4 billion. Projections indicate that by 2050, costs associated with flooding could soar to USD 90 billion, while sea level rise is expected to result in a CoI of USD 10 billion. The coastal provinces of Sindh and Baluchistan are particularly at risk, with substantial anticipated costs also concentrated in key districts of the Punjab. This situation underscores the critical need for targeted

mitigation and robust resilience strategies in infrastructure development to safeguard against future climate-related challenges.

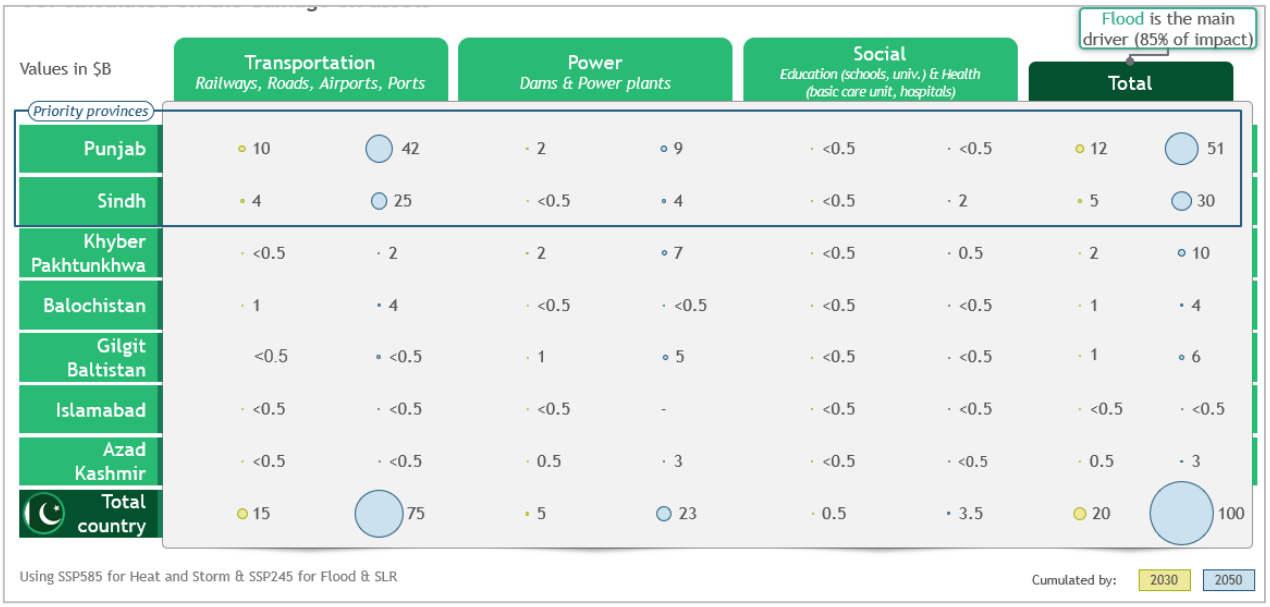


Figure 24 - Assets CoI x Type of Assets

iii. Economy

- Agriculture – Crops: Crop cultivation is pivotal to Pakistan's economy, contributing 7% to GDP and comprising 40% of agricultural GDP, with wheat, rice, cotton, and maize covering over 80% of the harvested area. However, crops in Pakistan are highly vulnerable to climate change, which has notably impacted output and contributed to food shortages. Heat and drought are the primary CIDs adversely affecting the industry, leading to impacts such as reduced yields, decreased labour productivity from high temperatures, and increased disease prevalence due to extreme heat. Specifically, crop yield from drought and extreme heat could decrease by up to 47% by 2050, with most of the production loss concentrated in the Punjab.

- The cost of inaction model projects that by 2050[12], the cumulative CoI will translate into significant economic losses mainly affecting the provinces of the Punjab and Sindh. It is anticipated that these impacts will result in ~8% loss in agricultural crops GDP in 2030 escalating to a 15% loss, approximately USD 5 billion being at risk in peak year (2050), with rice and wheat being the most affected crops accounting for more than 80% of this sector's CoI. In the Punjab, 10 districts have been identified as hotspots given their accountability for 50% of the province's CoI. Notable among these are Rajanpur, Okara, and Rahim Yar Khan[13].

- Agriculture – Livestock: Pakistan's livestock industry, crucial to its economy, accounts for 11% of the GDP and includes significant contributions from poultry. The Punjab holds the highest concentration of livestock, significantly supporting the country's food self-sufficiency with minimal food imports. However, the industry is increasingly vulnerable to climate change, with rising temperatures negatively impacting livestock health, fertility, and productivity. The first results indicate that bovine meat production could decrease by ~5% by 2050 due to the impact on cattle and buffalo production of meat and milk. The cost of inaction model estimates the cumulative CoI for the livestock sector

[12] CoI model built on 4 major crops representing 80% of the total harvested area in Pakistan: cotton, rice, wheat and corn.
[13] Top 10 districts: Rajanpur, Okara, Rahim Yar Khan, Bahawalnagar, Bahawalpur, Jhang, Sheikhupura, Muzaffargarh, Vehari, Khanewal

will translate into substantial economic losses due to the effects of extreme heat, mainly in the Punjab. These impacts are expected to result in ~18% annual livestock GDP loss in 2030 going up to a 25% loss in peak year (2050), which could equate to a USD 10 billion at risk annually with cattle and buffaloes being the most affected livestock. In the Punjab, 20 districts[14] have been identified as hotspots because they account for 40% of the province's CoI.

Livestock CoI assumptions

CoI is to be interpreted as the annual cost if livestock is lost to climate impact drivers. Given the probability of high livestock loss, it is possible that livestock farming as an activity could cease in some affected provinces. However, in this project the cessation of livestock farming has not been factored in as it has been assumed there will be stock replenishment every year (the baseline remains as is).

- Textile Industry: The textile sector in Pakistan is vulnerable to climate change, with significant effects on the economy and production stability. Pakistan has a fully integrated textile value chain, crucial to its economy, accounting for over 10% of the GDP and 60% of exports. Cotton production, the third most harvested crop, accounts for 9% of the harvested area and supports the textile industry by contributing 5% to the agricultural GDP. 90% of cotton farmers own less than 5 hectares, underscoring the crop's importance to smallholder farmers and its dual role in bolstering both the agricultural and textile sectors.

- In the downstream value chain, this sector employs 40% of the industrial workforce and accounts for 60% of the country's total exports. There could be significant loss in textile labour force productivity by 2050 due to temperature increase. The cost of inaction model estimates that the cumulative CoI for the textile sector will translate into substantial economic losses due to the effects of drought on raw materials input and extreme heat on labour productivity, mainly borne by the provinces of the Punjab and Sindh. Specifically, the model predicts a 4% loss of textile labour force productivity in 2050 due to temperature increase. All together, these impacts are expected to result in a 15% annual textile GDP in 2030 escalating up to a 30% loss in peak year 2050, which could mean about USD 9 billion at risk annually, primarily due to cotton shortages impacting textile production. Additionally, a 4% GDP loss (USD 1 billion) is anticipated due to decreased labour productivity from extreme heat. In the Punjab, 20 districts including Lahore and Faisalabad have been identified as hotspots because they account for 40% of the province's CoI.[15]

[14] Top 10 districts: Rajanpur, Okara, Rahim Yar Khan, Bahawalnagar, Bahawalpur, Jhang, Sheikhupura, Muzaffargarh, Vehari, Khanewal.
[15] Top 20 districts: Lahore Cantt, Lahore City, Gujranwala, Faisalabad City, Multan City, Sahiwal, Rawalpindi, Gujrat, Sheikhupura, Sargodha, Depalpur, Bahawalpur, Muzaffargarh, Sialkot, Jaranwala, Jhang, Faisalabad Sadar, Okara, Kot Addu.

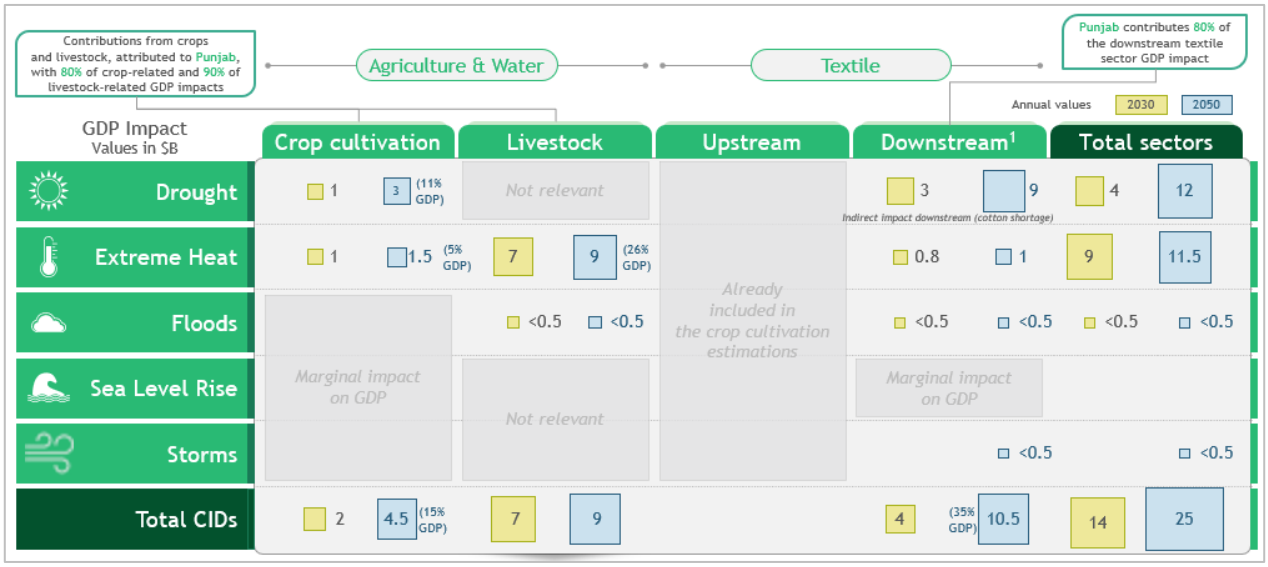


Figure 25 - Economic impact x Priority Areas

The projected total cost of climate inaction in Pakistan is estimated to be $250 billion by 2030 and $1.2 Trillion by 2050, equivalent to losses to priority sectors GDP of ~30% a year (max value in peak year).

Provincial Summary

The development of priorities to mitigate climate risk and the identification of specific A&R actions are tailored to each province's unique climate risk profile, as evaluated by the cost of inaction. Below is a synthesised summary of the essential A&R priorities, categorised by province:

Punjab

Key Climate Impact Drivers

- Extreme Heat
- Drought
- Floods

Key Vulnerabilities

- Reduction in Crop Yields
- Reduced Labour Productivity
- Increased Livestock Mortality
- Damage to Settlements

Priority Areas for Resilience Building

- Agriculture
- Textiles
- Settlements

Summary Narrative

Punjab is Pakistan's most populous province accounting for over 50% of the national population. It is an agrarian powerhouse - the province accounts for approximately 60-70% of the country's arable land, and is the largest producer of Pakistan's top five crops[16]. Its workforce is largely employed in the agricultural and textile sectors with key cities like Lahore and Faisalabad central to both. Punjab faces significant climate risks, namely, floods, extreme heat and drought. These climate risks pose significant displacement risks to the population, impacting the large workforce employed in the agriculture and textile sectors. Forced displacement, loss of working days, as well as destruction of croplands, textile mills and other productive assets will have significant impact on employment and productivity in Punjab, and therefore on Pakistan's economy.

Punjab is very vulnerable to extreme heat, which affects all districts of the province, with the majority scoring high on the risk index. Drought impacts all districts to varying degrees, with four districts severely affected, threatening food security and productivity across 15% of the province.

[16] Agriculture Marketing Information Service

Additionally, floods pose a significant risk to three districts, with the majority of the province facing a lesser degree of exposure.

The province's main vulnerabilities are within the critical sector of Agriculture and Water, both for crop cultivation and livestock. This vulnerability highlights the necessity for prioritised Adaptation and Resilience (A&R) actions aimed at reducing the impacts of extreme heat and drought. Priority A&R actions addressing specific vulnerabilities are suggested in the figure above, while an extensive list of no-regret actions can be found in the supporting documentation provided.

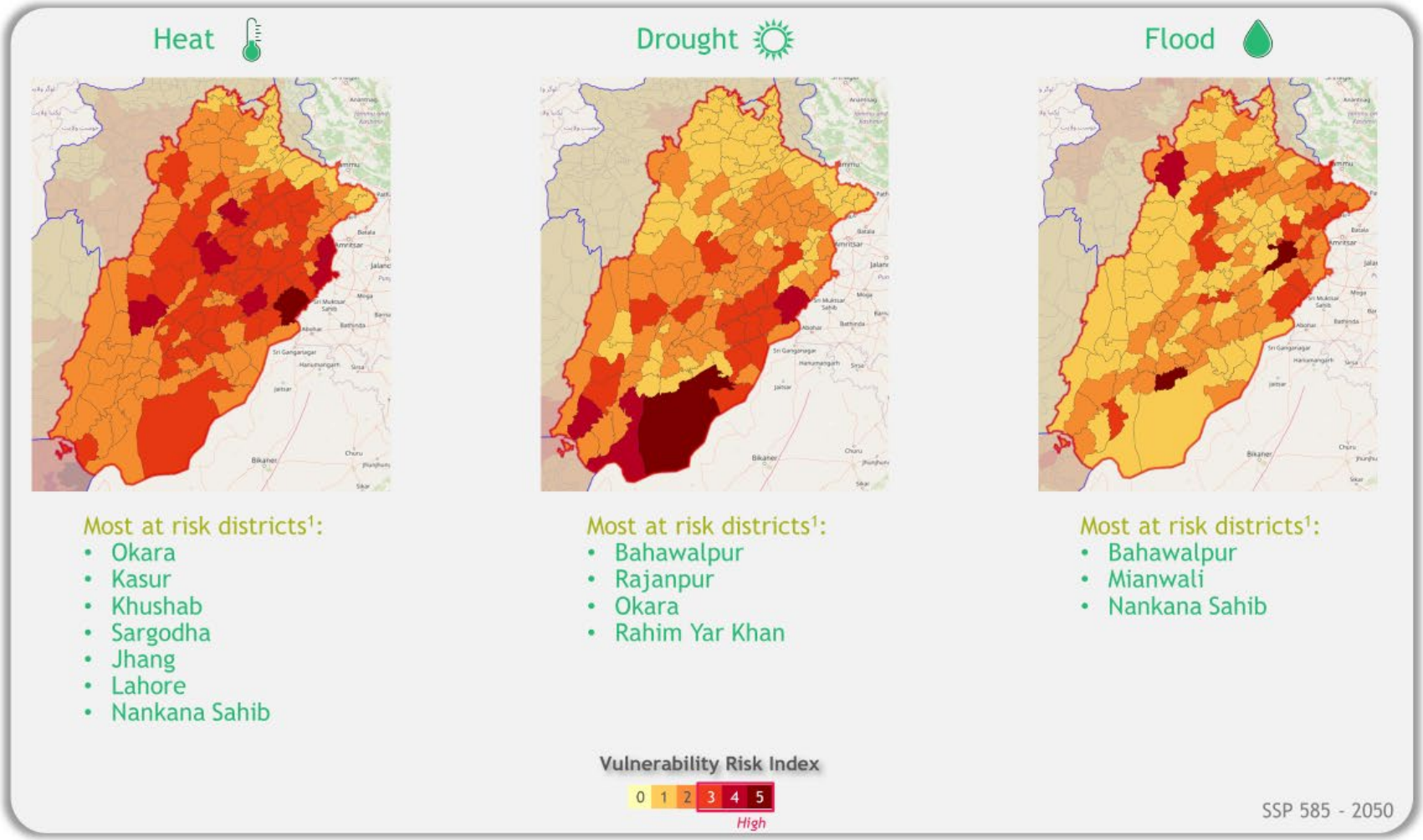
Priority focus for Punjab

As Pakistan's economic backbone, Punjab requires targeted adaptation strategies prioritised around its critical economic sectors: agriculture (crop cultivation and livestock) and textile manufacturing. Given Punjab's severe exposure to extreme heat, drought, and floods, strategies must be implemented immediately to achieve timely and effective results in these sectors.

Punjab, home to 60-70% of Pakistan's arable land, faces substantial risks to crop cultivation from extreme heat and drought. This will impact the livelihoods of farmers, as the agriculture sector is a major source of employment in Punjab.

The textile sector accounts for around 60% of Pakistan's annual exports and 40% of the industrial workforce. The sector therefore needs to be prioritised for careful A&R planning. Punjab hosts the largest number of spinning units and spindles in Pakistan, with 28% of textile industry units concentrated in Faisalabad alone. Extreme heat and drought adversely affect this sector by reducing labour productivity and the availability of raw materials.

The livestock sector is a significant risk due to increased fatality rates from extreme heat. This is a complex problem that could cause major food shortages, job losses and migration. Therefore, a considered scenario-based A&R plan is required – further work is needed to define the actions and strategies needed.



The maps shown are for the most impactful CIDs on the province, other CIDs impact is relatively minor
1. "Most at risk districts" are districts that score 4 or higher on the vulnerability risk index

Figure 26 - Punjab - CID Vulnerability Maps

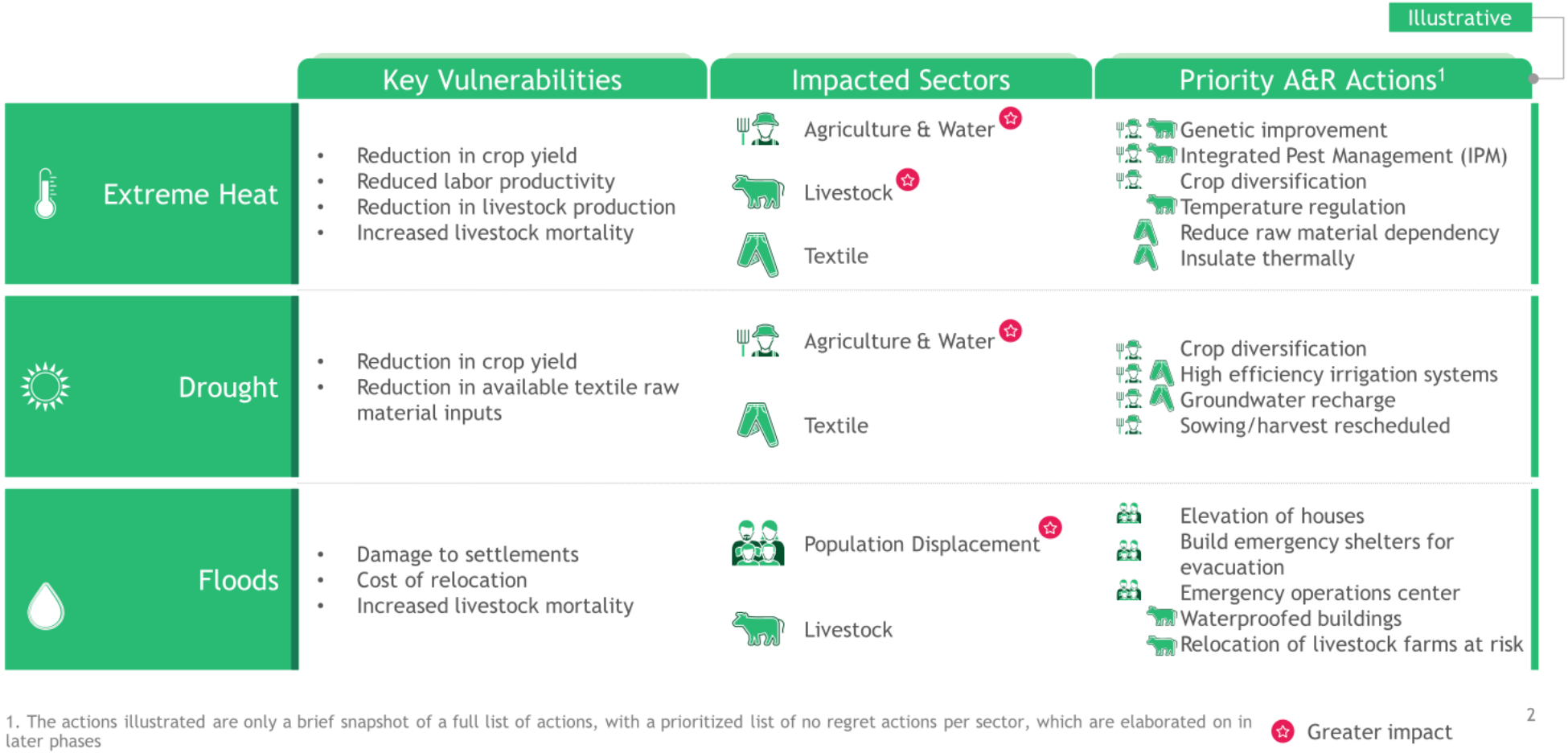


Figure 27 - Punjab - Key Vulnerabilities, Impacted Sectors, Priority A&R Actions

Sindh

Key Climate Impact Drivers

- Extreme Heat
- Drought
- Floods
- Sea Level Rise

Key Vulnerabilities

- Damage to Settlements
- Population Relocation
- Reduction in Crop Yields
- Increased Livestock Mortality
- Damage to Infrastructure Assets

Priority Areas for Resilience Building

- Population Flood Protection & Relocation
- Settlements
- Agriculture
- Textiles
- Resilient Critical Infrastructure

Summary Narrative

Sindh is the second-largest economy in the country, with significant contributions from the industrial and agricultural sectors. Karachi, the financial hub of Pakistan, plays a pivotal role in the province's economic landscape. The fertile Indus River delta supports a substantial portion of Sindh's agricultural activities, which in turn sustains a large part of the population. However, the province is highly vulnerable to all Climate Impact Drivers (CIDs), putting both its agricultural contributions and textile manufacturing output at risk.

