WFP
World Food Programme

SAVING LIVES
CHANGING LIVES

WFP Critical Corporate Initiative: Climate Response Analysis

Pakistan

Alliance

Bioversity International
CIAT
International Center for Tropical Agriculture
Since 1967 Science to cultivate change

CGIAR
RESEARCH PROGRAM ON
Climate Change, Agriculture and Food Security
CCAFS

December 2021

Acknowledgements

PUBLICATION INFORMATION

This publication is a product of the collaborative effort by the Alliance of Bioversity International and the International Center for Tropical Agriculture (The Alliance), the CGIAR Research Program on Climate Change, Agriculture and Food Security (CCAFS), and the World Food Programme (WFP).

Main authors: Adam Savelli (The Alliance), Benjamin Schiek (The Alliance), Anna Belli (The Alliance), Aniruddha Ghosh (The Alliance), Katie Hickson (Consultant), Harold Achicanoy (The Alliance), Alejandra Esquivel (The Alliance), Cesar Saavedra (The Alliance), Frans Schapendonk (The Alliance), Grazia Pacillo (The Alliance), Julian Ramirez-Villegas (The Alliance), Iftikhar Abbas (WFP), Shama Maqbool (WFP), Hafsa Noman (WFP), Godefroy Grosjean (The Alliance).

Project leaders: Godefroy Grosjean and Peter Läderach
WFP team leaders: Pablo Arnal and Vera Mayer

Proofreading: Scriptoria Solutions
Design and layout: Katya Kuzi

SPECIAL THANKS

The authors would like to thank Giancarlo Pini (WFP), Nicolas Bidault (WFP), Peter Holtsberg, (WFP), Arshad Jadoon (WFP), Faaria Ahsan (WFP), Karim Elguindi (WFP), Aftab Bhatti (WFP), Sarah Bashir (WFP), Khalid Rasul (WFP), (Sultan Mehmood (WFP), Mahamadou Tanimoune (WFP), Mohammad Ali (WFP), James Giles (Alliance), Felicitas Röhrig (Consultant), Dorcas Jalango (The Alliance), Megan Mayzelle (Scriptoria Solutions) and Stephanie Jaquet (The Alliance) for their contributions to this publication.

RECOMMENDED CITATION

This document should be cited as:

Savelli, A., Schiek, B., Belli, A., Ghosh, A., Hickson, K., Achicanoy, A., Esquivel, A., Saavedra, C., Schapendonk, F., Pacillo, G., Ramirez-Villegas, J., Abbas, I., Maqbool, S., Noman, H., Grosjean, G. 2021. WFP Critical Corporate Initiative: Climate Response Analysis Pakistan. The Alliance of Bioversity and The International Center for Tropical Agriculture; World Food Programme. 103 p.

Table of contents

Acknowledgements 2

Key messages 4

Acronyms and abbreviations 8

Introduction 9

Part 1. National context 10

1.1 Geography and agroecological characteristics 11

1.2 Socioeconomic context 12
1.21 Socioeconomic development and challenges 12
1.22 Basic needs coverage 13
1.23 Agricultural production 14
1.24 Food security and nutrition 15

1.3 National climate risk profile 16
1.31 Analysis of historical trends and projected changes in national climate indicators 16
1.32 Economic analyses using IMPACT 16
1.33 Impacts of climate change on food availability and stability through 2050 22

1.4 Analysis of Pakistan's climate-migration-security nexus 24
1.41 Migration in Pakistan 24
1.42 National climate-migration-security impact pathways 27
1.43 Quantifying the climate-migration-security nexus in Pakistan 28

1.5 National climate change policies and development strategies 30
1.51 National policies 30
1.52 National development strategies and finance mechanisms 30
1.53 International alliances and finance mechanisms 31

Part 2. Context within selected livelihood zones 33

2.1 Identification of livelihood zones 34

2.2 Climate risks across livelihood zones 38
2.21 Mean climate projections through 2050 38
2.22 Projections for selected climate hazards through 2050 40

2.3 The climate-migration-security nexus across livelihood zones 43

2.4 Hotspots of vulnerability co-occurrence 44

2.5 Provincial climate change policies and development strategies 48

Part 3. WFP Pakistan: Opportunities for enhanced climate resilience impact 50

3.1 Review of current climate resilience programming 51
3.11 Review of current WFP activities in selected livelihood zones 51
3.12 Gaps and opportunities for WFP programs 53

3.2 Recommendations for climate-resilient programming 54
3.21 Cross-cutting recommendations for WFP programming 54
3.22 Programmatic recommendations for ongoing WFP activities 57
3.23 High-potential programming modalities for WFP to pilot in Pakistan 61

3.3 Partnership opportunities for climate-resilient programming 63

3.4 Funding opportunities for climate-resilient programming 65

Part 4. Synthesis 68

Part 5. Works referenced 73

Part 6. Annexes 82

Annex 1 – IMPACT analysis: supplemental results 83
Annex 2 – Climate-migration-security analysis: detailed methodology 88
Annex 3 – Hotspots of vulnerability co-occurrence: detailed methodology 98

Key messages

PROJECTED CLIMATE CHANGE IMPACTS THROUGH 2050

- In addition to analyses at the national-level, this report focuses on how projected climate impacts through 2050 will affect food security and vulnerability in five livelihood zones selected by the World Food Program (WFP) Pakistan, based on agroecological conditions and the district-level 2017 Integrated Context Analysis: Sindh's irrigated plains, Sindh's Sandy Deserts, Balochistan's dry mountains, Balochistan's dry plateau, and Khyber Pakhtunkhwa's (KPK's) dry mountains.
- At the national level, mean temperatures are projected to rise by 2050 without a corresponding increase in mean precipitation, exacerbating drought and heat stress throughout much of the country. Where more precipitation is expected, it is likely to be erratic, contribute to floods, and complicate agricultural production by disrupting sowing and harvesting periods.
- Locally, mean temperature increases will be most drastic in southern areas of Balochistan and northern areas of KPK, and will occur across both growing seasons. Rising temperatures in northern KPK, particularly during the winter months, increase the risk of glacial melt and local glacial lake outburst floods (GLOFs) flowing downstream throughout the Indus River Basin. In KPK, projected increases in precipitation during both seasons further exacerbate the risks of glacial melt and flooding.
- Droughts, which are already severe, will grow to encompass new geographic areas and increase in severity through 2050 throughout Sindh's irrigated plains, Sindh's Sandy Deserts, Balochistan's dry mountains, Balochistan's dry plateau, and KPK's dry mountain livelihood zones during much of the year and both the *kharif* and *rabi* growing seasons.
- Heat stress is already a major issue and will worsen in severity across Sindh's irrigated plains, Sindh's Sandy Deserts, and Balochistan's dry plateau, particularly during the summer months and the *kharif* growing season.
- Across the selected livelihood zones, rain-induced flash flooding will, in the aggregate, likely remain below critical levels through 2050. The risk will remain concentrated in Sindh's irrigated plains and Sandy Deserts during summer and early autumn. Risk levels will also remain moderate in KPK's dry mountains during the spring months, although increased rainfall here may drive glacial melt, localized GLOFs, and riverine flooding downstream throughout the Indus River Basin.
- The co-occurrence of droughts and heat stress will expand to new geographical areas and grow more severe during both growing seasons by 2050. Areas of co-occurrence will expand throughout all the livelihood zones, with Sindh's irrigated plains, Sindh's Sandy Deserts, and Balochistan's western plateau facing the greatest threat.

ANALYSIS OF PAKISTAN'S CLIMATE–MIGRATION–SECURITY NEXUS

- Climate change is likely to drive migration and potentially lead to the outbreak of conflict through its negative impact on resource availability–a phenomenon possible in all assessed livelihood zones. In Balochistan's Western Dry Mountains, Balochistan's Dry Western Plateau, and KPK's Northern Dry Mountains, climate impacts may also lead to displacement and conflict by exacerbating pre-existing conflict dynamics. In KPK, both natural disasters and an influx of Afghan refugees may heighten the likelihood of scarcity-induced conflict and may amplify ongoing conflicts.

ECONOMETRIC ANALYSIS OF CLIMATE CHANGE IMPACTS ON THE AVAILABILITY AND STABILITY OF THE FOOD SUPPLY THROUGH 2050

- According to an economic analysis based on a future scenario involving high global carbon emissions, few mitigation efforts, and better technology, improvements in agricultural productivity and yield are projected to increase the availability and stability of the food supply through 2050. These increases are expected to decrease levels of hunger and undernourishment by heightening caloric availability and consumption. While these gains are in line with socioeconomic trends, they are due to rapid industrialization, technological innovation, and rising education levels rather than improving climatic conditions. In fact, agricultural gains will be suppressed by negative climatic trends that prevent the sector from reaching its maximum potential productivity. Maize and other cereal crops face the gravest threat, although the production quantities and yields of all commodities modelled–pulses, millet, sugarcane, vegetables, cotton, and wheat–are adversely impacted by climate change through 2050.
- Additionally, these gains may be distributed unevenly, leading to pockets of entrenched deprivation. A geospatial hotspot analysis of eight vulnerability dimensions finds different types of vulnerability occurring in tandem across all livelihood zones, with areas facing a high number of overlapping vulnerabilities most common in Balochistan's western plateau and, to a lesser extent, in Sindh's irrigated plains, Sindh's Sandy Deserts, and KPK's Northern Dry Mountains. Without effective intervention, current vulnerability indicates a predisposition toward future vulnerability, indicating that national-level gains in agricultural productivity or socioeconomic development may be felt less strongly in these areas.

CURRENT NATIONAL POLICIES AND PROGRAMS TO ADDRESS CLIMATE RESILIENCE

- Pakistan has developed a comprehensive policy framework to address climate vulnerability and food insecurity at the national level, and provincial-level adaptation and implementation is critical for local impact. In Sindh and KPK many policies suffer from implementation gaps due to a lack of funding and capacity at the district and provincial levels. In Balochistan, few national policies have been adapted for provincial implementation.

CURRENT WORLD FOOD PROGRAM PROGRAMMING TO ADDRESS CLIMATE RESILIENCE

- WFP Pakistan's current climate resilience programming mainly occurs in line with Strategic Outcome 4, Activities 6 and 7, often taking the form of institutional capacity building at the federal, provincial, and district-levels; community-based disaster risk managementtrainings; and the design of integrated disaster risk management frameworks.

RECOMMENDATIONS AND OPPORTUNITIES FOR FUTURE WORLD FOOD PROGRAM PROGRAMMING, PARTNERSHIPS, AND FUNDING STREAMS

- Several recommendations can support the climate resilience of Pakistan's most vulnerable communities. WFP can support provincial and local governments by identifying gaps in existing policy documents and can improve local-level impact by building the capacity of public agencies while acting as an implementing partner. WFP can also mainstream the targeting of climate-vulnerable beneficiaries throughout its own activities and support national and provincial social protection schemes by identifying climate-vulnerable beneficiaries. WFP's Food for Assets activities can be modified to focus on resilience building in addition to rapid recovery. Its Seasonal Livelihood Programming and Community-Based Participatory Planning activities, meanwhile, can be expanded geographically, tailored to fill policy implementation gaps, and linked to the medium- and long-term suitability of local production systems by supporting agricultural and non-agricultural alternatives where necessary. The planning of future Emergency Storage Facilities can account for projected climate impacts over coming decades, and the development of smaller community storage facilities can be considered. Finally, a greater focus can be placed on anticipatory action initiatives, including forecast-based finance in conjunction with early warning early action and WFP's Platform for Real-time Impact and Situation Monitoring.
- To achieve this agenda, partnerships with Pakistan's provincial and district-level authorities can be strengthened. Partnerships with international meteorological and environmental risk management organizations can enhance WFP's early warning and forecasting capabilities, while greater coordination with the International Organization for Migration can sensitize programming to current and future migration flows. The private sector can be leveraged to make asset creation activities more cost-effective and provide finance for micro- and small business development. Local public and civil society organizations are key for ground-level program implementation, and WFP can strengthen these and support the development of new ones, where necessary. Finally, additional partnerships with provincial, national, and international research institutions can help WFP develop evidence-based resilience programming.
- Due to the protracted nature of climate change, long-term, sustainable finance is needed to implement multi-year climate resilience initiatives. A greater emphasis can be placed on developing an outbound funding pipeline in which WFP Pakistan proactively approaches potential donors in order to communicate its credentials in the climate resilience space. Various multilateral development banks, such as the World Bank and Asian Development Bank, and bilateral development agencies, including the United Kingdom Foreign, Commonwealth, and Development Office and the Japan International Cooperation Agency, fund climate resilience programming but are not yet working with WFP. Finally, Pakistan's domestic private sector, through corporate social responsibility initiatives and individual charity and philanthropy, is an additional source of funding in line with Pakistan's robust culture of corporate and household charity.

Acronyms and abbreviations

ACLED	Armed Conflict Location & Event Data Project
ADP	Annual Development Programs
AEZ	Agroecological zone
BISP	Benazir Income Support Program
BRAVE	FCDO's Building Resilience and Addressing Vulnerability to Emergencies program
CBO	Community-based organization
CBPP	Community-based Participatory Planning
CPEC	China-Pakistan Economic Corridor
CC	Future scenario incorporating climate change impacts in IMPACT assessments
CGIAR	Consortium of International Agricultural Research Centers
CIAT	International Center for Tropical Agriculture
CMIP	Coupled Model Intercomparison Project
COVID-19	Coronavirus disease 2019
CSP	WFP's Country Strategic Plan
DFID	Department for International Development
DRM	Disaster risk management
DRR	Disaster risk reduction
ESF	WFP's Emergency Storage Facilities
EWEA	Early Warning – Early Action
EWS	Early warning system
FATA	Federally Administered Tribal Areas
FAO	Food and Agriculture Organization of the UN
FbF	Forecast-based Financing
FCDO	United Kingdom Foreign Commonwealth and Development Office
FFA	WFP's Food for Assets programming
GCF	Green Climate Fund
GDP	Gross domestic product
GIZ	Deutsche Gesellschaft für Internationale Zusammenarbeit
GLOF	Glacial lake outburst flood
HRF	WFP's Humanitarian relief facility
ICA	WFP's Integrated Context Analysis
IFAD	International Fund for Agricultural Development
IFI	International finance institution
IMPACT	International Model for Policy Analysis of Agricultural Commodities and Trade
IOM	International Organization for Migration
IPC	Integrated Food Security Phase Classification
kcal	Kilocalories
KPK	Khyber Pakhtunkhwa
LZ	Livelihood zone
MDB	Multilateral development banks
MOCC	Ministry of Climate Change
MPK	Mirpur Khas
MSME	Micro-, small, and medium-sized enterprises
NAP	National Adaptation Planning
NCCP	National Climate Change Policy
No-CC	Future scenario not incorporating climate change impacts, in IMPACT model
NMD	Newly Merged Districts
NSER	National Socio-Economic Registry
ODA	Official development assistance
OECD	Organisation for Economic Cooperation and Development
PDHS	Pakistan Demographic and Health Surveys
PDMA	Provincial Disaster Management Authority
PRISM	WFP's Platform for Real-time Impact and Situation Monitoring
PSDP	Public Sector Development Program
PV 2025	Pakistan Vision 2025
R&D	Research and development
RAM	WFP's Research, Assessment, and Monitoring Unit
RCP	Representative Concentration Pathway
RIMES	Regional Integrated Multi-hazard Early Warning System
SDG	Sustainable Development Goal
SLP	WFP's Seasonal livelihood programming
SO	A strategic objective in the WFP CSP
SSP	Shared socioeconomic pathway
THI	Therman humidity index
TTP	Tehrik-i-Taliban
UK Met	UK Meteorological Office
UN	United Nations
UNDP	United Nations Development Program
UNEP	United Nations Environment Program
UNICEF	United Nations Children's Fund
VAM	WFP's Vulnerability Assessment and Mapping Unit
VDO	Village development organization
WASH	Water supply, sanitation, and hygiene
WFP	World Food Program
WHO	World Health Organization

Introduction

The recent Zero Hunger Strategic Review of the World Food Program (WFP) has identified climate change as one of several new and complex drivers of hunger. This novel threat to global nutritional security requires new approaches in terms of both design and resourcing. In response, the Critical Corporate Initiative seeks to broaden and enhance WFP program design capacities through a collaboration between the Program and Policy Development Department and the Partnerships and Advocacy Department. This effort will support successful identification and pursuit of diversified financing opportunities to complement WFP's current resources.

As part of the Critical Corporate Initiative, WFP's Climate and Disaster Risk Reduction Programs Unit, in collaboration with the Research, Assessment and Monitoring unit (RAM), has engaged the Alliance of Bioversity International and the International Center for Tropical Agriculture (CIAT), part of the Consortium of International Agricultural Research Centers (CGIAR), to identify thematic programming, partnership, and funding opportunities. The initiative was conducted in Burundi, Guinea, Guinea-Bissau, Haiti, Nepal, Niger, Pakistan, Somalia, and Tanzania. In close coordination with national WFP officers, the Alliance of Bioversity International and CIAT identified livelihood zones, major crops, priority outcomes, and crucial climate and non-climate hazards for each country. Analysis was then conducted using a mixed methods research plan, including desk review, climate change modelling, the International Model for Policy Analysis of Agricultural Commodities and Trade (IMPACT) assessment, stakeholder workshops, and key informant interviews.

The results herein are organized into four parts. Part 1 provides an overview of Pakistan's national context, including its geography, agroecology, and socioeconomic development. The results of national-level climate risk profiling through 2050 are also presented, including climate trends, risks for key agricultural production systems, an econometric analysis of food availability and stability, and a quantitative analysis of Pakistan's climate-migration-security nexus. National-level policies and development strategies are briefly summarized Part 2, which focuses on five livelihood zones throughout Pakistan and explores their climate risks through 2050, their climate-migration-security nexus, and their hotspots of non-climate vulnerability and co-occurrence. Province-level climate policies and development strategies are also summarized. Part 3 explores how WFP Pakistan can better ameliorate the climate resilience of vulnerable households throughout the five selected livelihood zones in light of the findings presented in Parts 1 and 2. Recommendations for modified and new programming activities are made, along with suggestions about potential partnership and funding opportunities. Finally, Part 4 presents a synthesis of key analytical outputs and recommendations in both textual and tabular form.

PART 1.

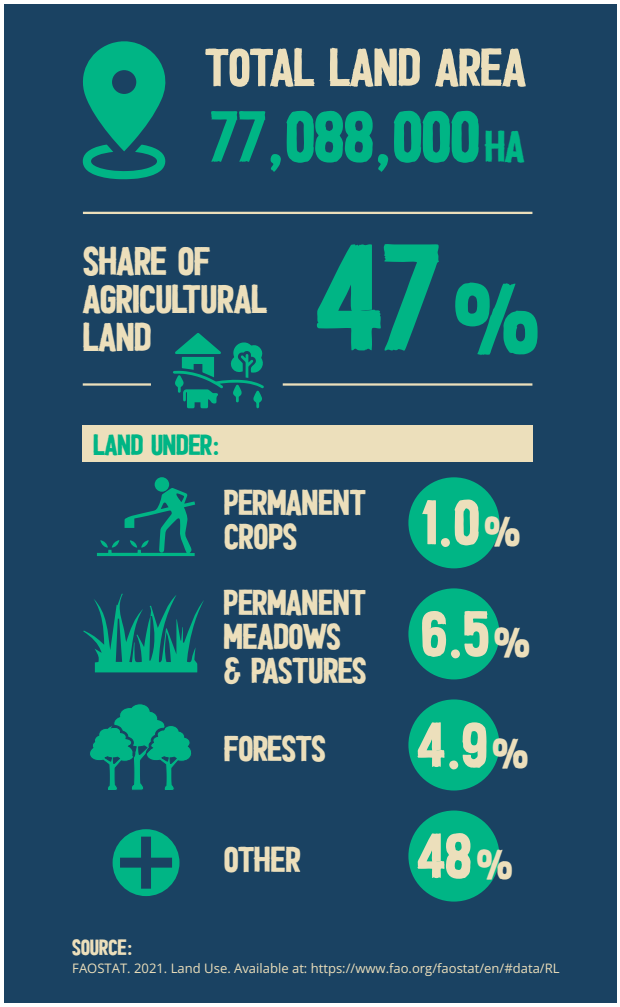
National context

1.1 Geography and agroecological characteristics

With a land area of 771,000 km², Pakistan is the 34th largest country on Earth and the second largest in South Asia [1]. Bordering Iran and Afghanistan to the west and China and India to the east, Pakistan also shares a maritime border with Oman and is separated from Tajikistan in the north by Afghanistan's slender Wakhan Corridor [2]. Pakistan's geography varies widely but generally slopes upward from its coastline along the Arabian Sea in the southwest, through the arid deserts of Northern Sindh and Balochistan, into Southern Punjab and Khyber Pakhtunkhwa (KPK), and up to the Himalayan Mountains of the northeast [3]. Across this wide-ranging geography are spread four climatic regions: the marine tropical coastlands, the subtropical continental lowlands, the subtropical continental highlands, and the subtropical continental plateau [3].

Ten agroecological zones (AEZs) are spread across Pakistan, representing not just its wide variety of geographic and climatic conditions, but also the diversity of agricultural production systems on which its population depends for sustenance and livelihoods. The country's southern border comprises just under 1,000 km of coastline and includes the Indus River Delta in Sindh, which is characterized by tidal creeks, mud flats, marshland, and mangrove forests [6]. Along the coast to the west, in Balochistan, the climate ranges from hyper-arid to arid subtropical with piedmont plains, low hill ranges, and mangrove forests where seasonal rivers drain into the sea [1]. The Indus Basin is flanked by two Sandy Deserts, the Thal and the Thar [2]. Pakistan's most fertile areas, the Indus Plain, the Balochistan Plateau, and the Pothwar Plateau, are all situated in the country's interior [5]. Northern Pakistan is characterized by the high mountains and valleys of the Himalayas, including the second highest peak on earth, K2, and more than 15,000 km² of glaciers [3].

Just under half of Pakistan's total land area is utilized for agricultural production; this number has remained stable for decades and accounts for nearly all arable lands, indicating that increased agricultural production must come from sustainable intensification rather than extensification [3], [4]. Wheat is Pakistan's largest production system, accounting for 30% of all harvested area on average from 2017-2019, followed by rice (10%), cotton (9%), maize (5%), and sugarcane (4%) [5] .

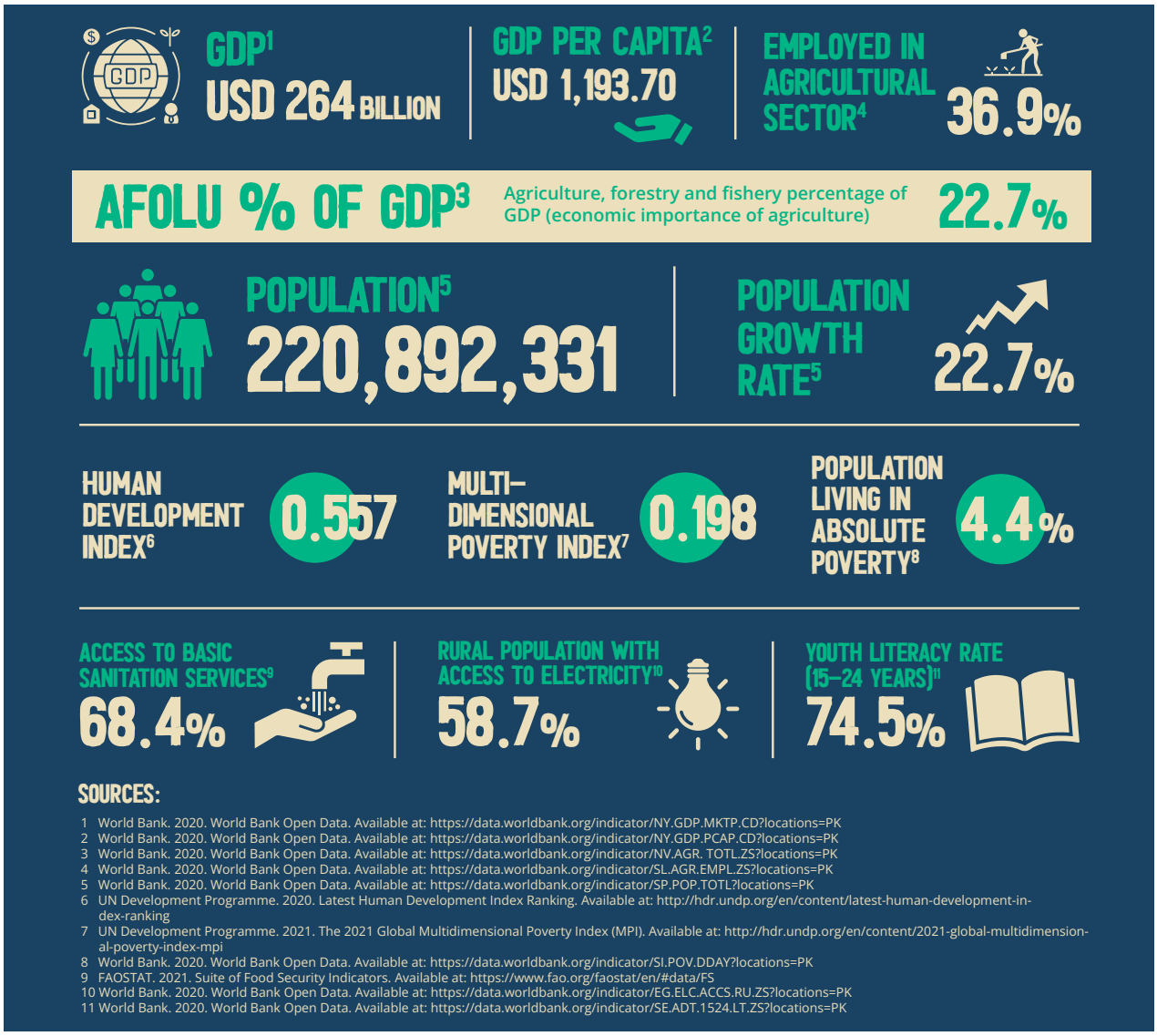


1.2 Socioeconomic context

1.21 Socioeconomic development and challenges

Apart from 2010, when floods submerged 60% of the country's landmass, Pakistan's gross domestic product (GDP) has steadily risen since 2000, to US $314.6 billion in 2018 [7]. However, that number dropped by 11.6% in 2019, with the GDP per capita declining to US $1,285 in tandem [7]. The average individual income has followed a similar trajectory since 2000, with a slightly longer decline between 2007-11, before recovering and reaching a peak of $10,095 in 2019 [6]. Services are the largest sectoral contributor to the GDP at 62%, followed by agriculture and industry, each of which comprises 19% of the total [10].

Despite economic growth and progress made toward poverty reduction, obstacles including administrative challenges, the poor delivery of public services, displacement, and gender-based discrimination have hindered socioeconomic development in Pakistan [11]. It is the sixth most populous country on Earth, and its population has doubled since 2004 to



217 million in 2019 [12]. In 2015, the last year for which data is available, 4.0% of Pakistanis lived in a state of absolute poverty on less than US $1.90 per day [13] However, approximately 38% of Pakistan's population, or 81.4 million people, live in a state of multidimensional poverty today [14]. Of that number, 22% experience severe multidimensional poverty, while an additional 13% of the population–approximately 28 million people–hover just above the threshold and are highly vulnerable to even minor economic shocks [14]. Although Pakistan's Gini coefficient in 2018 was just 0.31, the gains of Pakistan's sustained economic growth have been distributed unequally, with the top 10% of Pakistanis earning 45% of total income while the bottom 50% earned just 19% in 2019 [7], [15]. Due to the varying capacities of provincial and district governments, the levels of socioeconomic development vary widely across Pakistan's provinces, and further within demographic subdivisions.

Gender inequality is a critical issue in Pakistan; women suffer significantly worse educational and economic outcomes than their male counterparts. Pakistan ranks third-to-last globally in the Global Gender Gap Report 2020 [8]. Beginning in childhood, girls lack the same access to educational opportunities as boys, and female school enrolment rates trail those of boys by approximately 10% throughout childhood [8]. Economically, women are significantly less likely to be in a position to exercise control of their earnings or make household financial decisions, while the estimated earned income of women, adjusted for purchasing power parity, is less than one-fifth that of men–a gap that has increased between 2006 and 2019 [9].

Conflict and disaster-induced displacement are widespread, as Pakistan is home to 1.45 million refugees–the third-largest refugee population globally–and 106,000 internally displaced persons [18], [19]. Virtually all of Pakistan's refugees are Afghans who have fled the American War on Terror, while 86% of internal displacement is driven by disasters, and 14% by conflict [18], [19].

1.22 Basic needs coverage

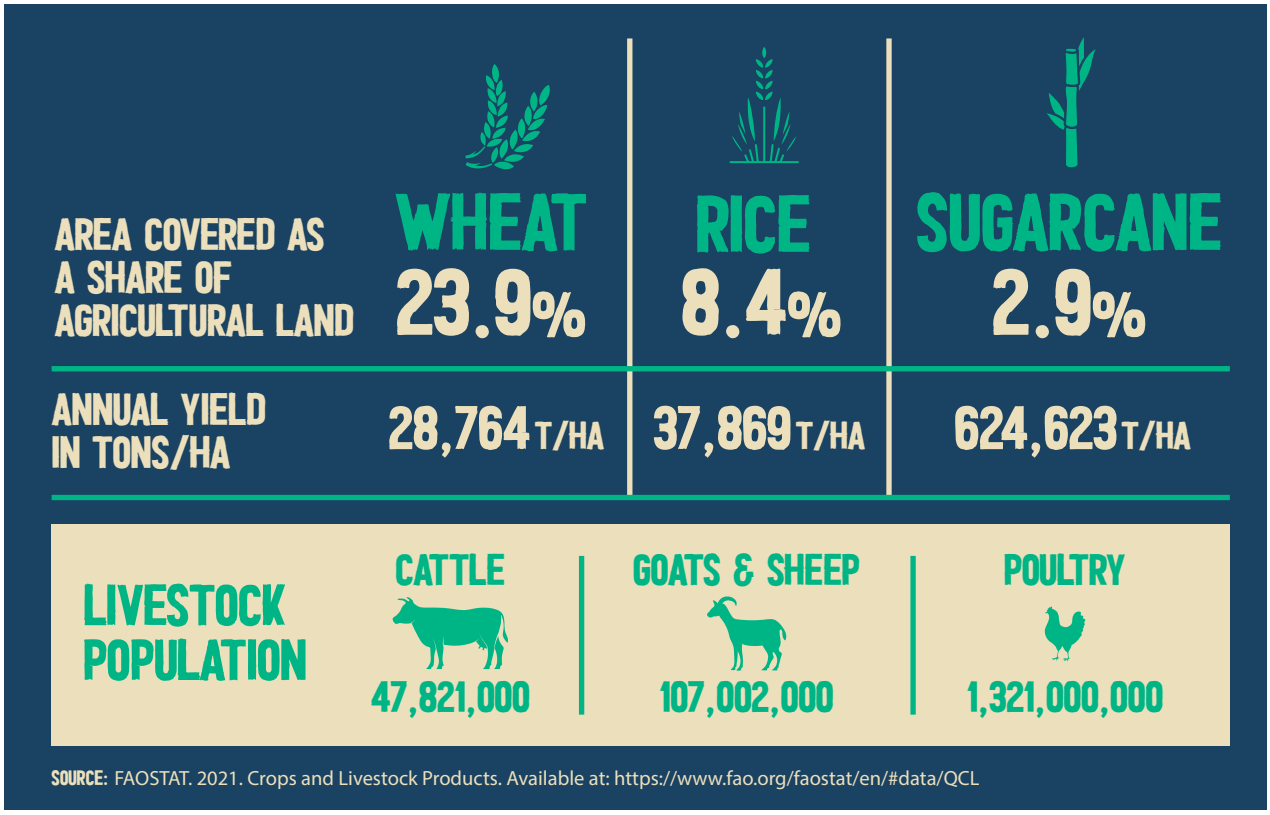
Basic needs such as potable water, sanitation, electricity, and education are out of reach for many Pakistanis. While 92% of Pakistanis have access to basic drinking water, just 35% are able to access safely managed drinking water, down from 38% in 2004 [21], [22]. Basic sanitation services are beyond reach for 40% of the population, and 29% of the national population lacks access to electricity, including 45% of those living in rural areas, down from 60% in 1998 [10], [23]. Of youths between 15 and 24 years of age, 75% are literate. However, access to education is gendered; while 81% of young men are literate, just 68% of young women can read [24], [25]. It is estimated that 23 million children between the ages of five and 16 are out of school [26].

Pakistan's national health system, while improving, is plagued by poorly financed services, high prices, unequally distributed human resources, and an insufficient number of specialized workers [28]. A 2016 study by *The Lancet* ranked Pakistan 154th of 195 countries in its Healthcare Access and Quality Index [29]. Although access to and quality of care increased dramatically between 1990 and 2016, Pakistan still ranks in the bottom 22% of countries measured [29]. In 2017, the average life expectancy was 66.5 years, placing Pakistan in the bottom third of countries in the Eastern Mediterranean Region according to the World Health Organization (WHO) [30]. For every 1,000 live births, 55.7 infants and 140 women die during childbirth [31], [32].

1.23 Agricultural production

Despite improving production, the agricultural sector as a whole is highly vulnerable to climate hazards and environmental risks, while 40% of the population suffers from chronic food insecurity [11]. Nonetheless, sustained agricultural growth–in terms of both crop and livestock production–has allowed Pakistan to become largely self-sufficient in feeding its population [12]. The availability of food groups critical to nutrition—cereals, meat, milk, vegetables, pulses, fruits, and oils—has increased in line with population growth in recent decades, enabling Pakistan to become largely self-sufficient [13]. However, increased production is threatened by a variety of climate risks, including droughts, rising temperatures, erratic precipitation, flooding, soil salinization, and increased incidences of pests and diseases (see *National climate risk profile* and C*limate risks across livelihood zones*).\

While a wide variety of food and cash crops are grown across Pakistan's diverse agroecological landscape, cereal crops are particularly critical for both food security and livelihoods. Wheat is Pakistan's primary staple crop and accounts for a large portion of Pakistan's cereal consumption, which as a whole accounts for 62% of total energy consumed [4]. Diets comprised mainly of wheat that are energy-rich but nutrient-poor are common due to poverty, subsidies, and a lack of nutritional awareness [14]. Wheat production comprises more than 30% of the total harvested area, 8.7% of agricultural value addition, and 1.7% of the total GDP [15], [16]. Rice is also vital to food security and livelihoods because it is Pakistan's second major staple food crop after wheat and, after cotton, its second most exported commodity [16]. In 2019, rice contributed 3.1% to agricultural value addition and 0.6% to the total GDP [16]. Maize is Pakistan's third most important cereal crop, accounting for 2.9% of agricultural value addition and 0.6% of the overall GDP in 2019-2020 [16].

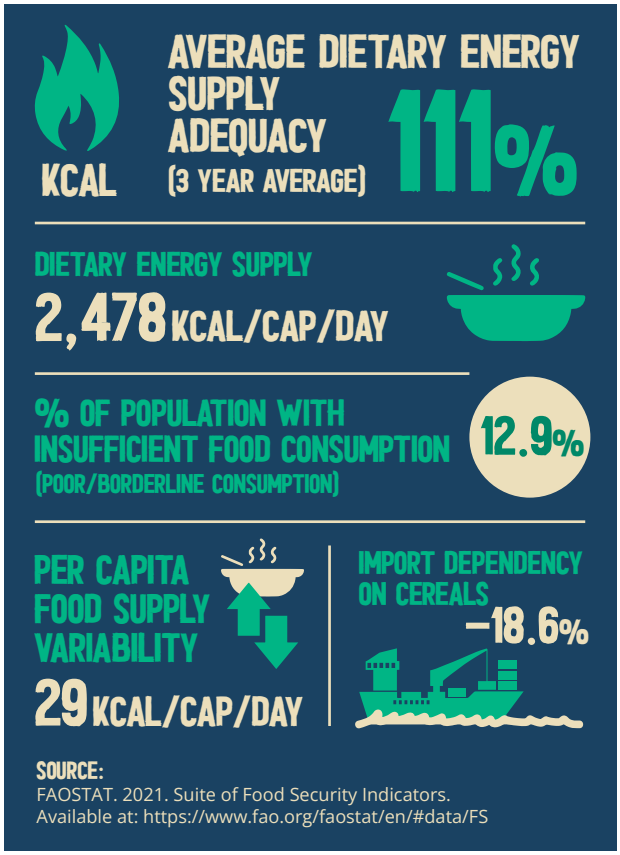


Livestock is the largest of Pakistan's agricultural subsectors, driving 60.6% of the agricultural GDP and 11.7% of the total GDP [16]. More than 8 million rural families across Pakistan derive at least 35% of their income from livestock production [16]. Livestock are reared across all provinces in Pakistan, but production is particularly important among small subsistence farmers, nomadic agro-pastoral communities with insecure land tenure, and in mountainous and rain-fed regions where crop production is challenging [4]. Market-oriented smallholders account for 70% of milk production [17]. The rearing of livestock is heavily gendered, with rural women spending an estimated 59% of their daily time on livestock-related activities [14]. Pakistan is the fourth largest producer of milk globally, and despite the importance of large commercial operations, a significant amount of production occurs traditionally rather than industrially [17]. Milk is the most available foodstuff per capita by weight, and its increased consumption is a core part of the Nutrition Section of the Planning Commission's Pakistan Dietary Guidelines for Better Nutrition [12], [13], [16].

1.24 Food security and nutrition

Food insecurity and malnutrition are endemic in Pakistan, driven by a variety of overlapping factors including poverty, poor dietary variety, and deficient water, sanitation, and hygiene (WASH) infrastructure [33]. Recent percentage gains in the population of food-secure and adequately nourished people have been offset by rapid population growth as well as economic and climate-induced shocks, leading to an increase in the absolute number of those with inadequate food and nourishment [33]. Of the 113 countries measured by the Global Food Security Index in 2019, Pakistan ranked 74th for affordability, 75th for availability, 93rd for quality and safety, 78th overall globally, and 18th overall out of the 23 countries in the Asia-Pacific region [36]. That same year, Pakistan's GDP per capita ranked 33rd out of the 233 countries for which there was data [18].

According to Food and Agriculture Organization of the United Nations (FAO) estimates, Pakistan's prevalence of undernourishment–a hunger-related indicator that measures a lack of dietary energy–has decreased from 21.9% in 2002 to 12.3% in 2018 [19]. However, progress has been uneven, with undernourishment increasing between 2007 and 2012, and again from 2017 to 2018 [19]. A separate Household Integrated Economic Survey conducted by the Pakistan Bureau of Statistics indicates that the percentage of undernourished people decreased from 25.5% to 20.3% over the same period, while the estimated number of undernourished people grew from 37.6 to 40.0 million people [14]. That survey also revealed large regional discrepancies, with undernourishment rates ranging from 48.4% in Balochistan, to 34.1% in Sindh, to 11.9% in KPK [14]. About 31.5% of Pakistani babies are born underweight, often due to the poor nutritional status of childbearing women [14].



1.3 National climate risk profile

In this section, historical and current climatic conditions are modelled into future projections of climate trends and agricultural production at the national level. For historical precipitation and temperature trends, Climate Hazards Group InfraRed Precipitation with Station data was combined with AgERA5 agrometeorological indicators derived from the European Centre for Medium-Range Weather Forecast's ERA5 dataset [20], [21]. For future projections an ensemble of downscaled Coupled Model Intercomparison Project (CMIP6) products were used, including the following models: ACCESS-ESM1-5, EC-Earth3-Veg, INM-CM5-0, MPI-ESM1-2-HR, and MRI-ESM2-0 for SSP5-8.5 scenario. These models were selected based on the climate sensitivity of 40 CMIP6 models; five models with lower sensitivity were selected. We focused on both near-term (2021–2040 or the "2030s") and medium-term (2041–2060 or the "2050s") projections to provide a general indication of trends over multiple horizons. Data from 2020 is excluded because full-year data was unavailable at the time of analysis.

1.31 Analysis of historical trends and projected changes in national climate indicators

A monsoon climate predominates in Pakistan, and two distinct growing seasons are widely followed: *kharif*, from roughly March to November, and *rabi*, from roughly October through June. With the exception of areas in the northern mountains, Pakistan is mainly arid, with hot summers and cool or cold winters. Historically, mean minimum temperatures range from 4°C in January to 22°C in July, and mean maximum temperatures from 24°C in January to 32°C in June [20], [21]. Rains are more common during *kharif*, which is Pakistan's rainy season. However, both seasons are relatively dry, with rainfall averaging between 1 mm per month in October and 28 mm in July. Generally, a month is considered to be dry if less than 100 mm of rain falls over a 30-day period [20], [21]. In Pakistan, no month averages more than 30 mm of rainfall.

Future projections at the national level indicate gradual but steady, slight increases in temperatures and moderate escalation in precipitation across all months of the year through 2050. During the early months of *kharif* and *rabi*, when cultivation typically occurs, heightened precipitation is expected, while the seasons become drier in the middle and wetter at the end, during harvest. These trends begin in the decades leading to 2030 and continue through 2050 and are common to both seasons (Figure 1).

1.32 Economic analyses using IMPACT

The economic analysis presented here uses IMPACT, an exploratory tool for assessing linkages between agricultural policy, climate change, and technologies in agricultural systems. The socioeconomic basis for the results presented in this chapter is Shared Socioeconomic Pathway 5 (SSP5), a policy, population, and GDP trajectory characterized by rapid industrialization, high levels of technological innovation, and improving education alongside fossil fuel-driven industrialization with little effort to mitigate the

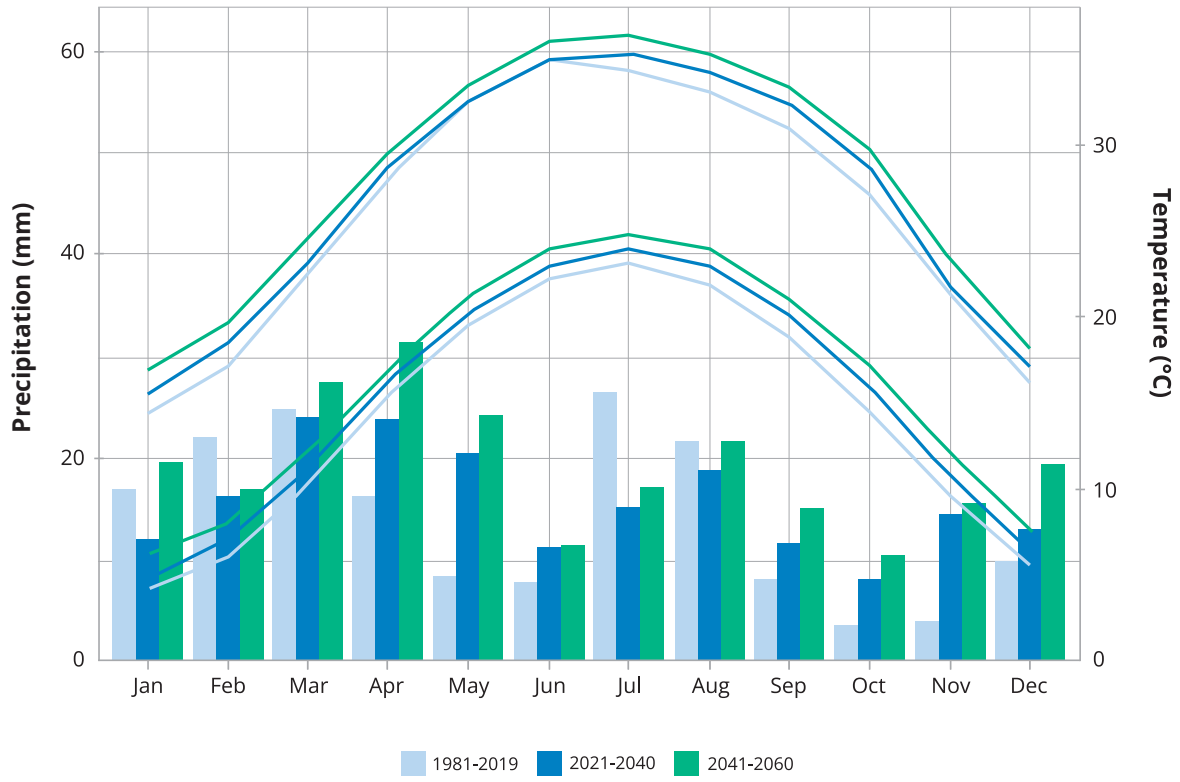


Figure 1. Historical and future projected monthly mean maximum and minimum temperature and precipitation in Pakistan

impacts of climate change [22].[1] Assumptions regarding future temperature increases due to carbon concentration and radiative forcing are captured in different Representative Concentration Pathways (RCPs), which account for long-term changes in temperature and precipitation but not for changes in climate variability or the incidence of extreme weather events [22]. For this study, RCP 8.5 is assumed–the most pessimistic carbon concentration scenario available–which projects a mean global temperature rise of 1.4-2.6 degrees Celsius by 2050 over the 2005 level. Overall, the combination of SSP5 with RCP 8.5 envisions a bleak climate change outlook, exacerbated by increased fossil fuel use, although some of the worst impacts in terms of food availability are partly offset by an optimistic forecast of enhanced technology and education levels. A "no climate change" (No-CC) scenario functions as a benchmark against which to compare the impacts of climate change.

In IMPACT, yield is modelled as a function of both biophysical and economic factors, meaning that negative climate impacts can be offset by technological improvements related to germplasm and farm management, for example, and by economic incentives for farmers to invest in inputs. Conversely, economic incentives can exacerbate biophysical yield loss if price signals lead investments elsewhere, or if farmers switch to more profitable alternative crops. These relative impacts then translate into a rebalancing of the comparative advantages or disadvantages of commodities with respect to one another, and of the comparative advantages of nations trading in these commodities. This rebalancing, in turn, shapes the price signals driving changes in economic yield and productive decisions at farm-level.

Because IMPACT results are reported at the country level and not disaggregated

1 IMPACT does not account for perturbations resulting from the COVID-19 pandemic.

by livelihood zone or demographic or economic group, their relevance lies in the context they provide for local decision making. Identifying points of climate resilience and vulnerability within Pakistan's agricultural sector equips policy makers with an inventory of agricultural strengths and weaknesses at the national level. This critical information can feed into the formulation of strategies to address climate hazards at the livelihood zone-level, which typically involve a rebalancing of investments across National Agricultural Research System programs, as well as investments in the infrastructure and institutions required to leverage points of resilience and mitigate points of vulnerability.

IMPACT outputs present one possible scenario of future conditions in order to provide general guidance on policy and development interventions. Below, IMPACT climate change (CC) projections out to 2050 for supply, demand, and food availability of key crop and livestock commodities are compared against their respective No-CC benchmark trajectories. This comparison is made to identify points of vulnerability and resilience in Pakistan's agricultural sector, particularly as regards food production and availability.[2] The

2 "Raw" CC trajectories, without comparison to No-CC trajectories, are provided in Annex.

commodity focus is chosen by in-country experts based on relevance to Pakistan's diets and farms, especially as regards current and future food and nutritional security.

IMPACT RESULTS: SUPPLY-SIDE IMPACTS OF CLIMATE CHANGE

Comparison of climate change scenarios against the No-CC benchmark scenario offers insight into how vulnerable or resilient crops are to the effects of climate change. As mentioned above, IMPACT allows farmers to adjust agricultural input levels and/or switch to new crops in response to price signals, thereby altering yield and area levels. Yields and area harvested may thus grow despite climate change-related biophysical setbacks if the corresponding investment in inputs is profitable to farmers. Conversely, the market forces modelled by IMPACT can also exacerbate some crops' biophysical yield loss.

In Pakistan, production of key commodities is projected to be substantially lower under climate change than under the No-CC benchmark (Figure 2). Lower production relative to the No-CC benchmark is especially pronounced for cereals, except for wheat. IMPACT attributes this situation primarily to lower projected yields, but reduced area is also projected to play a small role. Of all the key commodities, wheat production exhibits the most resilience to climate change, differing from its No-CC benchmark by -4.7% in 2030, and by -2.5% in 2050. This resilience is due mostly to larger area than in the No-CC scenario offsetting relatively lower yields.

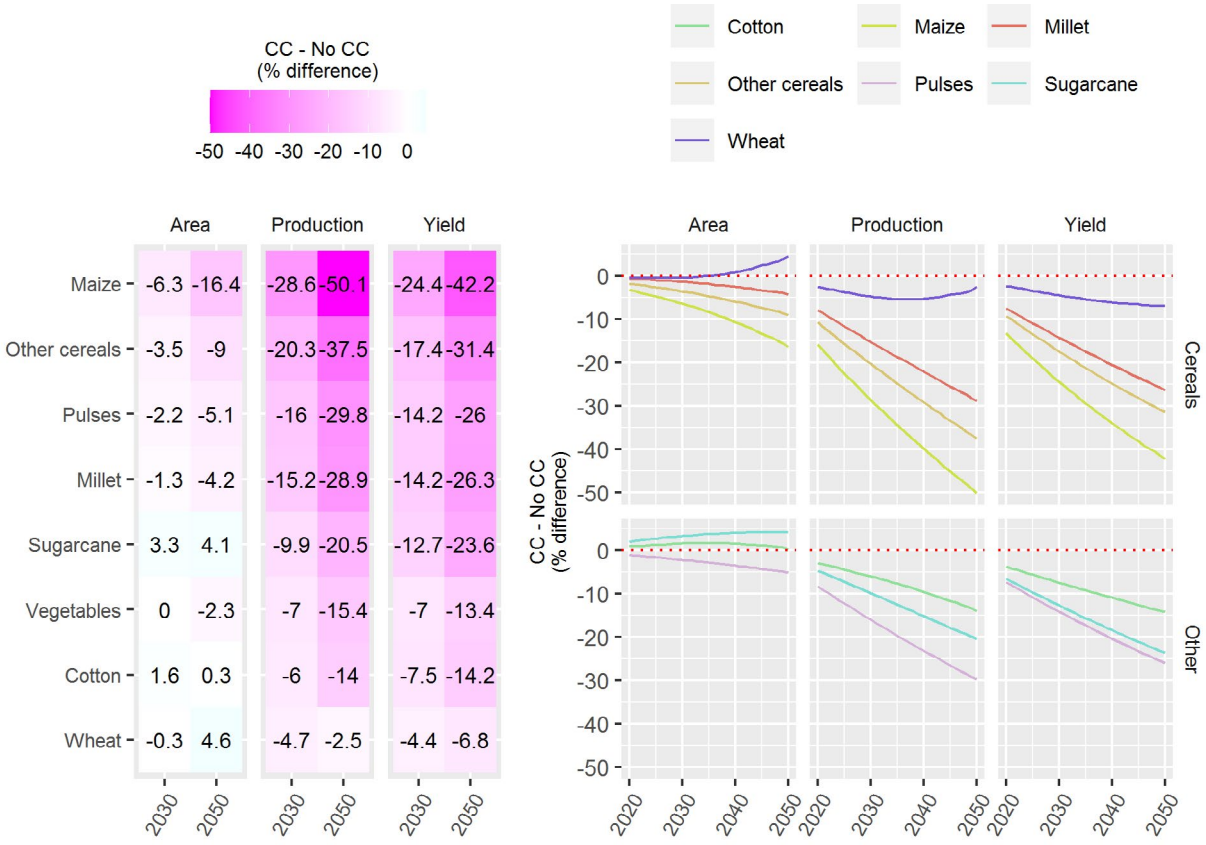


Figure 2. Difference between climate change and no climate change scenarios for area, production, and yield of key crops. For each year, the difference is calculated as the percentage difference between the CC value and the No-CC value.

IMPACT RESULTS: CLIMATE CHANGE IMPACTS ON DIETARY TRAJECTORY

Calorie availability is projected to be lower under CC than under the No-CC benchmark for key commodities (Figure 3). Lower calorie availability relative to the No-CC benchmark is especially pronounced for maize. Wheat calorie availability, on the other hand, exhibits relative resilience to climate change out to 2030, although a negative impact becomes evident thereafter. Calorie availability for pulses and livestock per capita exhibits the most resilience, differing little from No-CC benchmark trajectories.

IMPACT RESULTS: CLIMATE CHANGE IMPACTS ON THE PREVALENCE OF HUNGER AND MALNOURISHMENT

The share of population at risk of hunger is projected to be less than one percentage point higher by 2050 under CC than under the No-CC benchmark, while the number of undernourished children is more differentiated. The CC projection of the number of undernourished children is likewise less than one percent higher than the No-CC projection out to 2030; but the difference then increases to 2.5% by 2050 (Figure 4, left panel). This is consistent

Figure 3. Percentage difference between the consumption (kcal/capita/day) of key commodities with and without climate change. For each year, the difference is calculated as the percentage difference between the CC value and the No-CC value.

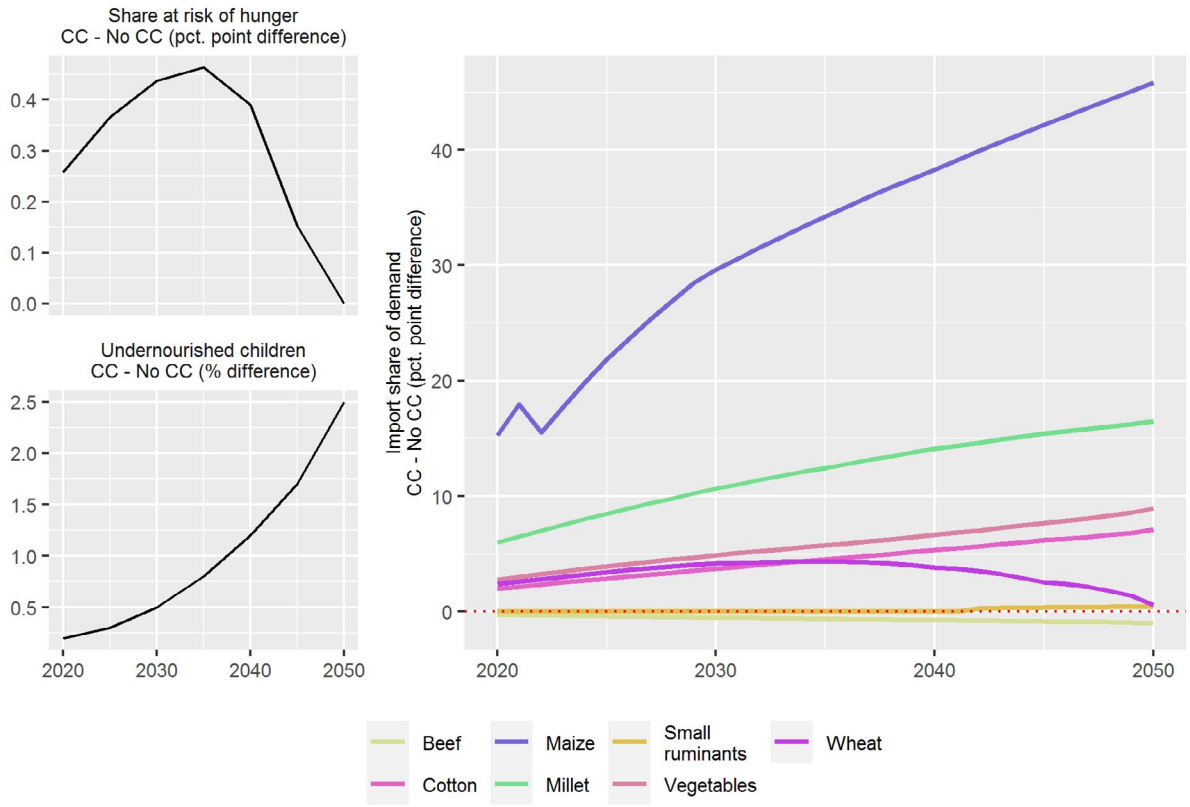


Figure 4. The difference between climate change and no climate change trajectories for key food availability indicators and commodities. For the undernourished children indicator, the difference is expressed as the percentage difference between the CC and No-CC values. For the share of population at risk of hunger and import dependence, the difference is expressed as a percentage point difference since these indicators are reported as percentages.

with the lower projected calorie intake under CC relative to No-CC intake, seen above. Import dependence for key commodities is projected to be considerably higher under CC than under the No-CC benchmark, and is especially pronounced for maize and millet (Figure 4, right panel).

CONCLUSIONS AND RECOMMENDATIONS BASED ON THE IMPACT ANALYSIS

While maize, millet, and other cereals exhibit considerable climate change vulnerability, wheat demonstrates resilience. This suggests that continued investment in improved wheat varieties could be a cornerstone in ensuring future staple food availability, especially considering wheat's historic role as the single largest calorie source in Pakistan. Maize and millet, while not as important as wheat in terms of direct human consumption, are the primary sources of livestock feed in the country (see Annex). To protect the livestock supply from climate change, then, some level of research and development (R&D) investment may be required to address the climate change vulnerability of these crops. Alternatively, it may be more worthwhile to research the viability of adapting substitute feed crops that exhibit resilience to climate change. Cassava, for example, is well known to be resilient to climate change, and is widely used in other countries as livestock feed. As a general rule, it is always worthwhile assessing the pros and cons of roots and tubers as an alternative carbohydrate source under climate change before investing entirely in cereals.

As diets gradually displace starchy staples such as cereals with fats, proteins, and more

nutrient-dense foods in accordance with Bennett's Law, it may be worthwhile to assess the viability of legume R&D as a means of decreasing legume import dependence and smoothing this dietary transition. Though pulses are not currently consumed or produced in large quantities in Pakistan, bean and lentil imports have steadily risen over the past three decades, and their exhibited resilience to climate change in terms of calorie availability may render them a future focus crop for food security.

Although livestock exhibit the greatest resilience of all commodities examined, the impacts of climate change on livestock are still poorly understood. Thus, these particular results entail high uncertainty, and major livestock R&D investment decisions should not be made on the basis of these results alone.

1.33 Impacts of climate change on food availability and stability through 2050

To predict the impact that climatic changes will have on Pakistan's food security through 2050, this section aggregates results from the above climatic and econometric analyses to assess future food availability and stability. As these analyses focus less on access and utilization, a brief exploration of these pillars is supplemented with recent peer-reviewed and gray literature.

While food production and availability are expected to improve by 2050, these gains are mainly due to non-climatic factors and will be suppressed by climatic trends that negatively impact the production quantities and yields of all modelled agricultural commodities. Although the production and yield of all commodities modelled are expected to be lower under the CC scenario, per capita calorie availability and consumption is projected to increase considerably in the coming decades, while the risk of hunger and malnourishment is projected to decrease. These gains are primarily due to increasing industrialization, a high degree of technological innovation, and improving educational levels, which are expected to offset the mainly negative climatic trends facing Pakistan's agricultural sector. With mean temperatures and precipitation are projected to rise by 2050, temperature increases exceed those in precipitation, exacerbating the likelihood of drought conditions that will probably degrade overall agricultural production. Additionally, shifting precipitation patterns will likely degrade overall agricultural production during both the *kharif* and *rabi* seasons. Increased rainfall during the early and late months of both seasons will complicate cultivation and harvesting, while less rainfall during the middle of both seasons may lead to droughts during crucial growing periods. These trends begin in the decade leading to 2030 and continue through 2050. Water for Pakistan's agricultural sector comes from a variety of sources including rainfall, snow, glacial melt, groundwater, and surface water–all of which are increasingly stressed and polluted [23], [24]. Worse drought conditions will further strain supply, potentially limiting the amount of water available for agricultural production and safe drinking.

Despite positive socioeconomic trends, climate change will continue to exacerbate the risks of hunger and malnourishment, particularly through its physical impacts on agricultural production and by degrading livelihoods in rural and food-insecure areas through 2050; this risk grows in significance from 2030 onwards. By 2050, production is projected to increase for wheat, vegetables, sugarcane, cotton, poultry, beef, and small ruminants, while decreasing for maize and millet, resulting in increased import dependency for livestock and negative impacts on maize calorie availability. Additionally, purposes like seed, industrial applications including starch, textiles,

paper, and processing, and livestock feed are projected to drive most maize and millet demand, heightening import dependency.

The stability of Pakistan's food supply faces a growing risk of climatic disruption due to negative climate trends, increasingly frequent and severe environmental shocks, and the climate's adverse effects on socioeconomic development. Increasing temperatures and precipitation in glacial areas are likely to drive glacial lake outburst floods (GLOFs) in Pakistan's northern regions, as well as increased flooding downstream throughout the Indus River Basin, where the majority of Pakistan's agricultural production occurs. Flooding and increasingly erratic rainfall, particularly in Sindh's desert regions, will exacerbate agricultural pest and disease outbreaks, including desert locust swarms. Climatic decline may also hasten the eruption of violent conflict, particularly as competition for ever-scarcer productive resources grows more intense, rural-urban migration flows accelerate unplanned urbanization, and the degradation of rural livelihoods facilitates the recruitment efforts of armed groups *(Section 1.4 – Analysis of Pakistan's climate-migration-security nexus and Section 2.3 – The climate-migration-security nexus across livelihood zones).* All of the above climatic and climate-induced shocks threaten to destabilize Pakistan's agricultural sector.

Due to production challenges, increasing import dependence, and poor market accessibility, food access also faces significant risk by 2050, while poverty and disease threaten utilization. Because households vulnerable to food insecurity are likely to both rely on agricultural production for income generation and experience vulnerability to environmental hazards, climatic risks threaten these households' access to food in two ways: by reducing the quantity of food they can grow for subsistence, and by lessening the amount they can spend on food purchases [12]. Increasing import dependence for all key commodities, particularly from 2030 onward, is likely to drive food prices up, putting nutritious foodstuffs out of reach of poor households. In remote parts of Pakistan, including large portions of Balochistan, Sindh, and Khyber Pakhtunkhwa, the co-occurrence of climate and non-climatic hazards is common, and market access is severely limited. Here, poverty is highly likely to drive poor utilization, while erratic rainfall and flooding both facilitate the spread of waterborne diseases, contributing malnutrition, and kill livestock [12].

1.4 Analysis of Pakistan's climate-migration-security nexus

To understand how climate change, migration, and conflict dynamics interact in Pakistan, a literature review has been combined with a two-step quantitative analysis. Based on national and international scientific literature, surveys, and monitoring data on displacement, natural disasters, and insecurity, the resulting outputs aim to identify key migration flows and the impact pathways through which climate change may drive migration and/or conflict, both at the national level (this section) and at the livelihood-zone level (*Section 2.3 - The Climate-migration-security nexus across livelihood zones*).

1.41 Migration in Pakistan

INTERNATIONAL MIGRATION

Emigration is common, particularly for economic reasons, and Pakistan is the third-largest refugee-hosting country in the world [25]. Emigrants represent almost 3% of the total Pakistani population and are generally single males of working age, educated, and unemployed, who rely on international social networks to pursue economic opportunities abroad [26]–[28]. While economic opportunity is the main driver of emigration, a small share of emigrants leaves Pakistan due to conflict, a loss of trust in the state, and poor educational opportunities [26]. Violence and persecution also drive out-migration, and, in 2019, 137,000 refugees and 66,000 asylum seekers fled Pakistan. Those seeking refuge are more likely to be families than single males. Many immigrants arriving in Pakistan hail from India, Afghanistan, Iran, Myanmar, and Sri Lanka. Afghan refugees represent the largest single block of immigrants, with a population of 1.4 million [29], [30].

INTERNAL MIGRATION

Internal migration is common in Pakistan, with an estimated 13% of the population residing somewhere other than their place of birth [27]. Pakistani internal migrants are most likely to move for social or economic reasons from rural to urban areas in the same province [31]. Rural-to-rural migration is also common, particularly in provinces that lack large urban capitals, such as the formerly Federally Administered Tribal Areas (FATA) and Azad Jammu and Kashmir [31]. Rural-to-rural migration is often motivated by social factors, such as marriage, and by the pursuit of economic and educational opportunities, whereas rural-to-urban migration is more economically driven for the purposes of diversifying livelihoods and mitigating agricultural risks [32], [33]. Overall, economic migrants are most likely to move to cities.

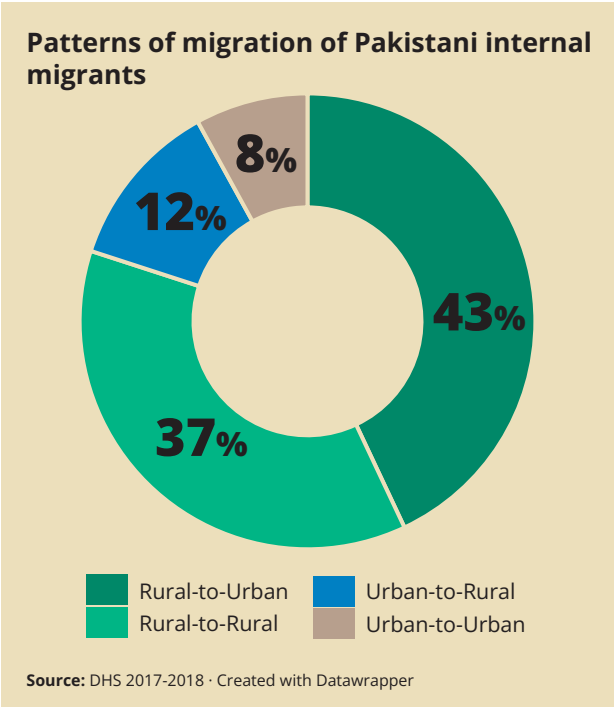


Figure 5. Patterns of internal migration in Pakistan

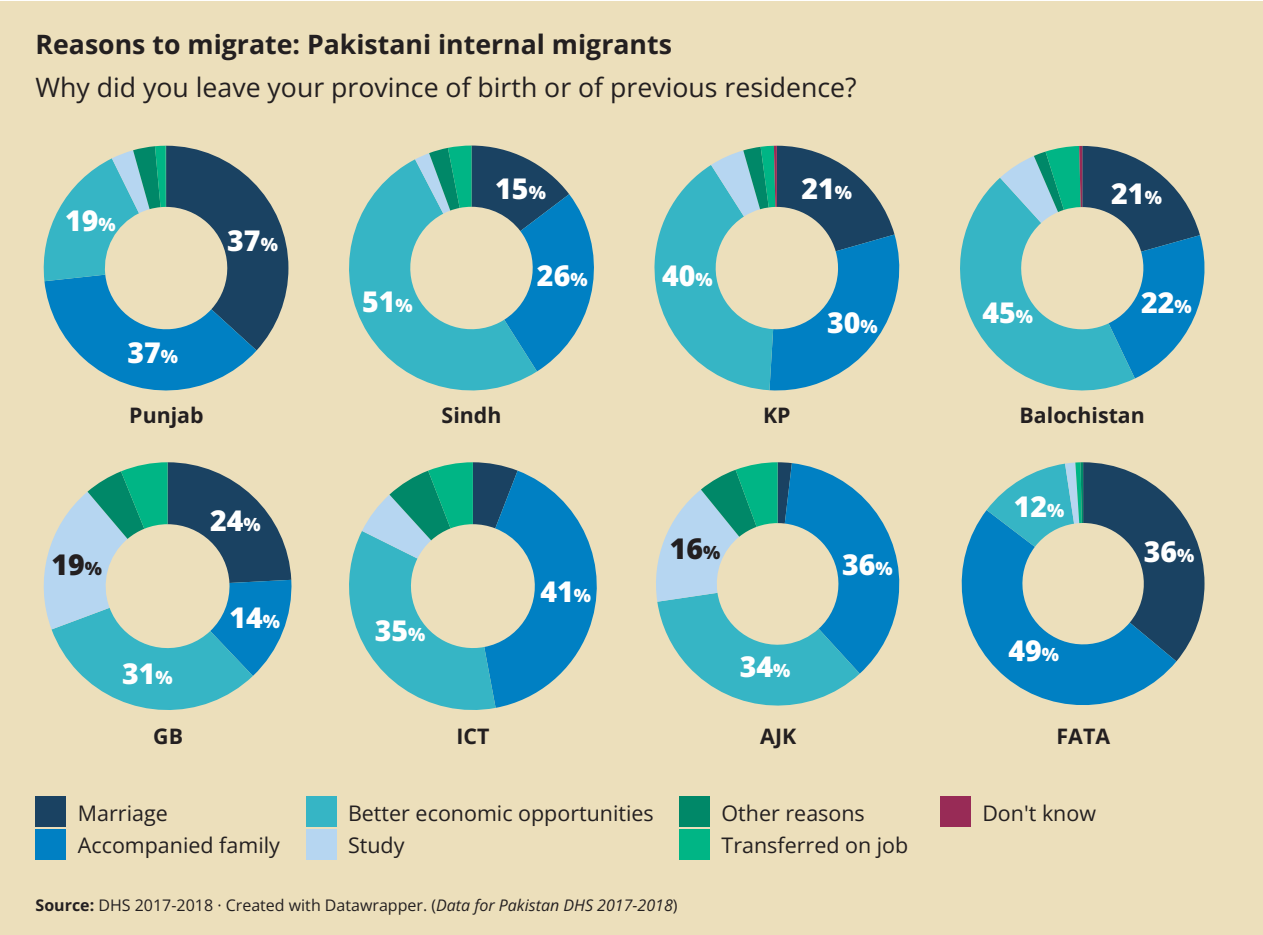


Figure 6. Reasons for internal migration in Pakistan

In contrast to international migrants, Pakistan's internal migrants are mainly young, married women from low- or middle-income households. Often, they have low levels of education, little household decision-making power, and limited economic independence. Many move in order to marry or to follow their families. Rural-to-urban migration is driven by high agricultural input prices, water and heat stress, the degradation of natural resources, and both slow and rapid-onset extreme climate events–all of which negatively impact the agricultural productivity of rural areas [32], [33]. As these migration flows are often unplanned, they can contribute to informal urbanization that leaves urban residents without access to public services to satisfy their basic needs and increases local tensions in turn [27], [33], [34].

Table 1. Demographic characteristics of Pakistani internal migrants

Main characteristics of Pakistani internal migrants	
Demographics of Pakistani internal migrants	
Internal migrants	**Percent (%)**
Female	55%
Age range 0-30	55%
No education or primary school	57%
Middle-Richest Wealth Index	51%
Married	60%

INTERNAL DISPLACEMENT

Between 2010 and 2019, nearly 18 million people were forced to move internally, either due to conflict for 2.1 million people, or due to natural disasters for 15.5 million [35]. Khyber Pakhtunkhwa and Azad Jammu and Kashmir, both faced with riverine flooding, GLOFs, and armed violence, are the worst affected provinces [27], [36]. However, flooding, soil salinization, and political conflict also drive migration in Punjab, Sindh, and Balochistan [27], [36]. Conflicts in KPK, the ex-FATA districts, and Balochistan are more likely to be waged by organized armed groups, while conflicts in Punjab and Sindh are often civilian protests and riots. Generally, both conflicts and climate hazards, primarily floods, contribute to internal displacement as a coping mechanism against violence, natural resource scarcity, and the degradation of agricultural livelihoods.

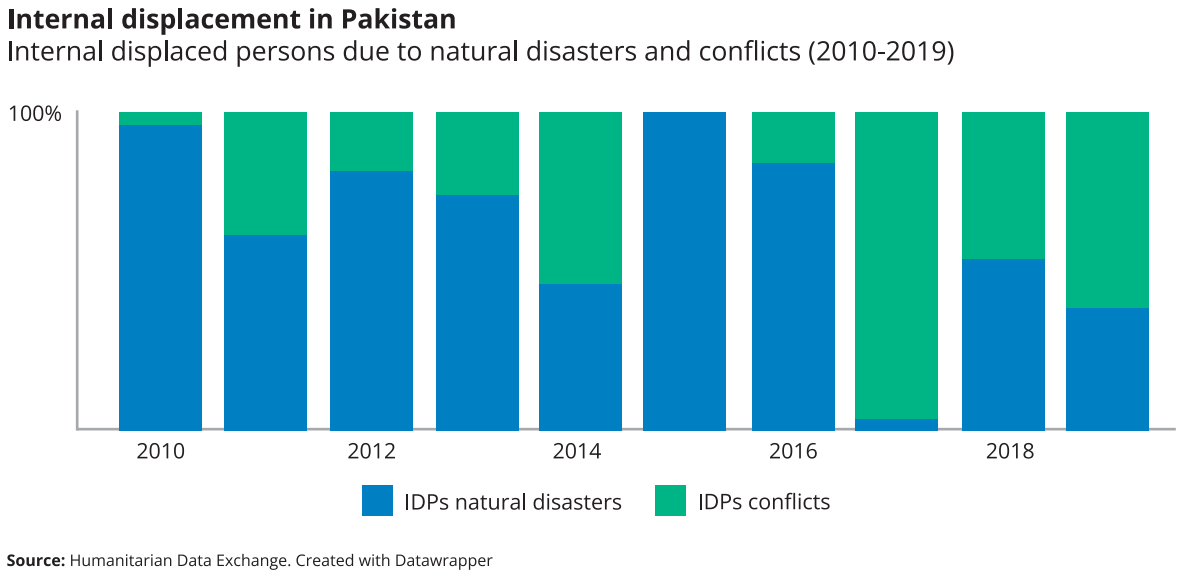


Figure 7. Climate and conflict-induced displacement in Pakistan

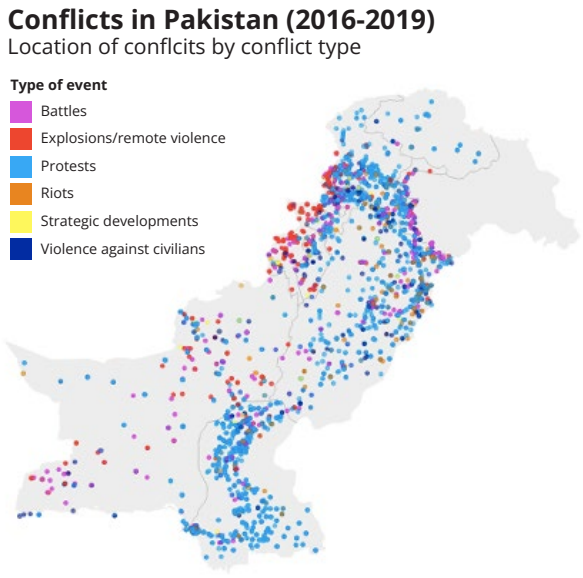


Figure 8. Conflict types and intensity in Pakistan

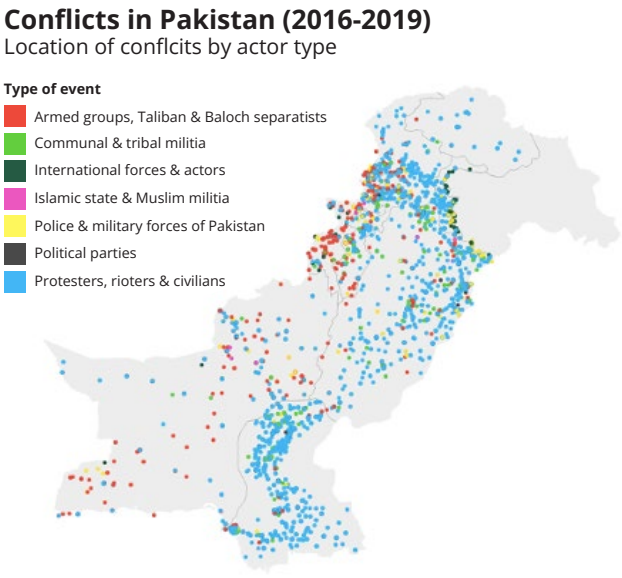


Figure 9. Conflict actors in Pakistan

1.42 National climate-migration-security impact pathways

At the national level, three impact pathways link climate change, migration, and conflict; already severe and increasing climate hazards impact food and resource availability as well as the viability of agricultural livelihoods, driving both displacement and voluntary migration within Pakistan [37], [38]. Resource scarcity is a significant pathway leading from climate migration to conflict. Simultaneously, pre-existing conflicts and tensions combine with weak state capacity and worsening climatic conditions to drive new conflicts [39]. Finally, natural disasters can rapidly displace large numbers of people and destroy economic infrastructure, exacerbating ongoing conflict dynamics. The national-level impact pathway diagram below aggregates these three impact pathways and illustrates the contextual factors that can help animate them throughout Pakistan (Figure 10).