Moreover, Sindh faces a heightened risk of population displacement due to the destruction of homes and cropland caused by floods. This disruption can severely impact economic activities, particularly in Karachi and the agricultural zones, leading to the loss of livelihoods, reduced industrial and agricultural output, and substantial economic challenges for Pakistan. Additionally, Sindh's vulnerability to sea level rise threatens long-term permanent displacement of its inhabitants. Sea level rise is expected to permanently displace around 4 million people by 2050.

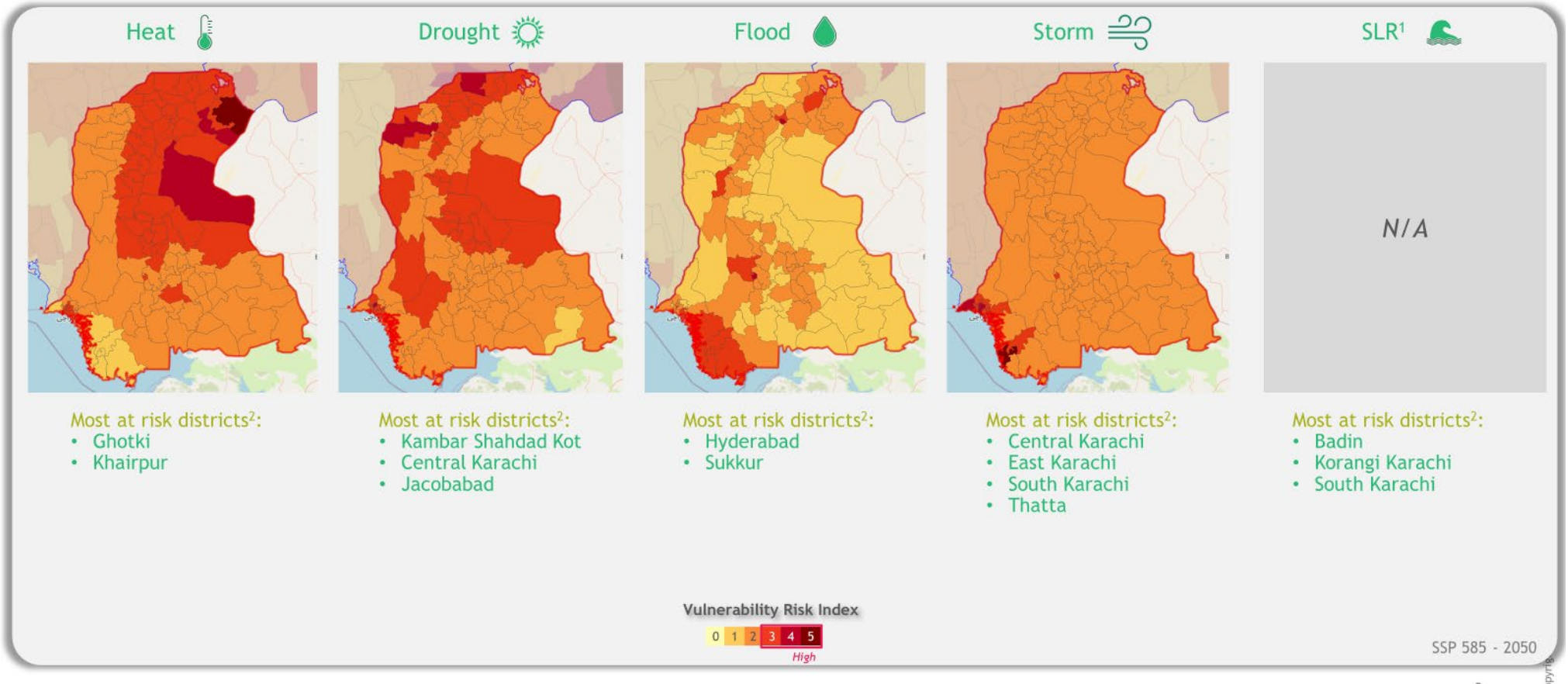
The province is notably exposed to all major climate risks in Pakistan. Extreme heat, drought, and storms pose substantial risks to almost all districts across Sindh, with most districts scoring high on the vulnerability index for extreme heat.

This diverse climate profile places all key economic sectors at significant risk. The agriculture and water sector primarily faces drastic reduction in yields and labour productivity. Increased livestock mortality, driven mainly by extreme heat, is the greatest threat to the livestock sector. Floods pose

significant risks to transport networks and power stations in Sindh, while also raising the threat of temporary displacement to inhabitants through destruction of homes. Lastly, sea level rise raises the risk of drowning transport networks, other infrastructure assets and homes, forcing people to gradually abandon the most affected districts.

Priority focus for Sindh

The climate risk profile of Sindh is varied, requiring an immediate, focused approach to key sectors at risk, particularly agriculture (crop cultivation and livestock) and textile manufacturing. Prioritising crop cultivation and textile manufacturing is urgent and critical, given their significant contributions to Pakistan's economy. Together with Punjab, Sindh accounts for more than 90% of Pakistan's installed capacity for textile manufacturing, with 38% of textile industry units concentrated in Karachi. Reduced crop yields and labour productivity affect both agricultural outputs and inputs for the textile industry. Additionally, adapting transport networks to withstand floods and sea level rise is crucial for maintaining economic stability. There is also the significant risk of population displacement. The potential humanitarian impact is massive, as floods cause temporary relocations and increased rebuilding costs, while sea level rise necessitates permanent relocation in the long term. Finally, as in Punjab, the high COI associated with the livestock sector demands a comprehensive A&R approach, combining multiple actions and strategies, and requiring thorough planning for effective results.



1. Sea Level Rise
2. "Most at risk districts" are districts that score 4 or higher on the vulnerability risk index

Figure 28 - Sindh - CID Vulnerability Maps

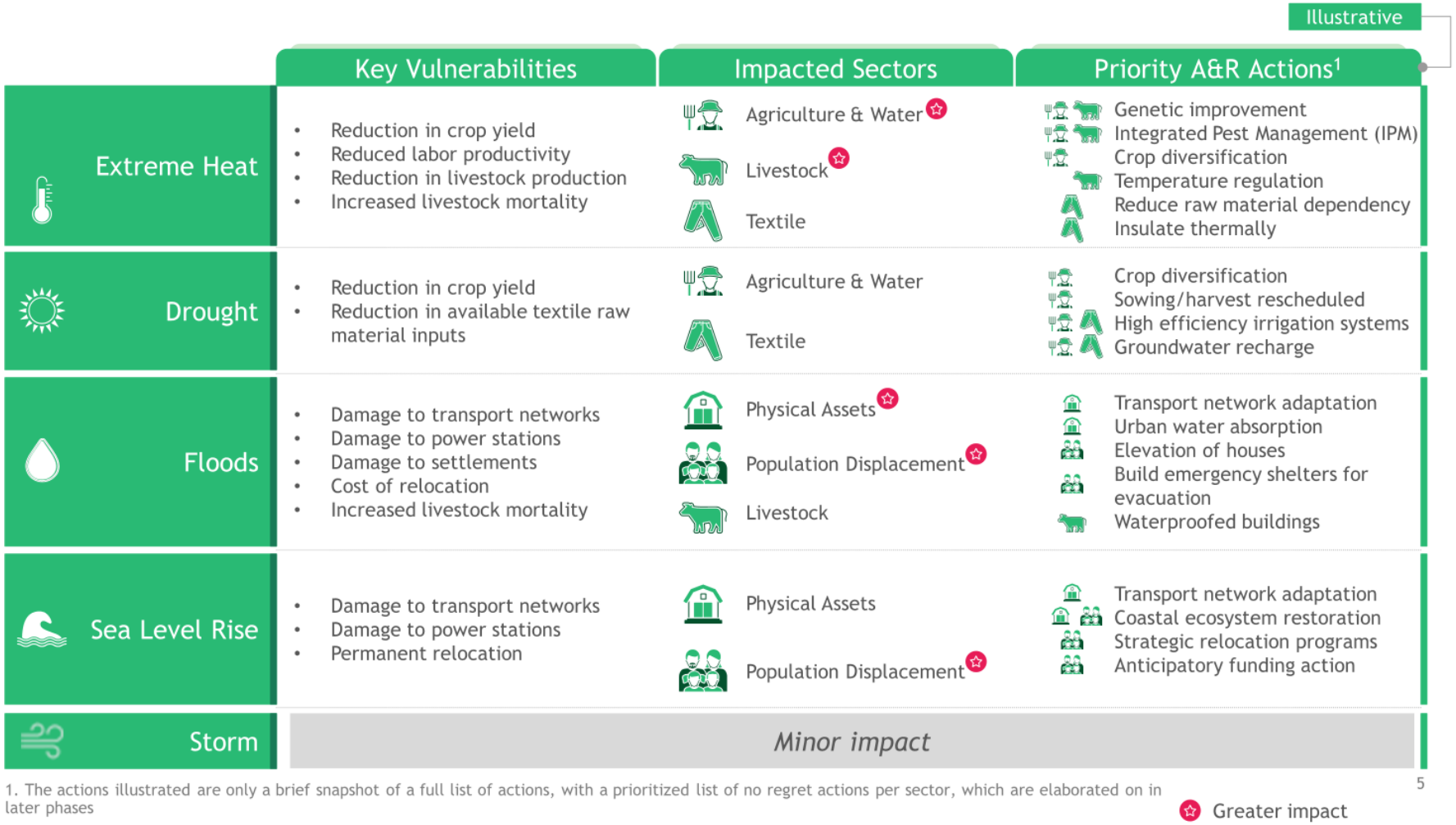


Figure 29 - Sindh - Key Vulnerabilities, Impacted Sectors, Priority A&R Actions

Khyber Pakhtunkhwa

Key Climate Impact Drivers

- Extreme Heat
- Drought
- Floods

Key Vulnerabilities

- Reduction in Crop Yields
- Reduction in Labour Productivity
- Increased Livestock Mortality
- Damage to Infrastructure Assets

Priority Areas for Resilience Building

- Agriculture
- Resilient Critical Infrastructure

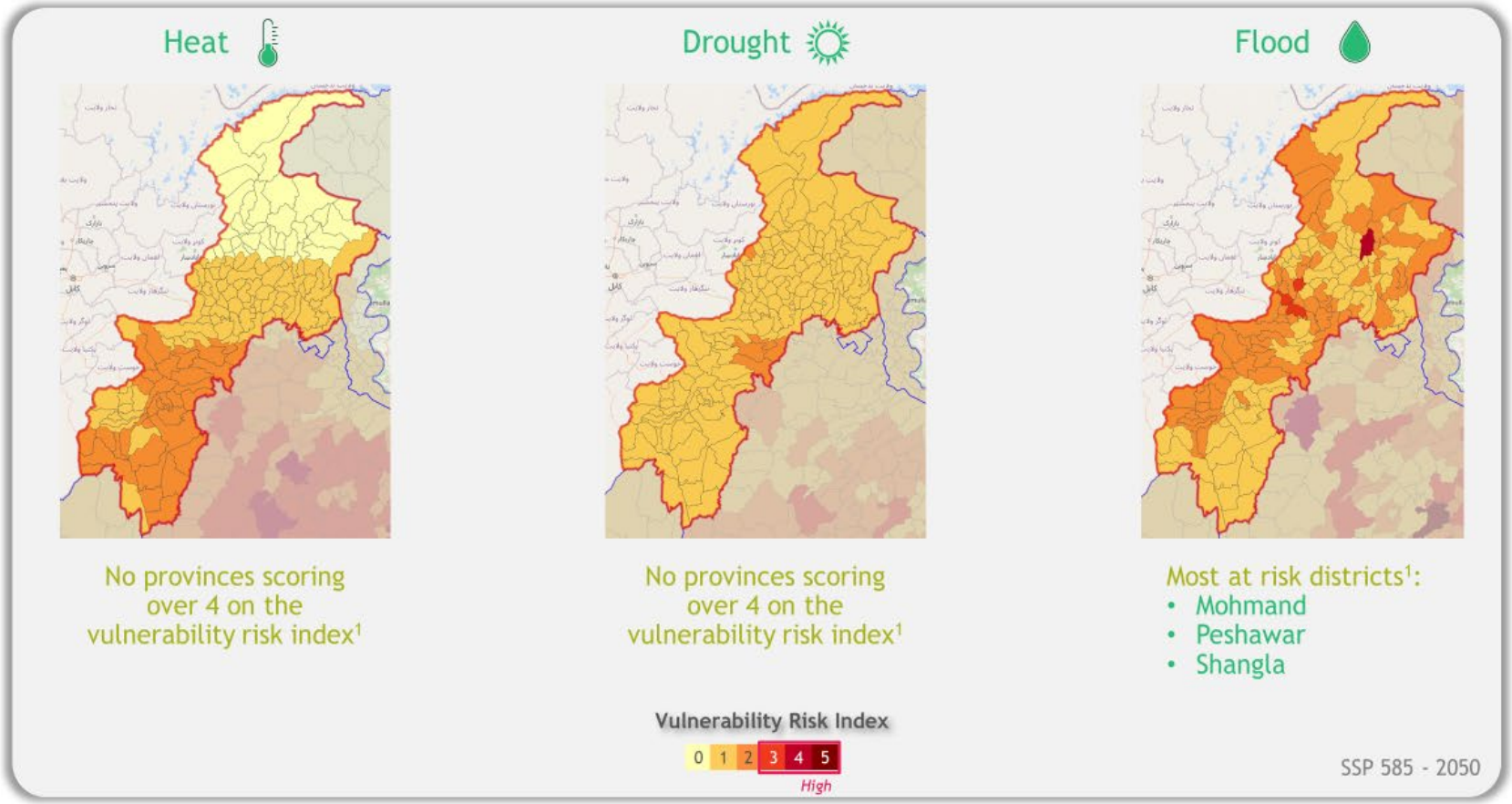
Summary Narrative

Khyber Pakhtunkhwa (KP) has the third largest provincial economy based largely on a diverse agricultural and livestock sector. KP's mountainous terrain makes it particularly susceptible to floods, which can damage power infrastructure, and population centres. Three districts—Mohmand, Peshawar, and Shangla—score over than 4 on the vulnerability risk index. Drought and extreme heat pose major threats, reducing crop yields, labour productivity, and livestock yield. These climate challenges pose serious risks to economic stability and employment in KP, potentially disrupting agricultural output and infrastructure. Population displacement due to these environmental threats could further strain the province's resources and economic activities, as well as putting pressure on regional stability.

Drought affects all districts, reducing crop yields, with a few districts showing high vulnerability. Although extreme heat impacts the province, no districts score over 4 on the vulnerability risk index, but a considerable number of districts are on the brink of greater exposure. Extreme heat and drought reduce crop yields and livestock productivity. Storms have a negligible impact on the province.

Priority focus for Khyber Pakhtunkhwa

KP's most impactful Climate Impact Driver (CID) is floods, which damage power infrastructure and population centres, which will drive to reconstruction and maintenance costs for assets and homes, as well as relocation costs for communities. KP needs to prioritise A&R strategies that reduce the province's exposure to damage of critical infrastructure that have significant knock-on effect on the province's communities and economic activity. The province's vulnerability to extreme heat and drought is less severe than in other provinces meaning the the agriculture sector faces less severe pressure comparatively. However, there is variability by district and many are on the brink of higher exposure so pre-emptive strategic planning would be beneficial.



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1. "Most at risk districts" are districts that score 4 or higher on the vulnerability risk index

Figure 30 - Khyber Pakhtunkhwa - CID Vulnerability Maps

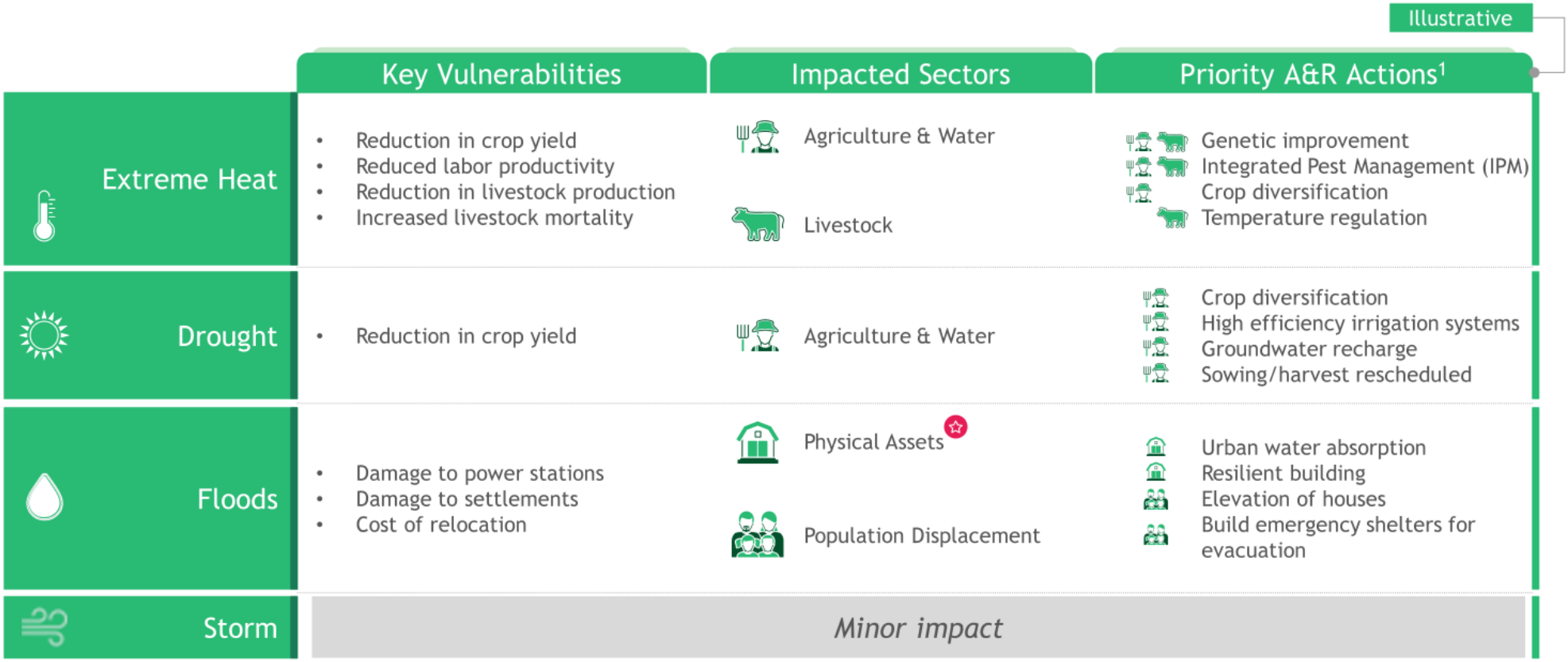


Figure 31 - Khyber Pakhtunkhwa - Key Vulnerabilities, Impacted Sectors, Priority A&R Actions

Balochistan

Key Climate Impact Drivers

- Extreme Heat
- Drought
- Floods
- Sea Level Rise

Key Vulnerabilities

- Reduction in Crop Yields
- Increased Livestock Mortality
- Damage to Infrastructure Assets
- Population Relocation

Priority Areas for Resilience Building

- Agriculture
- Textiles
- Resilient Critical Infrastructure
- Population Relocation

Summary Narrative

Balochistan, as one of Pakistan's two coastal provinces, has a diverse climate profile, making it susceptible to all Climate Impact Drivers (CIDs) affecting the country. Drought conditions lead to reduced crop yields, while extreme heat adversely affects livestock production. Sea level rise compels permanent relocations, particularly in coastal areas. Floods and storms damage transport networks and other critical infrastructure. Despite not being one of the key agricultural provinces, Balochistan is highly vulnerable to drought, sea level rise, storms, extreme heat, and floods. These vulnerabilities threaten the livelihoods of those dependent on agriculture and livestock, disrupt economic activities, and pose significant challenges to maintaining infrastructure. The compounded effects of these risks can lead to substantial economic setbacks for Balochistan and Pakistan as a whole.