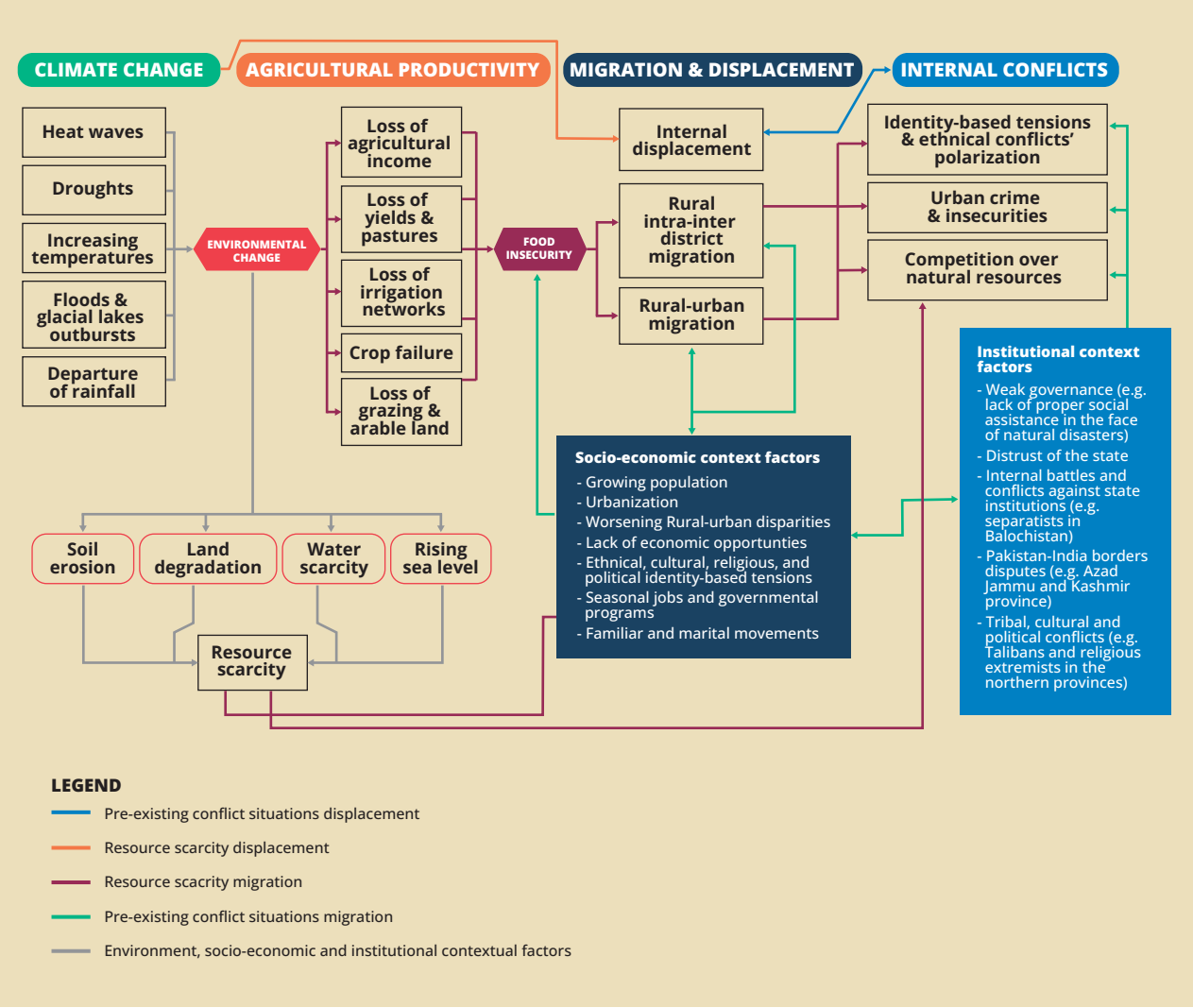


Figure 10. Impact pathways of the climate-migration-conflict nexus in Pakistan (original design)

The first pathway relates to resource scarcity; as climate change depletes the productivity and availability of natural and economic resources, increased competition can lead to conflict in both areas of origin and destination. More frequent and prolonged droughts, cyclones, heat waves, and flash floods negatively impact land access, soil fertility, freshwater availability, and pasture provisions–particularly in the lowland plains of Balochistan (LZ3, LZ4), Sindh (LZ1, LZ2), and Punjab. Many Pakistani communities are vulnerable to climate change due to their high levels of economic dependency on climate-sensitive sectors, like agriculture, which places severe stress on natural resources, and on irrigation networks in particular [34], [40], [41]. In Pakistan's mountainous northern regions, including KPK (LZ5), Gilgit-Baltistan, and Azad Jammu and Kashmir, floods, GLOFs, and landslides generate significant losses by destroying cropland and economic infrastructure, driving migration, displacement, and competition [27], [42].

Secondly, climate change is likely to exacerbate ongoing conflicts. Pakistan's state institutions have been challenged by organized groups pushing for greater political determination, including Baloch separatists in LZ3 and LZ4, Pashtun militants in LZ5, and religious separatism on the part of Tehrik-i-Taliban Pakistan (TTP) in LZ3, LZ4, and LZ5 [39]. The resulting violence between state and non-state actors has contributed to the displacement of many Pakistani migrants and refugees [39], [43, p. 2]. KPK and Balochistan have registered the highest provincial numbers of conflict-affected migrants due to ongoing battles between security forces and armed militant groups [39], [43, p. 2]. Conflict-induced displacement is generally oriented towards urban areas, leading to urban resource depletion and, in turn, additional conflicts related to ensuing resource scarcity [37], [39]. Furthermore, natural disasters–GLOFs, flash floods, and landslides–rapidly worsen household vulnerability, which can play into the hands of local militants [44]. High levels of poverty and unemployment are further elevated when disasters destroy household and community assets and drive rural-urban migration flows, particularly in KPK (LZ5). Large influxes of displaced households to urban areas increase pressure on productive resources and public services, limiting the ability of local authorities to satisfy the basic needs of poor households. Militant groups active in these areas, including TTP, exploit the resulting desperation to recruit and fuel further militancy [44]. This situation illustrates the complexity and of the climate-migration-security nexus, as the natural disaster and pre-existing conflict pathways are interwoven.

1.43 Quantifying the climate-migration-security nexus in Pakistan

To conduct this two-stage analysis, different datasets have been merged to capture relevant information on Pakistan's climatic variability, internal migrants' and households' characteristics, and local conflicts. The datasets employed include the Pakistan Demographic and Health Surveys 2017-2018 (PDHS), data on Conflict in Pakistan from the Armed Conflict Location & Event Data Project (ACLED), and three databases covering climate-related hazards, climate extremes, and soil fertility[3] [20], [45]–[48]. The latter have been used, based on an econometric formula originally developed for Somalia, to create variables on rainfall and temperature anomalies, namely standard indicators of the intensity of Pakistan's abnormal climatic conditions [49]. The results of this analysis are summarized below and, as necessary, supported by literature relevant to the Pakistani context.

3 Using these Pakistani datasets, an original quantitative econometrical analysis has been performed using both probit and negative binomial regressions.

In Pakistan, increasing positive rainfall anomalies, the presence of violence, and rurality increase the likelihood of out-migration [34], [37], [50], while rising maximum temperatures, peaceful protests, and high levels of food insecurity may discourage migration or lead to immobility [51]–[53]. Low-level positive rainfall anomalies are increasing and correlate with out-migration by benefiting agricultural productivity, which can provide households with the financial resources required for migration. Extreme positive rainfall anomalies that result in flooding may lead to displacement, but also increase the likelihood of vulnerable households becoming locally immobilized, or "trapped" [54]–[56]. On the other hand, increasing maximum temperature anomalies correlate negatively with instances of out-migration because heat waves decrease agricultural productivity, which limits the financial resources available for households to finance migration [51], [57]. Instances of violence, including attacks by militant groups and terrorist operations, correlate positively with the likelihood of households reporting an internal out-migrant, as has also been observed in other contexts [1]–[4]. However, contrary to some country-specific literature, peaceful protests, when combined with high levels of food insecurity at the household and district levels, seem to inhibit internal out-migration [52], [59]. This finding may indicate that vulnerable households prefer the relative safety of their home districts to the uncertainty of migration, and that extremely poor households reserve migration as an option of last resort, perhaps waiting until after they have other options for preserving their assets. Overall, the relationship between violence and migration is non-linear, as the odds of out-migration are reduced at low-to-moderate levels of violence but increase as violence intensifies. Vulnerable households, including those that are rurally located or have an unemployed or a female head, are more likely to report an out-migrant than their counterparts [34], [60].

Although it is just one factor among many that can lead to increased tensions, in-migration seems to be associated with an increasing number of riots at the district level, particularly when migrants move for economic reasons [37]. In-migration can contribute to local tensions in different ways. First, it may foster ecological marginalization by exacerbating unplanned urbanization and reducing both the quantity and quality of productive resources [37], [61]. In-migration may also contribute to ethnic polarization in destination areas by exacerbating intercommunal conflicts between different ethnically and culturally defined groups [37]. Overall, economically-driven in-migration correlates more strongly with instances of civil unrest than in-migration due to climate or conflict-driven displacement [37], [62], [63]. As evidenced in other contexts, economic migrants tend to be more educated and socially organized than climate-induced migrants, resulting in their higher propensity to participate in protests, which may morph into riots, for better living conditions, land rights, working conditions, and wages [1]. On the other hand, climate-induced migrants often experience higher levels of social and economic marginalization, limiting their propensity for organized political agitation [1]–[3]. Crucially, the political, economic, and social divisions accentuated by in-migration are often exacerbated by other contextual factors, such as highly unequal rates of land ownership, the presence of tenant or share-cropping arrangements, pre-existing conflict situations, high levels of food insecurity, and increasing rainfall and maximum temperature anomalies [64]–[67]. These factors suggest that the impact of in-migration is mediated through political and socioeconomic conditions that influence equality and integration, and that in-migration has an indirect effect on tensions and civil unrest.

1.5 National climate change policies and development strategies

A review of climate-related policies and strategies is conducted below. These have been mapped against current investments by the government, multilateral donors, bilateral donors, International Financial Institutions (IFIs), and the private sector, in order to highlight gaps and opportunities for WFP programs in alignment with national objectives such as Sustainable Development Goals (SDGs) 2, 13, and 17. This effort was undertaken through a literature review, discussions with the WFP country offices, and key informant interviews.

1.51 National policies

The first country in the world to integrate the SDGs into its own national development plans through a federal resolution, Pakistan has a rich policy landscape to address climate change, food security, and disaster risk reduction (DRR) and disaster risk management (DRM) at the federal level [68]. Pakistan's first Nationally Determined Contribution, submitted in 2016, projects that the country's emissions will reach 1,603 MT of carbon dioxide equivalents by 2030, a 296% increase from 2015; energy generation and agriculture account for 56% and 29% of total emissions, respectively [69]. A reduction of up to 20% of the projected 2030 emissions is pledged, contingent on financial and other forms of support from the international community [69]. Pakistan's National Adaptation Planning (NAP) process, meant to guide medium- and long-term resilience planning and facilitate international funding, is currently ongoing and funded by a US $2.7 million grant from the Green Climate Fund (GCF) [70]. The United Nations Environment Program (UNEP) is Pakistan's designated delivery partner and will assist with the plan's formulation and implementation [71]. Food security, water security, and DRR are the primary policy objectives of Pakistan's 2012 National Climate Change Policy (NCCP) [72]. Improved water management, agricultural productivity, community-based risk management, and environmental conservation form the policy's core prescriptions [72]. The NCCP's follow-up document, the Framework for Implementation of Climate Change Policy 2014-2030, elaborates on the aforementioned adaptation- and mitigation-related actions for target sectors and assigns timeframes for their implementation [73].

1.52 National development strategies and finance mechanisms

Pakistan's national long-term development plan, Pakistan Vision 2025 (PV 2025), is Pakistan's guiding national policy document and sets out 25 goals to be achieved by 2025 [74]. These include reducing the food-insecure population from 60% to 30%, increasing water storage capacity to 90 days, improving agricultural water use-efficiency by 20%, providing clean drinking water to the entire population, increasing the portion of population with access to improved sanitation from 48% to 90%, reducing infant mortality rates from 74 to less than 40 deaths per 1,000, and reducing maternal mortality rates from 276 to less than 140 per 1,000 [74]. PV 2025 identifies lagging agricultural productivity as a threat to national food security and calls for climate-specific food and water security policies to address widespread social vulnerability [74].

Pakistan's federal government is the main source of development funding nationally. Its Public Sector Development Program (PSDP) is geared toward achieving the targets set out in PV 2025, and with a budget of approximately US $5.7 billion for the 2021-2022 fiscal year, it is the largest development initiative [75]. The PSDP is focused on better transportation and regional connectivity, water conservation systems, health infrastructure, access to education, and livelihood opportunities [75]. The PSDP's 2021-2022 plan also addresses climate change mitigation and adaptation and ensuring food security through increased agricultural productivity [75]. Several national non-profit organizations active in rural development and poverty alleviation are financed jointly by public and international funds, including Pakistan's National Rural Support Program, the Pakistan Poverty Alleviation Fund, and the Sarhad Rural Support Program fund.

The Benazir Income Support Program (BISP) is one of Pakistan's most important federal social protection programs. Established by constitutional amendment and active across all Pakistani provinces since 2008, BISP's mandate is to fight poverty and uplift marginalized communities by providing cash transfers to impoverished households. Targeting is based on household asset surveys, the most recent of which was completed in 2018, at which point the programming was assisting 5.4 million families nationally. Of its Rs 180 billion budget in 2019-2020, Rs 128 billion was dedicated to unconditional cash transfers, Rs 8.2 billion to conditional transfers, and Rs 8.6 billion to the National Socio-Economic Registry (NSER) to identify beneficiaries and target interventions [76]. BISP is funded by the federal government and supported by donors including the World Bank, Asian Development Bank, and the United Kingdom's Department for International Development [77].

In 2019, BISP was brought under the administration of the newly established Ehsaas Program, administered by the federal government's newly formed Poverty Alleviation and Social Safety Division. Ehsaas is an umbrella of 134 social protection schemes, including conditional and unconditional cash transfer programs, shock-oriented precision safety nets such as Tahafuz, graduation programs like the National Poverty Graduation Initiative, targeting mechanisms including NSER and Data4Pakistan, financial inclusion and loan initiatives, scholarship programs, and various other social protection initiatives. In March 2021, the World Bank approved US $600 million in financing to assist Ehsaas in developing the Crisis-Resilient Social Protection Program, a new scheme to focus specifically on crisis-oriented household resilience [78].

Despite limited private-sector investment into development initiatives, there is a strong culture of charity in Pakistan, with households donating approximately US $1.5 billion in 2014 [79]. As a result, donations as a percentage of GDP are greater than 1%–a number on par with far wealthier nations such as the United Kingdom and Canada [79]. A majority of households donate to individuals who are perceived as "needy," whereas organizations are most likely to donate to mosques and other religious organizations [80]. Corporate philanthropy is also present, with an estimated US $81 million donated in 2018 [81]. The national Ehsaas program is a favorite destination of corporation donors, and oil and gas exploration is the most charitable corporate sector [81].

1.53 International alliances and finance mechanisms

Between 2017 and 2019, Pakistan received an average of US $1.97 billion in annual official development assistance (ODA) from international donors [82]. The World Bank Group's International Development Association was the largest donor, averaging US $535 million

annually during 2018 and 2019, followed by the Asian Development Bank (US $436 million), the United States (US $417 million), the United Kingdom (US $417 million), and the Global Alliance for Vaccines and Immunization (US $154 million) [82]. Other significant donors over the same period include, in descending order, Japan, the European Union, Germany, the United Nations Children's Fund (UNICEF), and the United Arab Emirates [82]. Economic infrastructure and services accounted for 33% of all ODA, followed by social infrastructure and services at 24%, education at 14%, health and population aid at 9%, humanitarian aid at 6%, production at 5%, other unspecified aid at 5%, multisectoral aid at 3%, and program assistance at 0.5% [82]. As climate-specific ODA flows are not tracked by the Organisation for Economic Cooperation and Development (OECD), it is difficult to say how much of these totals was dedicated to climate resilience initiatives.

Given the country's sovereign debt level, non-concessional loans from multilateral development banks are a controversial issue in Pakistan. Pakistan's total external debt and liabilities were worth US $116 billion at the end of 2020, or 42% of Pakistan's 2019 GDP [83]. In total, the government spent more than US $7 billion to service its external debt in the first half of 2021 [83]. There is an active political conversation in Pakistan regarding the utility of development loans, with many Pakistanis advocating for the cancelling of current debt and a cessation to additional loans. A 2019 World Bank Group decision ordering Pakistan to pay US $5.8 billion to a mining company resulted in nationwide protests and strikes claiming that debt servicing hindered plans to expand the welfare state [84].

With a portfolio of 77 active projects worth US $13.2 billion, World Bank Group is Pakistan's largest donor [85]. While the World Bank Group funds a large number and wide variety of projects, just 2% of the portfolio is represented by grants, making it–and its sister organization, the International Monetary Fund–particularly controversial. The Asian Development Bank is also a major donor, investing US $2.6 billion in Pakistan in 2020 [86]. The International Fund for Agricultural Development of the United Nations (IFAD) has three ongoing projects in Pakistan worth a combined US $465 million, with just over half financed by highly concessional loans from IFAD and the remainder funded by the national government [87]. Bilateral donors also play a large role in the financing of development and climate change adaptation projects and programs. Active Pakistani development partners include the United States Agency for International Development, the United Kingdom's Foreign Commonwealth and Development Office (FCDO)–erstwhile the Department for International Development (DFID)–the Japan International Cooperation Agency, Germany's Bundesanstalt für Geowissenschaften und Rohstoffe and Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ), and the Swedish International Development Cooperation Agency. Despite decades of sustained funding, the Swiss Agency for Development and Cooperation and Australian Aid have recently ceased funding operations in Pakistan in 2019 and 2020, respectively. Climate investment funds are also active in Pakistan, including the GCF, which is currently financing two adaptation projects worth a combined US $82 million, and the Global Environment Facility [88].

PART 2.

Context within selected livelihood zones

2.1 Identification of livelihood zones

Based on the results of WFP's 2017 Integrated Context Analysis in Pakistan, five AEZs, acting as proxies for livelihood zones (LZ), were selected by the country office for the focus of this research. The zones were selected due to their overlapping vulnerability to food security and key climate and environmental hazards, including droughts, flooding, landslides, locusts, and earthquakes. In each LZ, crops and livestock production systems critical to food security were also selected for deeper analysis. Section 2.1 introduces the selected LZs, and LZ-level vulnerabilities are explored in depth in sections 2.2-2.4.

LIVELIHOOD ZONE 1: **THE SOUTHERN IRRIGATED PLAINS IN BADIN AND MIRPUR KHAS, SOUTHEASTERN SINDH**

Located on the southern coast of central Sindh, Badin is bordered to the northeast by Mirpur Khas (MPK). These districts are home to a combined 3.3 million residents, of whom 75% live in rural areas and 25% in urban [89]. While most of Badin sits within the Indus Delta AEZ, with an arid tropical marine climate, silt and clay-filled soils, and a substantial irrigation network, it also abuts the Southern Irrigated Plains [12], [90]. This is where MPK is located, having a sub-tropical continental climate, porous soil, and a significant amount of canal-irrigated agriculture [12]. Much of Badin consists of alluvial plains where the Indus River flows into the Arabian Sea. Irrigated water diverted from the Indus River via a system of canals, rich with nutrients flowing downstream, and via pumped groundwater, are critical to agricultural production in both districts [90]. Across the two districts, wheat and cotton

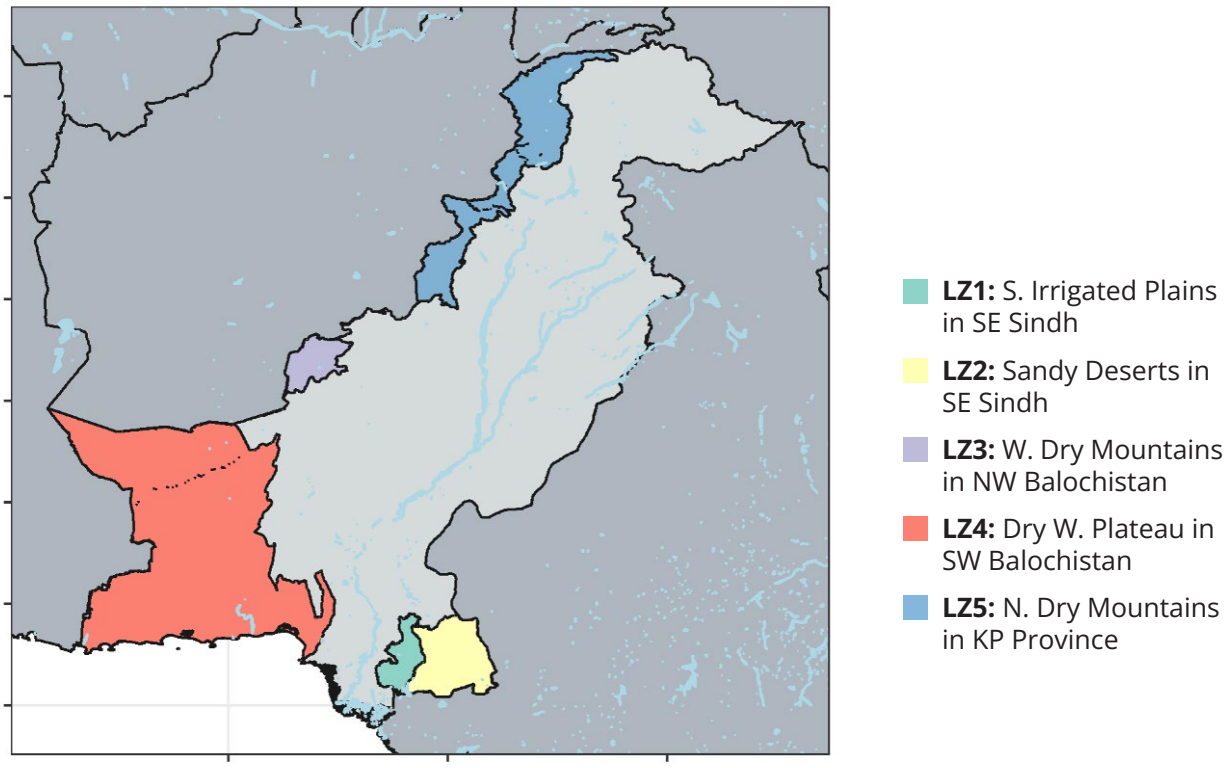


Figure 11. Selected livelihood zones in Pakistan

are widely grown in the *rabi* winter season, and sugarcane during the *kharif* summer months [91]. Cattle and small ruminants are the commonest livestock, and many households raise poultry for household consumption in back gardens. Citrus fruit, oilseed, and mangoes are additional cash crops in MPK, and the latter is widely exported [90].

Both Badin and MPK are classed as having low levels of human development, ranking in the bottom 30% of all districts, as well as in the ten bottom-performing districts in terms of human development growth between 2005 and 2015; the Human Development Index scores declined in both over this period [93]. According to the 2016 Multidimensional Poverty Index, 74.8% of Badin's residents experience multidimensional poverty at an intensity level of 57.9% [92]. In MPK, those numbers are 68.9% and 58.2% [92]. Urbanization in LZ1 is often unplanned and unregulated. As a result, previously cultivated lands are converted for housing and industrial purposes, inhibiting local food production. Many people who informally rely on these lands face issues related to insecure land tenure and a lack of legal protections, and are often displaced [90].

LIVELIHOOD ZONE 2: **SANDY DESERTS IN THARPARKAR AND UMERKOT, SOUTHEASTERN SINDH**

Tharparkar and Umerkot are both located in southeastern Sindh, along Pakistan's border with India. LZ2's population of 3.16 million residents is split nearly evenly between the two districts, which are overwhelmingly rural, with 82.3% of residents living outside of urban areas [89]. Both fall within the Sandy Deserts AEZ, with a small portion of Umerkot spreading into the Southern Irrigated Plains [12]. As such, this LZ is dominated by the Thar Desert, which is part of the larger Great Indus Desert; it has a subtropical desert climate with hot summers and mild winters and is extremely arid [12]. The Thar Desert landscape renders both crop and livestock production extremely difficult. Given the challenge of growing crops in the desert, livestock are critical to survival in terms of both income and sustenance. Approximately 90% of households own animals, with small ruminants, cattle, and camels being the most common [94]. Accordingly, millet is often grown as a source of livestock feed. Where possible, hardy crops such as guar or cluster beans, millet, and castor beans are cultivated, and in Tharparkar's southeastern corner, where rainfall averages 300 mm per year and the sand is infused with loam, wheat is cultivated on 2,195 ha of land [12], [95]. Nomadism, which has long been part of the local agro-pastoral tradition, is on the rise due to desperation rather than choice, as households are increasingly forced to travel further afield in search of productive resources, which are growing scarcer.

Both Tharparkar and Umerkot are very poor and have declining levels of human development; in Tharparkar, 87.0% of the population lives in a state of multidimensional poverty, experienced at an intensity of 55.2% [92]. While the situation has been slowly but steadily improving since 2006, it still has the fourth highest district rate in all of Pakistan [92]. In Umerkot, 84.7% live in multidimensional poverty, experienced at an intensity of 59.5% [92]. Although less data is available for Umerkot, both the incidence and intensity of multidimensional poverty have increased since 2010 [92]. Tharparkar is classed as having a very low level of human development, and ranks in the bottom 5% of Pakistani districts, decreasing six spots in rank between 2013 and 2015 [93]. Umerkot ranks in the bottom fifth of all districts and has fallen ten spots over the same period. Both districts are classed in the Integrated Food Security Phase Classification (IPC) phase 4 emergency category, just one level below catastrophe [14].

LIVELIHOOD ZONE 3: **WESTERN DRY MOUNTAINS IN KILLAH ABDULLAH AND PISHIN, NORTHWESTERN BALOCHISTAN**

Killah Abdullah and Pishin are located in

northwestern Balochistan, along central Pakistan's western border with Afghanistan. Of the 1.5 million residents split between these districts, 80% live in rural areas [89]. Both districts border the provincial capital of Quetta to the south, which is Balochistan's largest and Pakistan's tenth-largest city with just over one million residents [89]. LZ3, south of the Safed Koh mountains and west of the Indus River, mainly comprises semi-arid uplands within the Western Dry Mountains AEZ, which is characterized by short mild summers and long cold winters [12]. Northwestern Balochistan is dry and vulnerable to both winter droughts, which are frequent, severe, and caused by westerly disturbances, as well as summer dry periods, caused by a scarcity of monsoon precipitation that can reduce agricultural productivity by up to 50% [96]. Crops critical to food security in LZ3 include wheat, maize, and alfalfa. Apples, barley, onions, vegetables, melons, tobacco, cumin, and potatoes are also widely grown [97]. Livestock rearing is widespread, involving small ruminants, cattle, and camels, and millet is often grown as a source of fodder.

Both Killah Abdullah and Pishin are extremely poor and food-insecure. In 2014-15, 82.2% of Pishin's population lived in a state of multidimensional poverty, experienced at an intensity of 55.1% [92]. In the same year, an astonishing 96.9% of Killah Abdullah's residents experienced multidimensional poverty at an intensity of 66.2%–meaning poverty here is more widespread than anywhere else in Pakistan, and more intense than in all but one other district [92]. A United Nations (UN) report from 2019 classed both Pishin and Killah Abdullah as being in IPC phase 3 crisis category, with rural communities most severely affected [14]. Poor water access in LZ3 leads to depressed agricultural productivity, suboptimal sanitation, the spread of communicable diseases, malnutrition, and spikes in suicides–the latter particularly among women [98]. Unplanned urbanization is also rapidly transforming this LZ. As residents migrate from Pishin and Killah Abdullah to Quetta in search of work, the agricultural sector is left with a shortage of human resources, while population growth in cities often goes without an accompanying increase in adequate housing or public services. Conflict is an issue in LZ3, particularly in Killah Abdullah. TTP is active in the area and periodically attacks both security and civilian targets, especially in Chaman town, a key border crossing with the neighboring Kandahar Province in Afghanistan [99].

LIVELIHOOD ZONE 4: **THE DRY WESTERN PLATEAU OF AWARAN, CHAGAI, GWADAR, KECH, KHARAN, LASBELA, PANJGUR, AND WASHUK IN SOUTHWESTERN BALOCHISTAN**

Livelihood Zone 4 occupies the entire southwestern edge of Balochistan, and of Pakistan along the Arabian Sea and Iranian border. Despite Balochistan being Pakistan's largest and most sparsely populated province, just 66% of LZ4's 2.7 million residents live in rural areas [89]. Gwadar's population is 61% urban, as is 49% of Lasbela's and 33% of Kech's [89]. Awaran, Kharan, and Washuk–the LZ's least populated districts–are also the least urbanized [89]. All are located within the Dry Western Plateau AEZ, which is dry and tropical, with hot summers, cold winters, and frequent droughts [12]. Agricultural production is key to livelihood generation and sustenance in LZ4, although production is hampered by anachronous technology and recurrent environmental hazards [100]. Wheat, barley, vegetables, alfalfa, and fodder comprise the major *rabi* crops, while maize, fruits, tobacco, and vegetables are cultivated during *kharif* [101]. Apples, apricots, peaches, plum grapes, and pomegranates are all common fruits grown as cash crops [101]. Additionally, small ruminants, camels, and cattle are commonly reared. In coastal areas, aquaculture is often practiced.

All of the districts in LZ4 are classed as having low or very low levels of human development, and all have experienced declining levels

between 2005 and 2015 [102]. Of these districts, Awaran (.173) and Washuk (.188) have the lowest human development score, while Lasbela (.416) and Gwadar (.443) have the highest [102]. Data is not available for Kech or Panjgur. Multidimensional poverty is also widespread and severe in LZ4. In Panjgur, where 2010 data is the most recent available, 96.0% of the population experienced multidimensional poverty at an intensity of 60.4% [92]. In 2014-2015, multidimensional poverty was most widespread in Chagai (89.2%), Washuk (81.9%), and Kharan (78.4%), and most intense in Chagai (61.2%), Lasbela (58.0%), Kharan (57.9%), and Washuk (56.9%). Poverty- and drought-driven food insecurity is also widespread and severe in LZ4. In 2019, many drought-affected areas of Awaran, Gwadar, Kech, Kharan, and Panjgur were placed in IPC phase 3 crisis category, while rural areas of Chagai and Washuk were classed in IPC phase 4 category of emergency [14].

Balochistan is Pakistan's least populated province and the largest by land area, which is a development challenge in and of itself [103]. Many communities are isolated from public services such as schools, healthcare facilities, electrical grids, WASH infrastructure, and commodity markets for the exchange of goods. Long distances, rugged terrain, and poor-quality roads complicate the mobility of people and goods [104]. Ongoing conflicts between Baloch separatists and TTP, on one hand, and Pakistani security forces on the other, further complicate access to frontier districts such as Chagai, Washuk, Panjgur, Kech, and Gwadar.

LIVELIHOOD ZONE 5: **THE NORTHERN DRY MOUNTAINS IN BAJAUR, CHITRAL, LOWER DIR, UPPER DIR, KHYBER, KURRAM, MOHMAND, ORAKZAI, SWAT, NORTH WAZIRISTAN, AND SOUTH WAZIRISTAN IN KHYBER PAKHTUNKHWA PROVINCE**

The districts of LZ5 are located in Pakistan's extreme northwestern region, in northwestern KPK Province, where they border Afghanistan to the west and Gilgit-Baltistan to the east. Several districts in LZ5 are ex-FATA, which were incorporated into KPK as Newly Merged Districts (NMDs) in 2018. These NMDs are among Pakistan's least secure and developed in terms of human well-being. Of the LZ's 9.8 million residents, 90% live in rural communities [89]. Of these, Swat is the largest and most urbanized, with 30% of its 2.3 million residents living in urban areas, while Orakzai is the smallest, with 254 thousand residents living in rural settlements [89]. Orakzai, Mohmand, Bajaur, and South Waziristan are all classed as having no urban areas [89]. All of the districts in this LZ are situated within the Northern Dry Mountains AEZ, characterized by the high peaks and valleys of the Himalayan, Hindu Kush, and Karakorum mountain ranges [12]. The climate in these valleys, where most of the population lives, is extremely arid, with cold winters and mild summers [12]. While wheat and maize are the most widely produced crops in this LZ, fruits and vegetables are also important to food security, as well as sugarcane, fodder, and rice [105]. Tobacco is a major cash crop, and a majority of Pakistan's domestic production is grown in KPK [105]. Fruits, vegetables, and nuts are cultivated year-round. Livestock rearing is an important source of income for poor, remote, and landless communities, contributing 20% of the net income of farming households [105]. Goats are particularly common, as well as cattle and donkeys.

Large swaths of KPK, including the districts in LZ5, are poor and insecure. 2014-2015, 49.2% of KPK's individuals experienced multidimensional poverty at an intensity of 50.7% [92]. In FATA, 73.7% of households experienced multidimensional poverty at an intensity of 45.8% [92]. On average, 30.7% of households in the merged districts are classed as moderately food-insecure, and 3.3% as severely food-insecure [106]. A notable outlier is South Waziristan, where 58% of households are moderately food-insecure [106]. Food access is of particular concern in LZ5 because none of

its districts produce enough food to be self-sufficient. Small plots of land, insufficient water resources, and poor access to high-yielding seed varieties suppress agricultural productivity [106]. Thus, its markets are critical for distribution but rank lowest for adequate food availability nationally, at 15% in KPK and 39% in NMDs [12]. Although violence has abated since 2018, fallout from the American War on Terror led to instability and violence along the Afghan border in much of KPK, and TTP still engages in periodic attacks throughout the area. As a result, general human insecurity–in the form of decreased educational opportunities, particularly for girls; poor health outcomes; and the displacement of human resources–suppresses agricultural productivity [105].

2.2 Climate risks across livelihood zones

This section contributes to an understanding of current and future climate trends and hazards across selected LZs, including droughts, floods, and heat stress. Building on the methodology outlined in the introduction to Section 1.3, trends were assessed historically from 1980-2020 over the near term (2021-2040 or "2030"), and the medium term (2041-2060 or "2050"). For this analysis, RCP 8.5 and SSP5 were employed – a high-emissions and high adaptation-mitigation challenge trajectory. This RCP–SSP combination is the closest to the world's current emissions trajectory. We focus on 2030 given the short-term utility of this date for planning purposes, but extend the analysis to 2050 so as to assess post-2030 trends and because by 2030 the difference between RCPs is not substantial [107].

2.21 Mean climate projections through 2050

TEMPERATURE

Mean temperatures will steadily increase across all LZs through 2050, with a greater increase during *kharif* than in the *rabi* season. A 1-3°C rise in temperatures is projected for most areas across all LZs, with southern areas of Balochistan (LZ4) and Sindh (LZ1, LZ2) and northern areas of KPK (LZ5) expected to see the greatest increases, along with eastern areas of LZ5. Significant warming in northern KPK during the *rabi* season is especially concerning, because rising temperatures during the winter months may contribute to glacial melt, leading to GLOFs in northern areas and flooding further down the Indus Basin, potentially all the way to the delta in lower Sindh (LZ1).

PRECIPITATION

While significant and constant increases in precipitation are projected in LZ5 by 2050, most LZs are and will remain extremely dry. Increased precipitation in KPK across both seasons, particularly in combination with higher temperatures, may lead to worse flooding and landslides in LZ5, and particularly in the districts of Chitral, Upper and Lower Dir, Kurram, Khyber, and Orakzai. Slight increases in precipitation are projected for Tharparkar and Umerkot (LZ2), in line with the erratic and "unprecedented" cyclone rainfall noted by experts during key informant interviews. These rains are not always sufficient for sustained crop production, but can increase natural forages for desert locusts, worsening infestations. Extremely marginal increases are projected in Badin, Mirpurkhas (LZ1), and across Balochistan (LZ3, LZ4), which will remain very dry.

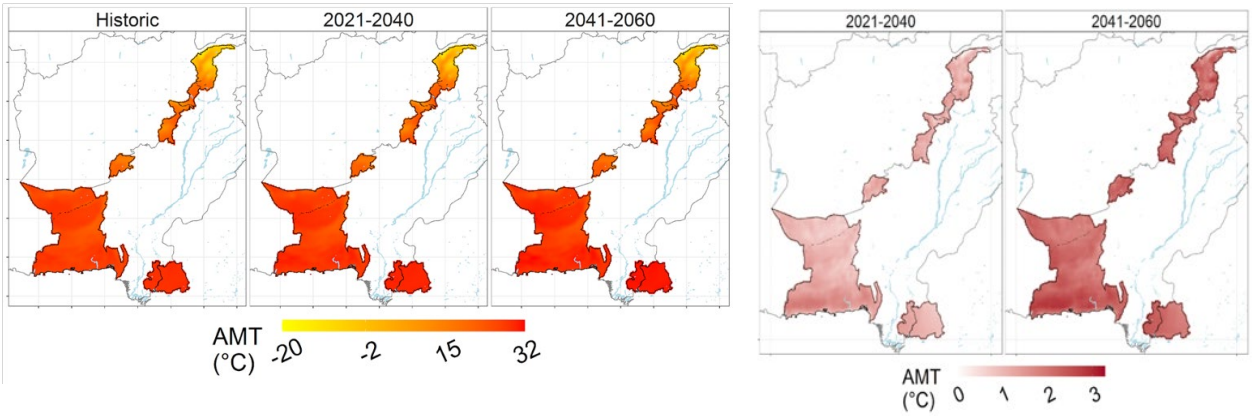


Figure 12. Historical trends and future projections for annual mean temperatures during the *kharif* season, with a color gradient indicating absolute temperatures in °C (left) and the annual mean temperature change in °C during *kharif* season (right) across selected livelihood zones by 2030 and 2050.

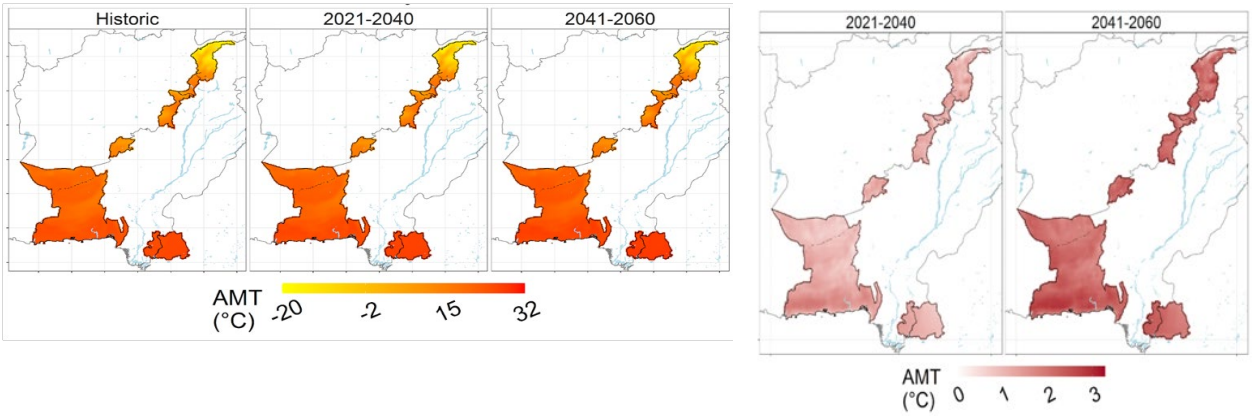


Figure 13. Historical trends and future projections for annual mean temperatures during the *rabi* season, with a color gradient indicating absolute temperatures in °C (left) and annual mean temperature change in °C during *rabi* the season (right) across selected livelihood zones by 2030 and 2050.

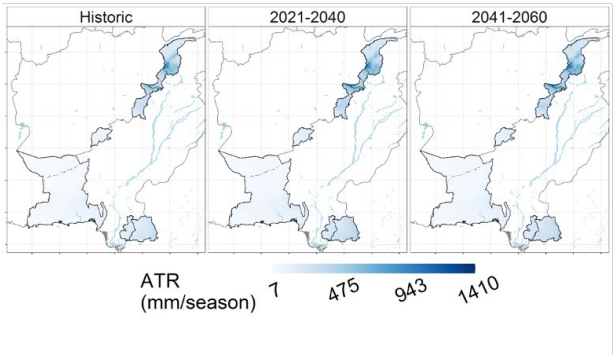


Figure 14. Historical trends and future projections of annual total rainfall (ATR) during the *kharif* season by 2030 and 2050.

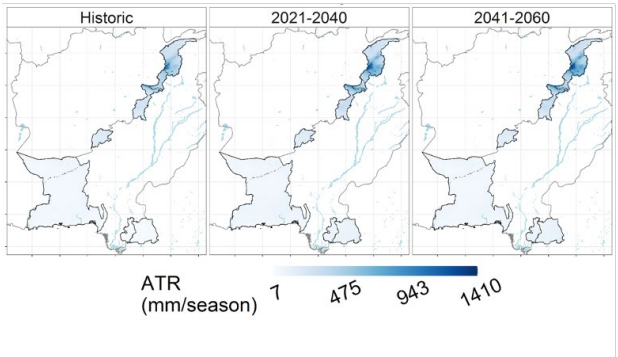


Figure 15. Historical trends and future projections of annual total rainfall (ATR) during the *rabi* season by 2030 and 2050.

2.22 Projections for selected climate hazards through 2050

DROUGHT

The risk of droughts will remain severe throughout all the months of the year and across all LZs through 2050. For this analysis, drought is characterized by a moisture stress indicator that calculates the number of days with the ratio of actual to potential evapotranspiration below 0.5 for every grid cell. The red line below indicates when a single month experiences 20 or more days of drought conditions. This threshold indicates severe conditions that endanger humans, crops, and livestock. All LZs are currently experiencing severe drought conditions throughout the year and will continue to do so through 2050, with the exception of LZ5, which is not experiencing drought conditions during January through April and likely will not do so in the future.

HEAT STRESS

Heat stress is currently concentrated in the low-lying irrigated plains, Sandy Deserts, and dry plateau regions of Sindh and Balochistan (LZ1, LZ2, LZ4), and will remain so through 2050. In the chart below, heat stress is represented as a probability that indicates the percentage of days per month that experience conditions exceeding specific temperature-humidity index values (THI), leading to moderate and severe heat stress for livestock. Figure 17, below, indicates THI levels across LZs historically and into the future throughout the year, using a threshold above which heat stress negatively impacts livestock (Rahimi et al. 2021) [108]. In KPK (LZ5), occurrences of heat stress will increase through the peak summer months, July and August. In both the irrigated plains and Sandy Deserts of southeastern Sindh (LZ1, LZ2), severe heat stress conditions will continue and extend later into the year. Heat stress is least intense in northwestern Balochistan, although it will become more frequent by 2050, particularly during the summer months.

FLOODING

Rain-induced flash flooding seems largely to remain within tolerable limits and generally follows monthly rainfall patterns. It is important to note that the below projections do not account for fluvial or riverine floods, coastal flooding due to storm surges, or GLOFs. KPK's dry mountains and Sindh's irrigated plains (LZ1) are the most exposed areas. Again, the projected jump in the flood risk during the summer months in Sindh's Sandy Deserts (LZ2) is likely driven by increasingly erratic occurrences of cyclonic rainfall, and should be understood within the context of an area that is and will remain overwhelmingly dry through 2050.

CO-OCCURRENCE OF DROUGHTS AND HEAT STRESS

Droughts and heat stress are especially damaging to agricultural production when experienced in tandem, and their co-occurrence is expected to grow in intensity and geographic dispersion by 2050, particularly during the *kharif* season in southern LZs. During *kharif,* new areas in northeastern LZ4 will experience severe co-occurrence, including Washuk, Chagai, and Kharan. Heat stress is also projected to increase in Killah Abdullah (LZ3) and parts of KPK, including North and South Waziristan, Khyber, and Mohmand (LZ5), while droughts are expected to increase in Chitral (LZ5). Given seasonably cooler temperatures, heat stress is less pronounced during the *rabi* season. However, similar long-term trends are projected with smaller increases in severity. Drought will continue to be more severe during the winter months in much of Tharparkar and Umerkot (LZ1), and co-occurrence will spread to new areas in northeastern Tharparkar.

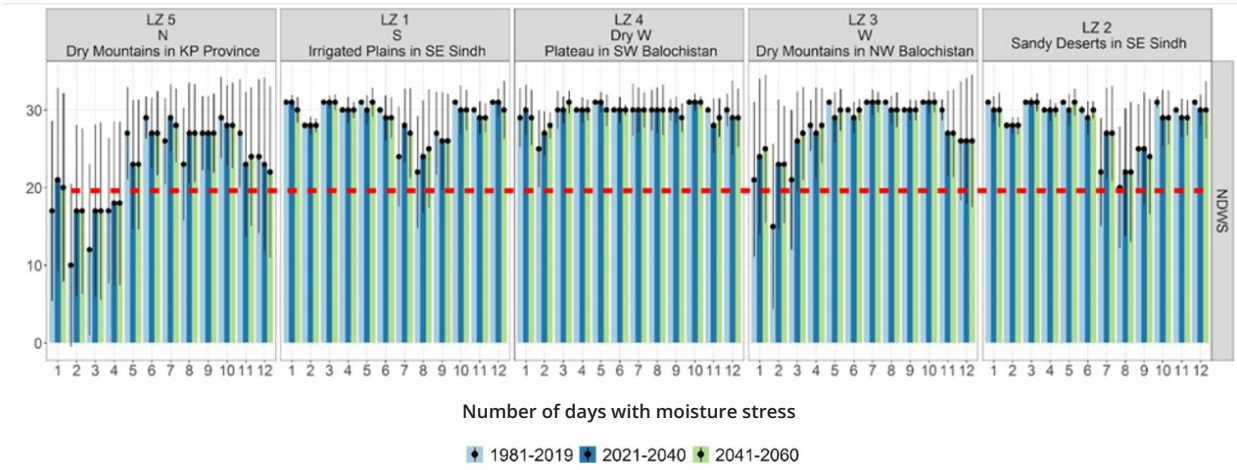


Figure 16. Monthly variation (x axis) in drought risk or water stress in historical and future projections. The red line represents the threshold (number of days per month, y axis) above which water stress has a detrimental impact on agricultural production.

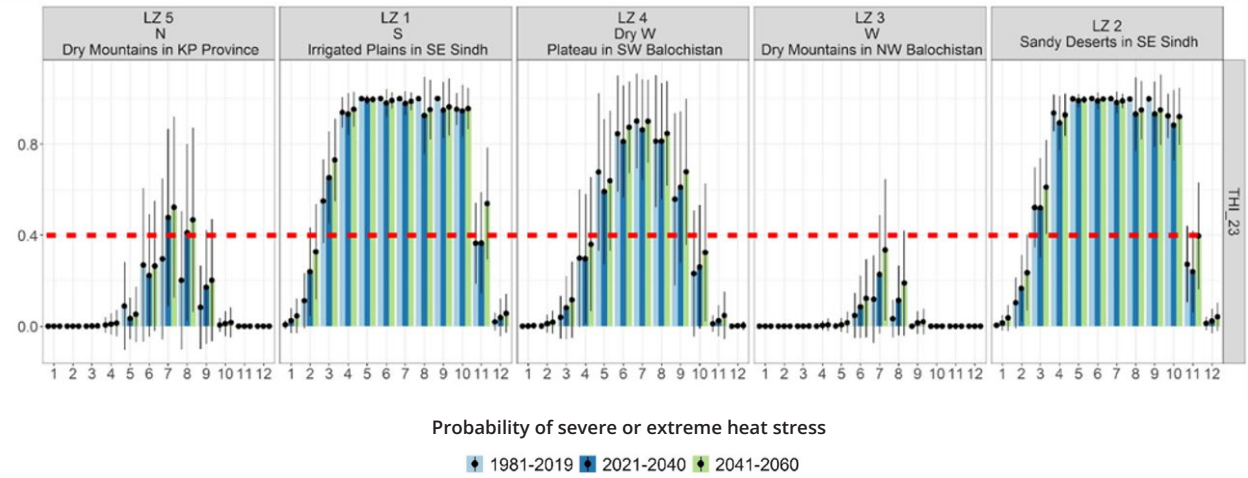


Figure 17. Monthly variation (x axis) of heat stress in historical and future projections. The red line indicates the threshold, in the percent of days per month (y axis), above which heat stress has a detrimental impact on livestock production and mortality.

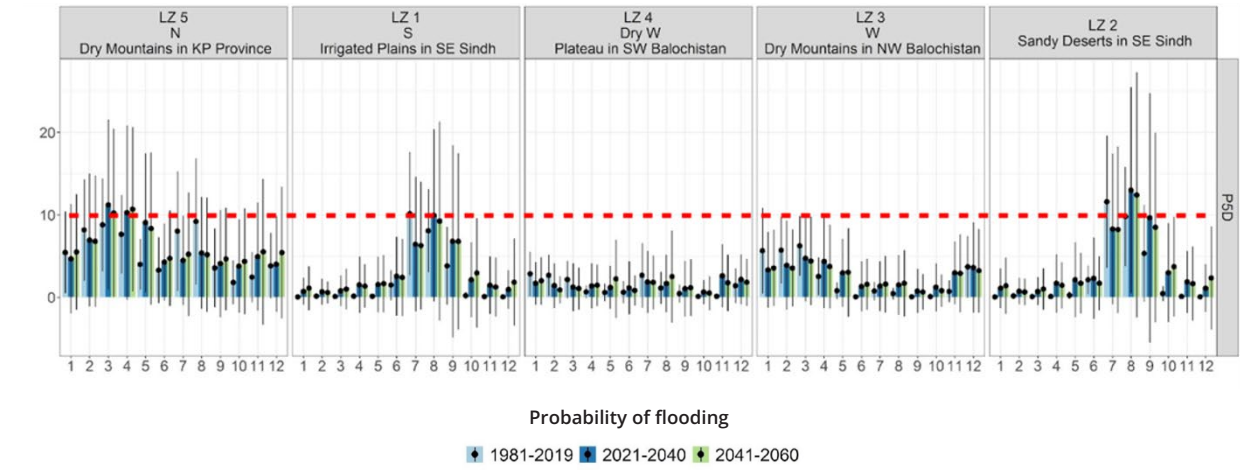


Figure 18. Monthly variation (x axis) of flood risk in historical and future projections. The red line indicates the threshold, in the percent of days per month (y axis), above which the flood risk has a detrimental impact on agricultural production.

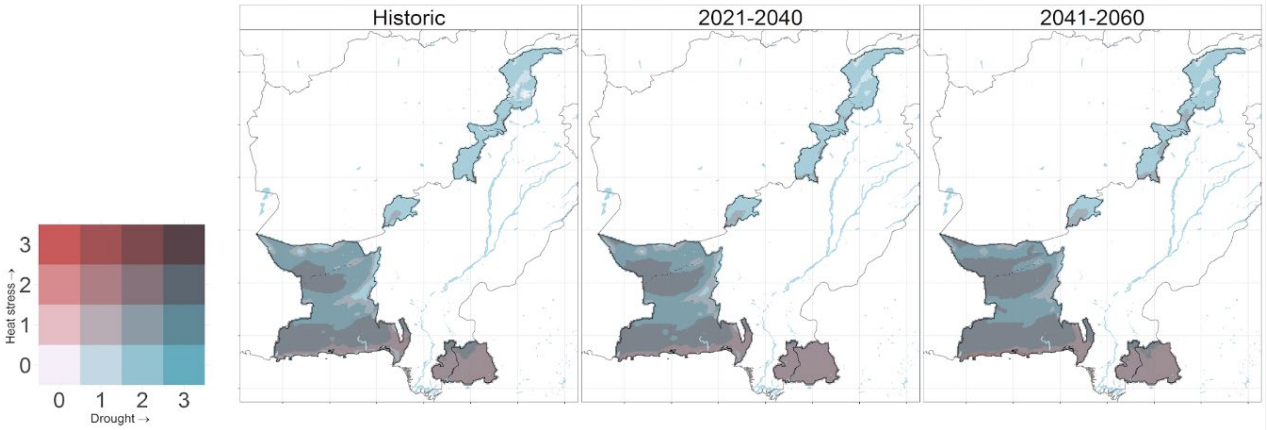


Figure 19. Historical and future spatial projections of the co-occurrence of droughts (blue) and heat stress (red) during the *kharif* season in Pakistan. The darker the color, the more severe the occurrence of the specific hazard, or their co-occurrence.

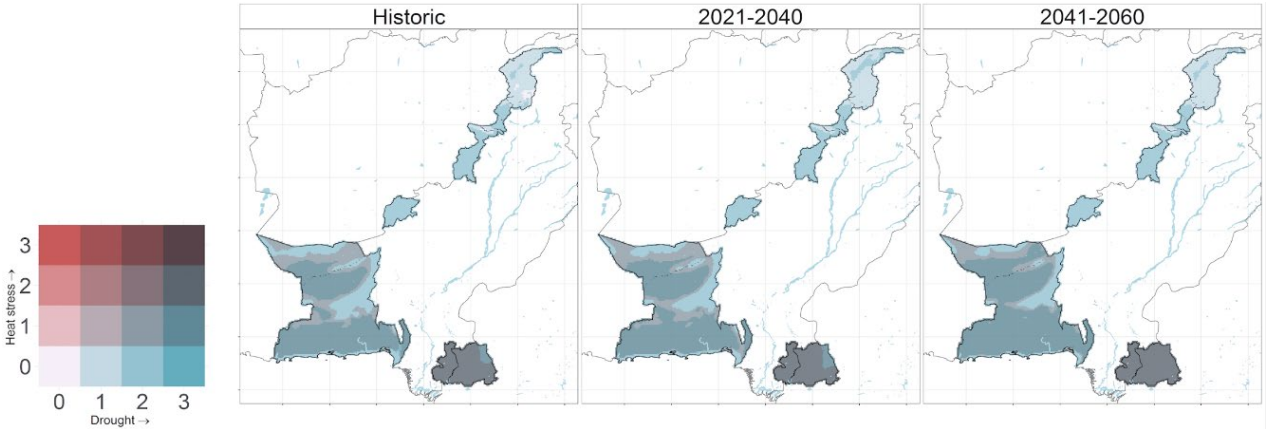


Figure 20. Historical and future spatial projections of the co-occurrence of droughts (blue) and heat stress (red) during the *rabi* season in Pakistan. The darker the color, the more severe the occurrence of the specific hazard, or their co-occurrence.

2.3 The climate-migration-security nexus across livelihood zones

Building on *Section 1.4 – Analysis of Pakistan's climate-migration-security nexus*, this section assesses Pakistan's varying social and climatic conditions to predict how the climate-migration-conflict nexus is likely to unfold differently across LZs (Table 2).

Table 2. Identified Impact pathways across selected livelihood zones

	Area	Relevant impact pathways
LZ1	Southern irrigated plains in Sindh	Resource scarcity
LZ2	Sandy deserts in Sindh	Resource scarcity
LZ3	Western dry mountains in Balochistan	Resource scarcity; pre-existing conflict
LZ4	Western dry plateau in Balochistan	Resource scarcity; pre-existing conflict
LZ5	Northern dry mountains in KPK	Resource scarcity; pre-existing conflict

In the Southern Irrigated Plains of Sindh (LZ1), droughts, increasing temperatures, flooding, erratic rainfall, and soil salinization will increasingly threaten agricultural productivity and drive out-migration to Karachi and Hyderabad [37]. With key production systems including cotton, rice, wheat, sugarcane, and chickpeas under threat, resource scarcity is widespread and will become increasingly common [109]. Rural communities in Badin have pivoted to fishing as a livelihood strategy, in turn depleting local fish stocks and leading to conflicts with established fishing communities [40]. In the original areas, decreases in agriculturally productive land have heightened conflict over the limited grazing and arable lands that remain.

The same is true for Sindh's Sandy Deserts (LZ2), which are characterized by rising temperatures, prolonged droughts, erratic rainfall, and out-migration to nearby urban and irrigated areas. These hazards also increase the potential for pastoral communities to compete with sedentary agriculturalists and other pastoralists for increasingly scarce water and fodder [109], [110]. Elevated migration of rural communities from Tharparkar and Umerkot to Karachi and Hyderabad has heightened competition over limited urban resources, inflaming identity-based tensions along with sectarian violence and criminal, mafia-oriented activity.

In Balochistan's Western Dry Mountains (LZ3), agriculturalists migrate due to underdeveloped local marketing facilities, environmental degradation from prolonged droughts, and security issues related to conflict between state security forces and Baloch militias [53], [109]. Nearly 80% of rural-to-urban out-migration is driven by economic concerns [109]. The deteriorating security situation in Afghanistan, spurred by the sudden withdrawal of American forces, poses an additional threat due to increasing refugee flows and the potential for changing political dynamics to heighten tensions between Baloch separatists, TTP, and Pakistani forces [111].

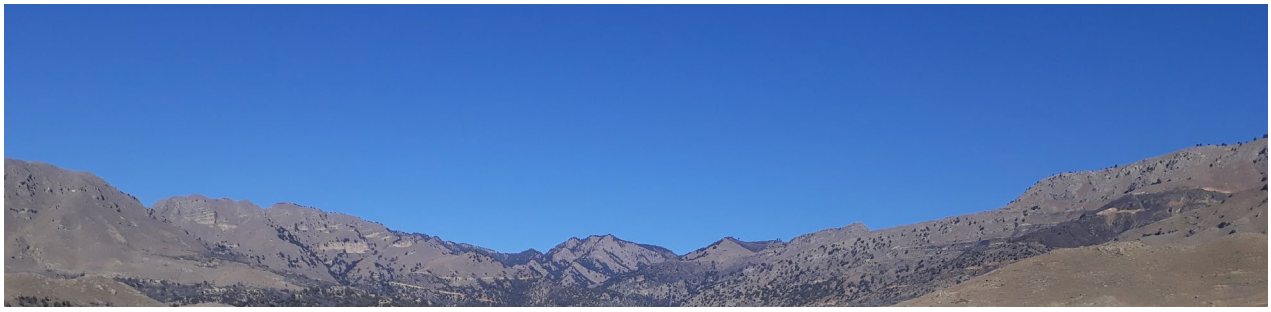
Similarly, migration in Balochistan's Dry Western Plateau (LZ4) is driven mainly by drought- and heat-induced scarcity along with ongoing conflict conditions. Heat waves, increasing temperatures, and decreasing precipitation cause water shortages, reducing crop productivity, and, in turn, these factors also drive rural-urban migration due to agricultural resource scarcity [12], [112], [113]. Baloch separatists are also active in southwestern Balochistan, and in addition, pre-existing conflict conditions influence migratory decisions. As in LZ3, Afghanistan's changing political situation may increase conflict in LZ4 [111].

The Northern Dry Mountains in KPK (LZ5) are affected by flooding, snow, droughts, and conflict-induced agricultural losses [12], [59]. Food losses caused by changing rainfall patterns, local violence, and poor market access underline the importance of non-agricultural livelihoods for households that, as a result, often migrate out of the LZ [12], [53]. In this context, economic out-migration, both permanent and seasonal, from rural districts to rural and urban areas, coincides with declining agricultural incomes and increasing food insecurity [53], [109]. Seasonal and permanent migration is essential for generating remittances, which contribute up to 31% of income for rural households in LZ5 [53]. Therefore, resource scarcity and pre-existing conflict conditions are the two impact pathways leading to migration and displacement in LZ5, both of which may be inflamed by natural disasters. As in LZ3 and LZ4, refugee influxes and conflict spillover from neighboring Afghanistan may exacerbate ongoing conflicts in LZ5, particularly in the NMDs, and strain public services [111].

2.4 Hotspots of vulnerability co-occurrence

METHODOLOGY

To assess the spatial distribution of vulnerabilities across selected LZs and identify areas prone to their co-occurrence, data was compiled on a set of indicators in Pakistan and then mapped. A group of nine indicators was selected to represent three primary pillars of vulnerability (Table 3): food and nutrition insecurity, gender-based educational inequality, and poor health. Food and nutrition insecurity is based on either a direct estimation of food insecurity or food consumption scores, alongside estimates of child development and nutrition. Inequality is represented by proxy, using education and education-based gender indicators. Health is represented by a combination of disease prevalence and mortality rates. Indicators were then tested to determine whether values covering the LZs showed sufficient spatial variability to meaningfully contribute to the vulnerability hotspots map. For those variables that met these criteria, values were binarized according to a threshold used to distinguish values demonstrating "high" vulnerability from those that did not meet this criterion. The resulting binary layers were then summed to show the prevalence of indicators displaying high vulnerability (Figure 21) and aggregated at the variable grouping level to indicate the combination of food and nutrition insecurity, gender-based educational inequality,



and poor health, all of which contribute to societal vulnerability. A similar process was used to produce maps showing additional indicators of vulnerability hotspots, although no aggregation into variable groupings was performed due to the diverse nature of the variables used. In Figures 23-24, "no areas of high vulnerability" means that the indicator values in this area did not exceed a predetermined threshold of "high" vulnerability. All variables used in the spatial analysis are shown as "included" in Table 1, and further methodological explanation is detailed in Annex 3.

Table 3. Indicators used to derive the vulnerability hotspot maps in Figures 21-24, including their categorization. All included indicators are identified as such, and the reason for any exclusions is shown.

Variable specificity	Variable grouping	Variable	Inclusion status
Primary	**Food and nutrition insecurity**	Food insecurity	Included
		Wasting prevalence	Included
		Stunting prevalence	Excluded (insufficient variation)
		Underweight prevalence	Included
	Gender and educational inequality	Male years of schooling	Excluded (insufficient variation)
		Female years of schooling	Included
		Gender education gap	Included
	Health	Plasmodium falciparum incidence rate	Included
		Plasmodium vivax incidence rate	Included
		Under 5 mortality per 1,000 live births	Included
Additional	**N/A**	Diarrhea prevalence	Included
		Net migration	Included
		Soil organic carbon content	Included
		Conflict events	Included
		Mean soil pH	Excluded (insufficient variation)
		Access to an improved water source	Excluded (insufficient variation)

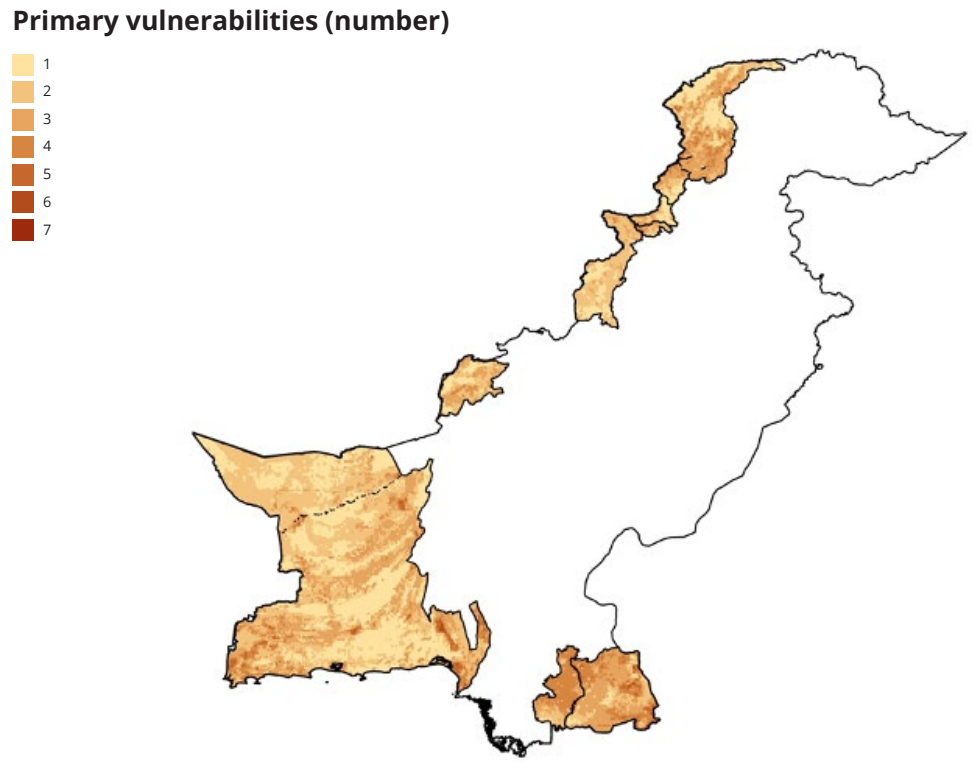


Figure 21. Total number of high-vulnerability metrics which span food security and nutrition, health, and inequality.

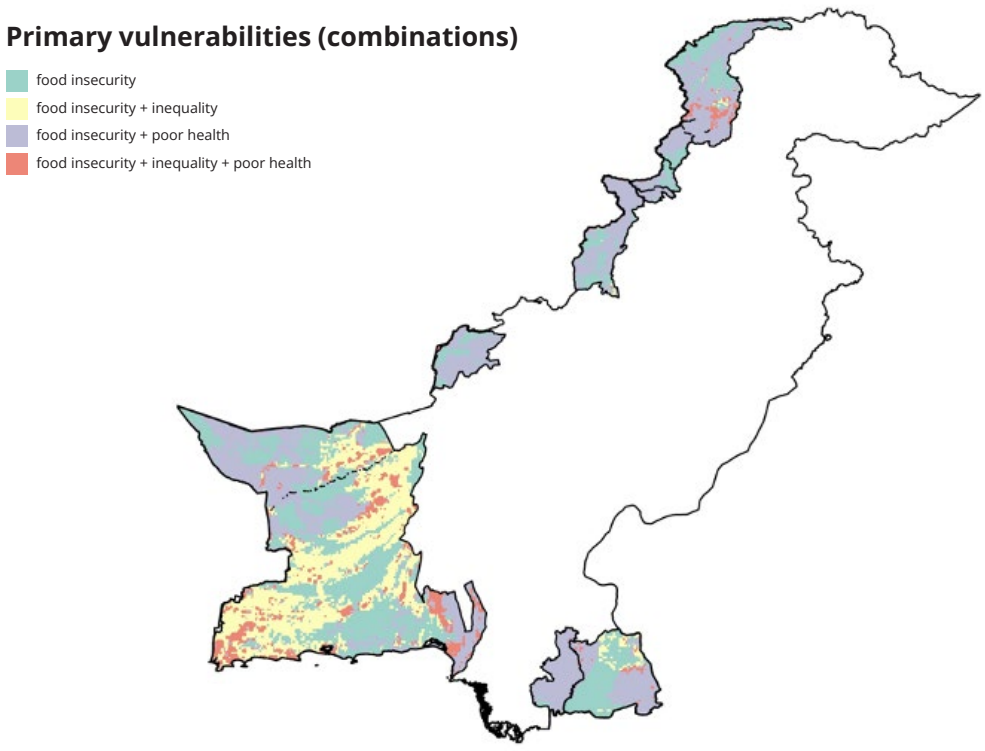


Figure 22. Food security and nutrition, inequality, and health hotspots across the livelihood zones, shown as combinations of vulnerability metrics. The specific vulnerability metrics used are labeled as "included" in Table 3.

Food insecurity is common in all LZs, often occurring in combination either with gender or educational inequality or with poor health, and occasionally with both. Food insecurity combined with poor health is present across large swaths of all LZs and is nearly ubiquitous in LZ1, LZ4, and LZ5. Inequality combined with food insecurity is most widespread across

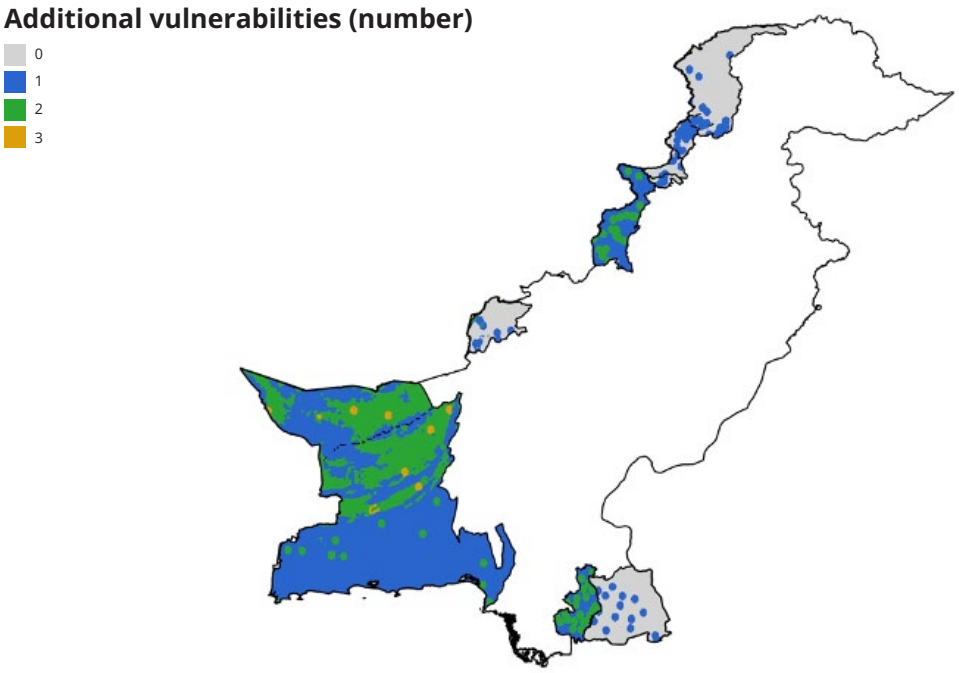


Figure 23. Total number of additional vulnerability metrics classified as "high" (negative outcome) in a given area.

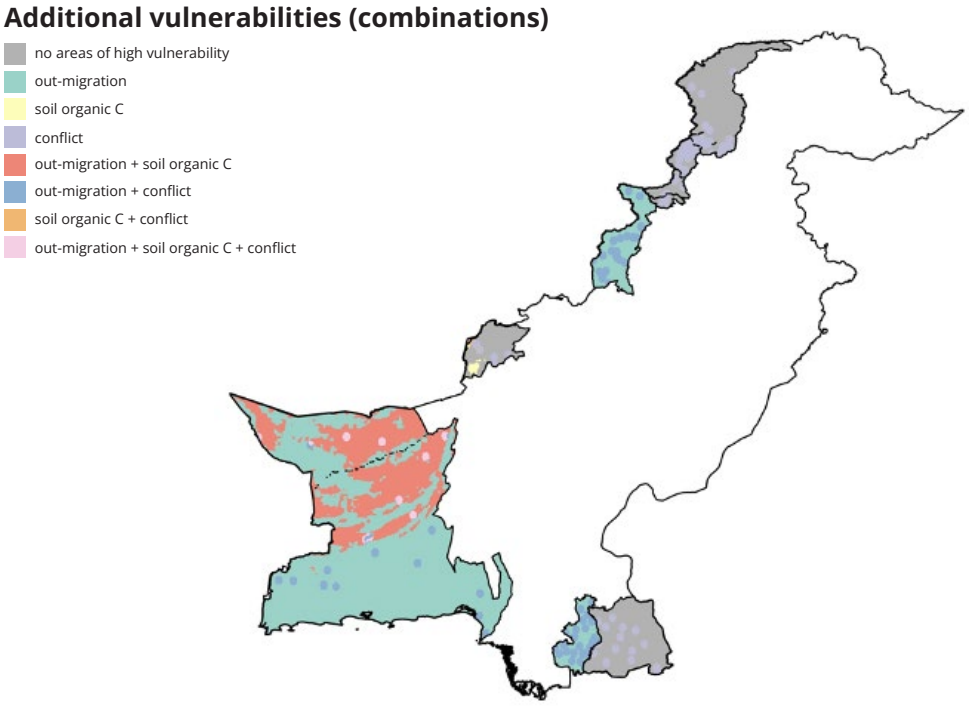


Figure 24. Combinations of additional vulnerability hotspots across selected livelihood zones. The specific vulnerability metrics used are shown as "included" in Table 3.

southwestern Balochistan's Dry Western Plateau (LZ4), although it is also scattered across parts of the Sandy Deserts in southeastern Sindh (LZ2) and KPK's Northern Dry Mountains (LZ5). Relatively small pockets exist where poor health, inequality, and food insecurity occur in tandem. These hotspots are found in all LZs but are most abundant in southwestern Balochistan (LZ4), northern NPK (LZ5), and northern regions of Sindh's Sandy Deserts (LZ2).

Outward migration is the most widespread additional variable, and the commonest combinations of additional variables are firstly, outward migration with low soil organic carbon, and secondly, outward migration with conflict. Outward migration rates are high across nearly all of LZ1 and LZ4, and across the southern portion of LZ5. Conflict events are scattered throughout all LZs, and they are especially concentrated in Sindh's Irrigated Plains (LZ1) and Sandy Deserts (LZ2) and in KPK's Northern Dry Mountains (LZ5). Outward migration and conflict occur in combination throughout much of Sindh's Irrigated Plains (LZ1), the southern areas of KPK's Northern Dry Mountains (ZL5), and sporadically throughout Balochistan's Dry Western Plateau (LZ4). Low soil organic carbon is concentrated in Balochistan's Dry Western Plateau (LZ4), where it only occurs in combination with out-migration and, to a lesser extent, conflict as well. The only other LZ to experience significantly low soil organic carbon is Balochistan's Dry Northern Mountains (LZ3), where it occurs on its own. The only LZ with hotspots of outward migration, conflict, and low soil organic carbon all occurring in combination is Balochistan's Dry Western Plateau (LZ4); these hotspots are all situated within 10 km of a 2018-2021 conflict event.

Without effective intervention, current vulnerability indicates a predisposition toward future vulnerability, meaning that national-level gains in agricultural productivity or socioeconomic development may be felt less acutely in these areas. Shocks and hazards do not occur in isolation, and each degrades a household's adaptive capacity to weather the next. Thus, households currently experiencing severe and overlapping forms of vulnerability are less able to adapt to subsequent shocks, and therefore more likely to suffer worse vulnerabilities in the future. In Pakistan, overall production of key commodities is projected to increase through 2050, as hunger and malnourishment decrease (Section 1.3B – Economic analyses using IMPACT). This finding indicates an opportunity to shift resources through policy and programming interventions to areas where vulnerability is entrenched and multi-dimensional–across all selected LZs (LZ1-5).

2.5 Provincial climate change policies and development strategies

In accordance with the 18th amendment to Pakistan's Constitution in 2010, the implementation of national policy frameworks is largely devolved to provincial governments. As such, it is common for national policy frameworks to identify a suite of priority actions to be taken, while leaving it to provincial governments to subsequently devise provincial policy frameworks that identify which actions are locally relevant, source funding, allocate resources, and generally oversee implementation at the local level.