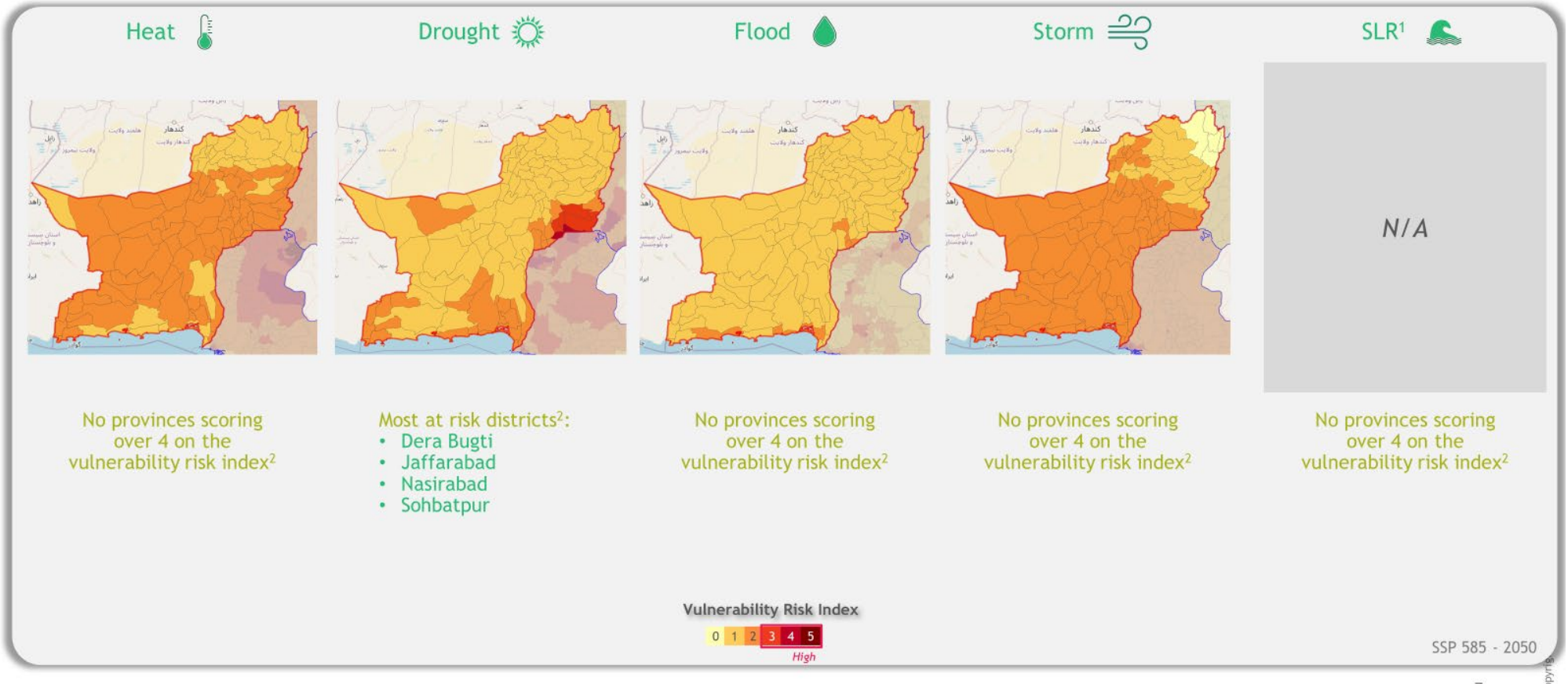
Balochistan shares a similar climate profile to Sindh but is generally less vulnerable. However, it still faces significant risks from various climate impacts. Sea level rise poses a critical threat, potentially leading to the long-term permanent displacement of its coastal population. Drought remains a particular concern, with districts like Dera Bugti, Jaffarabad, Nasirabad, and Sohbatpur being the most at risk. Extreme heat, drought, and storms are substantial risks affecting multiple districts, although none score over 4 on the vulnerability risk index. Floods and storms, while present, have a lower impact compared to other risks.

The province's vulnerabilities highlight the need for strategic adaptation measures to mitigate these threats and protect Balochistan's people and economy. With 5 million people at risk of permanent displacement from Balochistan by 2050, sea level rise is one of the major risks the province faces, prompting the need for targeted long-term adaptation strategies. Furthermore, drought and extreme heat pose significant challenges to Balochistan's agriculture sector by reducing crop yields

and increasing livestock mortality. Despite the risk in Balochistan being lower than in other provinces, the province is susceptible to all climate risks, emphasising the need to prioritise Adaptation and Resilience (A&R) actions across its priority sectors.

Priority focus for Balochistan

Despite being exposed to all climate risks in Pakistan, Balochistan is not at grave and immediate risk from any specific Climate Impact Driver (CID). Extreme heat and storms affect most districts in the province, but the vulnerability index is low. This presents an opportunity to set Adaptation and Resilience (A&R) plans in place early. Drought poses a significant risk to a few districts across the province, necessitating a focus on A&R actions to mitigate the impact on crop yields. Given that livestock contributes more than 50% to the province's agricultural GDP and 10% to Balochistan's overall GDP, prioritising the sector's resilience is essential. Increasing mortality rates highlight the need to assess and implement robust A&R strategies to safeguard the livestock sector.



1. Sea Level Rise
2. "Most at risk districts" are districts that score 4 or higher on the vulnerability risk index

Figure 32 - Balochistan - CID Vulnerability Maps

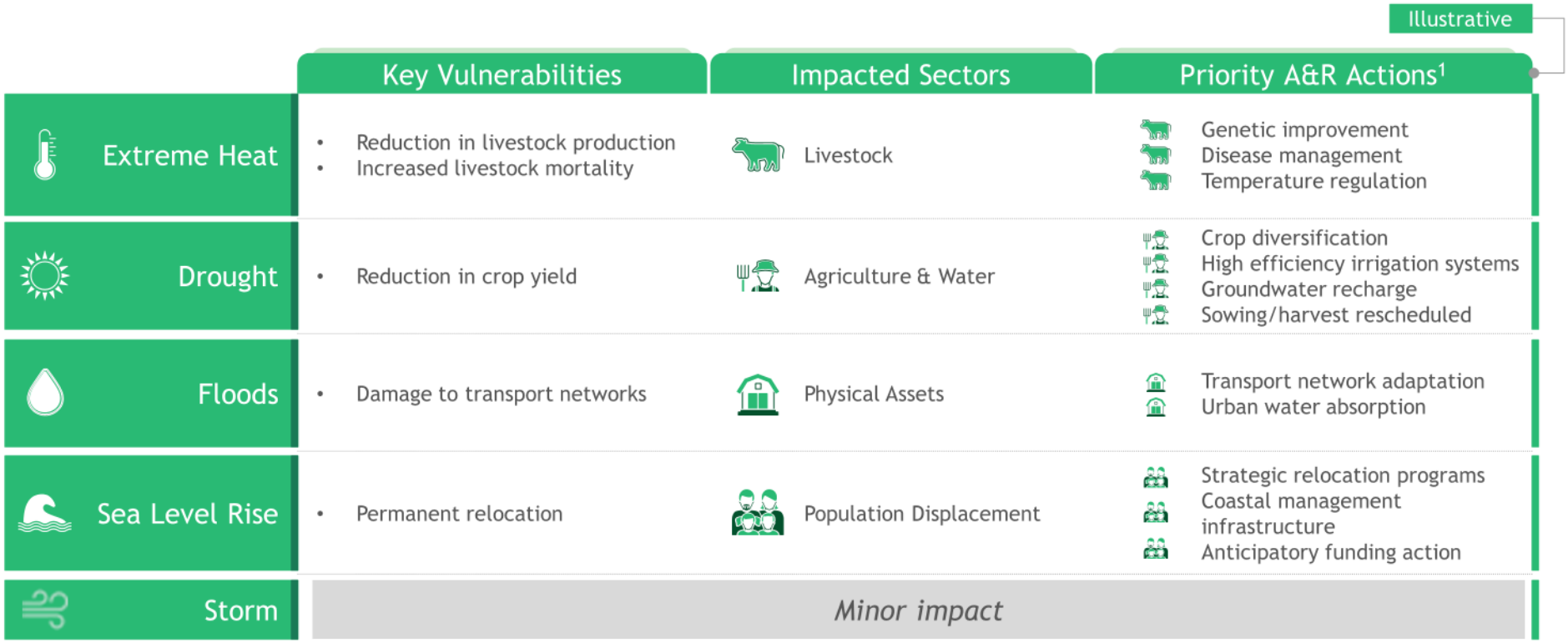


Figure 33 - Balochistan - Key Vulnerabilities, Impacted Sectors, Priority A&R Actions

Gilgit Baltistan

Key Climate Impact Drivers

- Glacial Lake Outburst Floods (GLOF)
- Floods
- Drought

Key Vulnerabilities

- Damage to Infrastructure Assets
- Damage to settlements
- Reduction in Crop Yields

Priority Areas for Resilience Building

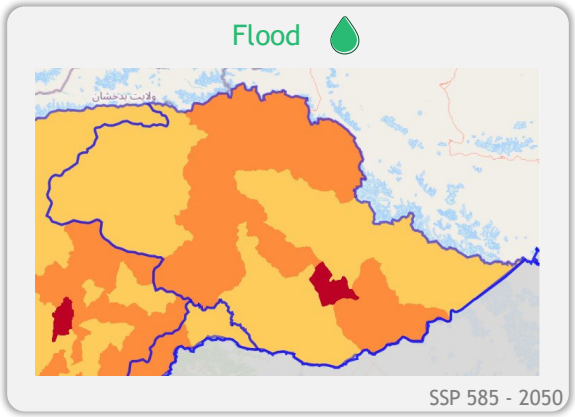
- Water and GLOF
- Agriculture
- Livestock
- Resilient Critical Infrastructure
- Population Relocation

Summary Narrative

Gilgit Baltistan is (GB) Pakistan's northernmost territory. It faces major threats from the formation of glacial lakes and resulting GLOF events. GLOF risk is not quantified by this project, however this should be noted as a key vulnerability. GB's mountainous terrain amplifies the threat of precipitation induced floods. In the short-term GB is exposed to a significant risk of land erosion along major water flow paths due to high water flow volumes, increased turbidity of drinking water and siltation in water reservoirs and irrigation channels, increased health risks and population displacement. This will also have adverse implications on biodiversity due to habitat loss. In the longer term the province will likely experience increasing water scarcity and frequent droughts during the summer months.

Priority focus for Balochistan

Floods significantly impact Gilgit Baltistan's agricultural output which is directly linked to community livelihoods as well as critical infrastructure and settlements. To address this, A&R strategies should be implemented, such as diversifying crop varieties to grow more flood-resilient crops or using genetically improved/modified seeds. Protective works should be undertaken along major water paths to avoid land erosion and protect vulnerable lands and settlements from floods. In the livestock sector, genetic improvement of livestock species can reduce the mortality rate caused by floods. Strengthening structures to make them waterproof can prevent houses from being flooded or destroyed, reducing the likelihood of families having to abandon their homes. Building the territory's resilience to floods should be a priority for Gilgit Baltistan to stabilise the economy and protect the livelihoods of its rural population.



Illustrative

	At Risk Districts	Impacted Sectors	Priority A&R Actions[1]
Floods	• Skardu	Agriculture & Water Livestock Population Displacement	Anticipatory funding action Waterproofed buildings Genetic improvement Crop diversification
Extreme Heat	*No districts at risk*		
Drought	*All districts have a very low score (1)*		
Sea Level Rise	*No districts at risk*		
Storm	*Minor impact*		

10

1. Actions are illustrative, full list of actions and no regret actions is available in the supporting documents provided

Figure 34 – Gilgit Baltistan - Key Vulnerabilities, Impacted Sectors, Priority A&R Actions

Impacts on Society & Cultural Assets

In addition to the initial findings, the assessment examines the extensive impacts of climate risks across dimensions including gender, society, and nature in Pakistan, uncovering significant vulnerabilities especially among women and children. About 50% of women and 15% of young girls are exposed to CIDs. Additionally, by 2050, three million malnourished children will also face similar risks. The analysis shows that 90% of the land is projected to face extreme heat exposure[17], severely affecting agricultural productivity, and leading to socioeconomic instability, as 35% of the agricultural workforce is significantly exposed. Education is notably disrupted, especially for girls, with climate risks threatening the educational journey of around 14 million girls by 2050.

Furthermore, cultural heritage sites, including the archaeological ruins at Mohenjo-Daro, the Fort and Shalimar Gardens in Lahore, and Taxila in Rawalpindi district, are under threat. Extreme heat poses a significant risk to 80% of these valuable assets. This highlights the need for prioritizing targeted climate resilience and conservation strategies to protect both natural and cultural resources.

Impacts on Vulnerable and Marginalised Groups

Pakistan's most vulnerable groups are women, children, the elderly, and disabled persons. These groups, similar to Pakistan's general population are exposed to all CIDs:

- 50% of women face exposure across all CIDs, with extreme heat and flood impacting the highest number of women with 90M and 60M respectively.
- Approximately 35% of children face exposure to all CIDs, where extreme heat (65M) and flood (45M) impact the greatest number of children.
- 10-15% of malnourished children face exposure across all CIDs, as well as 15% children with stunted growth.
- 35-50% of the elderly population also face exposure to all CIDs, particularly extreme heat (75M) and (50M) flood, and ~20% of the total exposed elderly population are living in poverty.
- Despite being a small percentage of the population exposed (<0.1%), due to their small number of Pakistan's total population too, a considerable number of disabled persons are exposed to climate risks with 285K exposed to extreme heat, 175K exposed to floods, and 170K exposed to drought, storms, and sea level rise.

Within vulnerable populations, women are a key group significantly affected by climate hazards. In fact, 50% of women are exposed to floods and SLR, markedly increasing their risk of displacement. Permanent displacement projections estimate 2.4 million women to be displaced due to SLR. These 2.4 million mostly reside in Sindh, mainly around Karachi in Saddar & Korangi towns, and 40,000 in Balochistan.

Climate change exacerbates existing inequities. Existing research shows that the effects of climate-related disasters are not gender neutral, with women and children being the highest risk groups. Key factors that contribute to the highest levels of vulnerability are: gender-based differences in time-use, access to assets and credits, treatment by formal institutions and the consequent strain on women's opportunities, limited access to policy discussions and decision-making, and a lack of sex-disaggregated data for policy change.

In the aftermath of the 2022 Pakistan floods, a social impact assessment was carried out by World Bank and UN Women to assess the socio-economic conditions of socially excluded and marginalised groups residing in flood affected areas. The assessment found that the livelihoods of female home-based, and on-farm and

[17] Extreme heat refers to the number of days with a temperature beyond 35°C.

off-farm agriculture and dairy/livestock workers were disproportionately affected. The severest impacts were found to focus on precarious workers, specifically women, older people, people with disabilities, and landless farmers, and associated with agricultural and livestock sectors. Furthermore, damage to infrastructure also restricted casual labour opportunities, with women, transgender persons, and people with disabilities disproportionately affected. These impacts were seen to increase the likelihood that women will be pushed into poverty and increase gendered economic inequality.

A key coping mechanism for households was the ability to travel to find daily labour. However, women in Pakistan are often culturally restricted from traveling alone away from the household, women also likely to have caring responsibilities. In an FCDO programme funding transport for health services, the majority went to women. Children were also pulled out of schools (particularly girls), with poor families reporting an inability to provide children with school supplies. Other children reported missing school for extended periods because they were repairing family homes. Girls became more vulnerable to child and early marriages as a coping strategy by dislocated families. It is estimated that almost 640,000 adolescent girls were vulnerable and at increased risk of coercion, Gender-Based Violence, and child marriage in the aftermath of the 2022 floods.

To address the vulnerabilities of Pakistan's most at-risk populations to climate risks, a multi-faceted approach is essential. Enhanced healthcare access, particularly in rural and flood-prone areas, should be prioritized through mobile health clinics and specialized programs for women, children, the elderly, and disabled persons. Mental health support systems must also be established to provide trauma care and psychological support. In education, rebuilding and reinforcing infrastructure in disaster-prone areas is crucial to ensure schools are resilient to floods and other hazards. Inclusive education programs should cater to vulnerable children, including those with disabilities, and ensure girls can continue their education during and after disasters. Integrating climate change and disaster preparedness into the curriculum will educate children about risks and coping mechanisms.

Social and economic support is vital, with sustainable livelihood programs for women in agriculture and livestock sectors, and vocational training and microfinance options to reduce economic vulnerability. Strengthening social safety nets, including cash transfer programs and food security initiatives, will support households during and after disasters. Legal and policy reforms are necessary to protect the rights of vulnerable groups and ensure their inclusion in disaster response planning. Investing in resilient infrastructure, such as flood defences and drought-resistant water systems, will mitigate the impact of CIDs.

Empowering local communities through participatory planning and capacity-building initiatives will ensure they have the resources and knowledge to respond effectively to disasters. Promoting women’s participation in policy-making and disaster management processes, and supporting women's leadership in community resilience projects, will empower women. Implementing measures to protect women and girls from gender-based violence and exploitation during displacement and recovery phases is crucial.

5 PATHWAY TO ADAPTATION AND RESILIENCE

5. Pathway to Adaptation & Resilience

This chapter considers actions that can be taken across priority themes to mitigate climate risks and enhance resilience in Pakistan.

Methodology and Prioritisation Approach

A tailored action list was developed by first reviewing Pakistan's National Adaptation Plan (NAP), to ensure alignment with national priorities, before studying and applying international A&R benchmarks and databases. A diverse group of stakeholders were engaged through multiple consultations to enrich the tailored action list with varied perspectives and to ensure scientific rigour. These groups included Government of Pakistan bodies, development partners, and national and international expert organisations.

The project team implemented a prioritisation approach to identify the greatest climate risks by priority areas. The team first undertook COI calculations, informed by climate impact drivers across each of the provinces and districts. They focused on the most severe risks, factoring the highest physical risks and severity of exposure, and the provinces and districts that are likely to be most impacted. The team then mapped the provinces and districts according to these calculations, illustrating priority areas where efforts are most critically needed.
The aim of the analysis below is to prioritise actions that are most relevant to the priority areas identified above. These prioritised actions have been grouped into three themes – people, assets, and the economy – with several *build actions* assigned to each theme. *Enabling actions* have been identified and also assigned to each theme to build Pakistan's capacity and support the implementation of the *build actions*.

The text box below provides a summary of the key *build actions*.

Summary of the three themes and prioritised *build actions

People – prioritised *build actions* focus on domestic infrastructure including affordable housing, emergency response coordination, and social protection initiatives with a focus on urban-poor communities.
Assets – prioritised *build actions* focus on elevating houses, building emergency shelters, and adapting transport networks.
Economy – this theme has been divided into two sub-themes as follows:

- **Agriculture-Crops** – prioritised *build actions* focus on climate smart agriculture practices, labour productivity, soil salinity, water availability and disease management and surveillance.
- **Agriculture-Livestock** – prioritised *build actions* focus on farming practices and upgraded infrastructure.
- **Textile Sector** – prioritised *build actions* focus on a reduction on raw material dependency, improvements in labour productivity, the fortification of infrastructure, and the use water-efficient machines.

**A full list of build actions can be found in the Appendix.*

The text box below provides a summary of the key *enabling actions*.

Summary of the three themes and prioritised *enabling actions

People – prioritised *enabling actions* focus on financial mechanisms that employ government or NGO support.
Assets – prioritised *enabling actions* focus on reducing risk exposure, and reducing disaster impacts.
Economy – this theme has been divided into three sub-themes as follows:

- **Agriculture - Crops sub-sector** – prioritised *enabling actions* complement *build actions* by focusing on mitigating the effects of population displacement through community advancement strategies and financial mechanisms.
- **Agriculture - Livestock sub-sector** – prioritised *enabling actions* focus on livestock insurance schemes.
- **Textile sub-sector** – no specific *enabling actions* have been identified.

**A full list of enabling actions can be found in the Appendix.*

1. People

Figure 26 below illustrates the core *build actions* and *enabling actions* as outlined in this People section.

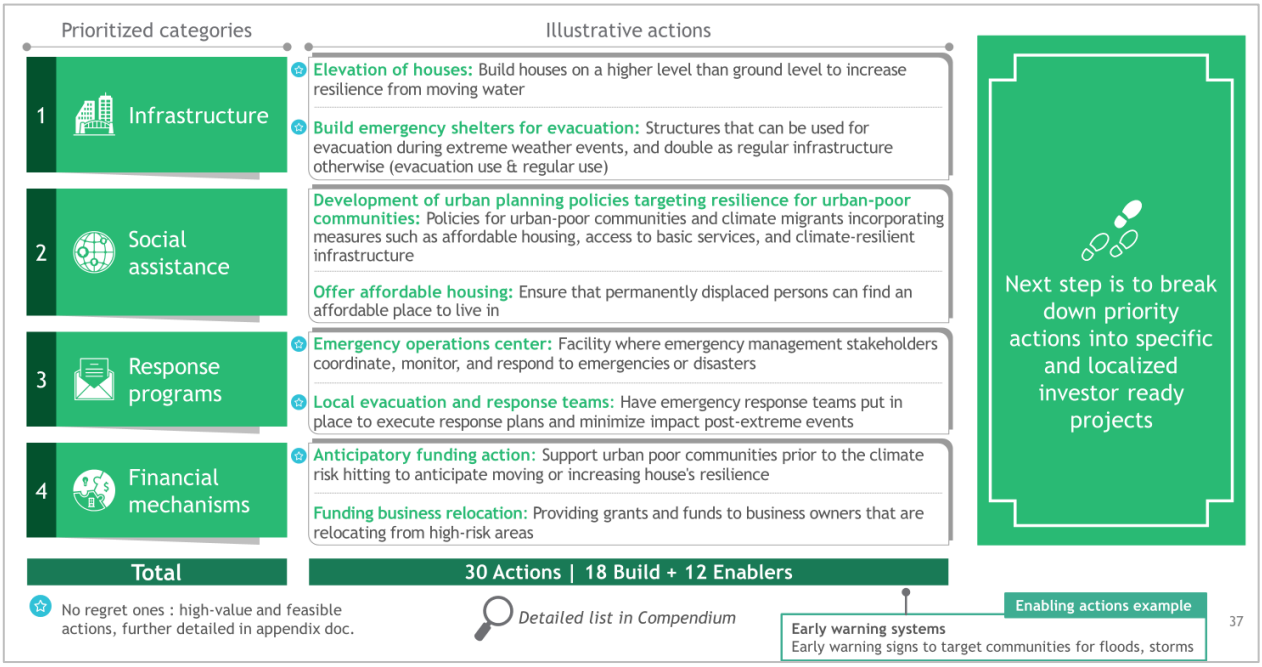


Figure 34 – Adaptation and Resilience Actions – the 'People' theme

Build Actions

The People theme identified a total of 30 actions, of which **18 are classified as *build actions***. This section of the report focuses on **three prioritised *build actions***; infrastructure, emergency response programming and social protection. Analysis by the project team identified that the strategy for addressing the risk of population displacement involves enhancing domestic infrastructure to withstand floods, establishing robust emergency response systems, and implementing social protection programs to support populations if displaced.