While Sindh and KPK have both published provincial climate change policies, Balochistan has not. KPK's Climate Change Policy, published in 2016, identifies fluctuating and extreme temperatures, erratic rainfall, the depletion of water resources, pest infestations, droughts,

and flooding as the climatic and environmental hazards most threatening to food security in the province [114]. To ensure food security, recommended policy measures include the dissemination of affordable food preservation and storage technologies, improved irrigation and water management facilities to reduce water stress, the implementation of various climate-smart practices related to crop and livestock production, and institutional capacity building for local organizations, provincial line departments, and other actors [114]. Sindh's Climate Change Policy was launched in 2019 [115]. Similar in structure to KPK's, Sindh's policy identifies increased temperatures, droughts, cyclones, sea level rise, saline water intrusion, and riverine flooding as the greatest threats to social and physical security, as well as to agricultural and aquacultural productivity and food security [115]. DRR is pursued through an "assessment and compensation mechanism" to help communities rapidly recoup losses, through the development of multipurpose buildings for shelter, through the involvement of communities in early warning and risk mitigation activities, and through the pre-emptive storage and supply of relief goods in high-risk areas [115]. Though both policies are ambitious, many portions of each have gone unimplemented due to a lack of funding and technical capacity.

Provincial-level funding and programming enable the implementation of national climate resilience, food security, and social protection initiatives at the local level. Provincially administered Annual Development Programs (ADPs) are often the best means for districts and tehsils to ensure local planning priorities are funded and implemented. The 2020-2021 budget for KPK's ADP was just over US $2.1 billion; the budget for Sindh's was US $1.1 billion, and for Balochistan's, US $988 million [116]–[118]. ADP budgets for the 2021-2022 year are currently being developed. National social protection programs are bolstered by Pakistan's various provincial governments. KPK's Sehat Sahulat Program, administered by the Khyber Pakhtunkhwa Social Protection Reform Unit, uses BISP's targeting to provide health care to 1.5 million impoverished households [77]. In Sindh and Balochistan, provincial Planning and Development Departments are responsible for the coordination of social protection initiatives [119].

PART 3.

WFP Pakistan: Opportunities for enhanced climate resilience impact

3.1 Review of current climate resilience programming

In line with WFP Pakistan's Country Strategic Plan 2018-2022 (CSP), the majority of the country office's activities targeting climate resilience fall under Strategic Outcome (SO) 4: "Communities in disaster prone districts have more resilient food systems and development gains are better protected by disaster risk management systems at all levels by 2022" [120]. Under SO 4, Activity 6 ("Support all levels of the Government and communities in adopting and operationalizing an integrated climate risk management system") and Activity 7 ("Strengthen the governments' and communities' capacity for disaster risk reduction") encompass a wide variety of activities. Under Activity 6, WFP works to develop the institutional capacity of federal, provincial, and district administrations by providing climate-related training for public servants and by supporting government agencies in data generation and utilization within public programs. As part of Activity 7, community-based DRM programming is used to train communities and authorities in disaster preparedness, design preemptive response plans for coordinating actors in the event of a crisis, and respond once a crisis occurs. School safety programs are also employed to boost understanding of climate hazards, develop response skills including first responder and search and rescue capabilities, and to facilitate DRM plans at the school and village levels [121].

The Pakistan country office is also in the process of carrying out the Three-Pronged Approach to design, plan, and implement programming (Activities 2 and 6). Initially, an Integrated Context Analysis (ICA) was completed at the national level in 2017 to identify hazard-prone districts. Secondly, Seasonal Livelihood Programming (SLP) is being used to bring together a wide range of partners in the design of long-term, multi-sectoral programming to facilitate income generation in vulnerable areas identified by the ICA. SLP work focuses explicitly on seasonality and gender, has been completed in various districts, and is still ongoing. Finally, Community-based Participatory Programming (CBPP), due to commence in November 2021, will be used to create "bottom-up" development plans that are directed and owned by local communities.

Under SO 5, Activity 8, WFP constructs and facilitates the management of large- and medium-scale warehouse facilities across all of Pakistan's provinces. Humanitarian relief facilities (HRFs) are large-scale storage facilities positioned at the regional level and used to store food and non-food assets locally so that they can be rapidly distributed to communities in the event of a disaster. Seven HRFs have been constructed in Pakistan, including two in Sindh, one in Balochistan, and one in KPK. Similarly, WFP also builds emergency service facilities (ESFs), which are smaller in scale, lower-capacity, and positioned closer to vulnerable communities. To date, 58 ESFs have been constructed in Pakistan, including 14 in Sindh, 11 in Balochistan, and 8 in KPK. HRFs and ESFs have recently been used to facilitate rapid responses to floods, droughts, and extreme snowfall events.

3.11 Review of current WFP activities in selected livelihood zones

The table below summarizes WFP Pakistan's work at the district level within the selected

LZs, as laid out in its 2020 Annual Country Report [122]. WFP is most active in LZ5 and least active in LZ1. Much of WFP's climate resilience programming falls under the umbrellas of emergency preparedness (SO 4, Activities 6 and 7) and institutional capacity strengthening (SO 5, Activity 8), which are ongoing in all LZs except LZ1.

Table 4. WFP Pakistan activities by livelihood zone in 2020 [122].

WFP activity	LZ1 Sindh irrigated plains	LZ2 Sindh sandy deserts	LZ3 Balochistan dry mountains	LZ4 Balochistan dry plateau	LZ5 KPK dry mountains
Unconditional Resource Transfers (Activity 1)	Badin, Mirpurkhas	Umerkot	Killah Abdullah, Pishin	Lasbela, Panjgur	North Waziristan
Conditional cash-based transfer platform (Activity 2)					Bajaur, Khyber, Kurram, Mohmand, North Waziristan, Orakzai
Malnutrition prevention activities (Activities 1 and 5)	Badin	Tharparkar, Umerkot	Killah Abdullah, Pishin	Chagai, Kharan, Panjgur	Bajaur, Khyber, Kurram, Mohmand, North Waziristan, Orakzai, South Waziristan, Upper Dir
Food Assistance for Assets (Activity 2)		Tharparkar, Umerkot		Chagai	Kurram, Mohmand, North Waziristan, Orakzai, Washuk
Emergency preparedness and institutional capacity strengthening (Activities 6 and 7)		Tharparkar, Umerkot	Killah Abdullah	Kech, Kharan	Chitral, Khyber, Kurram, Mohmand, Orakzai, South Waziristan
No activities				Awaran, Gwadar	Lower Dir, Swat

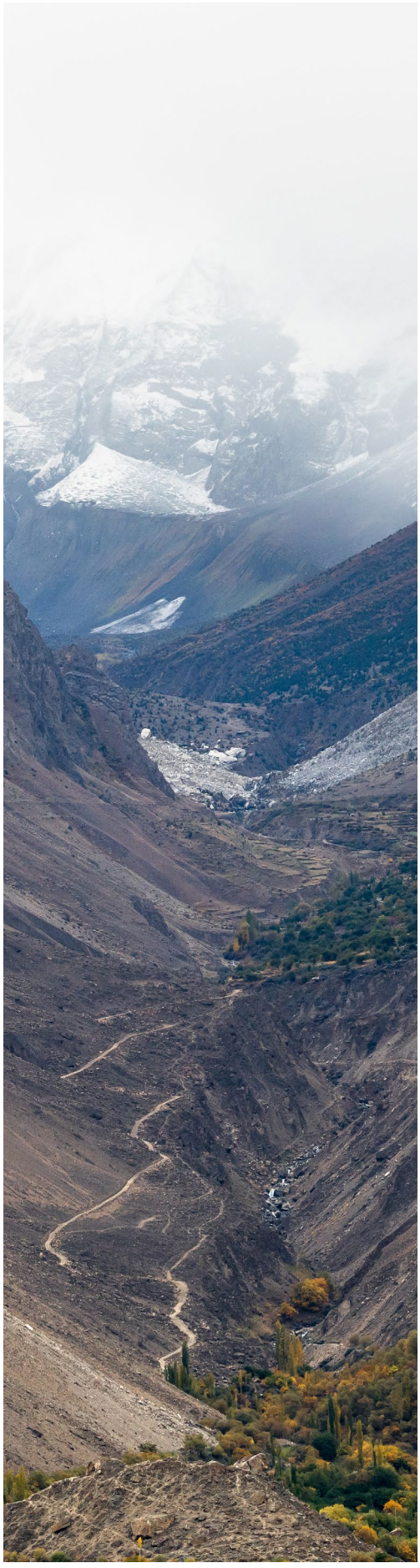
3.12 Gaps and opportunities for WFP programs

Pakistan's wide variety of federal and provincial climate change, food security, and DRR or DRM policies provides a wish list of development goals that are ambitious but often unachieved. While most policies furnish a list of recommended actions, implementation frameworks are often lacking, leading to insufficient coordination amongst line agencies, international organizations, and local stakeholders. Provincial governments often do not have the capacity, in resources or expertise, to implement policies at ground level, and the problem grows more severe at the district, tehsil, and union council levels. Where the capacity for local implementation does exist, funding may be insufficient.

WFP Pakistan is strategically positioned to support the country's public services rather than provide its own, and it will achieve the most impact in the future by continuing to develop the capacity, targeting, and reach of Pakistan's myriad development initiatives and social protection schemes. While WFP's crisis response work will continue to be critical to the physical security of many Pakistanis for at the least the medium-term future, proactively assisting the government to increase the resilience of climate-vulnerable communities is an equally important objective. This is in line with WFP Pakistan's CSP, which calls for the organization to "continue [its] transition from provider of humanitarian relief to facilitator of national development" [120].

While these recommendations are expanded in detail in the next section, broadly speaking, to pursue an agenda oriented toward long-term climate resilience, WFP Pakistan should work toward the following objectives:

- Identify implementation gaps in existing policy frameworks that WFP is well positioned to fill.
- Engage in partnerships with public authorities and development actors to implement policy actions at the local level comprised of districts, tehsils, and union councils.
- Build on its organizational strengths by modifying existing programs to be more climate-resilient.
- Implement new WFP programs and tools in Pakistan that have been proven effective in other contexts.



3.2 Recommendations for climate-resilient programming

Considering the aforementioned climate risks, climate impacts, current policies, and funding mechanisms, several high-potential food security interventions in alignment with the WFP mandate came to light. These interventions were validated through key informant interviews and an online workshop, and they offer insight into the most impactful potential next steps for WFP activities.

3.21 Cross-cutting recommendations for WFP programming

WFP CAN SERVE AS AN IMPLEMENTING PARTNER FOR KEY FOOD SECURITY AND CLIMATE RESILIENCE-RELATED POLICY MEASURES AT THE PROVINCIAL AND SUB-PROVINCIAL LEVELS.

- **Gap:** Although many ambitious policies related to climate resilience, food security, and DRR or DRM exist, their adaptation to local contexts and implementation is often lacking.
- **CSP relevance:** General (Activities 2, 3, 6, 7, and 8).
- **Climate hazards addressed:** Increasing temperatures, precipitation variability, droughts, heat stress, and floods.

WFP's national footprint, institutional capacity, historical remit, and new strategic positioning render it an ideal actor to drive the implementation of climate, food security, and DRR or DRM policies at the

province, district, tehsil, and union council levels (Activity 6, 7, 8). To achieve this objective, partnerships will be vital. Potential partners include federal, provincial, district, and community governments; relevant agencies including the Ministry of Climate Change, the National, Provincial, and District Disaster Management Authorities, the Ministry on National Food Security and Research, and the Ministry of Planning, Development, and Social Initiatives; other UN agencies such as the United Nations Development Program (UNDP), the FAO, and UNICEF; and local non-governmental organizations, community development organizations, and village development organizations (VDOs). Capacity gap analyses should be employed with provincial government partners to assess the specific policy actions that require support in implementation. This exercise can also serve as a collaborative means of sensitizing government partners to their own capacity gaps, acclimating them to the idea of working with WFP, and achieving buy-in for future programmatic collaboration.

In Sindh (LZ1 and LZ2), ambitious climate change and DRR and DRM policies are on the books but suffer implementation gaps. Specific actions within the Sindh Climate Change Policy that WFP is well positioned to animate include a "DRR 'assessment and compensation mechanism' to help communities rapidly recoup losses, the development of multipurpose buildings for shelter, the involvement of communities in early warning and risk mitigation activities, and the pre-emptive storage and supply of relief goods in high-risk areas" (Activity 7) [115]. Additionally, upskilling the capacity of communities to manage their own early warning systems and risk management activities, providing farmers and communities with localized livelihood diversification options, strengthening agricultural value chains at the local level, and developing local water storage and distribution infrastructure are proposed policy actions that WFP can help realize (Activities 2, 6, 7, and 8) [115]. Adjacent provincial DRR, DRM, and poverty reduction policies already in place offer similar opportunities. As WFP's Provincial Head for Sindh serves as the Head of the UN Branch Program team that coordinates inter-agency activity, WFP is well placed for collaboration.

In Balochistan (LZ3 and LZ4), institutional capacity in the provincial government is weak, and as a result, provincial policies related to climate change, food security, DRR, and DRM are lacking. However, the provincial government and especially the Provincial Disaster Management Authority (PDMA) are keen to adapt national policies to the provincial context. Experts consulted agree that policies at the provincial level are vital for short-term crisis response and medium- and long-term climate adaptation. Working in conjunction with Balochistan's PDMA and other relevant government and UN agencies, WFP could coordinate stakeholders, convene planning meetings, and assist in the policy formulation and implementation process–including for the forthcoming provincial DRM policy (Activities 6 and 7). WFP's Provincial Head in Balochistan has initiated a "One-UN" approach, led by WFP, in which all UN agencies coordinate on program development and implementation, and WFP is already collaborating with the UNDP in Noshki to develop provincial SDG Action Plans and a district-level SDG Localization Plan. If successful, this approach could be replicated in other districts and provinces and leveraged to develop impactful funding proposals that showcase partnership and multi-sectoral approaches, and, as such, are likely to be well-received by donors and financiers.

Despite the well-developed patchwork in KPK (LZ5) of provincial policies related to food security, climate change, DRR, and DRM, their implementation is uneven, and WFP can lead the implementation of many key measures, particularly in ex-FATA districts where local government capacity is low. The provincial office in KPK has significant experience related to DRR and DRM interventions and can use this proficiency to position itself as a driving force for medium- and long-term adaptation interventions targeting the climate disaster and food insecurity nexus. KPK's climate change and food security

policies call for the establishment of loss assessment, compensation, and rapid financial recovery mechanisms to support climate-vulnerable communities–systems which WFP is well positioned to help implement (Activities 2, 3, 6, and 7). WFP could leverage its success in working with the PDMA to implement early warning systems, training sessions, implementation plans, and inter-agency coordination mechanisms to respond to GLOFs by transferring this expertise to additional ex-FATA districts (Activities 6 and 7). Remote sensing and information and communication technology-driven early warning systems play an important role in damage mitigation for KPK's remote communities and are identified by KPK's policies as needing development and improvement (Activities 6 and 7). Of these communities, only Kurram currently hosts an automated weather station. WFP can also work closely with the Pakistan Meteorological Department to install and monitor automated weather systems in remote areas throughout KPK, ideally spaced at a range of 10-25 km apart, to provide data for early warning systems and provide upstream data for last-mile climate services (Activities 6 and 7). KPK's food security policy also identifies the importance of evidence-based policy making, and WFP has produced several comprehensive and high-quality research papers related to food security, climate change, and DRR and DRM in Pakistan at the national, provincial, and district levels. This tradition could be continued, specifically to produce climate change outlook studies with a focus on food security. Following on these reports, WFP could then develop costed policy implementation plans in line with recommendations from the research to show to donors active in the climate resilience space.

There is scope for WFP to collaborate with other UN agencies to ensure issues at the intersection of climate resilience and food security are adequately reflected in emerging national policy documents and implementation plans. Development of Pakistan's NAP has just begun, and Pakistan's National Climate Change Policy (2012) and Implementation Framework 2014-2030 (2013) are currently in the process of being revised [123]. Although UNEP and UNDP are leading policy formulation, WFP can work with UNDP to shape the text or subsequent implementation frameworks. As several international organizations are also conducting policy gap analyses, WFP could be careful to complement rather than replicate their work by maintaining a tight focus on the organization's core competencies and strategic direction. Where possible, special attention could be paid to adaptation plans that incorporate firstly migration driven by climate hazards and conflict scenarios, and secondly its potential knock-on effects on food insecurity.

WFP CAN INCORPORATE MEDIUM- AND LONG-TERM CLIMATE FORECASTING INTO ACTIVITIES THROUGH CLIMATE-SENSITIVE TARGETING.

- **Gap:** Many of WFP Pakistan's programming decisions are made without a climate vulnerability lens. Where this lens is used, it is based on rear-facing data that relies on historical trends as a proxy for current and future risk.
- **CSP relevance:** General
- **Climate hazards addressed:** Increasing temperatures, precipitation variability, droughts, heat stress, and floods.

To build on this exercise and accelerate its shift from disaster response to forward-looking resilience building, WFP could work to continuously include forward-looking climate forecasts into the design and targeting of core programming. In its remit, WFP's Vulnerability Analysis and Mapping (VAM) team is responsible for identifying vulnerable households, communities, and geographic areas. Going forward, a climate vulnerability metric could be developed and mainstreamed into key WFP Pakistan programming decision processes (Activities 1, 3, 4, 6, 7, and 8). Whether it takes

the form of one metric that incorporates several hazard-specific indicators, or a variety of metrics that are each hazard-specific, the resulting input should address the natural disasters and slow-onset hazards commonly faced by communities throughout the LZs identified here and across Pakistan as a whole–droughts; heat stress; GLOFs and riverine, monsoon, and other kinds of flooding; waterlogging; landslides; soil salinization; extreme snow; and locus infestations. Partnerships with weather and climate forecasting organizations–for example, the Pakistan Meteorological Department, the World Meteorological Organization, the Regional Integrated Multi-hazard Early Warning System for Africa and Asia (RIMES), and the United Kingdom's Meteorological Office (UK Met)–could also be leveraged to ensure a ready supply of short-, medium-, and long-term forecasts that can be used to not only identify currently vulnerable communities and those that will face increased climate threats in the future, but also interventions that can preempt emerging risks. In line with IMPACT analysis projections that maize and cereal availability will be negatively impacted by climate change, WFP's in-kind distributions may need to be adjusted over time to ensure nutritional sufficiency and dietary diversity (Activities 1 and 2). These activities may also need to be expanded across all selected LZs because food availability and stability are less likely to improve in areas of entrenched vulnerability than across the nation as a whole.

In addition to informing its own programming, WFP's enhanced beneficiary targeting capacity can support Pakistan's myriad social protection schemes by defining specific criteria linked to climate variability (Activity 3). At the national level, BISP is looking to incorporate new beneficiaries into its programs that are subject to an expanded set of vulnerabilities. WFP's VAM unit can help BISP execute targeting activities and based on current and future vulnerability to climate hazards, and design localized social protection programs to mitigate climate risk before it becomes entrenched (Activity 3). While BISP and Ehsaas are Pakistan's premier social protection programs, various other programs exist at the national and provincial levels and would benefit from similar climate vulnerability targeting support from WFP.

Additionally, WFP could work to understand how climate-driven migration flows are likely to evolve and drive future food insecurity (Activities 1-8). This objective is especially important in urban areas in and near the LZs, where WFP can work with local authorities to ensure that the needs of vulnerable migrant communities are met. Because newly arrived populations and vulnerable host communities are likely to face similar hardships, area-based interventions, in which the needs of both migrant and host communities within a geographic area are addressed, may be most appropriate. Such interventions often aim to bolster the reach and efficacy of public services, which is well aligned with WFP's remit in Pakistan (Activities 6, 7, and 8). Additionally, better understanding of internal migration dynamics would benefit WFP's distribution of conditional and unconditional resource transfers (Activities 1, 2, 3, and 4).

3.22 Programmatic recommendations for ongoing WFP activities

Building on the above recommendations, several ongoing WFP programs and activities can be modified to focus more on climate resilience across the selected LZs. Such climate-sensitive targeting and activity development would not only reduce the risks faced by vulnerable communities, but would also help WFP repackage some its core activities for donors in the climate resilience and development spaces.

FOOD FOR ASSETS

- **Gap:** WFP Pakistan's Food for Assets (FFA) initiative is focused on ex-post hazard recovery, and as such is unable to attract the long-term, sustainable funding that will enable it to preemptively boost the resilience of communities vulnerable to climate hazards.
- **CSP relevance:** Activity 2
- **Climate hazards addressed:** Increasing temperatures, precipitation variability, droughts, heat stress, and floods.

FFA can be refocused from ex-post recovery to ex-ante resilience in order to address emergent and slow-onset climate hazards that are likely to increase food insecurity over time. Additionally, activities key to sustainable livelihood generation, the upgrading of agricultural value chains, and overall market inclusion can generate economic empowerment in Pakistan's poorest areas. While local adaption and resilience building require more than simple asset development, FFA can be a powerful tool to address locally contextual risks, including livelihood diversification and integrated risk management planning, especially when used in conjunction with forecast-based finance and long-term adaptation initiatives.

Across all LZs, FFA can build resilience where droughts and heat stress are projected to increase in severity and geographic reach. Livestock shelters can provide shade for animals. Assets that store and distribute water and that increase water use-efficiency will also grow in importance, and include household rainwater capture facilities, shallow water ponds at the household level, deep water ponds at the community level, community reservoirs that feed into irrigation systems, solar water pumps, and drip irrigation systems. The distribution of improved, locally appropriate, and open-pollinated seed varieties can be incorporated into FFA activities. Doing so would not only assist in the recovery stage for farmers who may lack the resources to invest in a replacement crop, but also would support resilience by accelerating the dissemination of hazard-resistant crop varieties. All FFA activities can be designed for environmental and temporal sustainability and, where possible, incorporate nature-based and holistic "landscape" approaches. Tree plantation drives, perhaps in partnership with the government's Billion Tree Tsunami program that is currently running in KPK (LZ5), and payment for soil conservation can be used to improve soil water holding capacity and provide shade for crops and livestock. In LZs 1-4, the use of shade crops and physical shading infrastructure, such as tarping cloth, may can also improve soil moisture levels. In areas where irrigation networks already exist, including the Indus-fed system in LZ1 and the karez system in LZ3 and LZ4, communities can restore and maintain these systems through cleaning and desilting activities as well as physical restoration projects. Coastal communities in LZ4 may also benefit from the implantation of solar lift irrigation systems. In all LZs, transitions to drought-tolerant and, where possible, higher-value crop varieties can be supported.

FFA can also be used to address flooding, especially in LZ1 and LZ5, where it is projected to grow more severe. In these areas the construction of embankments, dikes, protective bunds, and livestock shelters can help shield households, crops, and livestock from inundation and waterlogging. These physical interventions can be employed alongside tree plantation drives and payment for soil conservation programs that use a landscape-based approach to enhance the land's natural ability to withstand extreme water events.

Across all LZs, FFA can support livelihood diversification, which will grow in importance as agricultural production systems are placed under increased stress by a changing climate. In all LZs, poultry production facilities ranging from 15-100 heads per household, as recommended by local experts during the validation workshop, can be developed at the household level, and

goat, cattle, and camel production can be paired with dairy product production facilities. Other value chain upgrades, such as improved input supply, flood-resistant and chilled storage and transportation technologies, and better road infrastructure can also be a target of FFA interventions that facilitate local value capture and improve market access. In LZ4, where many remote communities are cut off from markets, these interventions are especially pertinent.

In addition to resilient agricultural production systems, FFA can be used to support diversification into non-agricultural livelihood strategies. Micro-enterprise development can be explored through local reviews in which market needs are assessed, linkages established, and vulnerable households are connected with low-risk finance to support business development and with insurance to mitigate risk. In Balochistan (LZ3 and especially LZ4), for example, retail activities can be supported, as the provincial government is keen to encourage the construction of shops that improve rural market access. Here, where a growing reliance on food imports poses a pronounced threat to long-term food security, government-subsidized prices for key commodities would be the main draw. However, rural shops can serve as a locus for consumers and producers of all types of goods, and their construction and maintenance are a potential output of FFA programs. In other areas, market assessments are needed to gauge demand, linkages, and capacity. Vocational training programs–for in-demand services indicated by local-level market capacity and demand assessments–can also promote income diversification. Manufacturing and services–both sectors that are growing in Pakistan–are crucial to its transition to an upper-middle income economy and can also be supported by FFA activities [124], [125]. New manufacturing facilities can be constructed in partnership with the private sector to create job opportunities, and training in the provision of digital services can help implant a fast-growing sector in areas where climate change imperils agricultural livelihoods.

THREE-PRONGED APPROACH: SEASONAL LIVELIHOOD PROGRAMMING AND COMMUNITY-BASED PARTICIPATORY PLANNING

- **Gap:** SLP has not been widely applied and, where it has been, it suffers from a lack of follow-up. CBPP, due for imminent implementation, may not incorporate climate resilience to the greatest extent possible.
- **CSP relevance:** Activities 6 and 7.
- **Climate hazards addressed:** Increasing temperatures, precipitation variability, droughts, heat stress, and floods.

Where SLP activities have already been conducted, WFP could further engage district and union council-level administrations to drive forward climate-resilient livelihood interventions based on the SLP's outputs; WFP could also incorporate an explicit focus on the impacts of increased droughts, maximum temperatures, and migration. Though SLP activities are an ideal vehicle for promoting climate-resilient livelihoods and developing local adaptation strategies, they have been conducted in only a few districts of the selected LZs, with limited follow-up on recommended actions and next steps. In LZ1 and LZ2, SLP was only performed in Umerkot, where it was very successful. While the document was useful enough to be translated into the local Sindhi language and shared with other communities, apart from its dissemination, there is no plan to incorporate the plans into larger programming opportunities. In Balochistan, SLP work was only completed in two districts, including in Killah Abdullah (LZ3). However, the SLP's outputs were not incorporated into follow-up programming, and SLP work was not conducted in any other districts of LZ3 and LZ4. SLP has been completed in several districts in LZ5, including Kech, Khyber, Mohmand, Orakzai, and South Waziristan.

SLP activities could also be expanded into additional climate-vulnerable districts and linked to the medium- and long-term suitability of local production systems as informed by climate forecasting, while maintaining an explicit focus on the impacts of increased droughts, maximum temperatures, flooding, and migration. Here, through crop rotation or intercropping, SLP can support agricultural diversification to limit household dependence on production systems like maize, millet, and cereals which are likely to face climatic vulnerability. While alternative production systems must be assessed at the local level through additional research, legumes are a climate-resilient and nutritious potential option. Legumes boost soil nitrogen, provide soil cover that benefits moisture levels, reduce fertilizer and irrigation requirements, and intercrop well with cereal crops in Pakistan, including in Sindh and KPK [105], [126]. Additionally, legumes can be used as a forage crop to reduce pressure on millet, which also faces climatic challenges that may increase the cost of inputs for Pakistan's largely poor small ruminant producers [127]. SLP activities could also address LZ-level climate hazards (Table 6; Section 4.1 – Synthesis). Districts where SLP activities have not been undertaken but could be considered include Badin and Mirpurkhas (LZ1); Tharparkar (LZ2); Pishin (LZ3); Awaran, Chagai, Gwadar, Kharan, Lasbela, Panjgur, and Washuk (LZ4); and Bajaur, Chitral, Lower Dir, Upper Dir, Swat, and South Waziristan[4] (LZ5).

CBPP could be used to communicate long-term climate forecasts to communities and mainstream indigenous knowledge systems in local interventions. CBPP, used to design, plan, and implement programming related to resilience building, safety nets, and DRR activities, is due to roll out in November 2021 [128]. A "bottom-up" tool for planning local interventions, CBPP is meant to promote community ownership of programming and give communities a say in priority setting. It is an ideal vehicle to 1) educate Pakistan's most vulnerable communities about climate change and environmental hazards, 2) tap into indigenous knowledge about how to overcome environmental hazards, and 3) develop locally tailored long-term climate adaption plans which communities manage once the WFP project term ends. A two-way knowledge transfer can occur, wherein WFP uses planning meetings to present medium- and long-term climate forecasts and risk analyses to communities, and communities share indigenous adaptation strategies with WFP while simultaneously identifying priority policy actions and interventions to guide local WFP initiatives.

Finally, CBPP can be employed to develop the village profiling plans called for by several policies in Sindh and KPK. CBPP's participatory profiling approach can up-skill local communities and empower them to identify the developmental initiatives they feel would be most beneficial. These community-produced village profiles can then inform the district-level implementation plans of provincial policy frameworks, or the development of new provincial policies where they are currently absent. They can also work in tandem with FFA; CBPP can determine the assets desired by communities, and FFA can support their creation. Although CBPP activities are currently only planned in Orakzai, this activity should be quickly refined and, pending success, expanded to additional climate-vulnerable villages across selected LZs.

EMERGENCY STORAGE FACILITIES AND COMMUNITY STORAGE FACILITIES

- **Gap:** ESFs are popular with provincial authorities but focus only on crisis recovery rather than building resilience.
- **CSP relevance:** Activities 7 and 8
- **Climate hazards addressed:** Precipitation variability and floods.

Long-term climate forecasting could identify areas that will become increasingly vulnerable

4 SLP activities are currently planned in Bajaur and North Waziristan.

to hazards over the coming decades in order to effectively pre-position ESFs. This effort has been promoted by both the Sindh and KPK Climate Change Policies, as well as the Balochistan PDMA. In LZ1 and LZ2, Badin, Umerkot, and Tharparkar are all home to ESFs. Based on the results of the climate modelling included in this report, the construction of an ESF in MPK could be considered based on worsening droughts and heat stress. In LZ3, neither Pishin nor Killah Abdullah has an ESF. While nearby Quetta hosts both an HRF and an ESF, increasing vulnerability to heat stress and droughts may justify positioning ESFs in closer proximity. Although 11 ESFs have been built in Balochistan, there is only one in the eight districts of LZ4, in Gwadar. Initial planning has begun for additional ESFs in the Rakshan and Makran divisions within LZ4, although specific districts have not been confirmed. Additional ESFs could be considered based on the increasing severity, frequency, and geographic spread of droughts and heat stress throughout the LZs. Similarly, just one of KPK's 8 ESFs falls within LZ5, in Chitral. With the increasing likelihood of droughts, heat stress, and GLOFs, the proliferation of ESFs throughout the remaining districts could be beneficial.

In summary, districts where additional ESFs should be considered include:

- **LZ2:** Umerkot
- **LZ3:** Killah Abdullah and Pishin
- **LZ4:** Awaran, Chagai, Kech, Kharan, Lasbela, Panjgur, Washuk, and Awaran,
- **LZ5:** Bajaur, Lower Dir, Upper Dir, Khyber, Kurram Orakzai, Mohmand, Swat, North Waziristan, South Waziristan

The core functionality of ESFs could be reconsidered to address resilience-oriented initiatives as well as recovery. In drought-prone districts across all LZs, ESFs can be used for water impounding and emergency distribution. Although ESFs are not likely to store enough water to maintain widespread agricultural activity during drought conditions, assistance for highly vulnerable households may facilitate increased resilience for a small number of high-value crops or livestock. While ESFs are currently used by WFP to store resources that are distributed to communities, they may also be used by communities to store harvests or livestock in the event of flooding or an extreme snow event. They may therefore be a means of reducing post-harvest losses or preventing the death of livestock, although ESFs are unlikely to be able to store an entire district's worth of agricultural goods.

Finally, the development and construction of community storage facilities that are smaller than ESFs and positioned at the tehsil or union council level could be considered. Given the impact, popularity, and replicability of both HRFs and ESFs, a smaller version that could eventually be transferred to community ownership would improve community access and could enable these new recommended functionalities to a greater degree. There is potential to link this activity with FFA, thus transferring WFP's expertise in constructing and managing storage facilities to local communities.

3.23 High-potential programming modalities for WFP to pilot in Pakistan

FORECAST-BASED FINANCING AND THE PLATFORM FOR REAL-TIME SITUATION MONITORING

- **Gap:** Although many hazards are recurrent, WFP lacks a program to autonomously monitor climate shocks and preemptively deliver financial assistance to vulnerable households before they are impacted.
- **CSP relevance:** Activities 3, 6, and 7.
- **Climate hazards addressed:** Increasing temperatures, precipitation variability, droughts, heat stress, and floods.

Although Forecast-based Financing (FbF) is a modality widely used by WFP globally, it has yet to be implemented in Pakistan. FbF involves stakeholders–humanitarian or development organizations, PDMAs, and communities–agreeing on a predetermined slate of financing actions to mitigate the impacts posed to vulnerable communities by climate-related hazards [129]. Forecast triggers are then set, which serve as the indicators that a hazard is imminent and, when they are exceeded, automatically release funding to pre-identified beneficiaries. Standard operating procedures are critical to ensure that actions are in line with DRM plans, and ongoing monitoring systems allow stakeholders to continuously improve the targeting, triggering, and distribution of funds [129].

FbF falls within the larger category of anticipatory action initiatives and is often used in conjunction with Early Warning – Early Action (EWEA), which operates similarly to deploy interventions rather than funds. Pairing FbF with EWEA interventions is likely to increase their impact, and their simultaneous deployment could be discussed with stakeholders in initial scoping sessions. Both FbF and EWEA could be used to inform interventions that safeguard livelihoods from climate risks, and WFP's Consolidated Livelihood Exercise for Analyzing Resilience is a framework that may be suitable for this task in Pakistan [130]. WFP's *Integrated Risk Management Framework for Asia Pacific* works to connect various strategic outcomes–understanding risks and vulnerabilities, building systems and capacities, strengthening local adaptation, and climate-proofing value chains–with sudden-onset, slow-onset, and emerging climate risks. While these are emerging bodies of action, a growing evidence base is demonstrating the positive impact they can have on the ground [131]. FbF, in particular, has been shown to be not only impactful, but also cost-effective: a recent humanitarian return-on-investment analysis of WFP's FbF programming in Nepal found that the modality reduced physical damage to vulnerable communities by 75% and damage inflicted on crops and livestock by 50%, saving $34 in immediate response costs for every $1 invested while decreasing long-term recovery costs significantly [132].

Remote sensors and early warning systems (EWS) are a prerequisite for FbF, and WFP's Platform for Real-time Impact and Situation Monitoring (PRISM) may be a suitable means of integrating them with satellite data to monitor climate thresholds in order to employ shock-responsive social protection initiatives. A capacity gap analysis could be performed across vulnerable provinces and districts to understand where capable systems exist and where they may need to be further developed. This action is in line with the recommendation to boost remote sensing and EWS capacities through the five LZs, which is also a recommended policy action in the Sindh and KPK climate change policies, as well as a stated intention of the Balochistan PDMA. Once in place, remote sensors and EWS can be used in conjunction with PRISM to not just monitor current conditions, but also create forecasts of the impact that emerging hazards will have on vulnerable communities. EWS can also provide data for last-mile climate services accessible by local communities. To paraphrase a colleague from WFP's Asia Regional Office, "PRISM is useful because it can not only help stakeholders understand what the weather is, but what the weather will do." PRISM's outputs are interactive maps, charts, tables, and reports that are accessible to a wide variety of stakeholders, and can be used to improve the knowledge and capacity of national and local actors to take anticipatory action on the ground, thus enabling shock-responsive social protection initiatives [130].

Finally, potential beneficiaries will need to be identified and forecast triggers set for current and future climate hazards. The list of climate-vulnerable beneficiaries from the earlier "climate-sensitive targeting" recommendation may be used for this purpose. With regard to triggers, below is a list of hazards matched with LZs where thresholds will likely need to be established. While

example triggers are provided in Table 2, exact triggers should be discussed and agreed upon by local experts.

Table 5. Example triggers for FbF programming grouped by hazard and livelihood zone

Livelihood zone	Hazard	Example trigger
LZ1, LZ2, LZ3, LZ4, LZ5	Dry spell	> 20 consecutive days with less than 1 mm rain each
LZ1, LZ2, LZ3, LZ4, LZ5	Drought	> 20 consecutive days with less than .2 mm rain each
LZ1, LZ2, LZ3, LZ4, LZ5	Flood or waterlogging	Variable indicators for GLOFs and riverine and monsoon flooding
LZ1, LZ2, LZ3, LZ4, LZ5	Heat stress	THI exceeds X for 12 consecutive days
LZ1, LZ3	Soil salinization	Soil salinity level exceeds X
LZ1, LZ2, LZ4	Locust infestation	Locust swarms detected within X km

3.3 Partnership opportunities for climate-resilient programming

Based on the programmatic recommendations above, several potential partnerships may prove particularly promising for WFP activities that address the root causes of climate impacts at a meaningful scale.

At the national level, partnerships with Pakistan's various national agencies are already in place and should be strengthened where possible. In line with the previous section, partnerships with many national agencies and programs are mutually beneficial. Climate-vulnerable beneficiary targeting can strengthen Ehsaas and other social protection schemes, and forecasts from the Pakistan Meteorological Department can inform WFP programming. Coordination with the National Disaster Management Authority, PDMAs, and District Disaster Management Agencies is essential to community-based disaster risk management activities and resilience building. Ongoing partnerships with other line ministries and their provincial offices are also vital, including with the Ministry of National Food Security and Research, the Pakistan Agricultural Research Council, the Pakistan Meteorological Department, and the Ministry of Planning, Development, and Special Initiatives. WFP can also support provincial programs that have been successful in boosting climate resilience, such the Billion Tree Tsunami program in KPK (LZ5), and help facilitate their roll-out in other areas where they may have impact–in this case, in LZ1 and LZ2.

To ensure the accuracy of EWS and long-term climate forecasting, several of WFP's international partnerships could be leveraged domestically. RIMES, based in Bangkok, provides various weather, climate, hydrological, and disaster forecasting, decision support, and risk management tools for its member states and for collaborating countries like Pakistan [133]. Similarly, Pakistan is a founding member of the Asian Disaster Preparedness Center, which provides technical solutions for risk reduction and climate resilience to support national implementation of the Sendai Framework for Disaster Risk Reduction 2015–2030, the SDGs, and various other international policy frameworks [134]. WFP also has a burgeoning partnership with UK Met, a global leader in weather and climate forecasting. Contact with the World Meteorological Organization may also

be beneficial. All these partnerships can reinforce WFP's work on EWS, remote sensing, and climate-vulnerable beneficiary targeting.

While WFP already coordinates with other UN Agencies—the FAO, UNDP, UNICEF, and WHO—a close working relationship with the International Organization for Migration (IOM) may also be beneficial. Because climate-induced migration is likely to increase as environmental conditions grow harsher, understanding current and future migration flows will enable preemptive development planning to facilitate adaptation strategies.

Partnerships with strategically placed private-sector organizations can make WFP's FFA activities more cost-efficient. The cement subsector is Pakistan's third-largest in terms of corporate social responsibility donations (Section 3.3 – Funding opportunities for climate-resilient programming), and in-kind donations can be solicited for the construction and upgrading of physical assets key to climate resilience [135]. Cement and other building materials could be used to reduce the cost of livestock shelters, poultry and dairy production facilities, embankments, dikes, and karez restoration initiatives to address floods, droughts, water-use efficiency, and value-added agricultural production. Similar partnerships across all sectors could encourage job training for livelihood diversification and support outputs based on SLP.

Cooperation with local public and civil society organizations is key to WFP's resilience agenda and could be strengthened. Partnerships with public authorities at the district, community, and village levels are key to strengthening the efficacy and reach of public service delivery, as well as to enshrining the will of communities in development planning processes. WFP also relies on community-based organizations (CBOs) and VDOs for local service delivery, and could work to create and scale new ones. CBOs and VDOs are often employed within the context of specific projects, with their funding and utility relinquished once the project lifecycle comes to an end. While there is no simple solution for enabling their temporal sustainability, CBOs and VDOs are critical to both local civil society and service delivery, and they should be supported by larger public and international agencies. Greater coordination among UN agencies and large development organizations, such as the International Committee of the Red Cross and Red Crescent and the International Rescue Committee, could help ensure the ongoing utilization of local non-governmental organizations between large projects. Specifically, a means of supporting a consistent pipeline of sub-contracting work for community-level organizations would help them retain capacity and build influence.

Pursuing partnerships with commercial banks and microfinance institutions could connect households and micro-, small, and medium-sized enterprises (MSMEs) with sustainable financing opportunities. Such partnerships are especially critical for SLP activities which, despite their success in formulating climate-sensitive livelihood strategies, have languished without follow-up funding and generally gone unimplemented. The fact that livelihood strategies have been developed in partnership with WFP may relieve risk-averse financiers and help unlock funding for otherwise "underbanked" populations. The Pakistan Microfinance Network, Aga Khan Development Network, and FINCA Microfinance Bank Limited are well-positioned to provide microfinance, while the State Bank of Pakistan offers larger loans through its Agricultural Loans Scheme, and rural-oriented institutions such as Faysal Bank supply farm and non-farm loans for agricultural communities. WFP can serve as a key intermediary between climate-vulnerable communities and finance institutions.

National and international research organizations and universities can also help WFP fill knowledge gaps and support

evidence-based interventions. Pakistan's National Agricultural Research Center can help generate locally contextual climate-resilient food security solutions, along with provincial institutions such as the University of Agriculture, Peshawar; Sindh Agriculture University; and the Balochistan Agriculture College. International research organizations could provide technical backstopping for local interventions; examples are the International Institute for Environment and Development and CGIAR, including the International Food Policy Research Institute, the International Water Management Institute, the International Center for Agricultural Research in the Dry Areas, and the Alliance of Bioversity International and CIAT.

3.4 Funding opportunities for climate-resilient programming

Sourcing sustainable finance for long-term projects is a critical factor in positioning WFP Pakistan further along the development side of the humanitarian-development nexus. Unlike other UN agencies, WFP does not receive a portion of the funds contributed by countries to the UN system, and instead must source funding on a voluntary basis. Most of this funding is project-based and comes from governments and traditional international finance institutions (IFIs). While this situation allows WFP to capture significant funding dedicated to high-profile humanitarian crises, longer-term and more developmentally focused projects in middle-income countries, such as Pakistan, attract less funding and, in time, suffer from donor fatigue. As Pakistan's economy grows and progress is made on developmental issues, WFP's programming must inevitably focus more on institutional capacity building for public agencies, policy implementation, and technical upgrading, to addressing protracted and systemic developmental issues.

However, a lack of funding for long-term strategic initiatives complicates WFP Pakistan's strategy to pivot from humanitarian responses to anticipatory developmental interventions. Furthermore, the WFP's traditional fundraising mechanisms inhibit the organization's ability to respond to climate-related issues that are protracted in nature. Other UN organizations, such as the FAO and UNDP, are more closely associated with long-term interventions, meaning that for many donors, WFP is not immediately recognized as a likely partner for such programs. Pakistan's 2018-2022 CSP is budgeted to cost US $447 million in total, but between 2018 and 2020 the country office operated on an average annual budgetary shortfall of 29%, which increased to 52% in 2021. The situation is severer for activities explicitly targeting climate resilience such as Strategic Objective 4, Activities 6 and 7, which are experiencing a 96% shortfall in funding this year. Additionally, just four donors comprise WFP Pakistan's total 2021 funding base: Pakistan (79%), the USA (11%), Canada (9%), and Saudi Arabia (1%). Identifying new and diverse sources of sustainable funding for programming well suited to address climate challenges will be critical for WFP Pakistan to shift its developmental remit.

WFP Pakistan's ability to repackage and modify its current activities to focus on resilience rather than recovery will be key to attracting medium- and long-term climate funding. A proactive business development approach is also required whereby, rather than competing to capture a portion of ex-post recovery funding as it is pledged, the WFP country office instead packages and presents ongoing, modified, and newly introduced programming as focused on resilience rather than recovery. This "outbound" approach to business development would, ideally, enable WFP to rebrand itself in the eyes of key donors by showcasing specifically how its

programs can build resilience and how longer-term partnerships and funding opportunities are essential to resilience-oriented initiatives.

Multilateral development banks (MDBs) and IFIs present a funding opportunity for WFP, in partnership with Pakistan's public agencies, to oversee the implementation of strategic climate resilience initiatives. However, given their deep unpopularity at home, additional loans should be pursued in line with the government of Pakistan's political priorities, and with a close eye on how increasing sovereign debt may impact macroeconomic stability and national self-determination. The World Bank is highly active in this space, with ongoing projects exceeding US $100 million related to resilience-building in Sindh, climate-smart agriculture and water management, rural development and agricultural growth, social protection that is resilient to crises, locust-induced food insecurity, and Pakistan's COVID-19 response, among other focus areas [136]. The Asian Development Bank has highlighted "building resilience" as a key objective in its 2021-2025 country partnership strategy and, in 2020, contributed approximately US $800 million to support Pakistan's national health services and expand Ehsaas' social protection programs in the wake of COVID-19 [137]. IFAD is another potential financier because its funding for poverty alleviation and rural development projects throughout Pakistan is directly aligned with WFP's Strategic Objectives. Additional MDBs to consider include the Islamic Development Bank, European Investment Bank, and Islamic Corporation for the Development of the Private Sector. Climate-oriented IFIs are also potential partners, and WFP Pakistan is currently applying for funding from several, including the GCF and International Climate Initiative.

In addition to those with which WFP is already working, numerous bilateral development agencies are active in Pakistan's climate resilience space. The United Kingdom's FCDO, erstwhile the DFID, has an extensive climate resilience portfolio in Pakistan, including the wide-ranging Building Resilience and Addressing Vulnerability to Emergencies (BRAVE) program. Projects in the BRAVE portfolio overlap significantly with many of WFP's thematic programming areas, including cash transfers, livelihood diversification, MSME development, water governance, and education. Following its merger with DFID, the FCDO is undergoing a shift in its own strategic orientation, and climate adaptation is likely to grow in importance and funding in the years to come [138]. The European Union is also active in Pakistan and working extensively with the FAO, including on a five-year water management project in Balochistan and a land tenancy project in Sindh [139]. The Japan International Cooperation Agency operates programming in all provinces, including projects related to agricultural livelihood development in KPK, agricultural extension in Balochistan, and satellite weather forecasting and female livelihood development in Sindh [140]. While the GIZ is not very active in Pakistan's climate adaptation space, several ongoing projects related to economic development overlap with the livelihood diversification activities recommended above [141]. Finally, the China-Pakistan Economic Corridor (CPEC), while controversial, is an ongoing and well-funded program [142]. Though CPEC is mainly infrastructure-oriented, with significant activity in the port city of Gwadar (LZ4), this fact may be leveraged to develop road and transport infrastructure that is needed to improve market access in communities throughout Balochistan. In this case, a rights-based approach must be employed to ensure the basic needs and dignity of impacted communities are guaranteed.

Finally, domestic private-sector and philanthropic relationships can be cultivated to a greater extent. As already discussed (*Section 1.5B – National development strategies and finance mechanisms*), Pakistan has a robust culture of household and corporate charity. Unfortunately, the most charitable sector by a large margin is oil and gas, although substantial donations are made by fertilizer, banking, cement, and engineering corporations as well [135]. The largest non-oil-

and-gas donors include Fatima Fertilizer, Engro Corp, Pak Services Limited, Lucky Cement, Yunus Textile Mills Limited, Liberty Mills Limited, and Lucky Textile Mills Limited [135]. While Climate Action (SDG 13) spending represents less than 1% of total corporate social responsibility donations in Pakistan, resilience is the largest destination of funds within the Climate Action category [135]. The top corporate donors to Climate Action initiatives include Indus Motor Company Limited, Habib Bank Limited, Nishat Chunian Power Limited, and Crescent Steel & Allied Products Limited. [135]. Of course, SDG initiatives often overlap, and spending toward the following SDGs is likely to support activities that also help achieve WFP Pakistan's Strategic Objectives: Quality Education (SDG 4, 41% of total corporate social responsibility spending), Good Health and Well-being (SDG 3, 28% of the total), Clean Water and Sanitation (SDG 6, 8% of the total), Zero Hunger (SDG 2, 5% of the total), Decent Work and Economic Growth (SDG 8, 4% of the total), and No Poverty (SDG 1, 3% of the total) [135]. Individual charitable donations are a more challenging avenue but are also lucrative. Domestic above-the-line, mass media marketing campaigns can generate public awareness of WFP's activities in an effort to solicit donations from Pakistan's more than 200 million-strong Muslim population, all of whom are religiously compelled to donate to the needy in some form each year.

PART 4.

Synthesis

At the national level, Pakistan will grow hotter and drier by 2050, with drought conditions, shifting precipitation patterns, and erratic rainfall complicating agricultural production throughout much of the country. Increased flooding is also likely as glacial melt drives GLOFs in KPK and riverine flooding throughout the Indus Basin, and as high-intensity spurts of rainfall prompt flash flooding in Sindh's desert areas. A comprehensive framework of policies and social protection schemes is in place to address these climate hazards and the resulting potential for food insecurity, although its implementation has been delegated to the provinces, and local implementation varies widely in line with the capacity and resources of provincial administrations. Implementation is generally more advanced in Sindh and KPK than in Balochistan.

By 2050, climate change will impact agricultural production and food security differently across the five LZs analyzed here. In Sindh's irrigated plains (LZ1), increased temperatures, drought conditions, flooding, and soil salinization will negatively impact agricultural livelihoods. Sindh's Sandy Deserts (LZ2) will also experience increased droughts and temperatures, along with the potential for flash floods due to more erratic rainfall. Across Balochistan's western mountains (LZ3) and Dry Western Plateau (LZ4), droughts and heat stress will grow in severity and occur in tandem. Rising temperatures will drive glacial melt and flooding in KPK's Northern Dry Mountains (LZ5), while drought spreads to new areas. In all LZs, elevated out-migration toward urban areas is expected, which may drive conflict amongst "trapped" populations in their areas of origin and in vulnerable destination areas, and which may also amplify nascent and ongoing conflicts. Nationally, hunger and undernourishment are expected to decrease in line with socioeconomic development trends that indicate industrialization, improving education levels, and technological innovation, although it is critical that macro-level gains are distributed to climate-vulnerable areas which may not benefit from increased agricultural production. Such areas, identified through the presence of multiple overlapping vulnerabilities, exist across all five LZs but are most common in Balochistan's Dry Western Plateau (LZ4), in northern KPK (LZ5), and in Sindh's Sandy Deserts (LZ2).

While WFP Pakistan–given its reputation, expansive national footprint, and strong network of local, national, and international partners–is well positioned to support the climate resilience of vulnerable households, doing so will require the modification of existing activities to better address resilience, the introduction of new activities, and a revamped approach to securing funding. To this end, WFP Pakistan could help provincial governments recognize and fill policy gaps related to climate resilience and support national protection schemes in identifying and adding climate-vulnerable beneficiaries to their rolls. FFA activities can be modified to focus on resilience in addition to recovery. SLP activities can support households that are reliant on climate-vulnerable crops to diversify production systems and livelihood streams. Both SLP and CBPP should be expanded geographically. The construction of ESFs could also be expanded into additional districts within all remaining LZs, and the development of smaller community storage facilities could be explored. Anticipatory actions should be trialed and rapidly scaled up by pairing FbF with EWEA, potentially in conjunction with the WFP's PRISM platform. Existing partnerships with international actors should be leveraged to improve EWS and forecasting capabilities, new partnerships with the Pakistani private sector can improve livelihoods programming and drive down the costs of FFA, and new partnerships with the IOM, for example, can inform WFP programming in urban and migration-prone areas. Finally, a proactive and outbound approach to business development can enable WFP to establish itself as an implementing partner of choice in the climate resilience space and as an actor further along the development side of the humanitarian-development nexus, and can help WFP secure long-term, sustainable funding for climate-focused initiatives. These goals can be achieved

by targeting a wider network of multilateral, bilateral, and private-sector funding sources. The table below summarizes the findings and recommendations from this review exercise.

Table 6. Summary of analytical output and recommendations for increased climate resilience

Relevant WFP activities	LZ NO.		LZ1	LZ2	LZ3	LZ4	LZ5
	LZ description		Irrigated plains in SE Sindh	Sandy deserts in SE Sindh	Dry mountains in NW Balochistan	Dry plateau in SW Balochistan	Dry mountains in N. KPK
ANALYTICAL INSIGHTS	Current climate hazards	Drought	X	X	X	X	X
		Heat stress	X	X	X	X	X
		Flood	X	X			X
	Projected climate changes through 2050	Temperature	Hot and growing significantly hotter, especially during *kharif*	Hot and growing significantly hotter, especially during *kharif*	Hot and growing hotter, especially during *kharif*	Hot and growing significantly hotter, especially during *kharif*	Temperate but growing hotter, especially in colder northern glacial areas
		Precipitation	Dry and remaining dry	Dry with increasingly erratic desert rainfall	Very dry and remaining very dry	Very dry and remaining very dry	Moderate precipitation, increasing across both seasons
		Pluvial flooding	Moderate risk July-August and will remain so	Moderate risk July-September and will remain so	Low risk throughout the year and will remain so	Low risk throughout the year and will remain so	Low risk throughout the year but most likely in March-May and will remain so
		Heat stress	Severe during *kharif* and will remain so	Low risk of heat stress throughout the year and will remain so	Severe during March –October and will remain so	Severe during May–September and will remain so	Severe May-December and will remain so
		Drought	Severe throughout the year and will remain so	Severe throughout the year and will remain so, while expanding geographically	Severe throughout the year and will remain so	Severe throughout the year and will remain so, while expanding geographically	Severe throughout the year and will remain so, while expanding geographically
	Hotspot analysis of current non-climate vulnerabilities	Primary vulnerabilities	• Food insecurity • Poor health	• Food insecurity • Gender-based educational inequality • Poor health	• Food insecurity • Poor health	• Food insecurity • Gender-based educational inequality • Poor health	• Food insecurity • Gender-based educational inequality • Poor health
		Additional vulnerabilities	• Conflict • Out-migration	• Conflict	• Conflict • Low soil organic carbon content	• Conflict • Low soil organic carbon • Out-migration	• Conflict • Out-migration
		LZ may not benefit from increased agricultural production?	Yes	Yes	Yes	Yes	Yes
	IMPACT Analysis of climate change on food access and stability through 2050	Production increase projected by 2050:	Wheat, vegetables, sugarcane, cotton, poultry, beef, small ruminants				
		Production decrease projected by 2050:	Maize, millet				
		Availability considerations	• While food production and availability are expected to improve by 2050, these gains are mainly due to non-climatic factors (industrialization, technological innovation, improved education) and will be suppressed by climatic trends that negatively impact agricultural productivity. • Increasing temperatures, drought conditions, shifting precipitation patterns, and flooding are likely to suppress agricultural production through 2050. • In line with socieoeconomic development trends, per capita calorie availability and consumption is projected to increase considerably in coming decades, while the risk of hunger and malnourishment is projected to decrease. • However, these improvement may not be evenly distributed throughout geographic regions, demographics, and economic groups, indicating the likelihood of food insecurity becoming entrenched in climate vulnerable areas without significant intervention. • Production is projected to increase for wheat, vegetables, sugarcane, cotton, poultry, beef, and small ruminants. • Decreased production is projected for maize and millet, resulting in increased import dependency for livestock. • Projected negative impact on maize calorie availability.				
		Stability considerations	• Climatic and environmental hazards, including flooding and errating rainfall, are likely to have a negative impact on agricultural production. • Flooding and erratic rainfall are likely to lead to pest and disease outbreaks, includng desert locust swarms. • Climatic decline may also lead to food insecurity through its negative impact of rural livelihoods, ability to drive violent conflict, and contribute to unplanned urbanization.				
	Analysis of climate-migration-security nexus	Climate -migration-conflict impact pathways	• Resource scarcity	• Resource scarcity	• Resource scarcity • Pre-existing conflict	• Resource scarcity • Pre-existing conflict	• Resource scarcity • Pre-existing conflict *(Both exacerbated by natural distasters)*
		Out-migration toward urban areas	X	X	X	X	X
		Out-migration toward rural areas	X	X			

		LZ NO.	LZ1	LZ2	LZ3	LZ4	LZ5
	LZ description		S. Irrigated plains in SE Sindh	Sandy Deserts in SE Sindh	Dry mountains in NW Balochistan	Dry W. Plateau in SW Balochistan	N. Dry Mountains in KPK
CROSS-CUTTING RECOMMENDATIONS FOR WFP PROGRAMMING	Partnership opportunities		• **International:** International Organization for Migration, Regional Integrated Multi-Hazard Early Warning System for Africa and Asia, Asian Disaster Preparedness Center, UK Meteorgological Department, • **National:** Ministry of National Food Security and Research, Pakistan Agricultural Research Council, Pakistan Meteorological Department, Ministry of Planning, Development, and Special Initiatives, State Bank of Pakistan, Pakistan Microfinance Network, Aga Khan Development Network, and FINCA Microfinance Bank Limited, Faysal Bank • **LZ-Level:** PDMAs, DDMAs, village development organization, community-based organizations, local private sector firms				
	National-level policy support		• National Adaptation Plan (NAP) • National Climate Change Policy + Implementation Framework				
	LZ-level policy support		• Sindh Climate Change Policy • Sindh DRM Plan • Sindh Poverty Reduction Policy		• Forthcoming Balochistan Agriculture Policy • Forthcoming Balochistan DRR/DRM Policy • SDG Action Plans and SDG District Localization Plans		• KPK Climate Change Policy • KPK Food Security Policy • KPK DRM Plan • KPK Agriculture Policy
	Institutional capacity strengthening		• Support the identification of climate-vulnerable beneficiaries for national and provincial social protection programs/systems				
	Improved programme targetting to mainstream climate resilience		• Climate vulnerability metric(s) incorporated into VAM analyses to inform downstream programme design				
	Climate resource mobilization	Bilateral development partners	• UK Foreign, Commonwealth and Development Office, European Union/European Commission's Department for International Partnerships, Japan International Cooperation Agency, GIZ, China-Pakistan Economic Corridor				
		Multilateral development Banks	• World Bank, Asian Development Bank, International Fund for Agricultural Development, Islamic Development Bank, European Investment Bank, Islamic Corporation for the Development of the Private Sector				
		International and domestic private sector	• Non-oil and gas domestic private sector CSR: Fatima Fertilizer, Engro Corp, Pak Services Limited, Lucky Cement, Yunus Textile Mills Limited, Liberty Mills Ltd, Lucky Textile Mills Limited, Indus Motor Company Ltd., Habib Bank Ltd., Nishat Chunian Power Ltd., Crescent Steel & Allied Products Ltd. • Individual charitable donations solicited in-line with Islamic charitable traditions				
		International finance institutions	• Green Climate Fund, International Climate Inititiative				
		Outbound funding pipeline to support strategic pivot	• A proactive, outbound business development approach to sourcing climate resilience funds • Given WFP's historical positioning on the humanitarian end of the humanitarian-development nexus, new programmes must be developed and existing programmes repackaged to showcase the organization's climate resilience credentials, and compete against more established organizations for long-term funding				
SPECIFIC CSP RECOMMENDATIONS FOR WFP PROGRAMMING	Targeting	VAM targeting based on climate vulnerability metrics and climate-driven migration analysis	• 1.1, 1.2, 2.3/Act 01/URT • 3.1, 3.2, 3.3, 4.1, 4.3/Act 02/ACL • 5.1/Act 03/CSI • 2.1/Act 04/SMP • 4.1/Act 06/CAR • 4.1/Act 07/CAR • 4.3/Act 08/CSI	• 1.1, 1.2, 2.3/Act 01/URT • 3.1, 3.2, 3.3, 4.1, 4.3/Act 02/ACL • 5.1/Act 03/CSI • 2.1/Act 04/SMP • 4.1/Act 06/CAR • 4.1/Act 07/CAR • 4.3/Act 08/CSI	• 1.1, 1.2, 2.3/Act 01/URT • 3.1, 3.2, 3.3, 4.1, 4.3/Act 02/ACL • 5.1/Act 03/CSI • 2.1/Act 04/SMP • 4.1/Act 06/CAR • 4.1/Act 07/CAR • 4.3/Act 08/CSI	• 1.1, 1.2, 2.3/Act 01/URT • 3.1, 3.2, 3.3, 4.1, 4.3/Act 02/ACL • 5.1/Act 03/CSI • 2.1/Act 04/SMP • 4.1/Act 06/CAR • 4.1/Act 07/CAR • 4.3/Act 08/CSI	• 1.1, 1.2, 2.3/Act 01/URT • 3.1, 3.2, 3.3, 4.1, 4.3/Act 02/ACL • 5.1/Act 03/CSI • 2.1/Act 04/SMP • 4.1/Act 06/CAR • 4.1/Act 07/CAR • 4.3/Act 08/CSI
	Programme Design	Pilot new resilience programming that is anticipatory in nature	• 1.1, 1.2/Act 01/URT • 3.1, 3.2, 3.3, 4.1, 4.3/Act 02/ACL • 1.1, 1.3, 2.1, 4.3, 5.1, 6.2/Act 03/CSI • 3.1, 3.3, 4.1, Act 06/CAR • 1.3, 2.3, 4.1, 5.1, 5.2, 8.1/Act 07/CAR • 4.3/Act 08/CSI	• 1.1, 1.2/Act 01/URT • 3.1, 3.2, 3.3, 4.1, 4.3/Act 02/ACL • 1.1, 1.3, 2.1, 4.3, 5.1, 6.2/Act 03/CSI • 3.1, 3.3, 4.1, Act 06/CAR • 1.3, 2.3, 4.1, 5.1, 5.2, 8.1/Act 07/CAR • 4.3/Act 08/CSI	• 1.1, 1.2/Act 01/URT • 3.1, 3.2, 3.3, 4.1, 4.3/Act 02/ACL • 1.1, 1.3, 2.1, 4.3, 5.1, 6.2/Act 03/CSI • 3.1, 3.3, 4.1, Act 06/CAR • 1.3, 2.3, 4.1, 5.1, 5.2, 8.1/Act 07/CAR • 4.3/Act 08/CSI	• 1.1, 1.2/Act 01/URT • 3.1, 3.2, 3.3, 4.1, 4.3/Act 02/ACL • 1.1, 1.3, 2.1, 4.3, 5.1, 6.2/Act 03/CSI • 3.1, 3.3, 4.1, Act 06/CAR • 1.3, 2.3, 4.1, 5.1, 5.2, 8.1/Act 07/CAR • 4.3/Act 08/CSI	• 1.1, 1.2/Act 01/URT • 3.1, 3.2, 3.3, 4.1, 4.3/Act 02/ACL • 1.1, 1.3, 2.1, 4.3, 5.1, 6.2/Act 03/CSI • 3.1, 3.3, 4.1, Act 06/CAR • 1.3, 2.3, 4.1, 5.1, 5.2, 8.1/Act 07/CAR • 4.3/Act 08/CSI
		Focus on resilience in addition to recovery	• 1.1, 1.2/Act 01/URT • 2.2, 3.1, 3.3, 4.1, 4.3/Act 02/ACL	• 1.1, 1.2/Act 01/URT • 2.2, 3.1, 3.3, 4.1, 4.3/Act 02/ACL	• 1.1, 1.2/Act 01/URT • 2.2, 3.1, 3.3, 4.1, 4.3/Act 02/ACL	• 1.1, 1.2/Act 01/URT • 2.2, 3.1, 3.3, 4.1, 4.3/Act 02/ACL	• 1.1, 1.2/Act 01/URT • 2.2, 3.1, 3.3, 4.1, 4.3/Act 02/ACL
		Distribution of improved, locally appropriate seed varieties	• 3.1, 4.1/Act 02/ACL	• 3.1, 4.1/Act 02/ACL	• 3.1, 4.1/Act 02/ACL	• 3.1, 4.1/Act 02/ACL	• 3.1, 4.1/Act 02/ACL
		Expand ESFs into new districts	• 4.3/Act 08/CSI	• 4.3/Act 08/CSI	• 4.3/Act 08/CSI	• 4.3/Act 08/CSI	• 4.3/Act 08/CSI
		Develop Community Service Facilities	• 4.3/Act 08/CSI	• 4.3/Act 08/CSI	• 4.3/Act 08/CSI	• 4.3/Act 08/CSI	• 4.3/Act 08/CSI
		Expanded 3PA: SLP + CBPP - linked to the medium and long-term suitability of local production systems	• 3.1, 3.2, 4.1, 8.2/ Act 06/CAR	• 3.1, 3.2, 4.1, 8.2/ Act 06/CAR	• 3.1, 3.2, 4.1, 8.2/ Act 06/CAR	• 3.1, 3.2, 4.1, 8.2/ Act 06/CAR	• 3.1, 3.2, 4.1, 8.2/ Act 06/CAR
		Integrate FFA, SLP, CBPP	• 3.1, 3.2, 3.3/Act 02/ACL • 4.1/Act 06/CAR	• 3.1, 3.2, 3.3/Act 02/ACL • 4.1/Act 06/CAR	• 3.1, 3.2, 3.3/Act 02/ACL • 4.1/Act 06/CAR	• 3.1, 3.2, 3.3/Act 02/ACL • 4.1/Act 06/CAR	• 3.1, 3.2, 3.3/Act 02/ACL • 4.1/Act 06/CAR

		LZ NO.	LZ1	LZ2	LZ3	LZ4	LZ5
	LZ description		S. Irrigated plains in SE Sindh	Sandy Deserts in SE Sindh	Dry mountains in NW Balochistan	Dry W. Plateau in SW Balochistan	N. Dry Mountains in KPK
SPECIFIC CSP RECOMMENDATIONS FOR WFP PROGRAMMING	Programme Design	Integrate FFA and Community Service Facilities	• 3.1, 3.2, 3.3/Act 02/ACL • 4.3/Act 08/CSI	• 3.1, 3.2, 3.3/Act 02/ACL • 4.3/Act 08/CSI	• 3.1, 3.2, 3.3/Act 02/ACL • 4.3/Act 08/CSI	• 3.1, 3.2, 3.3/Act 02/ACL • 4.3/Act 08/CSI	• 3.1, 3.2, 3.3/Act 02/ACL • 4.3/Act 08/CSI
		FBF + EWEA + PRISM (Multi-hazard)	• 1.1, 1.2/Act 01/URT • 3.1, 3.2, 3.3, 4.1, 4.3/Act 02/ACL • 1.1, 1.3, 2.1, 4.3, 5.1, 6.2/Act 03/CSI • 3.1, 3.3, 4.1, Act 06/CAR	• 1.1, 1.2/Act 01/URT • 3.1, 3.2, 3.3, 4.1, 4.3/Act 02/ACL • 1.1, 1.3, 2.1, 4.3, 5.1, 6.2/Act 03/CSI • 3.1, 3.3, 4.1, Act 06/CAR	• 1.1, 1.2/Act 01/URT • 3.1, 3.2, 3.3, 4.1, 4.3/Act 02/ACL • 1.1, 1.3, 2.1, 4.3, 5.1, 6.2/Act 03/CSI • 3.1, 3.3, 4.1, Act 06/CAR	• 1.1, 1.2/Act 01/URT • 3.1, 3.2, 3.3, 4.1, 4.3/Act 02/ACL • 1.1, 1.3, 2.1, 4.3, 5.1, 6.2/Act 03/CSI • 3.1, 3.3, 4.1, Act 06/CAR	• 1.1, 1.2/Act 01/URT • 3.1, 3.2, 3.3, 4.1, 4.3/Act 02/ACL • 1.1, 1.3, 2.1, 4.3, 5.1, 6.2/Act 03/CSI • 3.1, 3.3, 4.1, Act 06/CAR
	Anticipatory emergency response - DRR/DRM	Anticipate climate migration flows	• 1.1, 1.2, 1.3, 2.3/ Act 01/URT • 5.1, 8.2/Act 06/CAR	• 1.1, 1.2, 1.3, 2.3/ Act 01/URT • 5.1, 8.2/Act 06/CAR	• 1.1, 1.2, 1.3, 2.3/ Act 01/URT • 5.1, 8.2/Act 06/CAR	• 1.1, 1.2, 1.3, 2.3/ Act 01/URT • 5.1, 8.2/Act 06/CAR	• 1.1, 1.2, 1.3, 2.3/ Act 01/URT • 5.1, 8.2/Act 06/CAR
	Anticipatory resilience building to identified climate hazards	Livestock shelters	• 3.1, 3.2, 3.3, 4.1, 4.3/Act 02/ACL	• 3.1, 3.2, 3.3, 4.1, 4.3/Act 02/ACL	• 3.1, 3.2, 3.3, 4.1, 4.3/Act 02/ACL	• 3.1, 3.2, 3.3, 4.1, 4.3/Act 02/ACL	• 3.1, 3.2, 3.3, 4.1, 4.3/Act 02/ACL
		Assets that store, distribute, and increase water use-efficiency	• 3.1, 3.2, 3.3, 4.1, 4.3/Act 02/ACL	• 3.1, 3.2, 3.3, 4.1, 4.3/Act 02/ACL	• 3.1, 3.2, 3.3, 4.1, 4.3/Act 02/ACL	• 3.1, 3.2, 3.3, 4.1, 4.3/Act 02/ACL	• 3.1, 3.2, 3.3, 4.1, 4.3/Act 02/ACL
		Irrigation networks maintained and upgraded	• 3.1, 3.2, 3.3, 4.1, 4.3/Act 02/ACL	• 3.1, 3.2, 3.3, 4.1, 4.3/Act 02/ACL	• 3.1, 3.2, 3.3, 4.1, 4.3/Act 02/ACL	• 3.1, 3.2, 3.3, 4.1, 4.3/Act 02/ACL	• 3.1, 3.2, 3.3, 4.1, 4.3/Act 02/ACL
		Construction of embankments, dikes, protective bunds	• 3.1, 3.2, 3.3, 4.1, 4.3/Act 02/ACL	• 3.1, 3.2, 3.3, 4.1, 4.3/Act 02/ACL	• 3.1, 3.2, 3.3, 4.1, 4.3/Act 02/ACL	• 3.1, 3.2, 3.3, 4.1, 4.3/Act 02/ACL	• 3.1, 3.2, 3.3, 4.1, 4.3/Act 02/ACL
		Payment for soil conservation	• 3.1, 3.2, 3.3, 4.1, 4.3/Act 02/ACL	• 3.1, 3.2, 3.3, 4.1, 4.3/Act 02/ACL	• 3.1, 3.2, 3.3, 4.1, 4.3/Act 02/ACL	• 3.1, 3.2, 3.3, 4.1, 4.3/Act 02/ACL	• 3.1, 3.2, 3.3, 4.1, 4.3/Act 02/ACL
		Tree plantation drives	• 3.1, 3.2, 3.3, 4.1, 4.3/Act 02/ACL	• 3.1, 3.2, 3.3, 4.1, 4.3/Act 02/ACL	• 3.1, 3.2, 3.3, 4.1, 4.3/Act 02/ACL	• 3.1, 3.2, 3.3, 4.1, 4.3/Act 02/ACL	• 3.1, 3.2, 3.3, 4.1, 4.3/Act 02/ACL
		Shade crops and physical shading infrastructure	• 3.1, 3.2, 3.3, 4.1, 4.3/Act 02/ACL	• 3.1, 3.2, 3.3, 4.1, 4.3/Act 02/ACL	• 3.1, 3.2, 3.3, 4.1, 4.3/Act 02/ACL	• 3.1, 3.2, 3.3, 4.1, 4.3/Act 02/ACL	• 3.1, 3.2, 3.3, 4.1, 4.3/Act 02/ACL
		Solar lift Irrigation systems			• 3.1, 3.2, 3.3, 4.1, 4.3/Act 02/ACL		
	Climate adaptation and Food Security	Crop diversification based on projected changes in climate and crop feasibility *(especially diversifying cereals with legumes*)*		• 1.1, 2.1, 3.1/Act 02/ACL • 4.1/Act 06/CAR	• 1.1, 2.1, 3.1/Act 02/ACL • 4.1/Act 06/CAR	• 1.1, 2.1, 3.1/Act 02/ACL • 4.1/Act 06/CAR	• 1.1, 2.1, 3.1/Act 02/ACL • 4.1/Act 06/CAR
		Diversification into viable non-agricultural livelihoods	• ?/Act 02/ACL • 4.1/Act 06/CAR	• ?/Act 02/ACL • 4.1/Act 06/CAR	• ?/Act 02/ACL • 4.1/Act 06/CAR	• ?/Act 02/ACL • 4.1/Act 06/CAR	• ?/Act 02/ACL • 4.1/Act 06/CAR

*Subject to additional research and local-level validation with stakeholders and experts

PART 5.

Works referenced

Works referenced

[1] MFF Pakistan, 'A Handbook on Pakistan's Coastal and Marine Resources', 2016. Accessed: Jan. 19, 2021. [Online]. Available: https://www.iucn.org/sites/dev/files/pk_coastal_resources_handbook.pdf

[2] CIAT and World Bank, 'Climate-Smart Agriculture in Pakistan', 2017. Accessed: Jan. 20, 2021. [Online]. Available: https://cgspace.cgiar.org/bitstream/handle/10568/83340/CSA_Profile_Pakistan.pdf?sequence=1&isAllowed=y

[3] FAO, 'FAOSTAT | Land Use', 2021. http://www.fao.org/faostat/en/#data/RL (accessed Jan. 28, 2021).

[4] CIAT and World Bank, 'Climate-Smart Agriculture in Pakistan', 2017. Accessed: Jan. 20, 2021. [Online]. Available: https://cgspace.cgiar.org/bitstream/handle/10568/83340/CSA_Profile_Pakistan.pdf?sequence=1&isAllowed=y

[5] FAO, 'Crops: Pakistan', FAOSTAT, 2021. http://www.fao.org/faostat/en/#data/QC (accessed Jun. 24, 2021).

[6] WID, 'Evolution of Average Income, Pakistan, 1950-2019', *World Inequality Database*, 2019. https://wid.world/country/pakistan/ (accessed Jan. 21, 2021).

[7] World Bank and OECD National Accounts, 'Gini Index (world Bank Estimate) - Pakistan', *The World Bank Data*, 2018. https://data.worldbank.org/indicator/SI.POV.GINI?locations=PK (accessed Jun. 29, 2021).

[8] K. Schwab, R. Crotti, T. Geiger, V. Ratcheva, and World Economic Forum, 'Global Gender Gap Report 2020', World Economic Forum, Geneva, 2019.

[9] UNDP Pakistan, 'Pakistan National Human Development Report on Inequality', Apr. 2021. Accessed: Jun. 24, 2021. [Online]. Available: https://www.pk.undp.org/content/pakistan/en/home/library/human-development-reports/PKNHDR-inequality.html

[10] World Bank Global Electrification Database, 'Access to Electricity, Rural (% of Rural Population)', *The World Bank Data*, 2021. https://data.worldbank.org/indicator/EG.ELC.ACCS.RU.ZS (accessed Jan. 26, 2021).

[11] WFP, 'Pakistan', 2021. https://www.wfp.org/countries/pakistan (accessed Feb. 08, 2021).

[12] WFP, SDPI, and Pakistani Ministry of Climate Change, 'Climate Risks and Food Security Analysis: A Special Report for Pakistan', 2018. [Online]. Available: https://reliefweb.int/sites/reliefweb.int/files/resources/Climate_Risks_and_Food_Security_Analysis_December_2018.pdf

[13] 'Pakistan Dietary Guidelines of Better Nutrition'. Accessed: Feb. 08, 2021. [Online]. Available: https://www.pc.gov.pk/uploads/report/Pakistan_Dietary_Nutrition_2019.pdf

[14] FAO Pakistan, 'Pakistan Overview of Food Security and Nutrition: Improving Access to Food', 2019. [Online]. Available: https://docs.wfp.org/api/documents/WFP-0000118587/download/?_ga=2.55200553.368757006.1611546077-302069180.1611546077

[15] FAO, 'FAOSTAT | Crops', 2021. http://www.fao.org/faostat/en/#data/QC (accessed Jan. 28, 2021).