The project team have provided summaries of each of the *build actions* below.

- **Infrastructure:** low capital expenditure *build actions* are targeted specifically at reducing the damage and destruction of domestic infrastructure at risk from flash flooding (pluvial and fluvial). These actions in turn reduce the cost of major repairs to infrastructure, or rebuilding entirely at an increased cost above ground level to increase resilience from moving water. In the context of Pakistan, infrastructure actions are applicable only to Pucca (built using bricks and cement) and Semi-Pucca (mix of brick, mud, and bamboo) houses which represent 70% of houses in Punjab.
- **Emergency response programmes:** *build actions* are focused on preparing for a timely response in the event of an emergency situation. *Build actions* include the planning for, and development of, emergency operations centres to coordinate, monitor, and respond to emergencies or disasters.
- **Social protection:** these are *build actions* that provincial governments can undertake to assist their populations in affording resilient houses and assist in the temporary and permanent relocation of populations, such as offering affordable housing to permanently displaced persons. Leveraging existing social protection systems, such as the Benazir Income Support Program (BISP) and the Pakistan Social Protection Program (PSP), can significantly enhance these efforts, with direct cost savings and time efficiencies.

Enabling Actions

Of the 30 actions within the People theme, **12 are classified as *enabling actions***. Figure 26 groups these enabling actions under a fourth category; Financial Mechanisms. Financial mechanisms are *enabling actions* that employ government or NGO support to financially aid the building of resilience and the relocation of individuals and businesses. This can include weather-indexed insurance that uses weather or climate data to determine policy payouts; social assistance actions including basic necessities like food stamps, rations, emergency food distribution, education, and healthcare subsidies; and community awareness and preparedness actions.

2. Assets

Figure 27 below illustrates the core *build actions* and *enabling actions* as outlined in this Assets section.

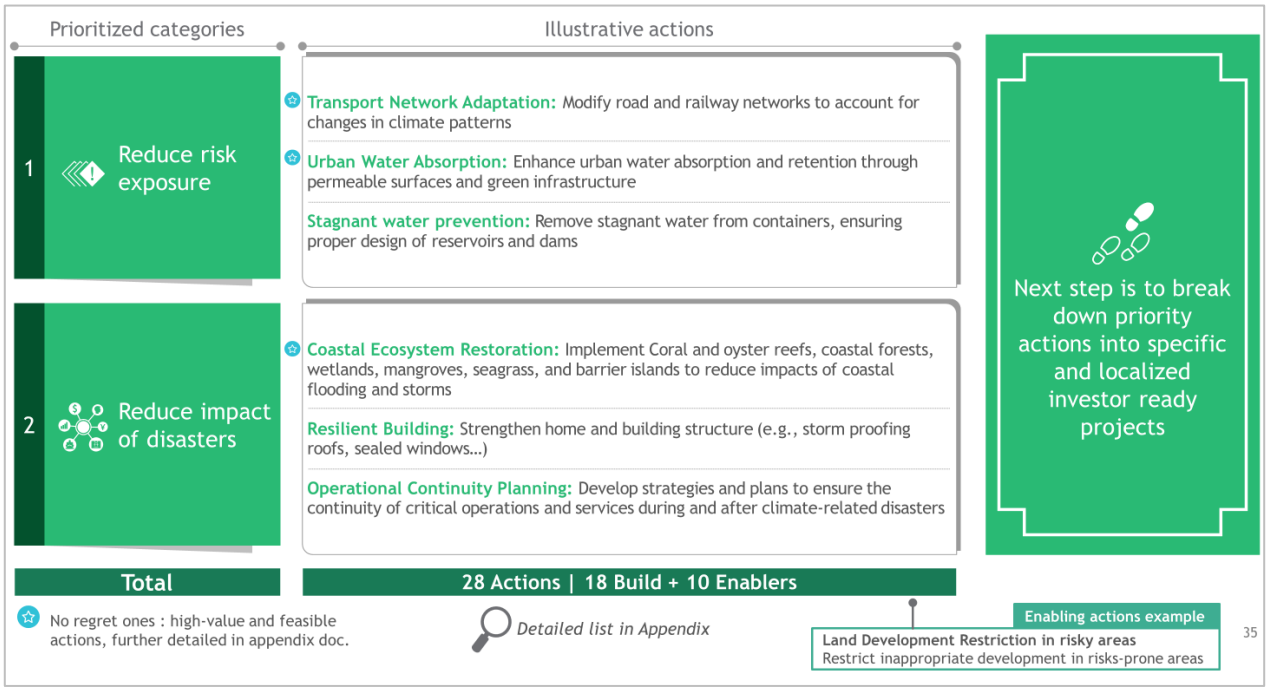


Figure 35 - Adaptation and Resilience Actions – the 'Assets' theme

Build Actions

The Assets theme identified a total of 28 actions, of which **18 are classified as *build actions***. Analysis by the project team identified fortifying infrastructure such as transportation networks and social facilities that are vulnerable to flooding and sea-level rise as a focus area. This section of the report focuses on **two prioritised *build actions*** for physical assets*;* reducing risk exposure, and reducing disaster impacts. The *build actions* have been carefully categorised to address specific vulnerability dimensions of the industry to mitigate the impacts of coastal flooding and storms.

The project team have provided summaries of each of the *build actions* below.

- **Reducing risk exposure:** *build actions* are focused on strategically lowering the exposition of physical assets to potential climate hazards.
    - **Transport network adaptation:** *build actions* are focused on approaches to modify road and railway networks to account for changes in climate patterns by, for instance, elevating roads and rail lines in flood-prone areas, using heat-resistant materials in construction, and redesigning drainage systems to manage heavier rainfall.

- **Reducing disaster impacts:** *build actions* are focused on implementing measures to shield infrastructure and assets from the detrimental effects of climate-related disasters.
    - **Coastal ecosystem restoration:** *build actions* are focused on the protecting, maintaining, and improving construct coral and oyster reefs, coastal forests, wetlands, mangroves, seagrass, and barrier islands to reduce impacts of coastal flooding and storms.

Enabling Actions

Of the 28 actions within the Assets theme, **10 are classified as *enabling actions*** to build Pakistan's capacity and support the implementation of *build actions*. These include the following:

- **Developing green urban financing mechanisms**, such as green bonds, which help fund resilient urbanisation.
- **Adaptation incentive programmes** are also part of the strategy, offering financial incentives or subsidies to promote the adoption of adaptation measures at the household level, such as flood-resistant construction or green infrastructure.
- **Formal land registration for resilience initiatives** involves registering peri-urban properties to incorporate them into the formal land management system, employing land conversion controls, zoning, and building codes to increase resilience in the face of disasters.

3. Economy

The Economy theme has been evaluated by the project team through the lens of three key sub-themes affected by climate risks; agriculture-crops, agriculture-livestock, and the textile value chain. This section of the report reviews the *build actions* and *enabling actions* for each respective sub-theme separately.

i. Agriculture – Crops

Figure 28 illustrates the core *build* and *enabling actions* as outlined in the Agriculture – Crops sub-theme.

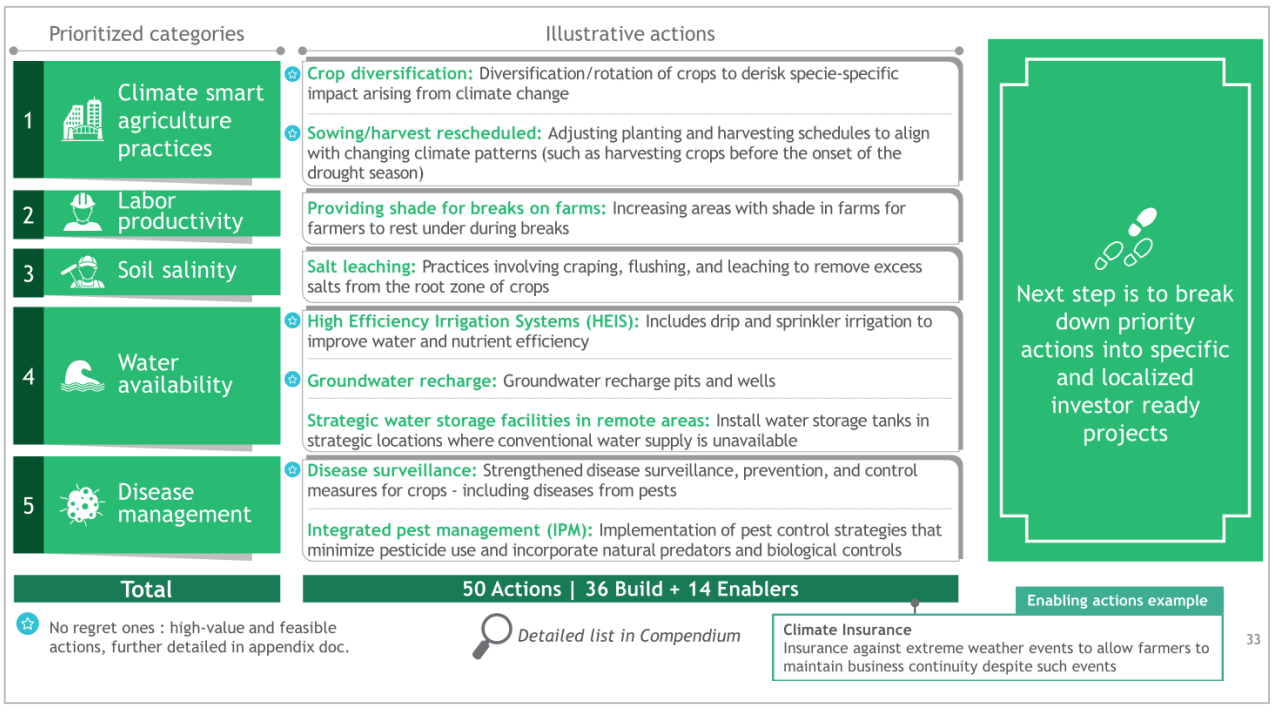


Figure 36 - Adaptation and Resilience Actions – the 'Agriculture – Crops' sub-theme

Build Actions

Crop cultivation is severely affected by drought and extreme heat, which, among other things, jeopardise yields and outputs. Various adaptation measures are essential for agriculture. Traditional climate-smart practices, such as crop diversification and rotation, enhance resilience and efficiency, recognised by Pakistan's National Climate Change Policy and adopted by experienced farmers. Ensuring water availability through efficient management practices, such as recharging groundwater, is vital, as demonstrated by donor and government funded initiatives such as Water Resource Accountability in Pakistan (WRA) and Recharge. Strengthened disease surveillance and control measures are also essential to protect crops and maintain agricultural productivity. In addition to these actions, new and more innovative approaches are being incorporated to better address vulnerabilities in the industry.

Within the Agriculture - Crops sub-theme, the project team identified a total of 50 actions, of which **36 are classified as *build actions***. To further enhance crop cultivation, *build actions* have been organised into specific categories tailored to these needs.

- **Climate smart agriculture practices:** These are practices that enhance the effectiveness and efficiency of farmers in managing their crops and increasing their resilience such as crop diversification/rotation of crops to derisk species-specific impact arising from climate change. Pakistan's National Climate Change Policy recognises the importance of crop diversification. The practice is adopted by more experienced farmers who are more aware of their risk exposure.
- **Labour productivity:** These actions are aimed at reducing the impact of prolonged exposure to extreme heat on the productivity of farmers (providing shade for breaks on farms).
- **Soil salinity:** These actions focus on reducing soil salinity through approaches such as salt leaching.
- **Water availability:** Water availability efforts in Pakistan focus on introducing best practices for efficient water management, reducing water requirements, conserving water, and enhancing water quality through methods such as recharging groundwater via pits and wells. These practices have been implemented under initiatives like WRAP and Recharge, with significant progress marked by the construction of 50 wells by June 2022.
- **Disease management and surveillance:** These actions are focused on disease prevention and surveillance through methods such as strengthened disease surveillance, prevention, and control measures for crops.

Enabling Actions

Of the 50 actions within the Agriculture, Crops theme, **14 are classified as *enabling actions***. These *enabling actions* complement build actions by focusing on mitigating the effects of population displacement. Community advancement strategies are employed to educate and inform communities about effective farmland management practices through workshops on water and soil management. Financial mechanisms play a crucial role as well, offering support through climate insurance and other aids to help farmers adopt new techniques and safeguard their economic stability.

Zoom on Climate Insurance

According to Pakistan Agricultural Coalition, the Government of Pakistan is focusing on expanding insurance coverage and enhancing the regulatory framework for insurance. In 2022, pilot insurance programs for crops like wheat and cotton were successfully implemented across three seasons, resulting in significant payouts due to extreme weather conditions. There are ongoing initiatives to scale these insurance programs to a national level, including establishing a regulatory framework that could incorporate all farmers and attract the participation of private insurers, underscoring the need for a national crop insurance scheme.

ii. Agriculture – Livestock

Figure 29 below illustrates the core *build actions* and *enabling actions* as outlined in this Agriculture – Livestock sub-theme.

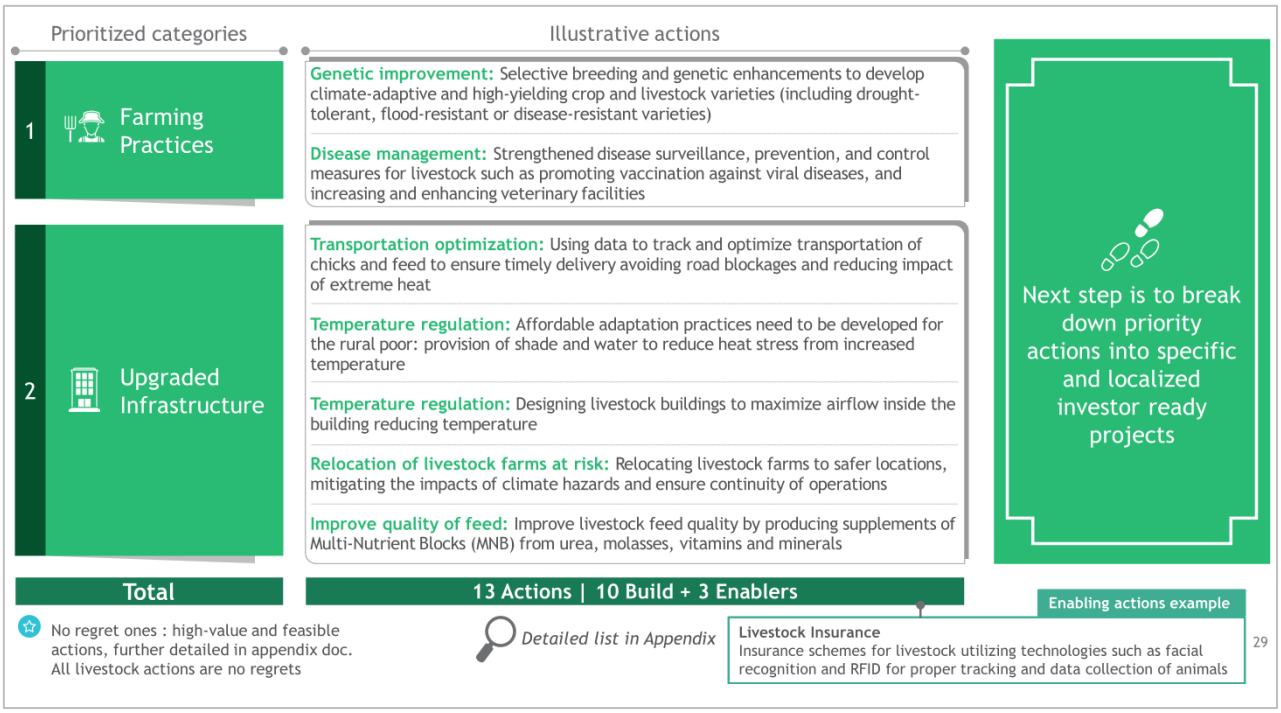


Figure 37 - Adaptation and Resilience Actions – the 'Agriculture – Livestock' sub-theme

Build Actions

Extreme heat adversely affects animal health and productivity. Actions include improving infrastructure to regulate temperatures on farms and protect animals from heat stress. To build resilience against the devastating impacts of extreme heat on the livestock industry, 10 prioritised *build actions* have been developed and grouped into two categories.

- **Farming practices:** These actions increase animals' resilience to heat, such as genetic improvement to develop climate-adaptive and high-yielding livestock varieties (including drought-tolerant, or disease-resistant varieties). Widespread adoption of these measures has not yet occurred, highlighting a need for enhanced collaboration with research institutes to accelerate action and expand the impact of such initiatives (a few initiatives such as the drought-tolerant Cholistani cattle breeding project are in place).
- **Upgraded infrastructure:** These actions target farms and livestock networks to upgrade infrastructure such as buildings, farm locations, and feed delivery chains to maximise the industry's adaptation and resilience to heat (for example, designing livestock buildings to maximise airflow inside the building reducing temperature).

Enabling Actions

Of the 13 actions within the Agriculture – Livestock sub-theme, **3 are classified as *enabling actions***. Enabling actions are key, including initiatives like livestock insurance schemes that incorporate cutting-edge technologies such as facial recognition and Radio Frequency Identification (RFID) to ensure precise tracking and data collection of animals. In Pakistan, these insurance schemes have been piloted under the National Crop Insurance Scheme. Additionally, a pilot program using facial recognition for livestock insurance has

been launched, and the Punjab government has started creating an animal database specifically for insurance purposes.

Actions to render livestock production manageable under extreme heat and drought conditions should be further studied in detail in the subsequent stage of this report. The feasibility of techniques such as passive or active cooling for livestock, genetic improvements, adapted farm infrastructure, and livestock insurance should be thoroughly examined. Some of these techniques have already been implemented in Pakistan with varying degrees of success. For example, livestock insurance in the early stages and genetic improvement have been tested on one species type. However, given the severity of risk exposure estimated by the CoI models, which renders stock replenishments uneconomical, the relocation of livestock production activities from high-risk zones should not be ruled out.

iii. Textile Value Chain

Figure 30 below illustrates the core *build actions* and *enabling actions* as outlined in this Textile Value Chain sub-theme.

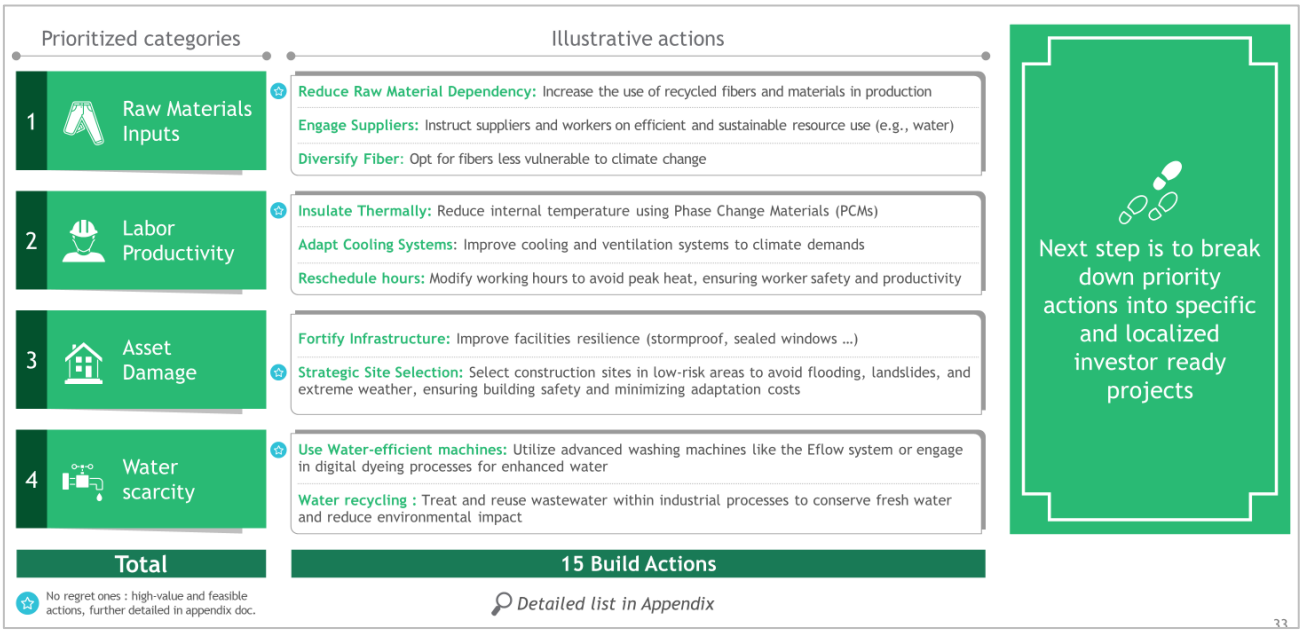


Figure 38 - Adaptation and Resilience Actions – the 'Textiles Sector' sub-theme

Build Actions

Climate impacts primarily arise from disruptions in the cotton supply chain due to climate-induced crop failures. The project team identified **a total of 15 actions**, of which **all 15 are classified as *build actions***. The prioritised build actions have been categorised to address specific vulnerabilities within the downstream textile industry.