[16] Government of Pakistan, 'Pakistan Economic Survey 2019-2020', *Government of Pakistan Finance Division*, 2012. http://www.finance.gov.pk/survey_1920.html (accessed Oct. 18, 2021).

[17] M. N. Tahir, R. Riaz, M. Bilal, and H. M. Nouman, 'Current Standing and Future Challenges of Dairying in Pakistan: A Status Update', in *Milk Production, Processing, and Marketing*, IntechOpen, 2019, pp. 1–24. Accessed: Feb. 08, 2021. [Online]. Available: https://www.intechopen.com/books/milk-production-processing-and-marketing/current-standing-and-future-challenges-of-dairying-in-pakistan-a-status-update

[18] World Bank and OECD National Accounts, 'GDP Per Capita (current US$)', *The World Bank Data*, 2019. https://data.worldbank.org/indicator/NY.GDP.PCAP.CD?most_recent_value_desc=false (accessed Jun. 30, 2021).

[19] FAO, 'Prevalence of Undernourishment (% of Population) - Pakistan', *The World Bank Data*, 2021. https://data.worldbank.org/indicator/SN.ITK.DEFC.ZS?locations=PK (accessed Feb. 09, 2021).

[20] Copernicus Climate Change Service, 'Agrometeorological Indicators from 1979 up to 2019 Derived from Reanalysis'. ECMWF, 2019. doi: 10.24381/CDS.6C68C9BB.

[21] Climate Hazards Center, USAID, and UC Santa Barbara, 'CHIRPS: Rainfall Estimates from Rain Gauge and Satellite Observations', 2021. https://www.chc.ucsb.edu/data/chirps (accessed Aug. 19, 2021).

[22] S. Robinson et al., 'The International Model for Policy Analysis of Agricultural Commodities and Trade (IMPACT): Model Description for Version 3', 2015.

[23] S. Khoso and A. A. Ansari, 'An Overview on Emerging Water Scarcity in Pakistan, Its Causes, Impacts and Remedial Measures', *Journal of Applied Engineering Science*, vol. 13, pp. 35–44, Jan. 2015, doi: 10.5937/jaes13-6445.

[24] P. Sleet, 'Water Resources in Pakistan: Scarce, Polluted and Poorly Governed', *Future Directions International*, Jan. 31, 2019. https://www.futuredirections.org.au/publication/water-resources-in-pakistan-scarce-polluted-and-poorly-governed/ (accessed Aug. 10, 2021).

[25] UNHCR, 'Refugee Statistics', 2020. https://www.unhcr.org/refugee-statistics/ (accessed Jan. 22, 2021).

[26] IOM, 'Comprehensive Profile of Pakistani Potential Migrants 2016', 2016. [Online]. Available: https://migration.iom.int/reports/pakistan-comprehensive-profile-pakistani-potential-migrants-2016

[27] IOM, 'Pakistan, Migration Snapshot', Aug. 2019.

[28] IOM, 'Pakistan: Survey on Drivers of Migration', Nov. 2020. [Online]. Available: https://dtm.iom.int/reports/pakistan-%E2%80%93-survey-drivers-migration-migrants-europe-during-covid-19-september-november-2020

[29] UNDESA, 'International Migrant Stock 2019', *United Nations Population Division*, 2019. https://www.un.org/en/development/desa/population/migration/data/estimates2/estimates19.asp

[30] UNHCR, 'Map Registered Afghan Refugees February 28', 2021. [Online]. Available: https://data2.unhcr.org/en/documents/details/85322

[31] National Institute of Population Studies, 'Pakistan Demographic Health Survey 2017-2018', Islamabad, 2019. [Online]. Available: https://dhsprogram.com/pubs/pdf/FR354/FR354.pdf

[32] A. S. Malik, 'Rural Urban Migration: Social-Cultural Changes in Pakistan – Preventive Measures Taken by Government and Civil Society to Control It', *The Professional Medical Journal*, vol. 22, no. 6, 2015, [Online]. Available: http://theprofesional.com/index.php/tpmj/article/view/1230

[33] M. A. Umar and F. Saeed, 'The Role of Heat Stress in Migration Decision: A Case Study of Faisalabad', Working Paper, 2018. [Online]. Available: https://think-asia.org/bitstream/handle/11540/7947/The%20role%20of%20heat%20stress%20in%20migration%20decision%20A%20case%20study%20of%20Faisalabad.pdf?sequence=1

[34] F. Saeed, K. M. Salik, and S. Ishfaq, 'Climate Induced Rural-to-Urban Migration in Pakistan'. 2016. [Online]. Available: https://www.semanticscholar.org/paper/Climate-induced-rural-to-urban-migration-in-Saeed-Salik/6cafd97edcb78e35ef01a0bdbe0efc94b1dab8a1

[35] IDMC, 'Displacement Data Pakistan – May 2020', 2020. https://data.humdata.org/dataset/idmc-idp-data-for-pakistan

[36] IDMC and NRC, 'Displacement Caused by Conflicts and Natural Disasters, Achievements and Challenges', *ReliefWeb*, Jan. 10, 2012. https://reliefweb.int/report/pakistan/displacement-caused-conflict-and-natural-disasters-achievements-and-challenges

[37] F. Ali, T. A. Khan, A. Alamgir, and M. A. Khan, 'Climate Change Induced Conflicts in Pakistan: From National to Individual Level', *Earth Systems and Environment*, vol. 2, pp. 573–599, 2018.

[38] V. Mueller, C. Gray, and K. Kosec, 'Heat Stress Increases Long-Term Human Migration in Rural Pakistan', *Nature Climate Change*, vol. 1, no. 4, pp. 182–185, 2014.

[39] S. Bhattacharya, 'Internal Conflicts in Pakistan', in *Emerging Conflicts and Regional Security in South Asia*, UNIDIR, 2018.

[40] J. Schilling, J. Vivekananda, M. Ali Khan, and N. Pandey, 'Vulnerability to Environmental Risks and Effects on Community Resilience in Mid-West Nepal and South-East Pakistan', *Environment and Natural Resources Research*, vol. 3, no. 4, 2013, [Online]. Available: http://www.ccsenet.org/journal/index.php/enrr/article/view/27141

[41] A. B. Farooqi, A. Z. Khan, and H. Mir, 'Climate Change Perspective in Pakistan', *Pakistan Journal of Meteorology*, vol. 2, no. 3, pp. 11–21, 2005.

[42] World Bank and Global Facility for Disaster Reduction and Recovery and the Climate Change Team of the Environment Department, 'Vulnerability, Risk Reduction, and Adaptation to Climate Change – Pakistan', 2011.

[43] IDMC, 'Flooding Worsens Situation for People Displaced by Conflicts in North-West', Sep. 2010. [Online]. Available: https://www.internal-displacement.org/publications/pakistan-flooding-worsens-situation-for-people-displaced-by-conflict-in-north-west

[44] M. R. Muzamil, P. Tschakert, B. Boruff, and B. Shahbaz, 'An Extreme Climatic Event and Systemic Vulnerabilities in the Face of Conflict: Insights from the Taliban Insurgency in Swat, Pakistan', *Regional Environmental Change,* vol. 21, 2021, [Online]. Available: https://link.springer.com/article/10.1007/s10113-020-01738-y

[45] ACLED, 'The Armed Conflict Location & Event Data Project', *Disaggregated Data Collection, Analysis, & Crisis Mapping Platform, 2021.* https://acleddata.com/ (accessed Aug. 17, 2021).

[46] The DHS Program, 'Pakistan: Standard DHS', *Demographic and Health Surveys*, 2018 2017. https://dhsprogram.com/data/dataset/Pakistan_Standard-DHS_2017.cfm?flag=0 (accessed Aug. 17, 2021).

[47] N. H. Batjes, E. Ribeiro, and A. van Oostrum, 'Standardised Soil Profile Data to Support Global Mapping and Modelling (WoSIS Snapshot 2019)', *Earth System Science Data,* vol. 12, no. 1, pp. 299–320, Feb. 2020, doi: 10.5194/essd-12-299-2020.

[48] C. Funk et al., 'The Climate Hazards Infrared Precipitation with Stations — a New Environmental Record for Monitoring Extremes', *Scientific Data*, vol. 2, no. 1, Dec. 2015, doi: 10.1038/sdata.2015.66.

[49] J.-F. Maystadt and O. Ecker, 'Extreme Weather and Civil War: Does Drought Fuel Conflict in Somalia through Livestock Price Shocks?', *American Journal of Agricultural Economics*, vol. 96, no. 4, pp. 1157–1182, 2014, doi: https://doi.org/10.1093/ajae/aau010.

[50] N. U. Din, 'Internal Displacement in Pakistan: Contemporary Challenges'. Human Rights Commission of Pakistan, 2010. [Online]. Available: https://www.humanitarianlibrary.org/sites/default/files/2014/02/22.pdf

[51] C. Alvarez and Q. Torres, 'Drought in Tharparkar: From Seasonal to Forced Migration', in *The State of Environmental Migration 2015*, 2015.

[52] R. Kuo, 'Economic Migration and Communal Violence in Pakistan', *International Migration*, vol. 57, no. 5, pp. 161–180, May 2019.

[53] G. Rasul and A. Hussain, 'Sustainable Food Security in the Mountains of Pakistan: Towards a Policy Framework', *Ecology of Food and Nutrition*, vol. 54, no. 6, pp. 625–43, 2015.

[54] A. Qaisrani, M. A. Umar, G. Siyal, A. Siyal, and K. M. Salik, 'Rural Livelihood Vulnerability in Semi-Arid Pakistan: Scope of Migration as an Adaptation Strategy'. Pathways for resilience in semi-arid economies (PRISE), 2018.

[55] R. Black, W. N. Adger, N. W. Arnell, S. Dercon, A. Geddes, and D. Thomas, 'The Effect of Environmental Change on Human Migration', *Global Environmental Change*, vol. 21, 2011, doi: 10.1016/j.gloenvcha.2011.10.001.

[56] M. A. Khan, J. A. Khan, Z. Ali, I. Ahmad, and M. N. Ahmad, 'The Challenge of Climate Change and Policy Response in Pakistan', Environmental Earth Sciences, vol. 75, 2016.

[57] S. Adaawen and B. Schraven, 'When Deserts Displace Humans: the Challenges of "Drought Migration"'. The Current Column, 2019. [Online]. Available: https://www.die-gdi.de/en/the-current-column/article/the-challenges-of-drought-migration/

[58] N. Elahi, 'Militancy Conflicts and Displacement in Swat Valley of Pakistan: Analysis of Transformation of Social and Cultural Network', *International Journal of Humanities and Social Science*, vol. 5, no. 3, pp. 226–236, 2015.

[59] S. Engel and A. M. Ibáñez, 'Displacement Due to Violence in Colombia: A Household Level Analysis', *Economic Development and Cultural Change*, vol. 55, no. 2, pp. 335–365, 2007, doi: 10.1086/508712.

[60] A. Jampaklay, K. Ford, and A. Chamratrithirong, 'How Does Unrest Affect Migration? Evidence from the Three Southernmost Provinces of Thailand', *Demographic Research*, vol. 37, no. 3, pp. 25–52, Jul. 2017, doi: 10.4054/DemRes.2017.37.3.

[61] G. Rasul, 'Towards a Framework for Achieving Food Security in the Mountains of Pakistan', 2014. [Online]. Available: https://www.researchgate.net/publication/281853603_Towards_a_Framework_for_Achieving_Food_Security_in_the_Mountains_of_Pakistan

[62] S. Javed, A. M. Nadeem, M. Z. Rafique, and M. A. Kamran, 'Determinants of Income Diversification among Rural Households in Pakistan', *Journal of Economics and Sustainable Development*, vol. 6, no. 14, pp. 45–49, 2015.

[63] W. A. V. Clark, 'Environmentally Induced Migration and Conflict'. 2007. [Online]. Available: https://www.wbgu.de/fileadmin/user_upload/wbgu/publikationen/hauptgutachten/hg2007/pdf/wbgu_jg2007_ex04.pdf

[64] V. Koubi, G. Spilker, Q. Nguyen, and T. Böhmelt, 'Environmental Migrants and Social-Movement Participation', *Journal of Peace Research*, vol. 58, no. 1, Dec. 2020, [Online]. Available: https://journals.sagepub.com/doi/full/10.1177/0022343320972153?journalCode=jpra

[65] S. Rüegger, 'Conflict Actors in Motion: Refugees, Rebels and Ethnic Groups', ETH Zürich, 2013. [Online]. Available: https://icr.ethz.ch/publications/conflict-actors-in-motion/

[66] K. Petrova, 'Natural Hazards, Internal Migration and Protests in Bangladesh', *Journal of Peace Research*, vol. 58, no. 1, 2021, [Online]. Available: https://journals.sagepub.com/doi/full/10.1177/0022343320973741

[67] W. N. Adger et al., 'Human Security of Urban Migrant Populations Affected by Length of Residence and Environmental Hazards', *Journal of Peace Research*, vol. 58, no. 1, pp. 50–66, Jan. 2021, doi: 10.1177/0022343320973717.

[68] USAID, 'Property Rights and Resource Governance - Pakistan', 2018. [Online]. Available: https://www.land-links.org/wp-content/uploads/2016/09/USAID_Land_Tenure_Pakistan_Profile_0.pdf

[69] K. Bakhsh, K. Abbas, M. A. Yasin, R. Ali, N. Ahmad, and M. W. A. Chatta, 'Climate Change-Induced Human Conflicts and Economic Costs in Pakistani Punjab', 2020. [Online]. Available: https://cgspace.cgiar.org/bitstream/handle/10568/99181/CSA%20_Profile_Punjab.pdf?sequence=1&isAllowed=y

[70] R. Ghimire, S. Ferreira, and J. H. Dorfman, 'Flood-Induced Displacement and Civil Conflicts', *World Development*, vol. 66, no. C, pp. 614–628, 2015.

[71] O. Koren and B. E. Bagozzi, 'From Global to Local, Food Insecurity Is Associated with Contemporary Armed Conflicts', *Food Sec.*, vol. 8, pp. 999–1010, 2016.

[72] 'Pakistan's Implementation of the 2030 Agenda for Sustainable Development › Resource Library', *SWITCH-Asia*. https://www.switch-asia.eu/resource/pakistans-implementation-of-the-2030-agenda-for-sustainable-development/ (accessed Jun. 25, 2021).

[73] Government of Pakistan, 'Pakistan's Intended Nationally Determined Contribution (PAK-INDC)', 2015. Accessed: Jan. 14, 2021. [Online]. Available: https://www4.unfccc.int/sites/ndcstaging/PublishedDocuments/Pakistan%20First/Pak-INDC.pdf

[74] Dunya News Staff, 'Pakistan Launches Efforts to Roll Out National Adaption Plan to Fight Climate Vulnerability', *Dunya News*, Mar. 25, 2021. Accessed: Apr. 27, 2021. [Online]. Available: https://dunyanews.tv/en/Pakistan/594167-Pakistan-launches-efforts-adaption-plan-fight-climate-vulnerability-Amin

[75] United Nations Framework Convention on Climate Change, 'National Adaptation Plans 2018: Progress in the Process to Formulate and Implement NAPs', 2018. Accessed: Apr. 27, 2021. [Online]. Available: https://unfccc.int/sites/default/files/resource/Progress%20in%20the%20process%20to%20formulate%20and%20implement%20NAPs.pdf

[76] Government of Pakistan, 'National Climate Change Policy', Islamabad, 2012. Accessed: Jan. 14, 2021. [Online]. Available: http://www.nrsp.org.pk/gcf/docs/National-Climate-Change-Policy-of-Pakistan.pdf

[77] 'Framework for Implementation of CC Policy.pdf'. Accessed: Apr. 28, 2021. [Online]. Available: http://www.gcisc.org.pk/Framework%20for%20Implementation%20of%20CC%20Policy.pdf

[78] 'Pakistan 2025- One Nation - One Vision.pdf'. Accessed: Mar. 24, 2021. [Online]. Available: https://policy.asiapacificenergy.org/sites/default/files/Pakistan%202025-%20One%20Nation%20-%20One%20Vision.pdf

[79] Government of Pakistan and Planning Commission, Ministry of Planning, Development & Special Initiatives, 'Public Sector Development Programme'. 2021. Accessed: Jun. 25, 2021. [Online]. Available: https://www.pc.gov.pk/uploads/archives/PSDP_2021-22.pdf

[80] BISP, 'Budget Summary'. 2019. Accessed: May 17, 2021. [Online]. Available: https://www.bisp.gov.pk//SiteImage/Misc/files/Budget-Summary-2019-20.pdf

[81] ILO, 'Mapping Social Protection Systems in Pakistan: The Status of Current Systems in Line with the UN Social Protection Floor Concept', 2019. Accessed: May 17, 2021. [Online]. Available: https://www.ilo.org/wcmsp5/groups/public/---asia/---ro-bangkok/---ilo-islamabad/documents/publication/wcms_737630.pdf

[82] World Bank, 'World Bank Supports Expansion of Ehsaas Social Protection Program in Pakistan to Increase Household Resilience to Economic Shocks', Mar. 25, 2021. https://www.worldbank.org/en/news/press-release/2021/03/25/pakistan-expands-ehsaas-social-protection-programs-to-increase-household-resilience-to-economic-shocks-with-world-bank-s (accessed Jun. 25, 2021).

[83] S. M. Amjad and M. Ali, 'Philanthropy in Pakistan (SSIR)', *Stanford Social Innovation Review*, Mar. 19, 2018. https://ssir.org/articles/entry/philanthropy_in_pakistan (accessed Jun. 23, 2021).

[84] Pakistan Centre for Philanthropy, 'The State of Individual Philanthropy in Pakistan', 2016. https://www.pcp.org.pk/uploads/nationalstudy.pdf (accessed Jun. 23, 2021).

[85] Pakistan Centre for Philanthropy, 'Corporate Philanthropy in Pakistan', 2018. Accessed: Jun. 23, 2021. [Online]. Available: https://pcp.org.pk/uploads/CPS-2018C.pdf

[86] OECD, 'Aid at a Glance Charts', 2021. https://www.oecd.org/dac/financing-sustainable-development/development-finance-data/aid-at-a-glance.htm (accessed Jun. 22, 2021).

[87] Data, 'GDP (current US$) - Pakistan', *The World Bank*, 2021. https://data.worldbank.org/indicator/NY.GDP.MKTP.CD?locations=PK (accessed Jan. 21, 2021).

[88] K. Tienhaara, 'World Bank Ruling Against Pakistan Shows Global Economic Governance

is Broken', *The Conversation*, Jul. 23, 2019. http://theconversation.com/world-bank-ruling-against-pakistan-shows-global-economic-governance-is-broken-120414 (accessed May 17, 2021).

[89] World Bank, 'Projects', 2021. https://projects.worldbank.org/en/projects-operations/projects-list (accessed May 17, 2021).

[90] Asian Development Bank, 'Pakistan, 2021-2025: Lifting Growth, Building Resilience, Increasing Competitiveness'. Dec. 31, 2020. Accessed: Jun. 22, 2021. [Online]. Available: https://www.adb.org/documents/pakistan-country-partnership-strategy-2021-2025

[91] IFAD, 'Pakistan', 2021. https://www.ifad.org/en/web/operations/w/country/pakistan (accessed Jun. 23, 2021).

[92] GCF, 'Pakistan', Jun. 10, 2019. https://www.greenclimate.fund/countries/pakistan (accessed Jul. 20, 2021).

[93] Government of Pakistan, 'Population Census', *Pakistan Bureau of Statistics*, 2021. https://www.pbs.gov.pk/content/population-census (accessed Mar. 09, 2021).

[94] I. Wilderspin, J. Giles, J. Hildebrand, M. Kahn, M. Lizarazo, and G. Grosjean, 'Climate-Smart Agriculture for Diasaster Risk Reduction in Sindh, Pakistan'. 2019. [Online]. Available: https://ccafs.cgiar.org/resources/publications/climate-smart-agriculture-disaster-risk-reduction-sindh-pakistan

[95] 'Tracing the impact of El Nino on agriculture and life in Mirpur Khas', *South Asia@LSE*, Oct. 13, 2017. https://blogs.lse.ac.uk/southasia/2017/10/13/tracing-the-impact-of-el-nino-on-agriculture-and-life-in-mirpur-khas/ (accessed Mar. 09, 2021).

[96] UNDP Pakistan, 'National Human Development Report 2017: Pakistan', 2017. Accessed: Oct. 18, 2021. [Online]. Available: http://hdr.undp.org/en/content/national-human-development-report-2017-pakistan

[97] United Nations Office for the Coordination of Humanitarian Affairs, 'Multidimensional Poverty in Pakistan - Pakistan', *ReliefWeb*, 2016. https://reliefweb.int/report/pakistan/multidimensional-poverty-pakistan (accessed Mar. 11, 2021).

[98] Fast Rural Development Program, 'Drought in District Tharparkar: Rapid Need Assessment Report', 2018. Accessed: Mar. 12, 2021. [Online]. Available: https://www.humanitarianresponse.info/sites/www.humanitarianresponse.info/files/documents/files/tharparkar_assessment_2018-frdp-acf-21oct18.pdf

[99] Government of Sindh, 'Development Statistics of Sindh', 2018. http://sindhbos.gov.pk/wp-content/uploads/2019/09/Development-Statistics-of-Sindh-2018.pdf (accessed Aug. 02, 2021).

[100] Naz, Dars, Ansari, Jamro, and Krakauer, 'Drought Trends in Balochistan', *Water*, vol. 12, no. 2, p. 470, Feb. 2020, doi: 10.3390/w12020470.

[101] A. W. Rana, M. S. Moeen, S. H. Shikoh, and S. Davies, 'Proposed Balochistan Agriculture Policy 2021', International Food Policy Research Institute, Washington, DC, 2021. doi: 10.2499/p15738coll2.134394.

[102] WHO, 'Pakistan: Drought in Balochistan and Sindh', 2019. Accessed: Mar. 17, 2021. [Online]. Available: https://reliefweb.int/sites/reliefweb.int/files/resources/who_situation_report_drought_pakistan_feb_2019.pdf

[103] 'ACLED Regional Overview – South Asia (20 - 26 March 2021).pdf'. Accessed: Apr. 28, 2021. [Online]. Available: https://reliefweb.int/sites/reliefweb.int/files/resources/ACLED%20Regional%20Overview%20%E2%80%93%20South%20Asia%20%2820%20-%2026%20March%202021%29.pdf

[104] M. I. Kumbhar, Z. K. Rind, F. K. Chang, N. Baloch, and S. Baloch, 'Effect of Climate Change on the Livelihood of Coastal Areas of Taluka Sonmaini, District Lasbela, Balochistan', *IJESNR*, vol. 21, no. 1, pp. 1–9, Aug. 2019, doi: 10.19080/IJESNR.2019.21.556053.

[105] A. Kakar, 'District Profile: Killa Abdullah', 2017. http://www.rspn.org/wp-content/uploads/2018/04/District-Profile-KillaAbdullah.pdf (accessed Mar. 17, 2021).

[106] A. Najam, F. Bari, and UNDP, 'Pakistan Human Rights Development Index 2017', UNDP Pakistan, 2017. Accessed: Mar. 11, 2021. [Online]. Available: http://hdr.undp.org/sites/default/files/reports/2847/pk-nhdr.pdf

[107] Natural Disasters Consortium et al., 'Balochistan Drought Needs Assessment Report', 2019. Accessed: May 21, 2021. [Online]. Available: https://reliefweb.int/sites/reliefweb.int/files/resources/balochistan_drought_needs_assessment.pdf

[108] ITC, 'Competitiveness of Rural MSMEs and Their Resilience to Covid-19 Crisis: Evidence from Balochistan, Pakistan', 2020. Accessed: May 21, 2021. [Online]. Available: https://www.intracen.org/uploadedFiles/intracenorg/Content/Redesign/Projects/grasp/GRASP-Balochistan%20survey2020.pdf

[109] V. Miller, J. Giles, M. Khan, H. Mumtaz, H. Savelli, and G. Grosjean, 'Climate-Smart Agriculture of Khyber Pakhtunkhwa, Pakistan', Alliance of Bioversity International & CIAT, FAO, Rome, Italy, 2021. [Online]. Available: https://cgspace.cgiar.org/handle/10568/113510

[110] WFP and Government of Khyber Pakhtunkhwa, 'Comprehensive Food Security & Livelihood Assessment: Merged Districts and Tribal Sub-Divisions Khyber Pakhtunkhwa', 2020. Accessed: Mar. 16, 2021. [Online]. Available: https://docs.wfp.org/api/documents/WFP-0000119302/download/?_ga=2.224051675.1367658290.1615881977-302069180.1611546077

[111] WFP and Government of Khyber Pakhtunkhwa, 'Comprehensive Food Security & Livelihood Assessment: Merged Districts and Tribal Sub-Divisions Khyber Pakhtunkhwa', 2020. Accessed: Mar. 16, 2021. [Online]. Available: https://docs.wfp.org/api/documents/WFP-0000119302/download/?_ga=2.224051675.1367658290.1615881977-302069180.1611546077

[112] J. Rahimi, J. Y. Mutua, A. M. O. Notenbaert, K. Marshall, and K. Butterbach-Bahl, 'Heat Stress Will Detrimentally Impact Future Livestock Production in East Africa', *Nat Food*, vol. 2, no. 2, Art. no. 2, Feb. 2021, doi: 10.1038/s43016-021-00226-8.

[113] G.M.Arifetal.,'Climate,Population,andVulnerability in Pakistan: Exploring Evidence of Linkages for Adaptation', Population Council, Islamabad, 2019. [Online]. Available: https://knowledgecommons.popcouncil.org/cgi/viewcontent.cgi?article=1754&context=departments_sbsr-pgy

[114] D. Mustafa, G. Gioli, M. Memon, M. Noshirwani, I. Idris, and N. Ahmed, 'Pinning Down Social Vulnerability in Sindh Province, Pakistan: From Narratives to Numbers, and Back Again', *Disasters*, vol. 43, no. 2, pp. 311–335, 2019.

[115] U. Jamal, 'Difficult Decisions Lie Ahead for Pakistan Amid US Withdrawal From Afghanistan', *The Diplomat*, Jul. 08, 2021. Accessed: Aug. 02, 2021. [Online]. Available: https://thediplomat.com/2021/07/difficult-decisions-lie-ahead-for-pakistan-amid-us-withdrawal-from-afghanistan/

[116] IUCN Pakistan, GEF, UNDP Pakistan, and Government of Pakistan, 'National Action Programme to Combat Desertification in Pakistan', 2017. [Online]. Available: https://www.iucn.org/sites/dev/files/pk_nap_desertification_report.pdf

[117] M. I. Kumbhar, Z. K. Rind, F. K. Chang, N. Baloch, and S. Baloch, 'Effect of Climate Change on the Livelihood of Coastal Areas of Taluka Sonmaini, District Lasbela, Balochistan', *International Journal Environmental Science* & Natural Resources, 2019, [Online]. Available: https://ideas.repec.org/a/adp/ijesnr/v21y2019i1p21-29.html

[118] EPA and Government of Khyber Pakhtunkhwa, 'Khyber Pakhtunkhwa Climate Change Policy'. Jun. 2016. Accessed: Apr. 29, 2021. [Online]. Available: http://kp.gov.pk/uploads/2016/11/Final_Climate_Change_Policy_for_KP_Province_25_October,_2016_WebSec_Comments.pdf

[119] Government of Sindh, 'Sindh Climate Change Policy', 2019. [Online]. Available: http://www.epasindh.gov.pk/downloads/CLIMATE%20CHANGE%20POLICY%20DRAFT.docx

[120] Government of Khyber Pakhtunkhwa Finance Department, 'Budget Estimates', 2021 2020. https://www.finance.gkp.pk/article/integrated-budget-call-circular-2020-21 (accessed Jun. 25, 2021).

[121] Government of Balochistan, 'Citizens' Budget: Fostering Sustainable and Inclusive Growth', 2021. Accessed: Jun. 25, 2021. [Online]. Available: https://balochistan.gov.pk/budget-categories/citizens-budget/

[122] Zameen News Staff, 'Sindh Budget 2020-21 Unveiled; No New Taxes Imposed', *Zameen News*, Jun. 18, 2020. Accessed: Jun. 25, 2021. [Online]. Available: https://www.zameen.com/news/sindh-budget-2020-21-unveiled-no-new-taxes-imposed.html

[123] ILO, 'Mapping Social Protection Systems in Pakistan: The Status of Current Systems in Line with the UN Social Protection Floor Concept', 2019. Accessed: May 17, 2021. [Online]. Available: https://www.ilo.org/wcmsp5/groups/public/---asia/---ro-bangkok/---ilo-islamabad/documents/publication/wcms_737630.pdf

[124] WFP, 'Pakistan Country Strategic Plan'. 2018. [Online]. Available: https://www.wfp.org/operations/pk01-pakistan-country-strategic-plan-2018-2022

[125] Aga Khan Development Network, 'Pakistan: Aga Khan Agency and WFP Build Capacity in Disaster Preparedness', *Prevention Web*, Jun. 29, 2018. https://www.preventionweb.net/go/59015 (accessed Jun. 25, 2021).

[126] WFP, 'Annual Country Report', 2020. Accessed: Aug. 17, 2021. [Online]. Available: https://www.wfp.org/operations/annual-country-report/?operation_id=PK01&year=2020#/21397

[127] UNEP, 'Pakistan to Develop National Adaptation Plan for Climate Change', *Global Adaptation Network*, Mar. 25, 2021. https://www.unep.

org/gan/news/press-release/pakistan-develop-national-adaptation-plan-climate-change (accessed Apr. 27, 2021).

[128] World Bank national accounts data and OECD National Accounts, 'Manufacturing, Value Added (% of GDP): Pakistan', *The World Bank Data*, 2021. https://data.worldbank.org/indicator/NV.IND.MANF.ZS?locations=PK (accessed Jun. 22, 2021).

[129] World Bank and OECD National Accounts, 'Services, Value Added (% of GDP) - Pakistan', *The World Bank Data*, 2020. https://data.worldbank.org/indicator/NV.SRV.TOTL.ZS?locations=PK (accessed Jul. 24, 2021).

[130] I. Wilderspin, J. Giles, J. Hildebrand, M. Kahn, M. Lizarazo, and G. Grosjean, 'Climate-Smart Agriculture for Diasaster Risk Reduction in Sindh, Pakistan'. 2019. [Online]. Available: https://ccafs.cgiar.org/resources/publications/climate-smart-agriculture-disaster-risk-reduction-sindh-pakistan

[131] T. Mehmood, Zia-Ul-Haq, S. Mahmood, M. K. Nawaz, H. M. Asam, and M. K. Shafi, 'Forage Preservation Technology for Sustainable Livestock Industry in Rainfed Areas of Pakistan: A Review', *PAB*, vol. 9, no. 3, pp. 1849–1855, Sep. 2020, doi: 10.19045/bspab.2020.90197.

[132] WFP, 'Three-Pronged Approach (3PA)'. 2017. Accessed: May 12, 2021. [Online]. Available: https://docs.wfp.org/api/documents/WFP-0000023753/download/?_ga=2.102653249.1314814393.1620792076-302069180.1611546077

[133] WFP, 'Forecast-Based Financing (FbF): Anticipatory Actions for Food Security'. Apr. 2019. Accessed: Jun. 22, 2021. [Online]. Available: https://docs.wfp.org/api/documents/WFP-0000104963/download/?_ga=2.7866874.93645384.1624346584-302069180.1611546077

[134] K. Fara and N. Bidault, 'An Integrated Risk Programming Framework (IRPF) for Asia Pacific', World Food Programme Regional Bureau Bangkok, n.d.

[135] WFP, 'The Evidence Base on Anticipatory Action', May 2020. https://docs.wfp.org/api/documents/WFP-0000115977/download/ (accessed Jun. 22, 2021).

[136] WFP, 'Forecast-based Financing in Nepal: A Return on Investment Study'. May 07, 2020. Accessed: Jun. 22, 2021. [Online]. Available: https://www.wfp.org/publications/forecast-based-financing-nepal-return-investment-study

[137] RIMES, 'Key Services', 2021. https://www.rimes.int/?q=key-services (accessed Jun. 26, 2021).

[138] ADPC, 'ADPC At a Glance', 2021. https://www.adpc.net/igo/contents/adpcpage.asp?pid=2 (accessed Jun. 26, 2021).

[139] UNDP, 'Corporate Philanthropy in Pakistan', 2017. Accessed: Jun. 26, 2021. [Online]. Available: https://pcp.org.pk/uploads/Corporate%20Philanthropy%20in%20Pakistan%202017.pdf

[140] World Bank, 'South Asia - All Projects', *The World Bank Data*, 2021. https://www.worldbank.org/en/region/sar/projects/all (accessed Jun. 23, 2021).

[141] Asian Development Bank, 'Asian Development Bank Member Fact Sheet: Pakistan'. 2020. Accessed: Jan. 22, 2021. [Online]. Available: https://www.adb.org/sites/default/files/publication/27786/pak-2019.pdf

[142] R. Dissanayake, 'The Shape of Things to Come? FCDO After the Cuts', *Center For Global Development: Commentary and Analysis*, May 26, 2021. https://www.cgdev.org/blog/shape-things-come-fcdo-after-cuts (accessed Jun. 26, 2021).

[143] FAO, 'FAO + European Union Investing in a Sustainable and Food Secure Future', Rome, 2021. Accessed: Jun. 26, 2021. [Online]. Available: http://www.fao.org/3/cb2372en/cb2372en.pdf

[144] JICA, 'Activities in Pakistan', 2021. https://www.jica.go.jp/pakistan/english/activities/index.html (accessed Jun. 26, 2021).

[145] GIZ, 'Pakistan', Dec. 31, 2020. https://www.giz.de/en/worldwide/362.html (accessed Jun. 26, 2021).

[146] M. A. Notezai, 'What Happened to the China-Pakistan Economic Corridor?', *The Diplomat*, Feb. 16, 2021. https://thediplomat.com/2021/02/what-happened-to-the-china-pakistan-economic-corridor/ (accessed Jun. 22, 2021).

[147] J. Kearney, 'Food Consumption Trends and Drivers', *Philosophical Transactions of the Royal Society B: Biological Sciences*, vol. 365, no. 1554, pp. 2793–2807, 2010.

[148] B. M. Popkin, 'Nutritional Patterns and Transitions', *Population and Development Review*, pp. 138–57, 1993.

[149] M. K. Bennett, 'Wheat in National Diets', *Wheat Studies*, vol. 18, no. 02, 1941, Accessed: Aug. 19, 2021. [Online]. Available: https://econpapers.repec.org/article/agsfrisws/142802.htm

[150] J. Kearney, 'Food Consumption Trends and Drivers', *Philosophical Transactions of the Royal Society B: Biological Sciences*, vol. 365, no. 1554, Sep. 2010, Accessed: Aug. 18, 2021. [Online]. Available: https://royalsocietypublishing.org/doi/full/10.1098/rstb.2010.0149

[151] A. Drewnowski and B. M. Popkin, 'The Nutrition Transition: New Trends in the Global Diet', *Nutrition Reviews*, vol. 55, no. 2, pp. 31–43, Feb. 1997, doi: 10.1111/j.1753-4887.1997.tb01593.x.

[152] J. Périssé, F. Sizaret, and P. Francois, 'The Effect of Income on the Structure of the Diet', *FAO Nutrition Newsletter*, vol. 7, no. 3, pp. 1–9, 1969.

[153] UNICEF, WHO, and World Bank, 'Prevalence of Stunting, Height for Age (Modeled Estimate, % of Children Under 5) - Pakistan', *The World Bank Data*, 2020. https://data.worldbank.org/indicator/SH.STA.STNT.ME.ZS?locations=PK (accessed Jun. 29, 2021).

[154] C. Gray and V. Mueller, 'Drought and Population Mobility in Rural Ethiopia', *World Development*, vol. 40, no. 1, pp. 134–145, 2012.

[155] S. Henry, B. Schoumaker, and C. Beauchemin, 'The Impact of Rainfall on the First Out-Migration: A Multi-level Event-History Analysis in Burkina Faso', *Population and Environment*, vol. 25, no. 5, 2004, [Online]. Available: https://www.jstor.org/stable/27503895

[156] V. Koubi, G. Spilker, L. Shaffer, and T. Bernauer, 'Environmental Stressors and Migration: Evidence from Vietnam', *World Developmen*t, vol. 79, no. C, pp. 197–210, 2016.

[157] L. Cunningham, 'Assessing the Contribution of Aquaculture to Food Security: A Survey of Methodologies', Rome, 1010, 2005. Accessed: Aug. 19, 2021. [Online]. Available: http://www.fao.org/3/y5898e/y5898e.pdf

[158] WFP, 'HungerMap', 2021. Accessed: Jan. 26, 2021. [Online]. Available: https://hungermap.wfp.org/

[159] IHME, GHDx, and VidHub, 'Local Burden of Disease', 2021. Accessed: Aug. 18, 2021. [Online]. Available: http://vizhub.healthdata.org/lbd

[160] Malaria Atlas Project, 'Explorer', 2020. Accessed: Aug. 18, 2021. [Online]. Available: https://malariaatlas.org/explorer/#/

[161] WorldPop, 'Migration Flows', 2021. https://www.worldpop.org/geodata/listing?id=26 (accessed Aug. 18, 2021).

[162] ISRIC, 'Soilgrids Web Portal', 2021. https://soilgrids.org (accessed Aug. 18, 2021).