- **Reduce raw materials dependency:** Increase the use of recycled fibres and materials in production.
- **Labour productivity:** Increased average temperatures and extreme heat lower workers productivity thanks to thermal insulation such as Phase Change Materials[18].
- **Fortify infrastructure:** Improve facilities resilience (storm-proof, sealed windows).
- **Use water-efficient machines:** Utilise advanced washing machines like the Eflow[19] system or engage in digital dyeing processes for enhanced water efficiency.

[18] Substance which releases/absorbs sufficient energy at phase transition to provide useful heat or cooling.

[19] eFlow technology in textiles uses a system to nebulize dye into nano-sized droplets, significantly reducing the use of water, chemicals, and energy compared to traditional dyeing methods.

No Regret Actions

The project team build on the analysis of *build actions* and *enabling actions* **through the development of *no regret* actions**. *No regret* actions are actions that have been **identified as highly feasible and presenting high value**. A set of *no regret* actions have been identified for each of the three priority themes. The rationale behind their selection can be found in the report Annex.

Figure 31 provides a summary of the *no regret* actions across the three sub-themes of the Economy priority theme.

Priority area	Actions
Economy Agriculture, Livestock	Genetic improvement: Develop climate-adaptive livestock varieties.
	Disease management: Enhance disease control and vaccination for livestock.
	Transportation optimisation: Use data to optimise transportation of livestock.
	Temperature regulation (shade and water): Provide shade and water to reduce heat stress.
	Temperature regulation (building design): Design buildings for optimal airflow.
	Temperature regulation (technologies): Implement temperature regulation technologies.
	Waterproofed buildings: Strengthen buildings to resist water intrusion.
	Relocation of livestock farms: Move farms to safer locations.
	Adapt modern reproductivity techniques: Use "Embryo Transfer Technology."
	Improve quality of feed: Produce high-quality livestock feed supplements.
Economy Agriculture, Crops	Crop diversification: Rotate crops to mitigate species-specific climate impacts.
	Sowing/harvest rescheduling: Adjust planting and harvesting schedules to climate patterns.
	High Efficiency Irrigation Systems (HEIS): Use drip and sprinkler systems for efficient water use.
	Groundwater recharge: Implement groundwater recharge techniques.
	Disease surveillance: Strengthen disease control measures for crops.
Economy Textile Value Chain	Reduce raw material dependency: Increase use of recycled fibres.
	Insulate thermally: Use Phase Change Materials for thermal insulation.
	Use water-efficient machines: Implement advanced water-efficient washing machines.
	Strategic site selection: Choose low climate risk sites for construction.

Figure 39 - *No regret* actions for the Economy theme

For the Agriculture – Livestock sub-theme, all of the *build actions* are considered *no regret* actions due to their critical role in enhancing adaptation and resilience to heat. There are 10 actions identified, ranging across farming practices, and upgraded infrastructure. The Agriculture – Crops sub-theme *no regret* actions include the introduction of high-efficiency irrigation systems, which significantly improve water use efficiency, and robust crop surveillance programs. Such surveillance is crucial for pre-emptive management of pests and diseases, ensuring the sustainability of crop production.

For the Textile sub-theme, actions involve boosting the utilisation of recycled materials and enhancing thermal insulation using Phase Change Materials (PCMs). To conserve water, advanced water-efficient technologies such as the eFlow system are being implemented. Moreover, the choice of construction sites in low climate risk areas is strategic, aimed at improving building safety and minimising the necessity for future adaptations.

Figure 32 provides a summary of the *no regret* actions across the People and Assets priority themes.

Priority area	Actions
People	Elevation of houses: Build houses on a higher level to increase resilience against moving water.
	Build emergency shelters: Create structures for evacuation during extreme weather events with adapted sanitation infrastructure
	Emergency operations centre: Establish facilities for coordinated emergency management.
	Local evacuation and response teams: Implement emergency response teams to execute plans.
	Local evacuation and response drills: Conduct drills to minimise impact post-extreme events.
	Anticipatory funding action: Support urban poor communities to anticipate risks and increase house resilience.
Assets	Transport network adaptation: Modify road and railway networks for climate resilience.
	Urban water absorption: Enhance water absorption through permeable surfaces and green infrastructure.
	Coastal ecosystem restoration: Construct natural barriers like reefs and wetlands to reduce flooding impacts.
	Flood defence construction: Build barriers or levees to protect against floods.

Figure 40 - *No regret* actions for the People theme and Assets theme

For the People theme, 6 actions have been identified that speak to the immediate needs of domestic infrastructure, emergency response coordination, and social protection initiatives. For the Assets theme, 4 actions have been identified, including adaptive construction techniques and coastal ecosystem restoration actions, to provide dual benefits of protection and biodiversity conservation.

Future A&R Pathway Development

The identified actions represent thematic areas that are likely to improve Pakistan's adaptation and resilience if such areas are targeted by public or private sector investment. To develop an actionable pathway for enhancing Pakistan's resilience these actions must be further developed into specific and bankable projects with a defined geographic (e.g., district) and operational scope. Such projects will likely cover a broad range of "actions" and require a mix of both public and private financing (private financed projects will ensure that improving Pakistan's resilience occurs in tandem with sustainable economic development).

To enable the successful design and implementation of projects (and therefore Pakistan's pathway to enhanced climate adaptation and resilience) a dedicated facility should be established to a) ensure that the pipeline of A&R projects is high quality (maximising impact), bankable and aligns with the goals/interests of both federal and provincial governments

6 MOVING AHEAD: CLOSING THE ADAPTATION FINANCING GAP

6. Moving Ahead: Phase 2 and Closing Pakistan's Adaptation Financing Gap

If Pakistan is unable to adapt and mobilise financing for climate resilience this will have severe adverse implications for Pakistan's macroeconomic stability, regional security, migration/displacement, and food security.

To ensure this project is fully actionable, it must transition from a prioritised list of actions to a pipeline of localised projects, grounded in practical, achievable steps. The next step involves categorising these actions into distinct investment archetypes to streamline funding and leverage the analytical model to provide a granular view that accurately identifies specific areas at risk, facilitating targeted and effective implementation of adaptation and resilience strategies.

To prepare for the next phase, three distinct archetypes of investments were identified: public impact projects, which typically yield less direct profit; commercial opportunities, which showcase higher profit potential; and blended finance opportunities that integrate aspects of both public support and private investment. To refine the investment archetypes, the analysis has been expanded to include four distinct archetypes, each based on the level of capital investment needed and the potential for economic return, catering to specific investor profiles. These range from low-yield, high-impact public infrastructure investments to high-capital, profitable commercial ventures, as well as policy-driven public sector programs, and nimble, community-based solutions, offering a spectrum of opportunities for diverse funding sources and investment objectives.

The next steps involve leveraging the advanced analytical models built during this project. These models enable the utilisation of data to prioritise projects based on their socio-economic return on investment (ROI) and assess the specific contributions of each project towards reducing the COI. This approach ensures that funds are allocated efficiently, focusing on provinces where the impact is maximised. Furthermore, this detailed analysis helps in understanding potential funders by aligning project goals with funding criteria, thereby ensuring a focused and effective implementation of adaptation and resilience strategies in areas most at risk.

Urgent action will require early, clear decisions from the government of Pakistan and the engagement of Pakistan's entire population. Pakistan's federal government, provinces and districts will need to come together effectively through a whole of government approach, which will require substantial effort and coordination, given the complexity of the task.

Phase 1 Recommendations

This initial phase proposes 10 overarching enablers for the Government of Pakistan to successfully take forward the A&R initiatives as presented in this paper:

1. Integrate A&R Impact into Development Project Decision-Making:
It is important to consider the cost of climate inaction and mainstream physical climate risk assessments to enable the identification of opportunities for building climate resilience. A&R investments often have limited revenue streams and are seen as 'unbankable'. However, these types of investments improve the climate resilience of people, the planet, or the economy, therefore it makes sense to assess and appraise their impact in terms of the social, environmental, and economic benefits that these investments confer. Cost of inaction analysis and pricing in A&R benefits can be used to screen investment opportunities in order to prioritise those with the highest impact and benefits (MoPDSI and NDRMF).

2. Develop the National Adaptation Plan (NAP) at the Provincial Level:
Prioritise actions within the National Adaptation Plan (NAP) based on these cost of inaction findings. Cascade Pakistan's National Adaptation Plan into robust short-term provincial implementation plans and financing strategies which should include opportunities for private capital mobilisation (MoCC).

3. Develop District Adaptation Plans:
Establish district level adaptation plans for the most at risk districts within each province, devolving decision making to the lowest appropriate levels (provincial Planning and Development Boards, Provincial Disaster Management Authorities and District Disaster Management Authorities).

4. Encourage the Special Investment Facilitation Council to Prioritise A&R Investment:
Incorporate climate adaptation and resilience into the SIFC and Board of Investment project criteria and improve A&R progress tracking and coordination through the newly established Climate Change Authority (SIFC, BoI, MoCC).

5. Introduce an A&R Project Preparation Facility:
Strengthen the enabling environment for project preparation for A&R investments at the federal level harnessing existing expertise and mandates (NDRMF, ADB, FCDO).

6. Provincial Level A&R Project Development:
Employ cost of inaction methodology and physical climate risk assessments to prioritise a shortlist of 5-10 priority adaptation projects within each province. Cost and screen these projects by investment archetypes and explore private finance mobilisation strategies (Chief Ministers, provincial P&D Boards).

7. Adopt an evidence-based Resilience Taxonomy:
Within the ongoing 'Green Taxonomy' development, adopt an evidence-based approach that enables capital market issuers, investors, and other stakeholders to identify climate resilience investments, assets, and entities, and to facilitate the flow of capital. This classification framework can then be implemented to form the basis for domestic budget tagging and financial disclosures. In turn this will improve the tracking of adaptation finance flows (MoF, SBP, MoCC, World Bank).

8. Integrate Climate Related Financial Risk into Supervisory Activities:
Seek to integrate climate-related risks in the prudential, financial, regulatory, and supervisory frameworks. Measuring and managing climate-related financial risks is critical for institutions across Pakistan's financial system (SBP, SECP, MoF).

9. Draw up Agriculture and Textile Resilience Roadmaps:

Consider provincial roadmaps in at-risk provinces to improve government coordination and build climate resilience within the agricultural and textile sectors to protect against future GDP loses (Chief Ministers, provincial P&D Boards, PPD fora).

10. Engage Textile, Agricultural and Livestock Corporations:

Engage domestic and multinational private sector corporations operating within climate vulnerable textile and agriculture value chains in Pakistan to increase awareness of future climate risks and explore financing opportunities (MoCC, SECP).

UK Support to Build Pakistan's Climate Resilience

Where the UK faces shared challenges, such as on climate change, we stand with Pakistan. The British High Commission Islamabad offers several areas of programmatic Official Development Assistance support to the government and people of Pakistan to build climate resilience, including:

1. Building Resilience and Addressing Vulnerability to Emergencies (BRAVE):

Budget: £97 million (2021 – 2028)

Summary : BRAVE aims to save lives and improve the coping capacity of the most vulnerable people, while increasing the ability of the GoP, civil society and communities to mitigate and respond to the effects of climate change.

Climate Resilience Activities:

- Community-based resilience pilots, including risk management, risk reduction and adaptation activities that develop skills and practices to develop adaptive, absorptive, and anticipatory capacity to climate change.
- Deliver predictable, timely, flexible and effective humanitarian response in the event of both small and large-scale shocks.
- Targeted technical assistance, based on live Political Economy Analysis, to resolve problems identified by BRAVE as it progresses.
- Technical support to the GoP Social Protection secretariat to develop a crisis responsive delivery system and beneficiary centric payment system to enable crisis-resilience of poor and vulnerable households during and after disasters.
- Evaluate and inform key stakeholders, specifically the GoP on the processes that work for adaptation and resilience programming in Pakistan and provide options for scalable, replicable models.

Anticipated Results:

- ICF KPI 1 – 3 million people better prepare and adapt to the effects of climate change.
- ICF KPI 4 – 1 million people with improved resilience as a result of BRAVE community resilience interventions
- At least 500,000 people supported with humanitarian response and immediate recovery that meets urgent needs and restores living conditions and reduces vulnerability to future shocks.

2. Water Resource Accountability in Pakistan (WRAP):

Budget: £30 million (2021 – 2028)

Summary: To improve water governance and management issues in Pakistan to be able to adapt to changing climate while ensuring environmental sustainability, with a focus on collaboration and engagement with provinces, research and media engagement.

Climate Resilience Activities:

- Water Governance support to improve the capacity of water institutions at federal and provincial levels (Punjab and Khyber Pakhtunkhwa), such as water commissions, water regulatory authorities and irrigation departments.
- Testing innovative Nature-based Solutions to build climate resilience e.g. Constructing gabion walls to protect against flooding and erosion, building ice-stupas for food storage, restoration of natural flood drainage pathways, restoration of degraded ecosystems, etc.
- Providing a catalytic funding facility to scale-up innovative solutions aimed at mainstreaming data-driven water governance, nature-based solutions as well as responses to humanitarian events.

Results to date:

- 81,663 direct beneficiaries supported to better adapt to the effects of climate change (41,578 male, 40,085 female)
- 4,000 hectares of land brought under sustainable land management practices
- Strengthened institutional capacity of the Punjab Agriculture and Irrigation departments, and increased awareness of supporting institutions such as Ministry of Water Resources, Ministry of Climate Change, Punjab Planning and Development Department, etc.

3. Climate Investment Fund for Pakistan (CIFPAK):

Budget: £108 million (2024 – 2031)

Summary: CIFPAK aims to crowd in private climate finance using a blended finance approach (public/private, concessional/non-concessional), supported by targeted technical assistance. The programme will particularly support implementation of Pakistan's National Adaptation Plan as well as Pakistan's recovery and reconstruction needs in the wake of the 2022 floods. It will also aim to deepen Pakistan's capital markets to unlock new sources of private capital through the development of innovative green financing instruments.

Climate Resilience Activities:

- Mobilising private climate finance for adaptation projects using blended finance
- Preparing bankable investment projects to build climate resilience
- De-risking innovative capital market financial instruments to mobilise private finance
- Technical assistance to strengthen the ecosystem for private climate finance

Expected Results:

- CIFPAK aims to mobilise 2.0x DFI capital and 3.0x private capital
- Directly support over 100,000 low carbon climate resilient jobs through its blended finance investments
- Support over 250,000 direct and indirect beneficiaries to enhance their climate resilience and livelihoods

4. Sub-National Governance II (SNG-II):

Budget: £37 million (2018 – 2026). (This is the budget for the entire programme which includes a few climate related activities)

Summary: SNG II is primarily a governance programme and aims to improve the management of the public sector in Pakistan. The programme works alongside the federal, provincial (Khyber Pakhtunkhwa-KP, Punjab, Sindh) and local governments to build sustainable government institutions and improve the management of public finances. It does this by:

- Improving the way government plans and budgets;
- Supporting government institutions to adapt to a changing context particularly related to supporting climate change adaptation – especially with regard to the current floods;
- Generating additional funds for the public service by helping government to increase tax revenue, as well as improve the utilisation of existing resources;
- Improving service delivery at local level.

Climate Resilience Activities:

The subset of activities related to improving climate resilience and adaptation includes:

- Developing and piloting a risk governance framework in Sindh that aims to improve coordination between the provincial government and the district level for effective disaster preparedness and response;
- Instituting disaster risk financing in budgetary allocations and climate budget tagging in KP and Punjab;
- Developing and enacting a comprehensive legal framework – the Land Use Building Control Act – in KP for regulating land use and enforce building regulation;
- Developing a Green Financing Strategy for Punjab;
- Developing Disaster Risk Financing Strategy for KP

Results:

- In Punjab- SNG II's work on disaster risk financing and climate budget tagging paved the way for allocation of PKR 29 billion (£89 million) for climate induced and other disasters in the budget for 2024-25. This allocations reflects a progressive increase over last year's allocation of PKR 12 billion (£ 37 milion).
- In KP (in pilot SNG districts), implementation support on Land Use Building Control Act resulted in 60 housing societies being declared illegal (till date), and measures introduced that safeguard agricultural and protected lands.
- In Sindh, a risk governance framework has been developed and is currently undergoing a third-party evaluation.

5. British Investment Partnerships in Pakistan:

BIP is the UK Government's development and diplomacy offer on international investment. It brings together UK support for financial instruments, expertise and partnerships. It is focused on mobilising finance at scale, high standards and development impact. For example, the UK's development finance institutions, British International Investment, chairs the Adaptation and Resilience Investors Collaborative and are proactively seeking private sector climate adaptation investments in Pakistan.

The UK Offer:
British Investment Partnerships in Pakistan

British International Investment

Equity – Direct investments of $10 million to $250 million. Active LP in PE and VC funds.

Debt – $10 million to $250 million, corporate lending, senior loans and subordinated tier II to financial institutions, project finance, and risk sharing facilities.

Concessional Finance – Climate Innovation Facility for pioneering climate solutions

MOBILIST

Invests equity capital in listed products and helps address technical barriers to listing.

Identifies products through **competitions** and supports first listing.

No transactions in Pakistan to date.

Private Infrastructure Development Group

Pioneering infrastructure changing lives

INFRACO ASIA

Development of early-stage infrastructure concepts into sustainable transformative projects.

Provide funding support to **prepare projects**, and to **attract** later stage project **financing**:

Development stage capital

Project preparation support (technical, financial, HSES)

Debt or equity financing for construction

PIDG Technical Assistance

The PIDG TA Team manages grant funding to support PIDG Group activities. This funding is **designed to reduce the costs** of infrastructure projects to make economically viable projects financially viable in order to attract private finance:

General technical assistance grants, Viability Gap Funding (VGF), Capital grants and concessional capital

INFRAZAMIN PAKISTAN

Local infrastructure credit enhancement facility in **Karachi**.

Addresses market failures in financing of credit worthy infrastructure projects via **credit enhancement of local currency debt instruments in Pakistan**.

Two transactions completed: (i) Pakistan and South Asia's first gender bond, (ii) Multinet digital infrastructure facility.

GuarantCo

GUARANTEES FOR DEVELOPMENT

Credit guarantee cover available for a single transaction is between **$5 million to $50 million**. **20 years max tenor**.

Will not cover more than 50% of total project debt.

Contingent credit solutions: **partial credit guarantees, liquidity extension guarantees, EPC guarantees, portfolio guarantees, framework guarantee**.

UK Government Centres of Expertise

Quality technical assistance is a vital complement to development finance to help build the environment to attract investment.

Advice and support from UK civil service, academic and private sector.

Covering: infrastructure, public finance, financial services, green and inclusive growth, and trade.

UK Export Finance

UK's national export credit agency. Helps UK companies to **win** export **contracts**, **fulfil** more **orders** and **get paid.**

Loans, guarantees and insurance

Minimum 20% UK content required to be eligible

Tied and non-concessional

Currently limited operations in Pakistan due to Pakistan's current credit rating

7 ANNEX: ADAPTATION AND RESILIENCE ACTIONS

7. Annex – Detailed Methodology

Climate Modelling Methodology Overview

CID	Increased temperatures	Drought	Extreme Precipitation	Sea level rise and extreme sea levels	Wind patterns and tropical cyclones
Data source	CMIP6 EC- Earth3	CMIP6	CMIP6 Fathom Global Release 3.0	IPCC AR6 Coastal Futures Nasa Earth Data (NASADEM) Alaska satellite facility	IBTrACS CIMP6
Methodology	Temperature projections: Utilize CMIP6 for near surface air temperature projections and ERA5 reanalysis for historical data to project temperature patterns for the Pakistan. **Heat index:** Heat index is a heat stress indicator used by the US National Oceanic and Atmospheric Administration (NOAA) National Weather Service for issuing heat warnings. It is calculated using multiple linear regression based on daily maximum temperature and relative	Consecutive Dry Days (CDD): Maximum number of days in a row with precipitation below 1 mm in a year. Standardized Precipitation-Evapotranspiration Index (SPEI): Calculate standardized anomalies of the water balance by comparing precipitation and potential evapotranspiration (PET) data to historical climatology. **Standardized Soil Moisture Index (SSMI):** Determine standardized anomalies of soil moisture content by considering precipitation, PET, soil properties, and vegetation characteristics. Standardized Surface Flow Index (SSFI):	**Precipitation:** The sum of liquid and frozen water, comprising rain and snow, that falls to the Earth's surface. It is the sum of large-scale precipitation and convective precipitation. This parameter does not include fog, dew or the precipitation that evaporates in the atmosphere before it lands at the surface of the Earth. Max 24hr precipitation: Maximum precipitation on a single day in period (year or	Flooding scenario (areas and depth): Calculate inundated areas using bathtub model with an eight-way hydrological connectivity rule provided elevation from NASA and vertical displacement from Alaska satellite facility and sea level/extreme sea level scenario from IPCC AR6/Coastal Futures. Vertical displacements: Synthetic Aperture Radar (SAR) data used to understand the slope and roughness of the earth's surface &	Cyclone track simulation: Use spatial probability based on coordinates of past cyclones' first observation (Poisson Law) and past cyclone tracks + statistical correlation with climate drivers from CMIP6

	humidity (calculated from daily mean specific humidity and surface pressure). **Wet-bulb globe temperature index:** A heat stress indicator that is calculated as weighted mean of wet-bulb temperature, globe temperature, and daily maximum temperature. The wet-bulb temperature index is a heat stress indicator that indicates the human cooling capacity through sweating. It is calculated from the equivalent potential temperature based on daily maximum temperature and water vapor mixing ratio (calculated from daily mean specific humidity and surface pressure). **Unproductive days:** Identify and count the	Measure standardized Anomalies of surface water flow by comparing current flow values to the long-term average. **Effective Drought Index (EDI):** Assess the severity of drought conditions by quantifying the deviation of current weather conditions from projected climate conditions	month). Precipitation is deposition of water on the Earth's surface, either rain, snow, ice, or hail. **Pluvial and fluvial flooding:** Incorporate hydraulic models based on shallow water equations to predict how the water behaves during flooding events. Pluvial flooding refers to flooding that happens due to excessive rainfall overwhelming the local drainage capacity. Fluvial flooding that occurs as a result of the overflowing of rivers, streams etc.	distance from satellite to earth's surface. Images of the same area every six months for two years (January 2021 to Dec 2022) is used to calculate the displacement of the surface from the line of sight of the satellite (adjusting for the satellite's orbit) and converted to vertical displacement.	

	number of unproductive days based on the heat index exceeding 42°C (danger classification according to PAGASA)				

Cost of Inaction Methodology Overview

The Cost of Inaction is a concept used to quantify the economic, environmental, and social consequences of not taking adequate measures to mitigate or adapt to climate change. It essentially represents the potential losses and damages that could occur as a result of failing to implement effective climate policies or interventions. Calculating the cost of inaction involves estimating the financial impacts associated with the continued progression of climate change, including but not limited to lost productivity, damage to infrastructure, health costs, and the loss of ecosystems and biodiversity.

The modelling of the cost of inaction evaluates the economic and social repercussions of not addressing climate risks, categorised into three main dimensions: people, economy, and ecosystems. This model breaks down the impacts into two primary types: direct and indirect costs, with a mention of a third dimension, the opportunity cost of inaction, not covered in depth in this report.

- **Direct costs:** from climate change represent the immediate financial losses incurred, encapsulating tangible damages such as destruction to physical assets, diminished labour productivity due to extreme weather conditions, and infrastructure damage resulting from disasters such as floods or cyclones. Furthermore, these costs cover expenses related to the displacement of communities, quantifying the direct impact on a nation's GDP[20] and the livelihoods of its citizens.
- **Indirect costs:** analysis of indirect costs concentrates on the cascading economic and social implications stemming from direct losses in key sectors such as livestock and agriculture. By meticulously modelling the impact of these direct losses on the output of specific sectors, the project team extrapolate these effects to understand their influence on the nation's trade dynamics, employment rates, and household incomes. This methodological approach allows the project team to trace how initial climate-induced damages ripple through to broader economic and societal realms. It emphasises the extensive nature of climate impacts, going beyond initial damages to illustrate their profound influence on trade, labour markets, and the financial well-being of communities, thereby shedding light on the multifaceted challenges posed by climate change.
- The **Opportunity Cost of Inaction**, not detailed here, offers a third dimension to consider. It revolves around the economic growth or investment opportunities forgone due to unaddressed climate risks. Missed chances for investing in green technology or infrastructure, which could have both spurred economic development and mitigated climate impacts, represent significant losses. This perspective underscores the critical economic and societal implications of failing to act against climate risks.

The diagram below illustrates these two main types of impacts - direct and indirect - across the three dimensions of people, economy, and ecosystems. Each dimension comprises different modules, breaking down the complex web of climate change impacts into manageable, quantifiable parts.

[20] GDP impact refers to the variation of gross added value vs. an 'as is' baseline scenario where no action is taken, all things being equal (annual values)

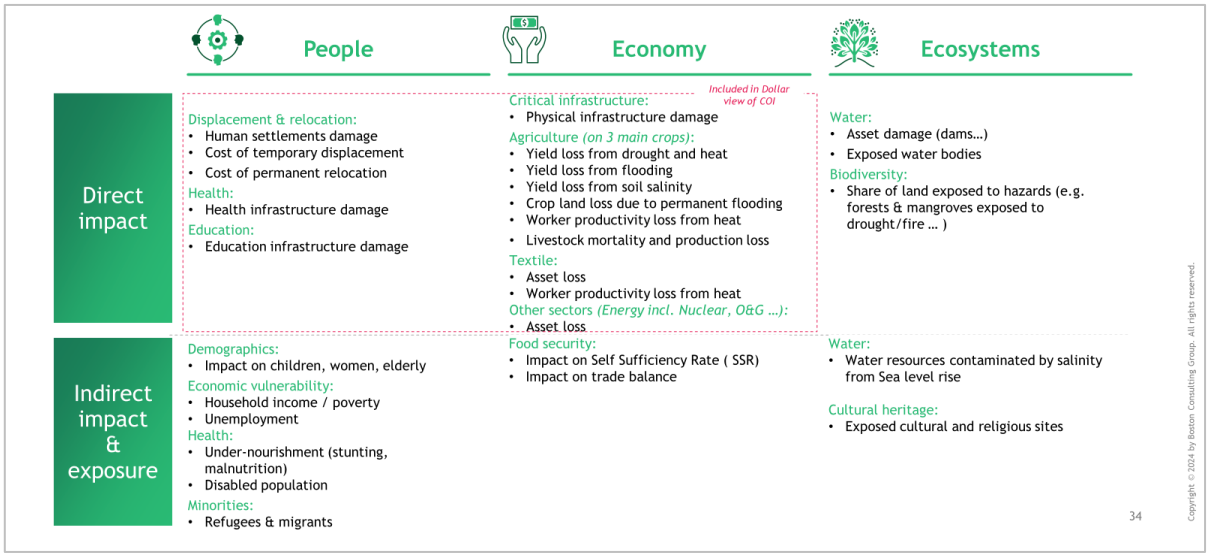


Figure 41 - Direct and indirect impact across people, economy, and ecosystems

In the sections that follow, the project team will delve into the specifics of how each module's calculations are performed. This will include an exploration of the data sources utilised, the assumptions made during the analysis, and the planned approaches for enhancing the precision and accuracy of the models developed.

However, it should be noted that Cost of Inaction is computed by each CID.

1.1.1 Direct cost of inaction

a. **Modelling the physical impact on assets**

The capital cost of climate events that damage physical assets is calculated by considering three core components: the type and location of the assets, their average value, and the damage functions tailored to specific climate events. Building a thorough Point of Interest database constitutes the initial step in this modelling process. This database catalogues various types of POIs—schools, healthcare facilities, roads, airports, etc.—along with their size and precise geo-location. These details are crucial as they allow the project team to gauge the level of risk each POI faces, such as the potential flood depth at a given location.

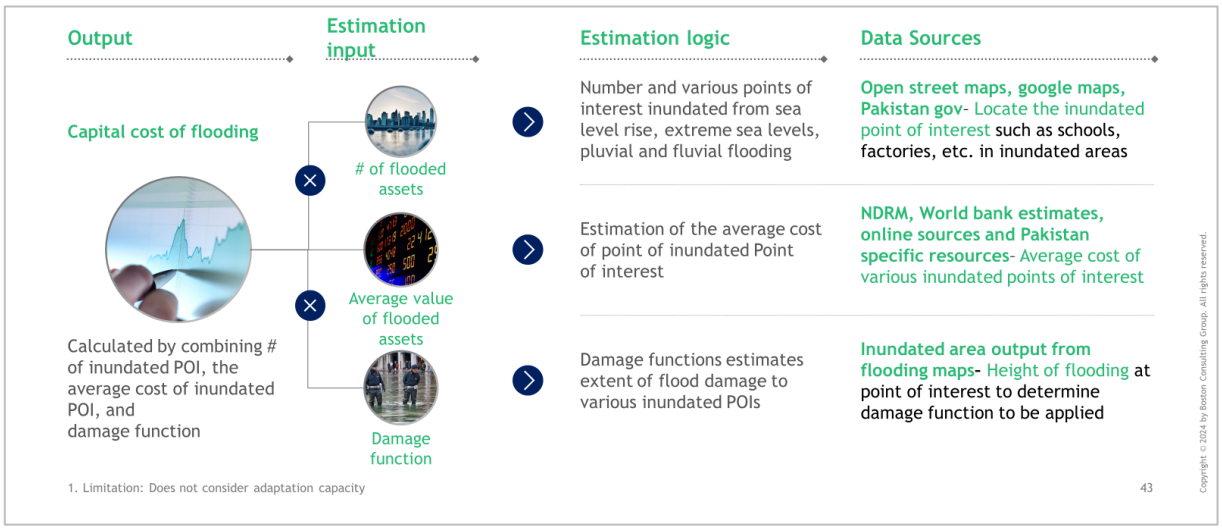


Figure 42 - Methodology of calculating the capital cost of flooding

To ensure extensive coverage of POIs, the model utilises a myriad of data sources. These include platforms and databases such as the UN Office for the Coordination of Humanitarian Affairs (OCHA), the Humanitarian OpenStreetMap Team (HOT), and Google Maps, which collectively contribute to a robust dataset. This dataset underpins the model's capacity to determine the vulnerability of each POI to climate-induced events and to calculate the associated costs accurately. The subsequent steps in the process involve estimating the average value of the damage that would occur to these assets during such events and applying the appropriate damage functions to estimate the overall cost to capital. (Refer to the diagram below for sources and data coverage details.)

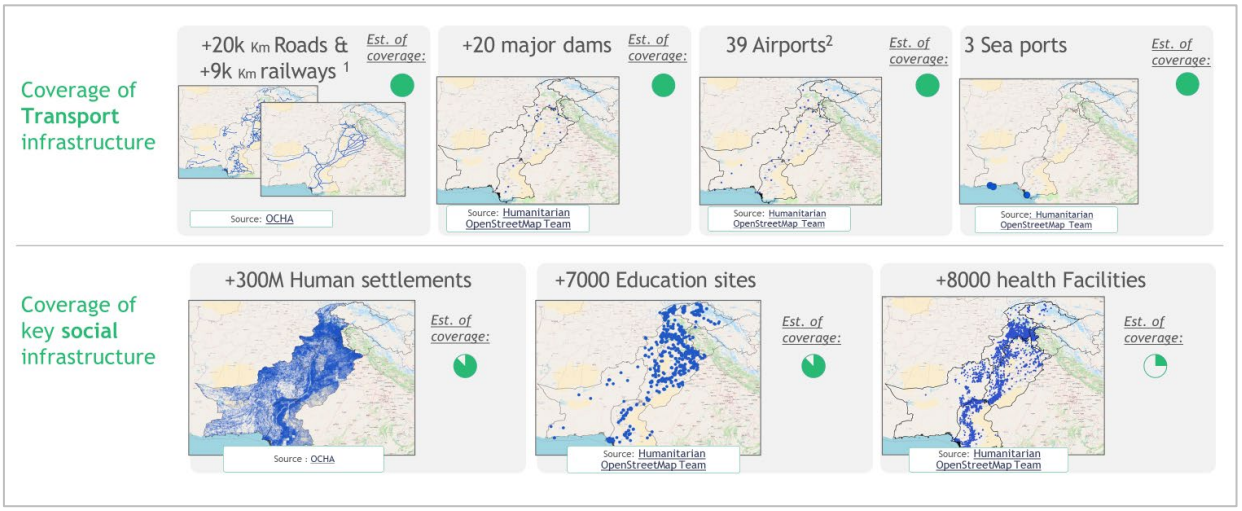


Figure 43 - Coverage overview of transport and key social infrastructure

Following the establishment of a POI database, the second step in modelling physical damage is the creation of a unit cost database. This database captures the repair or replacement costs for each asset type, with adjustments made for country-specific variables and the scale of the POI. Such granularity ensures that the model reflects the true cost implications unique to the country's economic context.[21]

Armed with these two critical datasets, the final stage in quantifying physical damage involves applying climate-specific damage functions. These functions relate the severity of a given CID to the percentage of damage expected for each POI. For instance, a damage function might indicate that a severe flood could damage a small clinic to a greater extent than a large hospital, due to differences in infrastructure robustness and flood preparedness. The figure below exemplifies a damage function[22], illustrating how damage percentage varies with the nature of the climate event, its magnitude, and the characteristics of the impacted asset[23].

[21] Source of unit cost: Airports, Railways, Human settlements & Universities: NDMRF Database / Roads: World Bank and China Pakistan Economic Corridor / Schools: UK Programme in Pakistan and 141 Schools NGO / People relocation: Pakistan's Afghan refugees report / Basic care unit: Punjab province report / Hospital: Dawn article about cancer hospital at Pims / Dams: Damer-Bhasha & Kurram Tangi dams public reports

[22] European Commission Joint Research Centre for agriculture and infrastructure

[23] "Flood Depth-Damage Functions for Built Environment" by A. Pistrika, G.Tsakiris and L.Nalbantis

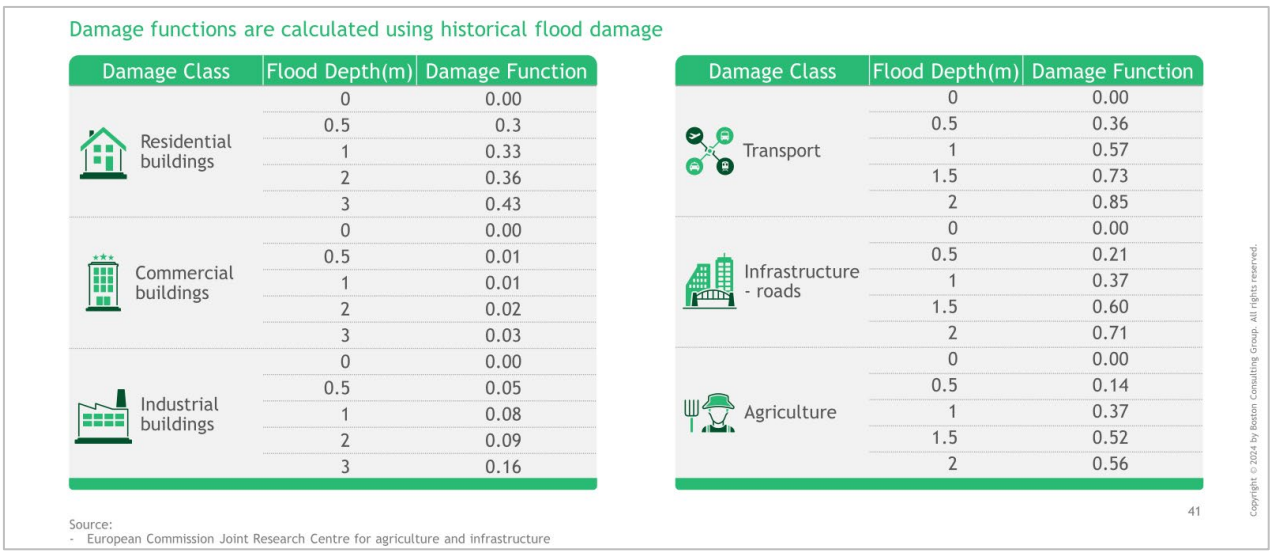


Figure 44 - Damage function examples for temporal flooding

Damage class	CCFTotal	Mean	Std	Offset
Residential	0.53	370	0.567	46.08
Industrial	0.3544	1058.93	0.801	72
Transport	0.2241	308.09	0.836	72
Airports	0.2051	308.09	0.51	72
Commercial	0.2051	308.09	0.51	72

1. Offset and wind speed (V) in km/h. The offset determines the wind speeds on which building damage is starting to occur
2. CCFTotal is cost-component factor also serving as the upper-limit building damage
3. Damage curves follow a modified cumulative distribution function as below:

$$Damage\ function(V, CCFTotal, mean, std, offest) = CCFTotal * lognormCDF[(V - offest), mean, std]$$

Figure 45 - Damage function example for extreme wind events

b. **Modelling impact resulting in population displacement**

The models' approach to population displacement distinguishes between temporary and permanent scenarios, driven by various flooding events. Sea level rise is projected to eventually cause permanent displacement, as it renders affected settlements irrecoverable over time. Contrastingly, temporary displacement is primarily triggered by pluvial, coastal, and fluvial flooding events. The duration of such temporary relocations is estimated based on the extent of damage incurred by the settlements.

To compute the costs of displacement, the analysis considers three key elements:

1. Demographic and Human Settlement Data: This includes population distribution in relation to flood risk zones and the structural integrity of their habitats.
2. Resettlement Unit Costs: This covers the expenses for establishing new settlements or rehabilitating existing ones, exclusive of the costs to repair the physical settlement damages, which are addressed separately in the physical assets damage section.

3. Damage Function Application: The damage function is applied to determine the threshold of flooding that necessitates relocation. For permanent displacement due to sea level rise, the assumption is that affected settlements will not recover. In cases of temporary displacement, the relocation duration is estimated from the settlement damage percentage, guiding decisions on the type and duration of support required for displaced populations.

In summary, this model strategically delineates the costs of population displacement, ensuring a thorough financial assessment that informs planning for resilience and adaptive capacity.

c. **Modelling the Impact on Agriculture**

The agriculture sector, vital for food security and economic stability, is increasingly at risk due to climate change. Within the broader agricultural sector, climate change levies its toll on two critical subsectors: livestock and crop production. Both face distinct challenges and potential costs if timely and effective action is not taken. This section delves into how climate change specifically affects these subsectors and the consequent economic ramifications.

This section will explore the cost of inaction in the face of evolving climate conditions that threaten agricultural productivity. The project team will examine how shifts in temperature, precipitation patterns, and extreme weather events can lead to reduced crop yields, increase soil salinity, and crop land permanent loss. For livestock, the focus will be on the impact of extreme temperatures, and floodings, which can lead to decreased livestock productivity and increased mortality rates.

Addressing these challenges is not just about securing food—it's about safeguarding livelihoods and preserving the social fabric. The failure to act against these impending risks carries with it the potential for significant economic losses and social upheaval. The forthcoming analysis aims to quantify these risks, presenting a clear financial depiction of the impacts on agriculture if adaptation and mitigation strategies are not implemented.

c.1. Agriculture CoI related to crop yield loss

To assess the cost of inaction in agriculture, five specific models have been constructed to quantify the impact on crop yields stemming from various climate events. The focus is narrowed to four key crops—wheat, rice, cotton, and maize—chosen for their status as Pakistan's staple crops and their substantial contribution to the country's agricultural output. The modules address:

The **Yield Loss from Drought and Heat** models are designed to evaluate the impact of climate-induced aridity and heat stress on crop productivity. By leveraging the scientific crop model WOFOST[24], one can estimate potential yields under water-limited conditions, which assume no irrigation interventions are in place. Furthermore, an adapted version of this model accounts for Pakistan's existing irrigation practices, adjusting water inputs to reflect the mitigating effects these systems have on yields. This crop modelling process integrates weather projections, soil characteristics, and agro-management data, including factors such as growing seasons and crop varieties, along with their specific traits. The result is granular, annual projections of yield potential for each crop type, providing a detailed understanding of how climate change could affect agricultural yields at a highly localised level. This approach enables precise modelling of the effects of climate change on agriculture, allowing for more targeted adaptation and resilience strategies.

[24] World Food Studies - WOrld FOod STudies – Wageningen University, NL

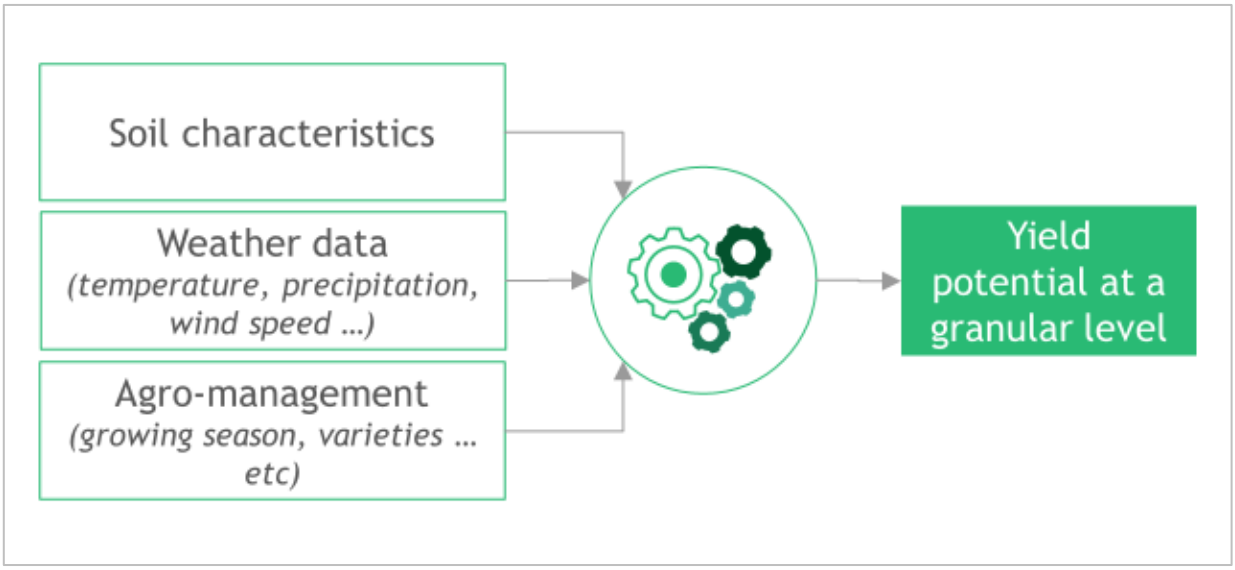


Figure 46 – The WOFOST model

The **Yield Loss from Temporary Flooding** model explores the effects of short-term flooding events on the agricultural cycle, focusing on their ability to disrupt growing seasons and reduce crop yields. This analysis takes into account several key factors, such as the resilience of different crop varieties to excess water, and demonstrating how some crops withstand flooding better than others. Furthermore, the timing of floods in relation to the agricultural calendar is critical, with floods during crucial growth or harvest periods potentially causing significant damage and yield loss. By evaluating these dynamics, along with the duration of floodwater stagnation on fields and the rate at which water recedes, the impact of temporary flooding on the four main crops is modelled, providing insight into the financial and production losses incurred.

The **Yield Loss from Permanent Flooding** analysis quantifies the loss of arable land and the subsequent decrease in yields due to long-term flooding, especially in regions prone to persistent waterlogging. This estimation integrates data on absolute sea level rise, land elevation, and land subsidence to project which agricultural lands and assets will be permanently submerged. Utilising multiple data sources, including the IPCC's Sixth Assessment Report (IPCC AR6) and NASA earth data, this model assesses the long-term impact of permanent flooding on agriculture, highlighting the critical need for adaptation and resilience strategies in affected areas.

Yield Loss from Soil Salinity model addresses the detrimental effects of rising sea levels on soil health and, consequently, on agricultural productivity. To systematically evaluate how rising soil salinity influences crop yields, a four-step methodology underpins the model:

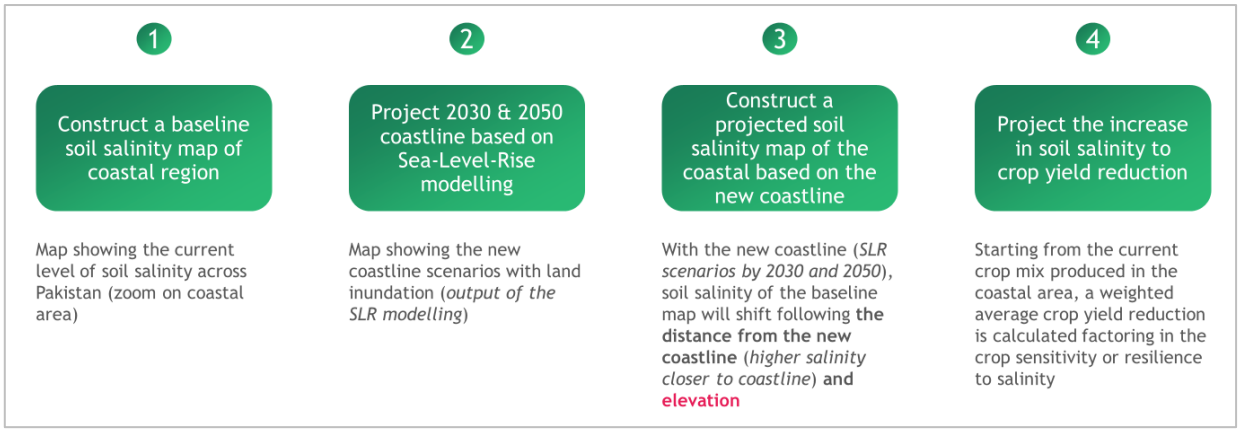


Figure 47 - Methodology followed to model the impact of soil salinity on crop yield

1. Baseline Soil Salinity Mapping: The initial phase involves creating a detailed salinity map along the coastline, establishing a current benchmark of soil salinity levels across coastal agricultural lands.
2. Coastline Change Projection for 2030 & 2050: Utilising SLR projections, this step forecasts shifts in the coastline for the years 2030 and 2050, anticipating how advancing seas will reshape the land-water interface[25].
3. Projected Soil Salinity Mapping: With new shoreline estimates, this phase develops a forward-looking salinity map. It incorporates factors such as proximity to the shifting coast and land elevation to predict future soil salinity distributions. [26,27,28]
4. Impact Projection on Crop Yields: The final step translates increased soil salinity levels into specific effects on crop yield productivity. This involves calculating the anticipated reduction in yields for each crop type due to the altered salinity conditions. The yield loss is then built to each specific crop type[29].

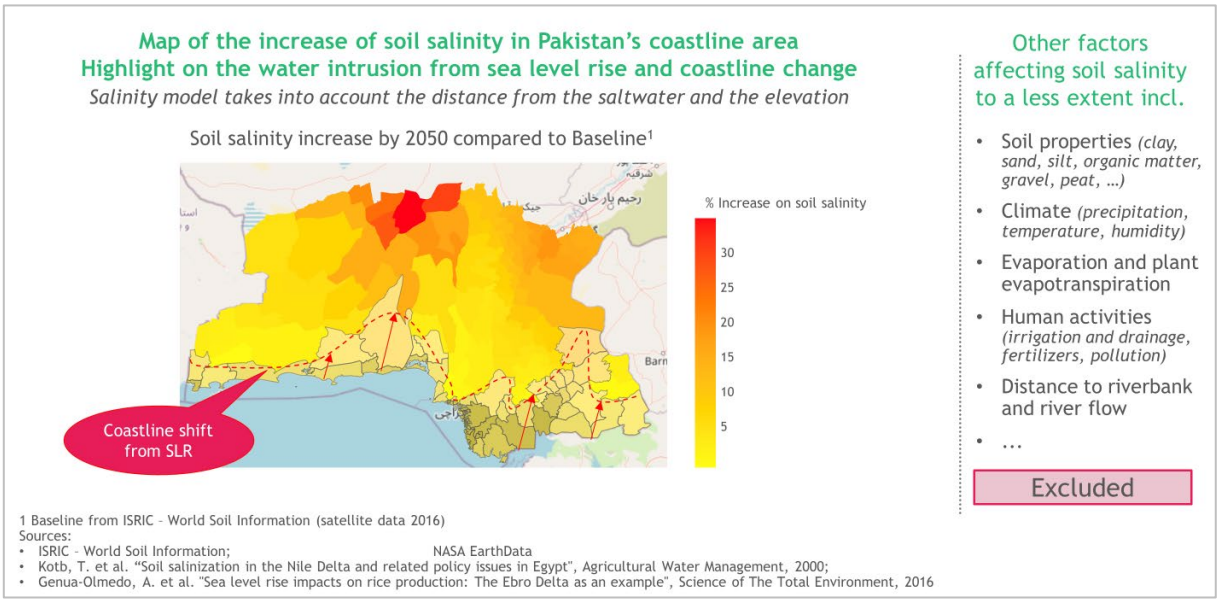


Figure 48 - Map showing Soil salinity increase by 2050 compared to baseline

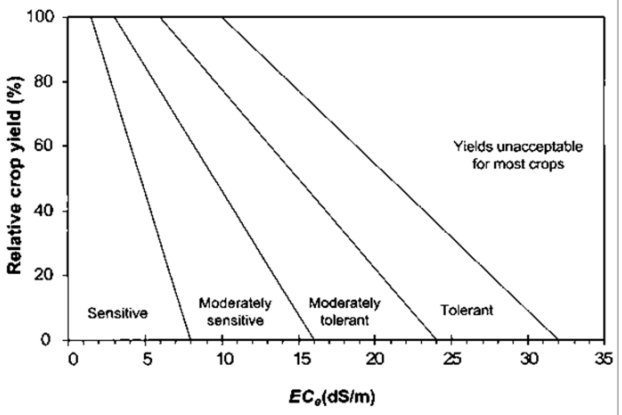
[25] Data sources like NASA Earth data and ISRIC world soil information were used
[26] Kotb, T. et al. "Soil salinization in the Nile Delta and related policy issues in Egypt", Agricultural Water Management, 2000;
[27] Genua-Olmedo, A. et al. "Sea level rise impacts on rice production: The Ebro Delta as an example", Science of The Total Environment, 2016
[28] Baseline built from ISRIC – World Soil Information
[29] FAO annex for crop salt tolerance data

Relative Yield as a function of Soil Salinity is given by $Y_r = 100 - b(EC_e - a)$

Crop Mix in Pakistan's coastline

	Crop	Salinity Tolerance	(a) Salinity Threshold	(b) Slope
1	Wheat	Moderately Tolerant	6.0	7.1
2	Rice	Sensitive	3.0	12
3	Maize	Moderately Sensitive	1.7	12
6	Cotton	Tolerant	7.7	5.2

Y_r: *Relative Yield;* EC_e: *Soil salinity*
a: *Salinity threshold (dS/m);* b: *Slope*



Source: FAO annex for crop salt tolerance data

Figure 49 - Crop resistance to soil salinity and relative yield function

It is important to note that this model focuses solely on the impact of sea-level rise on soil salinity. It does not account for other influential factors like soil composition (e.g., clay, sand), evaporation rates, or human activities that can also affect soil salinity levels.

The **Heatwave Impact on Labour Productivity Loss in Agriculture** model adopts a detailed approach to explore how extreme temperatures affect the efficiency of the agricultural workforce. By leveraging scientific research, this model identifies the impact of heatwaves, focusing on unproductive days—defined as those with a heat index exceeding 42°C. At this critical threshold, productivity is notably impaired due to the increased physiological risks and reduced working capacity.

Establishing Temperature Thresholds: The model determines a crucial temperature threshold based on empirical evidence, highlighting the point at which heat significantly reduces labour capacity. Days surpassing this heat index threshold are considered unproductive, reflecting the direct impact of extreme heat on the ability of workers to perform effectively due to the associated physiological risks and diminished capacity for work.

Analysing Heatwave Patterns: This step involves the examination of historical and projected climate data to evaluate the trend of increasing heatwave occurrences. By projecting a rise in both the frequency and severity of unproductive days, the model provides critical insights into the expected temporal distribution and intensity of future heatwaves that could affect agricultural regions. Understanding these patterns is vital for anticipating the challenges that lie ahead in maintaining agricultural productivity under changing climatic conditions.

Quantifying Productivity Loss: In this phase, the model calculates the anticipated increase in unproductive days over the forthcoming decades, offering projections of labour productivity loss. This calculation considers various factors, including the nature of the labour (whether it is performed indoors or outdoors) and the potential availability of tools or measures (such as sheds or air conditioning) that could mitigate the impact of heat on labour productivity. Through this thorough analysis, the model quantifies the expected productivity losses in agriculture due to escalating heatwave events, providing valuable data for planning and implementing adaptive strategies to safeguard agricultural labour efficiency.[30]

[30] Based on article "Working on a warmer planet: The impact of heat stress on labour productivity and decent work" from the ILO

These models collectively provide a thorough estimate of how climate change could erode agricultural productivity in Pakistan. They serve as a critical tool for understanding the potential economic and food security implications of inaction.

c.2. Agriculture CoI related to livestock production loss

In addressing the multifaceted impact of climate change on livestock, this section focuses in on two critical consequences: the decline in meat and milk production attributed to heatwaves, and the surge in mortality rates stemming from both heat stress and flooding events. Understanding these impacts is crucial for developing strategies to safeguard livestock health and productivity against the backdrop of a changing climate.

Production Loss from Heatwaves: Heatwaves pose a significant challenge to livestock, particularly poultry. Heatwaves also affects livestock's ability to produce milk and meat efficiently. Elevated temperatures can lead to heat stress, which disrupts metabolic rates, lowers feed intake, and decreases fertility, directly impacting production levels. This analysis will explore the physiological effects of heat stress on different livestock species and quantifies the potential reduction in meat and milk yields during prolonged heatwave conditions. The model behind this section is as explained in the tables below[31][32][33][34][35][36][37][38].

Methodology for modelling heatwaves impact on milk & meat production	
Objective	Calculate the loss in meat and milk production in tonnes for cattle and buffaloes due to heat stress.
Detailed Methodology	The methodology incorporates a four-step process to estimate the impact of heat stress on milk and meat production: 1. CEIT (The Current Effective Temperature Index) Calculation: This initial step assesses heat stress by considering factors such as temperature, humidity, wind speed, and sunlight exposure. 2. DMI (Dry Matter Intake) Adjustment: Adjusts the DMI for animals under heat/ cold stress using the previously calculated CEIT. 3. Corrected DMI: Computes the DMI taking into account the potential impacts of climate change. 4. Production Estimation: Translates the energy intake from DMI into estimations of meat and milk production, considering both the efficiency and the energy requirements per unit of production.
Data sources	Climatic Data: Minimum and maximum temperatures, wind speed, and humidity (Copernicus) Livestock Data: Distribution and productivity rates of cattle and buffaloes (GLW 4: Gridded Livestock Density and FAOSTAT.)
Assumptions	Modern Facility Prevalence: The model assumes that a certain percentage of production facilities are modern, which influences the resilience of livestock to heat stress. Specifically, 20% for cattle and buffalo facilities, in line with the expert validation.

[31] An analysis of the effects of climate change on livestock: A case study in the Lao People's Democratic Republic, FAO
[32] Caloric stress: Characteristics and strategies for defending in cattle (meat or milk), Dr. Aníbal Fernández Maye
[33] Experiments on Energy-Efficient Evaporative Cooling Systems for Poultry Farm Application in Multan (Pakistan)
[34] Heat Stress in Small Ruminants, Kelly Froehlich Assistant Professor & SDSU Extension Sheep and Goat Specialist
[35] Sheep & Goat Death Loss, 2009 By Adam W. Pi
[36] Agriculture Marketing Information Service Pakistan
[37] Global Spatially-Disaggregated Crop Production Statistics Data for 2010 Version 2.0
[38] WWF Pakistan

Literature references	The methodology and production loss estimates draw on key literature sources which provide foundational knowledge on livestock response to heat stress and the corresponding adjustments in feed intake and production capacity (An analysis of the effects of climate change on livestock - A case study in the Lao People's Democratic Republic, FAO)

Increased Mortality Rates from Heat and Flooding: Beyond affecting productivity, extreme weather events such as heatwaves and floods have a more dire consequence - increased mortality rates among livestock populations. Heat stress can lead to critical health issues, increasing vulnerability to diseases and potentially leading to death. Similarly, flooding can destroy grazing lands, contaminate water supplies, and cause direct physical harm to animals, further elevating mortality rates. This segment assesses the risk factors associated with these events and estimates their impact on livestock survival[39][40].

Methodology for modelling mortality rates in flooding	
Objective	To project the number of livestock losses due to drowning in floods, categorised by type (cattle, buffaloes, poultry, goats, and sheep), scenario (SSP 2-4.5 and SSP 5-8.5), for year 2030 and 2050, respectively.
Detailed Methodology	Definition of Losses: Livestock losses are accounted for as animals that perish due to drowning from flooding, which also includes fatalities from exhaustion and stress when trapped in waterlogged areas. Distribution Data: Utilised livestock distribution information from the Global Livestock Density (GLW 4) and FAOSTAT databases. Flood Data: Incorporated flood data from Fathom's data. Damage Functions: Applied three livestock damage functions derived from literature, specifically "Agricultural Damage Functions for Flooding: Impact and Loss Assessment for the RiskScape[41] Tool." These functions consider each livestock category's size and swimming ability.
Method of Validation	Comparison Analysis: Validated the model by comparing its projections with the actual number of livestock losses reported during the 2022 floods, as per the GIEWS Special Alert (dated 29 September 2022) by the FAO.
Data Sources	Livestock Distribution: GLW 4: Gridded Livestock Density and FAOSTAT. Flood Data: Fathom.
Assumptions	Poultry Facilities: It is assumed that 95% of poultry facilities are modern, as verified by agricultural experts. Cattle and Buffalo Facilities: It is assumed that 20% of poultry facilities are modern, as verified by agricultural experts.

Methodology in modelling heatwaves mortality rates	
Objective	Project the number of livestock losses attributable to heat stress, organised by type (cattle, buffaloes, chickens, goats, and sheep), under various temperature and humidity scenarios (SSP 2-4.5 and SSP 5-8.5), for year 2030 and 2050, respectively.
Detailed Methodology	The Temperature Humidity Index (THI) was utilised to evaluate livestock fatalities from heat stress. Established thresholds from literature provided the basis for these assessments.

[39] GIEWS Special Alert, 29 September 2022, FAO, not including poultry
[40] Agricultural damage functions for flooding Impact and loss assessment for the RiskScape Tool
[41] https://riskscape.org.nz/

Method of Validation	Literature Comparison: The model's assessments were cross-referenced with findings from research, including studies on caloric stress in cattle, energy-efficient cooling systems for poultry, and heat stress impacts on small ruminants.
Data Sources	Livestock Distribution Data: GLW 4: Gridded Livestock Density and FAOSTAT. Climate Data: Temperature and relative humidity information were obtained from the Copernicus Climate Change Service. Heat Stress Thresholds (THI): Applied the THI using established fatality thresholds from scholarly articles on livestock heat stress.
Assumptions	Facilities: Similar to the flood model, a percentage of modern facilities is assumed for poultry (95%), and cattle and buffaloes (20%), as verified by agricultural experts. For goats, the assumption incorporates mortality rates from extreme THI conditions.
Literature references	Fernández Maye, A. Caloric Stress: Characteristics and Strategies for Defending in Cattle (Meat or Milk). Froehlich, K. Heat Stress in Small Ruminants, Kelly Froehlich, Assistant Professor & SDSU Extension Sheep and Goat Specialist. Pi, A.W. Sheep & Goat Death Loss, 2009.

d. Modelling the cost of inaction in the Textiles sector

In Pakistan, the textile industry stands as a cornerstone of the economy, contributing significantly to the country's exports and employing a vast portion of the workforce. Given its critical role, understanding and quantifying the impact of climate change on this sector is paramount. The analysis employs two specialised models to calculate the cost of inaction, specifically tailored to address the unique challenges faced by Pakistan's textile industry.

- Heatwave-Induced Labour Productivity Loss: The productivity of textile workers, a key determinant of the industry's output, is vulnerable to the rising temperatures associated with heatwaves. Despite the predominantly indoor nature of textile work, the lack of adequate cooling in many facilities can lead to significant declines in worker efficiency. This module adapts the approach used for agriculture to the textile sector's context, assessing the impact of indoor heat stress on productivity and its economic consequences for Pakistan's textile exports (please see c.1. Agriculture COI related to crops yield loss / heatwave labour productivity loss).

Physical Damage to Textile Infrastructure: Pakistan's textile industry relies heavily on its physical assets. This model extends the physical asset damage analysis to textile-specific infrastructure, evaluating how climate-related events—such as floods and storms—pose a risk to these assets. The aim is to estimate repair and reinforcement costs, ensuring the industry's resilience against such climate threats.

These analytical models shed light on the dual risks of labour productivity loss and physical damage within Pakistan's textile sector due to climate change.

1.1.2 Indirect cost of inaction

The indirect costs of inaction on climate change, while encompassing a broad spectrum of impacts, can be particularly explained through KPIs such as employment, self-sufficiency rate, and trade growth. These KPIs offer a lens through which the wider economic and social ramifications of climate change on sectors critical to Pakistan, such as agriculture and textiles, can be assessed.

Employment: The economic sectors crucial to Pakistan, such as agriculture and textiles, face a nuanced challenge from climate change, significantly influencing job security through a different mechanism than initially outlined. The modelling specifically assesses how the loss of added value in these sectors, due to factors such as adverse weather events and heat stress, impacts the funds allocated to labour. This analysis assumes wage rates remain constant; thus, any reduction in sectoral expenditures on labour is indicative of potential job losses. By examining the flow from diminished sectoral value to reduced labour expenditures, and subsequently to lower household expenditures, the project team quantify the broader employment implications. This approach allows the project team to detail how climate-induced shifts in agriculture and textiles not only reduce direct employment opportunities due to efficiency and productivity losses but also lead to wider economic and social effects through decreased household incomes, highlighting the intricate relationship between sectoral climate impacts and overall employment trends.

Self-Sufficiency Rate: The resilience of Pakistan's agriculture sector to climate change is pivotal for maintaining self-sufficiency in staple crops, crucial for food availability and national security. Project analysis extends beyond the impacts of soil salinisation and drought to also encompass production losses due to land rendered unusable by climate events and yield reductions directly attributable to flooding. These factors collectively contribute to a decrease in domestic crop production, potentially increasing the country's dependence on imported food. This shift not only challenges Pakistan's self-sufficiency objectives but also heightens its exposure to the volatilities of the global market. By quantifying the extent of production loss from land lost to climate impacts and the yield drops resulting from flooding, the project team aim to highlight the critical need for adaptive strategies to safeguard food security in the face of changing climate conditions.

Trade Growth: The competitive edge of Pakistan's export-oriented textile industry is at risk from both direct and indirect climate impacts. Damage to physical assets and diminished labour productivity can lead to higher production costs. The analysis focuses on the volume impact and considers the loss of export volume, focusing exclusively on agricultural commodities, such as staple crops and livestock products. These factors could collectively restrict the volume of goods available for export, thereby affecting trade growth, limiting the sector's contribution to the national economy, and hindering economic development.

The methodology for quantifying economic KPIs related to climate change's cost of inaction utilises the Pakistan Social Accounting Matrix (SAM)[42]. This approach provides a granular analysis of economic interactions and sectoral dependencies within Pakistan, illuminating the flow of goods and services. The integration of the SAM—a detailed economic model that captures production, consumption, and income distribution across different economic actors—enables the project team to simulate the direct and indirect impacts of climate change on specific economic sectors. Specifically, one can identify how climate-related disruptions in key sectors, such as agriculture and textiles, ripple through to affect broader economic outcomes, including employment and GDP growth.

Alongside the economic KPIs that outline the indirect costs of climate inaction, the analysis broadens to include a suite of exposure KPIs. These additional indicators are pivotal in painting a thorough picture of climate change's multifaceted impacts, extending beyond the immediate economic sphere to encompass social impacts, effects on cultural heritage, and consequences for natural ecosystems.

[42] Pakistan SAM https://dataverse.harvard.edu/dataset.xhtml?persistentId=hdl:1902.1/19361

8. Annex – Adaptation and Resilience Actions

People

Extreme heat | Sea level rise | Drought | Wind | Floods (incl. precipitation) | Aligned with NAP | 'No regret' actions

Category	Action	Description	CIDs addressed	
1. Damage to houses			**Primary**	**Secondary**
1.Infrastructure	Water floodgates	Water floodgates, designed to be installed on homes' doors and windows to prevent floodwaters from entering buildings	Floods	Sea level rise
	Backwater Valves	Installing backwater valves in sewer lines to prevent sewage backflow during floods	Floods	Sea level rise
	Sandbag barriers	Using stacks of sandbags around houses to prevent floodwater entering the building	Floods	
	Upgrading informal settlements resilience	Upgrade informal settlements based on the action plan adopted in the national urban resilience strategy and subnational adaptation plans	Floods	
	Promoting green infra-structure in housing	Construct green roofs and permeable pavements to promote rainfall infiltration	Floods	
	Elevation of houses	Build houses on a higher level than ground level to increase resilience from moving water	Floods	
2. Social Assistance	Development of urban planning policies targeting resilience for urban-poor communities and climate migrants	Policies for urban-poor communities and climate migrants incorporating measures such as affordable housing, access to basic services, and climate-resilient infrastructure	Floods	Sea level rise, Wind

Infrastructure actions are applicable only to Pucca and Semi-Pucca houses which represent 70% of houses in Punjab. Pucca houses are houses built using bricks and cement, while semi-pucca is a mix of brick and mud/bamboos

Category	Action	Description	CIDs addressed	
2. Temporary relocation			**Primary**	**Secondary**
1.Infrastructure	Build emergency shelters for evacuation	Structures that can be used for evacuation during extreme weather events, and double as regular infrastructure otherwise (evacuation use & regular use)		
	Continuity plan for critical supply chains	Develop and implement robust continuity plans for critical supply chains that ensure uninterrupted access to essential goods, services, and resources amidst extreme climate events		 
2.Response Programs	Emergency operations centre	Facility where emergency management stakeholders coordinate, monitor, and respond to emergencies or disasters		
	Local evacuation and response drills and simulations	Conduct regular evacuation drills and simulations in vulnerable communities to enhance preparedness, raise awareness, and test the effectiveness of response plans		
	Local evacuation and response teams	Have emergency response teams put in place to execute response plans and minimise impact post-extreme events		

Category	Action	Description	CIDs addressed	
3. Permanent relocation			**Primary**	**Secondary**
1.Infrastructure	Strategic relocation programs	Intentional movement of populations from areas at high risk or vulnerability to climate change impacts to safer or more sustainable locations, incl. new cities		
	Coastal management infrastructure	Infrastructure solutions, such as seawalls or dykes, to protect coastal areas from erosion, storm surges, and sea-level rise		
2. Financial Mechanisms	Funding business relocation	Providing grants and funds to business owners that are relocating their business from high-risk areas		
	Anticipatory funding action	Release a sum of cash to the urban poor communities prior to the climate risk hitting so they can make their decisions on moving or increasing their house's resilience		
3. Social Assistance	Offer affordable housing	Ensure that permanently displaced persons can find an affordable place to live in their new location		
	Invest in low climate risk regions	Invest in the economy of regions with low climate risk across dimensions such as job creation, so that people living in high-risk areas can easily relocate and start their life in a low-risk region		

Category	Action	Description	CIDs addressed	
4. Enablers			**Primary**	**Secondary**
1. Financial Mechanisms	Disaster contingency funds	Dedicated funds to provide financial support for disaster response and recovery efforts in vulnerable communities		
	Weather-indexed insurance	Insurance that uses weather or climate data as the basis for determining policy payouts		
2. Social Assistance	Protection programs for climate migrants with a particular focus on gender and disability	Ensure that gender and disability inclusive programs are put in place to accommodate displaced populations from extreme weather events		
	Basic necessity support	Food stamps, rations, emergency food distribution, education and healthcare subsidies		
	Partnerships with NGOs and local healthcare providers	Joint programs to deliver services and programs to address the psychological and social needs of individuals and communities who have been forcibly displaced or relocated (incl. Organised community events for inclusion and acceptance)		
	Peer support groups and counselling services/centres	Inclusive groups for displaced individuals to foster support for each other		
	Vulnerability assessments of population	Conduct assessments to identify and understand vulnerable communities and their needs in relation to climate change, enabling targeted adaptation measures and interventions		
	Increase timeline of post disaster emergency response and relief	Increase response timelines to encompass further dealing with post disaster relief		

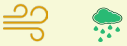
Category	Action	Description	CIDs addressed	
4. Enablers			**Primary**	**Secondary**
3. Community Awareness & Preparedness	Educate communities using flood maps	Show communities flood maps so they understand whether their house is at risk		
	Early warning systems	Early warning signs to target communities for floods, storms		
	Community events on climate hazards and preparedness	Organised gatherings aiming to raise awareness and promote preparedness for extreme climate events (incl. communication efforts aimed at raising public awareness and disseminating information about safety measures and preparedness strategies for various climate-related hazards)		
	Media campaigns promoting safety and preparation best practices	Strategic communication efforts aimed at raising public awareness and disseminating information about safety measures and preparedness strategies for various climate-related hazards		
	All actions related to Population Displacement aligned with the NAP have been prioritised (2 out of 2)			

Assets

Rationale for no regret actions is available in the next slides

Extreme heat | Sea level rise & extreme sea events | Drought | Wind | Floods (incl. precipitation) | Aligned with NAP | 'No regret' actions

Category	Action	Description	CIDs addressed	
1. Assets damage			**Primary**	**Secondary**
1. Reduce risk exposure	A. Preventive relocation			
	Community Voluntary Resettlement	Plan and facilitate the voluntary relocation or retreat of vulnerable communities from high-risk areas to safer locations		
	Infrastructure Relocation	Relocate essential infrastructure to safer locations, mitigating the impacts of climate hazards and ensure continuity of operations		
	Transport Network Adaptation	Modify road and railway networks to account for changes in climate patterns		
	B. Avoid water accumulation			
	Urban Water Absorption	Enhance urban water absorption and retention through permeable surfaces and green infrastructure (permeable pavements, green roofs, etc.)		
	Active Water Removal	Introduce systems that actively remove water, maintaining proper water flow and reducing the risk of flooding in vulnerable areas		
	Sustainable Drainage	Enhance drainage networks and promote sustainable urban drainage solutions		
	Stagnant water prevention	Remove stagnant water from containers, ensuring proper design of reservoirs and dams		
	C. Monitoring of disasters			
	Early Warning Systems	Design and implement early warning systems to anticipate disruption and emergencies		
	Urban Stormwater Monitoring	Monitor and control systems to manage and control stormwater in urban areas to reduce flooding risk and damage		
	Climate Vulnerability Assessment	Enable data collection and assessment of the vulnerability of assets to climate change impacts		

Category	Action	Description	CIDs addressed	
1. Assets damage (cont.)			**Primary**	**Secondary**
2. Reduce impact of disasters	A. Fortify exposed areas			
	Coastal Ecosystem Restoration	Implement Coral and oyster reefs, coastal forests, wetlands, mangroves, seagrass, and barrier islands to reduce impacts of coastal flooding and storms		
	Flood Defence Construction	Construct barriers or levees to protect vulnerable areas from flood events		
	B. Fortify buildings			
	Resilient Building	Strengthen home and building structure (e.g., storm proofing roofs, sealed windows…)		
	Preventive Maintenance	Introduce regular upkeep and preventive measures to protect homes from the impacts of climate change		
	Reinforcement of Elevated Structures	Strengthen elevated structures, such as bridges or wind turbines, to withstand stronger winds associated with climate change		
	Climate Adapted Cooling	Enhance cooling and ventilation systems		
	Advanced insulation Materials	Use innovative materials such as fibre-reinforced composites, self-healing concrete, permeable pavements increase infrastructure's resiliency to extreme weather		
	C. Continuity of operations			
	Operational Continuity Planning	Develop strategies and plans to ensure the continuity of critical operations and services during and after climate-related disasters		

All actions related to Physical Assets aligned with the NAP have been prioritised (9 out of 9)

Category	Action	Description	CIDs addressed
2. Enablers			**Primary**
1. Financial & Insurance instruments	Green Urban Financing Development	Develop financing instruments for resilient urbanisation (green bonds)	
	Climate Finance Access Enhancement	Enhance access to climate finance mechanisms, such as climate funds, grants, and loans, to support climate adaptation initiatives in livelihood and productivity sectors	
	Climate Risk Insurance Development	Develop insurance policies that are specifically designed to address the risks and impacts of climate change on properties	
2. Fiscal Policies	Adaptation Incentive Programs	Provide financial incentives or subsidies to promote the adoption of adaptation measures at the household level, such as flood-resistant construction or green infrastructure	
	Adaptive Intergov. Fiscal Transfers	Introduce intergovernmental fiscal transfers focused on a multi-sectoral investment menu which targets adaptation interventions	

Category	Action		Description	CIDs addressed
2. Enablers				**Primary**
3. Regulations	Clean Land Development		Create new land areas by filling, draining, or otherwise altering bodies of water	
	Land Market and Regulation Reform	☆	Address poorly functioning land markets and onerous land use regulations to limit current low-density growth patterns	
	Formal Land Registration for Resilience	☆	Register peri-urban properties to make them part of the formal land management system, with land conversion controls, zoning and building codes to increase resilience in the face of disasters	
	Land Development Restriction in risky areas	☆	Restrict inappropriate development in risks-prone areas	
	Corporate-Government Climate Resilience Integration		Integrate corporate resiliency considerations into national and local adaptation policies, promoting collaboration between government and businesses to enhance overall resilience	

Economy

Agriculture – Crops

Category	Action		Description	CIDs addressed	
Reduction in Yield / Loss of land				**Primary**	**Secondary**
Climate smart agriculture practices	Crossbreeding/genetic improvement	☆	Selective breeding and genetic enhancements to develop climate-adaptive and high-yielding crop varieties (including drought-tolerant, heat-tolerant and, flood-resistant)	 	
	Fungal symbionts		Use of beneficial fungi that enhance plant resilience and nutrient uptake		 
	Cold storage facilities	☆	Efficient storage infrastructure that reduces post-harvest losses and extends the shelf life of perishable produce		
	Green/glass/polyhouse for farming		Indoor, controlled environment to protect crops from extreme weather events		 
	Cover crops		Crops grown in between cash crops to enhance soil health		
	Crop diversification	☆	Diversification/rotation of crops to derisk specie-specific impact arising from climate change	 	
	Sowing/harvest rescheduled		Adjusting planting and harvesting schedules to align with changing climate patterns (such as harvesting crops before the onset of the drought season)	 	

Category	Action	Description	CIDs addressed	
Labor Productivity			**Primary**	**Secondary**
Labor Productivity	Heat appropriate clothing	Promoting wearing heat appropriate clothing such as protective headwear		
	Providing shade for breaks on farms	Increasing areas with shade in farms for farmers to rest under during breaks		
	Increase number of working hours on the field	Hire more farmers or extend working hours of existing farmers to counteract reduced productivity from heatwaves		
Soil Salinity				
Soil Salinity	Salt leaching	Practices involving craping, flushing, and leaching to remove excess salts from the root zone of crops		
	Irrigation water drainage	Providing adequate drainage of irrigation water from crops to minimise the amount of water that evaporates leaving behind salts		
	Salt tolerant crops	Selective breeding and genetic enhancements to develop salt tolerant crops		
	Soil liming	Applying limestone to soil to increase pH level making it less acidic and enhancing soil health and improving crop yields		

Category	Action	Description	CIDs addressed	
Water Availability			**Primary**	**Secondary**
Water Availability	High Efficiency Irrigation Systems (HEIS)	Includes drip and sprinkler irrigation to improve water and nutrient efficiency	☀	🌡
	Managed Aquifer Recharge (MAR)	Involves various methods for water storage and management, including rainwater harvesting through dry land farming and rooftop water harvesting	☀	
	Regenerative agriculture	Regenerative agriculture to curb water body pollution	☀	
	Land contouring	Levelling/hedging farmland for minimised soil erosion and water consumption using practices such as laser land levelling	☀	
	Alternative water sources	Utilise alternative water sources (sea, fog, rainwater)	☀	
	Wastewater treatment facilities	Improve water quality and reuse wastewater as alternative water source and promote practices such as kitchen gardening	☀	
	Strategic water storage facilities in remote areas	Install water storage tanks in strategic locations where conventional water supply is unavailable	☀	
	Water infrastructure with improved resiliency	Interventions to upgrade infrastructure to minimise water loss such as: Piped, treated, utility-managed surface water systems with interventions such as filters ensure protection of water infrastructure	☀	
	Selecting water efficient crops	Encourage the use of low water consuming crop varieties	☀	
	Regular maintenance of sewage systems	Actively monitoring, cleaning, and clearing of sewage system ensures operation of sanitation infrastructure	☀	
	Implement Adequate Water Pricing	Modernise the Abiana framework by digitising assessment and collection systems	☀	
	Water requirement dashboard	Develop a dynamic dashboard for monitoring crop water requirements (hydro-agro informatics systems)	☀	
	Groundwater recharge	Groundwater recharge pits and wells	☀	🌡
	Gravel Filtration	Gravel based drinking water treatment systems	☀	

Category	Action	Description	CIDs addressed	
			Primary	Secondary
Water Availability	Accounting and management of water resources	Systems and practices to properly track data on water resources (dams, storage tanks, etc.) for localised adaptation	☀	
	Water source profiling	Identifying and assessing all watersheds and river basins for proper monitoring and management	☀	

Category	Action	Description	CIDs addressed	
Disease Management			**Primary**	**Secondary**
Disease Management	Disease surveillance	Strengthened disease surveillance, prevention, and control measures for crops - including diseases from pests		
	Greenhouse farming	Indoor, controlled environment to protect crops from pests and diseases		
	Fungal symbionts	Use of beneficial fungi that enhance disease resistance		
	Cover crops	Crops grown in between cash crops to enhance pest management and disease control		
	Breeding disease resilient crops	Investment in breeding programs to develop disease-resistant varieties		
	Integrated pest management (IPM)	Implementation of pest control strategies that minimise pesticide use and incorporate natural predators and biological controls		

Category	Action	Description	CIDs addressed	
Enablers			**Primary**	**Secondary**
Community Advancement	Water and soil management program workshops	Conduct training programs to educate farmers and land managers on efficient water and soil management techniques		
	Community seed banks	Establishing local seed banks to conserve and distribute diverse and climate-adapted crop varieties		
	Improved info dissemination	Establishing communication channels to disseminate weather forecasts and advisories to farmers in a timely manner		
	Weather monitoring systems	Strengthening weather monitoring systems to provide timely and accurate climate information to farmers		
Financial Mechanisms	Extending credit facilities to small farmers	Restructure financial tools for smallholder farmers to incentivise diversification and improved land management		
	Economic incentives, subsidies for climate resilient farming	Provision of financial incentives and subsidies for farmers adopting climate-resilient practices		
	Climate Insurance	Insurance against extreme weather events to allow farmers to maintain business continuity despite such events		
	Pay at Harvest (PAH) model	The PAH model allows farmers to receive insurance cover at the start of the season but pay the premium after they have harvested and sold their produce		
	Water conservation incentives	Financial incentives for private corporation and community-based water conservation		
	Financing adoption of CSA	Increase access to credit for on-farm technology adoption and purchase of inputs that support CSA		

Category	Action	Description	CIDs addressed	
Enablers			**Primary**	**Secondary**
Market Development	Market development for climate resilient agri-products	Support of the development of market linkages for climate-resilient products, such as certification programs for organic or climate-friendly produce		
	Increasing public private coordination for CSA	Establish a coordination mechanism to maximise synergies between public and private institutions in CSA		
	Business support forums	Support creation of forums for collaboration between small farmers and other stakeholders in crop-specific value chains		
	Update farmers with market prices and information	Introduce regulatory frameworks to connect farmers to the market and equip them with price and market information		

19 actions related to Agriculture & Water aligned with the NAP have been prioritised out of 50 priority actions

Agriculture – Livestock

Category	Action	Description	CIDs addressed	
Production reduction, Increased mortality & Diseases infestations			**Primary**	**Secondary**
Farming practices	Genetic improvement	Selective breeding and genetic enhancements to develop climate-adaptive and high-yielding crop and livestock varieties (including drought-tolerant or disease-resistant varieties)		
	Disease management	Strengthened disease surveillance, prevention, and control measures for livestock such as promoting vaccination against viral diseases, and increasing and enhancing veterinary facilities		
Upgraded infrastructure	Transp. optimisation	Using data to track and optimise transportation of chicks and feed to ensure timely delivery avoiding road blockages and reducing impact of extreme heat		
	Temperature regulation	Affordable adaptation practices need to be developed for the rural poor: provision of shade and water to reduce heat stress from increased temperature		
		Designing livestock buildings to maximise airflow inside the building reducing temperature		
		Implementation of technologies that regulate temperature and improve comfort for livestock		
	Waterproofed buildings	Strengthening home and building structure through sealing foundations, water-resistant coating, thick walls to increase resilience against water intrusion and heat		
	Relocation of livestock farms at risk	Relocating livestock farms to safer locations, mitigating the impacts of climate hazards and ensure continuity of operations		
	Adopt modern reproductivity techniques	Develop capacity to use "Embryo Transfer Technology" to improve livestock reproduction		
	Improve quality of feed	Improve livestock feed quality by producing supplements of Multi-Nutrient Blocks (MNB) from urea, molasses, vitamins and minerals		

All livestock actions are no regret actions – no regret actions rationale on next slides

Category	Action	Description	CIDs addressed	
3. Enablers			**Primary**	**Secondary**
Enablers	Livestock insurance	Insurance schemes for livestock utilising technologies such as facial recognition and RFID for proper tracking and data collection of animals		
	Community led rangeland development	Develop and improve rangelands with community involvement		
	Community led feed conservation	Involve the business community in the promotion of feed conservation measures and fodder banks for the dairy and poultry sectors		

All actions related to Livestock aligned with the NAP have been prioritised (3 out of 3)

Textile Value Chain

Category	Action	Description	CIDs addressed
1. Raw materials inputs			**Primary**
1. Enhance supply chain resilience	Monitor Supply Chain	Assess suppliers' regional risks, resilience, and resources using technology such as satellite monitoring	
	Engage Suppliers	Instruct suppliers and workers on efficient and sustainable resource use (e.g., water)	
	Diversify Suppliers	Create redundant supply chains to reduce disruption risks, including local alternatives to mitigate global disruptions	
2. Switch to less exposed inputs	Reduce Raw Material Dependency	Increase the use of recycled fibres and materials in production	
	Diversify Fiber	Select for fibres less vulnerable to climate change	
	Elevate Industry Positioning	Develop new high segment value addressing new global trends by upgrading cotton quality and/or transitioning to higher value fibres (that are less climate vulnerable)	

Category	Action	Description	CIDs addressed	
2. Labour Productivity			**Primary**	**Secondary**
1. Improve buildings insulations	Insulate Thermally	Reduce internal temperature using Phase Change Materials (PCMs)		
2. Sustainable cooling equipment	Adapt Cooling Systems	Improve cooling and ventilation systems to climate demands		
3. Adapt working hours	Reschedule hours	Modify working hours to avoid peak heat, ensuring worker safety and productivity		

Category	Action	Description	CIDs addressed	
3. Asset Damage			**Primary**	**Secondary**
1. Fortify existing buildings	Detect Flooding	Install water sensors or flood detection systems		
	Enhance Factory Drainage	Improve grading and drainage around the factory		
	Fortify Infrastructure	Improve facilities resilience (stormproof, sealed windows …)		
	Mitigate Flooding	Utilise sump pumps to reduce flood damage		
	Diversify Transport	Secure delivery by diversifying transport means and routes (e.g., use trucks over river vessels)		
2. Optimise new constructions	Strategic Site Selection	Select construction sites in low-risk areas to avoid flooding, landslides, and extreme weather, ensuring building safety and minimising adaptation costs		

No actions related to Textile in the NAP have been identified

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