[163] FAO, 'AQUASTAT database', 2021. http://www.fao.org/aquastat/statistics/query/results.html (accessed Jun. 15, 2021).

[164] ACLED, 'Map', Aug. 28, 2019. Accessed: Aug. 18, 2021. [Online]. Available: https://acleddata.com/dashboard/

[165] Earthdata, 'Fire Information for Resource Management System (FIRMS)', 2021. https://earthdata.nasa.gov/earth-observation-data/near-real-time/firms/ (accessed Aug. 18, 2021).

[166] Harvard Center for Geographic Analysis, 'Harvard WorldMap', ArcGIS Online, 2021. Accessed: Aug. 18, 2021. [Online]. Available: https://worldmap.maps.arcgis.com/home/index.html

[167] D. J. Weiss et al., 'A Global Map of Travel Time to Cities to Assess Inequalities in Accessibility in 2015', *Nature*, vol. 553, 2018, doi: doi:10.1038/nature25181.

[168] C. Plutzar et al., 'Changes in the Spatial Patterns of Human Appropriation of Net Primary Production (HANPP) in Europe 1990–2006', *Regional Environmental Change*, vol. 16, no. 5, pp. 1225–1238, Jun. 2016, doi: 10.1007/s10113-015-0820-3.

[169] Institute for Health Metrics and Evaluation (IHME), GBD Compare, and GHDx, 'Low- and Middle-Income Drinking Country Water and Sanitation Facilities Access Geospatial Estimates 2000-2017', *Global Health Data Exchange*. 2020. doi: 10.6069/19PR-QE36.

PART 6.

Annexes

Annex 1: IMPACT Analysis: supplemental results

IMPACT 2020-2050 projections of yield, harvested area, animal numbers, and production under climate change

In Pakistan, production is projected to increase for wheat, vegetables, sugarcane, cotton, and key livestock commodities. The increase in wheat production is due to a projected increase in yield, whereas the increase in cotton and sugarcane production is due primarily to projected increases in area harvested. (Recall that increases in yield in IMPACT are primarily due to improvements in technology and management.) The projected increase in vegetable production is due to a mixture of both increased yield and area. At the same time, substantial decreases are projected for maize and millet due to stagnating or contracting yields and area harvested (Figure 25).

Future projections in terms of percentage changes can present a misleading picture of the relative prevalence of commodities if not interpreted against their underlying baseline and future magnitudes. This is especially true if the baseline magnitudes are small. For this reason, a companion table of projections expressed as magnitudes is provided below (Figure 26), and a more detailed view of harvested area shares is presented below.

In IMPACT, land area allocation among crops is modelled based on the relative values and productivity of the crops. An exogenous area growth factor is also included in this calculation to capture "factors other than direct market effects, such as government programs encouraging cropping expansion, contraction due to soil degradation, or conversion of land from agriculture to nonagricultural uses" [22]. These exogenous growth factors are based on historical trends and expert consultation regarding future trajectories.

A more detailed view of future cropland use trajectories is presented in Figure 27, showing that, although cropland is projected to expand, the relative cropland use shares of these key commodities are projected to change very little, with wheat and cotton projected to occupy the largest share of harvested area out to 2050. The residual category "other cereals" is included for context. Other cereals besides maize, wheat, and millet are projected to occupy the second largest share of cropland, followed by sugarcane, maize, vegetables, and millet.

IMPACT 2020-2050 demand side projections under climate change

TOTAL AND DISAGGREGATED DEMAND

Demand for key crop and livestock commodities is projected to grow considerably out to 2050 (Figure 28). Increased livestock demand is projected to come mostly in the form of increased rural household demand, although urban household demand is also projected to play an increasingly substantial role. In the case

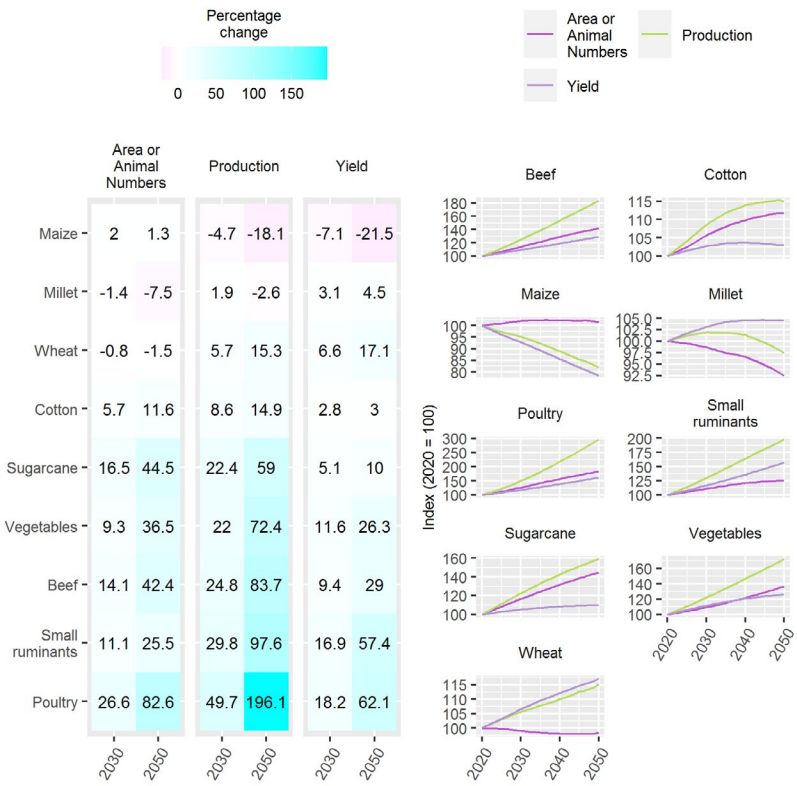


Figure 25. IMPACT 2020-2050 projection of percentage changes in yield, production, and area or animal numbers for key crop and livestock commodities. In the index plots on the right, production, yield, and area harvested are expressed as percentages of their respective 2020 levels.

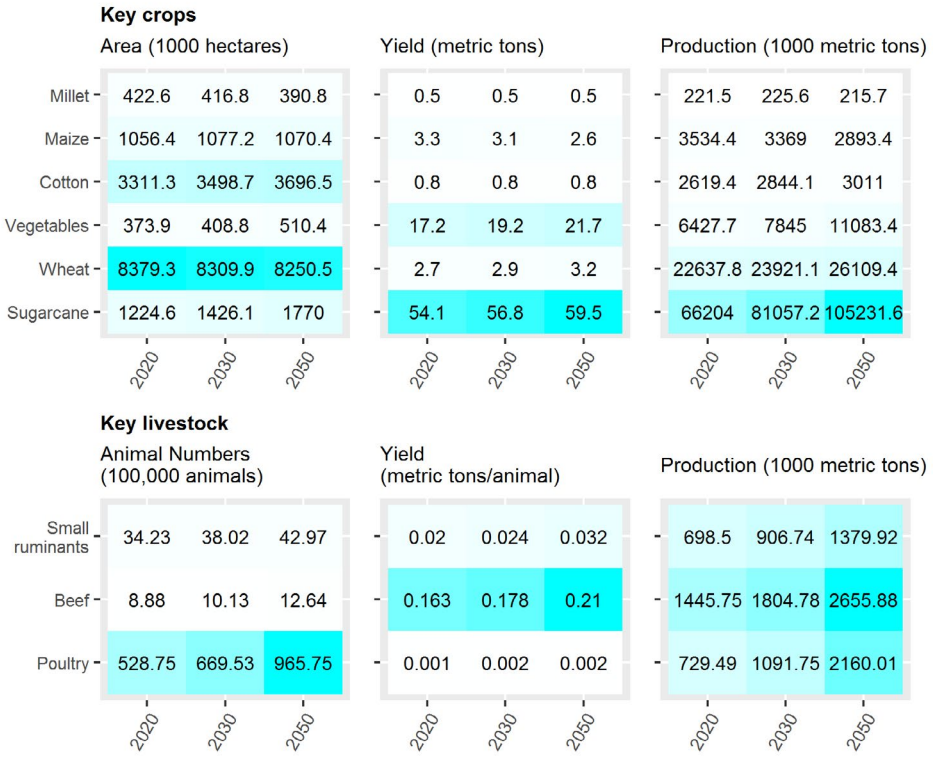


Figure 26. IMPACT projected yield, production, and area or animal numbers for key crop and livestock commodities in 2020, 2030, and 2050.

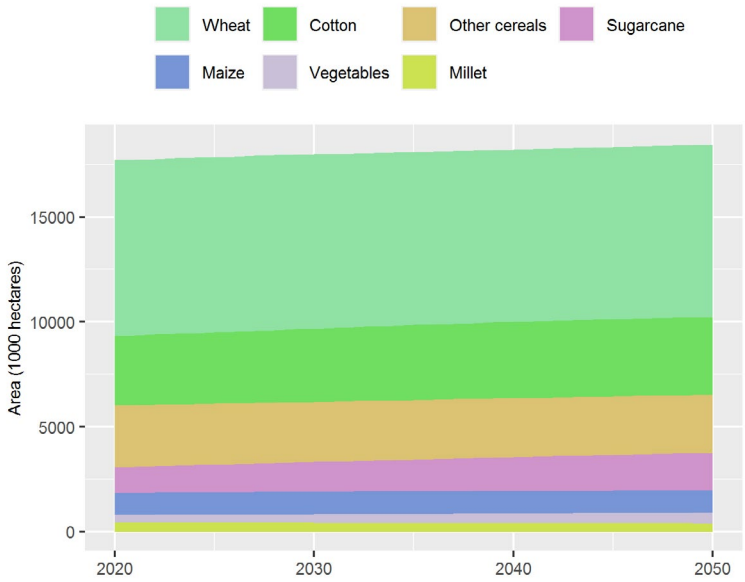


Figure 27. IMPACT 2020-2050 projection of harvested area for key crops and residual categories.

of poultry, export demand is also projected to play a small but increasing role.

Increased demand for vegetables, maize, and wheat is likewise projected to come primarily in the form of rural household demand, with urban household demand also playing an increasingly substantial role. In the case of maize, livestock feed demand as well as seed and industrial demand ("other demand") are projected to play a major role. To a lesser extent, this is also true for wheat. Millet demand is projected to come primarily in the form of livestock feed demand, followed by household demand. Demand for cotton and sugarcane are projected to be entirely in the form of seed/industrial and intermediate demand, respectively[5].

DIET TRAJECTORY

Per capita consumption of all key food commodities is projected to increase considerably in the coming decades. Per capita diet composition out to 2050 is presented in Figure 29. This accounts for food available from both domestic production and international trade[6]. The residual categories "other cereals", "pulses", and "other animal products" are included for context. The primary source of calories is projected to be wheat, followed by animal calories from livestock milk and meat other than beef, poultry, and small ruminant meat. Maize and other cereals apart from wheat and millet are projected to form the third largest calorie source out to 2050. Large percentage increases in per capita consumption are projected for pulses, beef, vegetables, small ruminants, and poultry, but these calories sources are projected to remain a relatively small part of the diet. Direct consumption of millet is projected to remain very low, although indirect consumption will occur through the consumption of animal products (recall that most millet demand is for livestock feed).

In more aggregate terms, consumption of

5 "Intermediate demand" refers to processing factory demand and is based on the demand for final processed goods (for example, peanut butter). The "Other Demand" category "summarizes all other demands for agricultural products from sectors outside of the focus of IMPACT (for example, seeds, industrial use)" [22].

6 Calorie availability is widely accepted as a reasonable proxy for calorie consumption (see for example Kearney (2010) [143], although the former may be higher than the latter by 10%-14%, the difference being lost as waste at the retail and household levels [144].

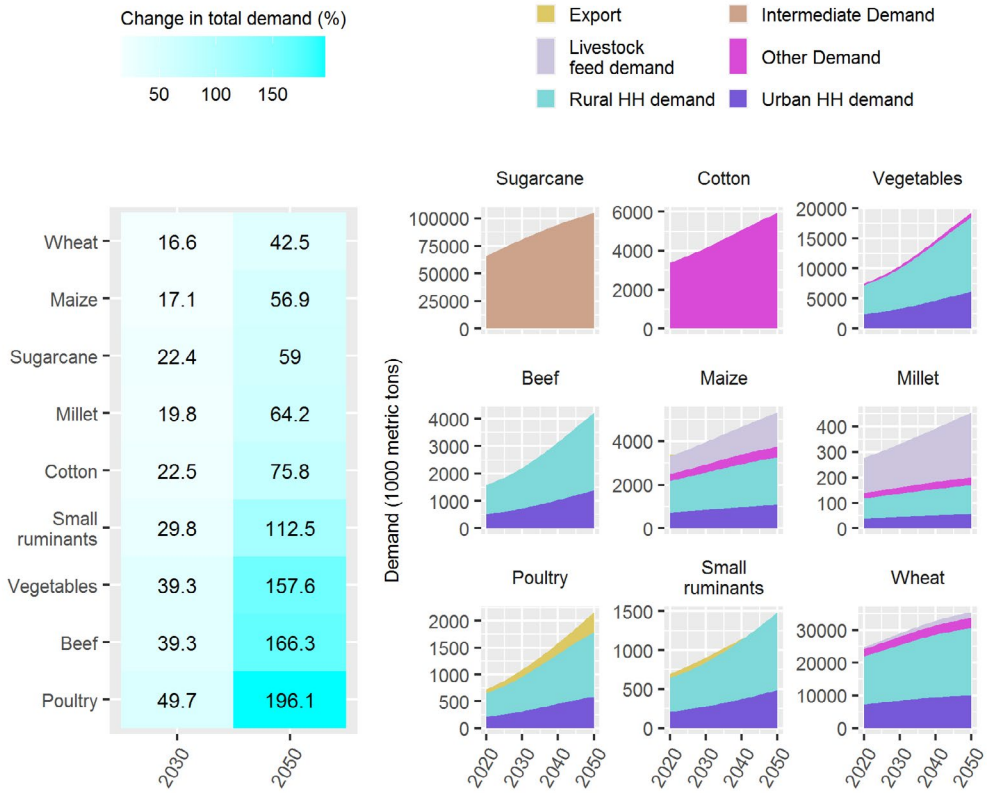


Figure 28. IMPACT 2020-2050 demand profiles for key crops.

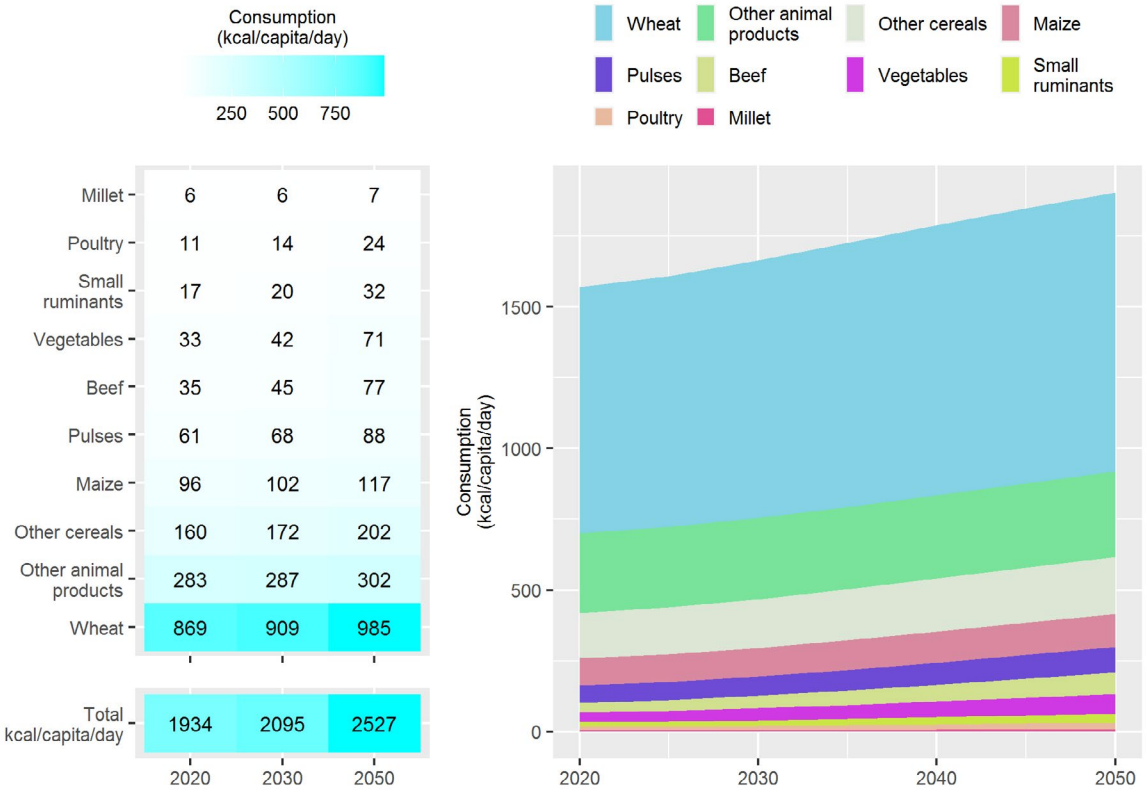


Figure 29. IMPACT 2020-2050 projection of kcal/capita/day for key commodities.

starchy staples (cereals, roots & tubers) is projected to rise from about 1156 kcal/capita/day to 1217 kcal/capita/day in 2030, and then to 1349 kcal/capita/day in 2050. However, as a share of total diet, starchy staple consumption is projected to decline from about 60% to 58% in 2030, and then 53% in 2050. This is consistent with Bennett's law, an empirical trend often seen in developing nations [145]. Consumption of animal products, while rising steadily to 731 kcal/capita/day in 2030 and then 870 in 2050, is projected to fall by a couple percentage points in terms of dietary share–from 36% to 34% in 2050. Consumption of fruits and vegetables, while remaining a small part of the diet, is projected to increase both in magnitude and percentage terms, from 4% of the diet to 7% in 2050.

The projected increase in total calorie intake per capita would clearly be a welcome development vis-a-vis food security. However, careful attention must be paid to composition. A developing nation's "nutrition transition" from starchy staples to animal calories and other carbohydrate sources is often a transition from starchy carbohydrates to sugary foods and fat calories, with the protein calorie share of diet remaining constant [146]–[148]. Care must therefore be taken to promote replacement of the declining starchy staple share of diet with consumption of proteins (whether of animal or vegetable origin), complex carbohydrates, and fibers; while keeping consumption of fats (especially saturated and trans fats) and free sugars below the World Health Organization's recommended levels of 30% and 10% of the diet, respectively.

IMPACT 2020-2050 projection of prevalence of hunger and malnourishment under climate change

IMPACT outputs two explicit measures of food availability: numbers of undernourished children and share of population at risk of hunger. These measures are calculated based on well-documented empirical relations. The share at risk of hunger indicator is calculated as a function of the ratio of available calories to a minimum level of required calories. The numbers of undernourished children indicator are calculated as a function of average per capita calorie consumption, female access to secondary education, the quality of maternal and child care, and health and sanitation. See Robinson et al. for details (2015) [22]. Import dependence for the procurement of key dietary staples may also provide insight into a nation's food security.

The percentage of population at risk of hunger and numbers of undernourished children are projected to decline in the coming decades (Figure 30, left panel). Because the number of undernourished children is partly a function of education, the projected improvement in this variable is due in part to the chosen socioeconomic pathway, SSP5, which assumes improved education levels around the world. The improving nutritional security outlook is also in agreement with recent historical trends [149]. However, import dependence for key commodities is projected to increase substantially out to 2050 (Figure 30, right panel). Increasing import dependence is especially pronounced for maize, millet, and cotton, which are all projected to rise upwards of 30% by 2030 and upwards of 50% by 2050.

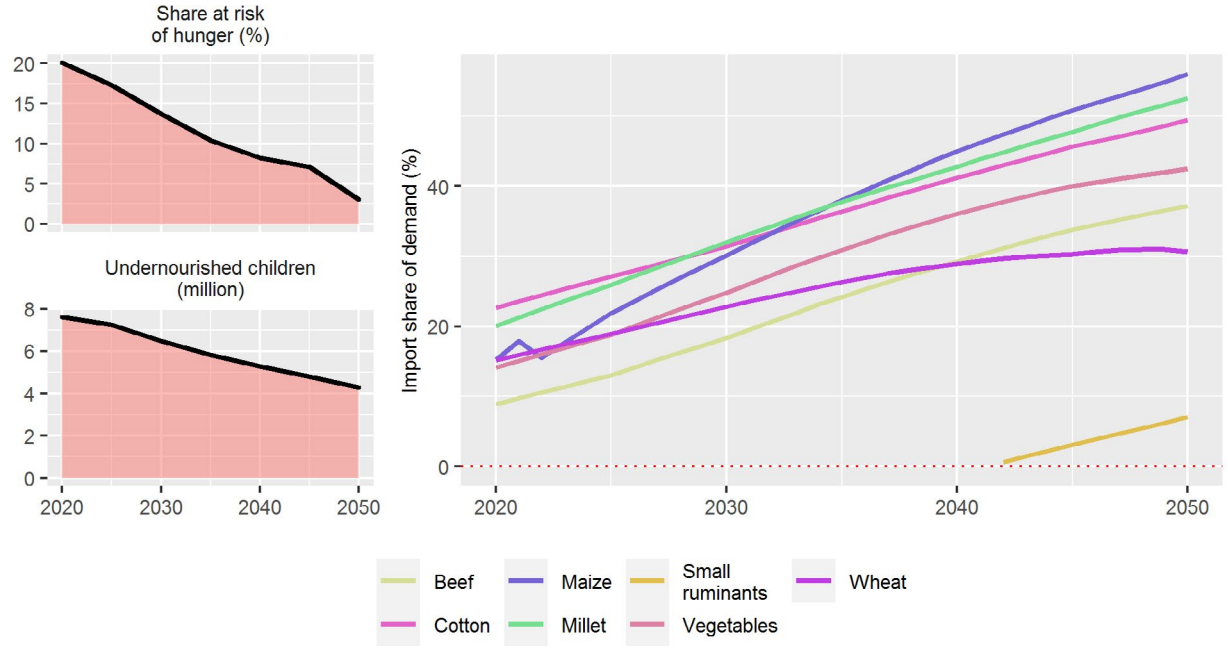


Figure 30. IMPACT 2020-2050 projection of (clockwise from top left) share of population at risk of hunger, import dependence by commodity, and numbers of undernourished children.

Annex 2: Climate-migration-security analysis: detailed methodology

Data and methods

To empirically quantify the climate-induced migration-security nexus, a two-stage analysis has been developed to answer two research questions:

1. **Are climate variability and conflicts drivers of internal migration?**
2. **Can internal migration affect the likelihood of reporting increasing local tensions?**

The two-stage analysis has been set up with to capture both the drivers of internal migration and the drivers of conflicts in order to test (1) whether climate variability and conflicts may increase the likelihood of internal migration and (2) whether conflicts may be exacerbated by the intensity of internal migration flows.

To answer these questions, baseline data has been collecting from several socioeconomic, climate, and conflict datasets. Pakistan's Demographic and Health Surveys 2017-2018 (PDHS) have been used as master datasets to collect information on internal in- and out-migration[7] [46]. The PDHS has been used to create two cross-sectional datasets, one for

7 In-migrants are defined as persons whose district or city of birth is different from the city or district where they have been registered by the PDHS. Out-migrants are persons that have been reported as migrants by their household, and have moved to a different district or city than that of their birth.

in-migration and one for out-migration at the district and household-level, respectively. The latter is considered the best level of analysis, in particular for the models of the first stage, given that individual migration is usually thought to be a household-level decision made partially to reduce household expenditures. [150], [151]. The two cross-sectional datasets provide information on individual migration at the household level, households' socio-economic characteristics, and district-level variables on poverty, inequality, and food security that play an important role in influencing the migration decision-making process [152]. Among them, the dependent variables of interest are the ones that capture the presence of migration as well as the intensity of the phenomenon, thus a dummy variable (0,1) on the presence of in- or out-migrants within households and districts, and a numerical variable to count the number of migrants per family and district. The spatial dimension of these variables is identified by the districts of enumeration which represent both the districts of departure of the out-migrants and the districts of destination of the in-migrants. The temporal dimension of the datasets is provided by the year of in-migration for the in-migrants while, for the out-migrants, it is given by the months and years of out-migration.

Due to the overlapping geographic dimensions of migration at district-level (i.e., where districts of departure for out-migrants and districts of arrival for in-migrants intersect), the cross-sectional datasets have been used to conduct two analyses. Firstly, the dataset for out-migration has been used to conduct the first stage of the analysis, to explore the drivers of migration at the household level. Secondly, the dataset for in-migration has been used to test the second stage, whether incoming migrants may impact local security at the district level. For this reason, the latter dataset has been collapsed from the household to the district-level.

Additionally, the two master datasets have been merged with climate and conflict data to test whether a changing climate and local violence may contribute to households' migratory decisions and, consequently, to local security. Temperature and precipitation anomalies[8] have been created by using international climate data stores that cover the majority of districts reported in the PDHS [46]. The anomalies that have been included in the analysis are standard indicators of the intensity of abnormal climatic conditions that account for spatial and temporal differences in terms of temperature and precipitation variability, following the model developed by Maystadt et al. (2014) [49]. To understand the impact of both abundant rainfall and extreme temperature anomalies on migration, climate anomalies have been divided into quintiles (Q1-Q5) to capture both minor and extreme climatic variances [38]. The extreme quintile (Q5) aligns with the 90th percentile of rainfall and temperature anomalies so that it captures for abnormal climatic conditions. Quintiles on temperature anomalies been excluded due to ambiguous results. Conflict data is sourced from the Armed Conflict Location & Event Data Project (ACLED) to capture both low and high-intensity conflicts [45]. Conflict variables are constructed as the total of different conflict types in each Pakistani district [49].

The timescale of both climate and conflict data have been selected to align with the years for which data is available regarding flows of internal in- and out-migrants, as well as with the years of the PDHS. To merge the climate anomalies and conflict data with the PDHS, the years of migration and the districts of enumeration have been taken as the main variables of interest. For households that haven't registered a migrant, and thus, do not register a year of migration, the years of the PDHS interview are used instead. As a result, the analysis focuses

8 Temperature anomalies refer to maximum temperature variance, positive and negative, in the maximum temperature reported in Pakistan over a given time-period. Rainfall anomalies refer to variances in the total amount of rainfall registered in Pakistan, positive or negative, over a mean value over a given time-period.

on households that have reported an in- or out-migrant between 2017 and 2018, with lagged climate and conflict variables for the years 2016 and 2019.

The first stage of the analysis uses the dataset on out-migration to analyze the main drivers of internal migration in Pakistan. The analysis aims to evaluate possible correlations between climate and migration by testing how adverse climatic conditions, as well as local conflicts, may increase or decrease out-migration within Pakistan. The model used to test these hypotheses is a probit model where the dependent variable Y_{jdt} is a dummy on out-migration for whether the household *j* in district *d* has an out-migrant by year *t* (1). The dummy takes the value 1 if the household reports an out-migrant, and 0 if it does not. The main independent variables of interest are S_{dt-1} and T_{dt-1}, thus climate anomalies and local conflicts in district d at time *t-1* [38], [150], [151], [153]. Variables on climate and conflicts are lagged district-level variables at time *t-1* to capture anomalies and tensions during the twelve months prior to the year *t* of out-migration (1).

$$Y_{jdt} = \beta_0 + \beta_1 S_{dt-1} + \beta_2 T_{dt-1} + \beta_3 X_{jd} + \alpha_t + \gamma_r + u_{jdt} \quad (1)$$

with

$$P(Y_{jdt} = 1 \mid S_{dt-1}, T_{dt-1}, X_{jd} = \Phi(\beta_0 + \beta_1 S_{dt-1} + \beta_2 T_{dt-1} + \beta_3 X_{jd} + \alpha_t + \gamma_r + u_{jdt})$$

Socio-economic control variables at the household *j* and district *d* level (X_{jd}) have been included as they are considered critical determinants in migratory decision-making processes [150], [151]. In particular, controls on households' demographics and human, social, and physical capital have been incorporated [151]. Demographics refer to the sex of the head of the household. Human capital refers to the presence of skills within the households that can both positively influence migration and reduce the households' vulnerability to climate change [151]. To control for the households' human capital, the educational level and employment status of the household's head has been used. Social capital refers to the presence of prior migratory phenomena within the households, as out-migration is assumed to be more likely if other members of the households have previously migrated. Indeed, prior migration, capturing the presence of members in the households with a past migratory experience, should be able to predict a reduction in the risks and costs of future migration, and an increase in the likelihood of additional out-migration within the household [150], [151]. Physical capital refers to the presence of assets owned by the households, in particular agricultural land and a bank account that can provide direct access to financial services. These two assets may reduce a household's vulnerability in the face of natural hazards and to provide enhances access to finances that can be invested in migration [151]. Additionally, the wealth index of poor and poorest households and a variable related to household nutritional status have been included to control for the households' overall well-being. The variable related to nutritional status functions as a proxy for the number of stunting children per household [154]. At the district level, controls on inequality and food security have been included in order to proxy for local economic development and social well-being [151]. Inequality is proxied by the ratio between very poor and very rich households per district, while food security considers the number of women with a very low Body Mass Index (BMI) at the district [154]. Finally, α_t and γ_r are time and regional fixed effects that capture unobservable characteristics, and u_{jdt} is the error term. All models have been weighted using the regional weights given by the DHS.

For the second stage of the analysis, involving conflicts, the intensity of conflict, by district and by year, have been used as dependent variables in order to assess whether the presence of internal migrants may contribute to their intensification. A negative binomial regression has been tested to produce results on this potential association following this equation:

$$C_{dt+1} = \beta_0 + \beta_1 M_{dt} + \beta_2 K_d + \beta_3 P_{dt} + \gamma_r + u_{dt}$$

C_{dt+1} is the count dependent variable that captures the intensity of several conflict types at the district level *d* for the years after the migratory phenomenon $(t + 1)$. M_{dt} is the main variable of interest regarding the intensity of in-migration, accounting for the number of in-migrant that have entered the district *d* in the year *t*. The analysis has been further enriched with controls at the district level (K_d) relating to economic development and overall wellbeing (including food insecurity, poverty, and unequal land ownership) in order to test their impact on local conflicts. Moreover, a variable that captures ongoing conflicts (P_{dt}) has been included to test whether future conflicts correlate with ongoing tensions. Finally, u_{dt} is the regional fixed effect to control for unobservable characteristics, such as population pressure.

The negative binomial regression has been considered the best model to implement this analysis given the characteristics of the dataset and, in particular, the presence of an over-dispersed count dependent variable C_{dt+1}. Negative binomial models are often used as a generalization of the Poisson regression to model overdispersion [151].

Descriptive statistics – variables for the climate-migration-security analysis

REGRESSION TABLES

General Category		Variables	Description of the variables	Count	Mean	Standard Deviation	Minimum	Maximum
Variables of Interest	*Future Conflicts*	Battles (12)	Number of battles (t+1)	221	3.05	5.36	0	27
		Protests (12)	Number of protests (t+1)	221	49.34	89.98	0	570
		Riots (12)	Number of riots (t+1)	221	5.41	11.79	0	69
		Total Conflicts (12)	Number of conflicts (t+1)	221	63.06	111.37	0	597
	General In-migration	In-migration	Number of in-migrants per district (t)	221	2.40	7.83	0	206
	Specific In-migration	Climate-Conflict In-migration	Number of climate-conflict in-migrants per district (t)	221	0.02	0.40	0	8
		Economic In-migration	Number of economic in-migrants per district (t)	221	0.59	2.14	0	30
		Familiar-Marital In-migration	Number of familiar-marital in-migrants per district (t)	221	1.62	5.46	0	152
		Educational In-migration	Number of educational in-migrants per district (t)	221	0.09	0.55	0	11
Controls	*Economic Development and Well-Being of the Districts*	Number of very rich HH per district	Very rich HH per district	221	23.12	42.11	0	728
		Inequality ratio	Ratio between very poor and very rich HH per district	221	3.06	9.56	0	120
		Number of HH with agricultural land	HH that own agricultural land per district	221	32.76	31.14	0	340
		Number of stunting women per district	Stunting women per district	221	35.50	25.72	5	355
	Lagged Conflicts	Ongoing conflicts	Total conflicts (t)	221	50.84	97.51	0	597
	Climate Anomalies	Positive Rainfall Anomalies	Dummy on positive anomalies in the total amount of precipitation (t)	221	0.37	0.48	0	1
		Negative Rainfall Anomalies	Dummy on negative anomalies in the total amount of precipitation (t)	221	0.44	0.50	0	1
		Positive Temperature Anomalies	Dummy on positive anomalies in maximum temperature (t)	221	0.38	0.49	0	1

BASELINE PROBIT MODEL ON LOW AND EXTREME RAINFALL ANOMALIES

VARIABLES	Out-migration (1)	Out-migration (2)	Out-migration (3)	Out-migration (4)	Out-migration (5)	Out-migration (6)	Out-migration (7)
Rainfall Anomalies							
Low Rainfall Anomalies (Q1)	0.327***	0.326***	0.292***	0.335***	0.325***	0.328***	0.299***
	(0.100)	(0.0997)	(0.104)	(0.103)	(0.0997)	(0.100)	(0.104)
Extreme Rainfall Anomalies (Q5)	-0.0189	-0.0185	-0.135	-0.118	-0.0202	-0.0399	-0.116
	(0.135)	(0.134)	(0.141)	(0.156)	(0.134)	(0.136)	(0.142)
Conflcts							
Battles (12)	0.00238						
	(0.00723)						
Explosions-remote violence (12)		0.00713					
		(0.0126)					
Protests (12)			-0.00476***				
			(0.00177)				
Riots (12)				-0.0590*			
				(0.0330)			
Strategic developments (12)					0.00327		
					(0.0280)		
Violence against civilians (12)						-0.0428	
						(0.0400)	
Conflicts (12)							-0.00335**
							(0.00144)
Demographics							
Female head	0.340***	0.341***	0.334***	0.341***	0.340***	0.333***	0.334***
	(0.0942)	(0.0943)	(0.0943)	(0.0946)	(0.0943)	(0.0944)	(0.0944)
Household size	0.00878	0.00868	0.00927	0.00899	0.00872	0.00897	0.00920
	(0.0102)	(0.0102)	(0.0101)	(0.0102)	(0.0102)	(0.0101)	(0.0101)
Human Capital							
Educated Head (Secondary or Higher)	-0.0134	-0.0134	-0.0233	-0.0178	-0.0135	-0.0114	-0.0209
	(0.0796)	(0.0797)	(0.0797)	(0.0797)	(0.0796)	(0.0794)	(0.0797)
Unemployed head	0.427***	0.427***	0.429***	0.421**	0.426***	0.424**	0.426**
	(0.165)	(0.165)	(0.165)	(0.165)	(0.165)	(0.165)	(0.165)
Social Capital							
Migratory experiences in the HH	0.0891*	0.0890*	0.0980**	0.0969*	0.0899*	0.0977*	0.0992**
	(0.0498)	(0.0503)	(0.0493)	(0.0509)	(0.0504)	(0.0502)	(0.0495)
Physical Capital							
HH agricultural land ownership	-0.0177	-0.0180	-0.0100	-0.0205	-0.0183	-0.0169	-0.0127
	(0.0816)	(0.0816)	(0.0813)	(0.0814)	(0.0816)	(0.0814)	(0.0813)
Wealth Index (Poor HH)	0.0380	0.0363	0.00632	0.00516	0.0345	0.0326	0.00684
	(0.0924)	(0.0927)	(0.0923)	(0.0924)	(0.0927)	(0.0927)	(0.0923)
HH bank account	0.102	0.102	0.116	0.121	0.102	0.112	0.114
	(0.0789)	(0.0789)	(0.0789)	(0.0785)	(0.0787)	(0.0784)	(0.0788)
Location and Nutritional Status of the Household							
Rural HH	0.275***	0.277***	0.193**	0.179**	0.274***	0.230**	0.202**
	(0.0924)	(0.0929)	(0.0894)	(0.0900)	(0.0925)	(0.0919)	(0.0893)
Number of stunted children in the household	-0.0897*	-0.0896*	-0.0888*	-0.0869	-0.0898*	-0.0880*	-0.0891*
	(0.0536)	(0.0536)	(0.0539)	(0.0535)	(0.0536)	(0.0535)	(0.0538)
Economic Development and Well-Being of the Districts							
Total women with low BMI (district lev.)	-0.0584	-0.0606	0.000337	-0.0184	-0.0589	-0.0315	-0.00987
	(0.0372)	(0.0380)	(0.0438)	(0.0459)	(0.0384)	(0.0471)	(0.0442)
Inequality ratio (district lev.)	-0.00756	-0.00799	-0.0132*	-0.0140*	-0.00795	-0.0110	-0.0129*
	(0.00674)	(0.00686)	(0.00707)	(0.00751)	(0.00678)	(0.00699)	(0.00702)
Constant	-1.753***	-1.747***	-1.517***	-1.519***	-1.745***	-1.686***	-1.550***
	(0.135)	(0.133)	(0.149)	(0.173)	(0.133)	(0.140)	(0.149)
Year of Migration FE	YES	YES	YES	YES	YES	YES	YES
Region of Enumeration FE	YES	YES	YES	YES	YES	YES	YES
Observations	12,639	12,639	12,639	12,639	12,639	12,639	12,639

Robust standard errors in parentheses
*** Significant at the 1 percent level
** Significant at the 5 percent level
* Significant at the 10 percent level

SPECIFICATION OF THE BASELINE PROBIT MODEL USING DHS WEALTH INDEX

	Out-Migration													
	Out-migration - Richest							Out-migration - Poorest						
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)
VARIABLES														
Extreme Rainfall Anomalies (Q5)	0.335	0.327	0.382	0.340	0.376	0.329	0.397	-0.370	-0.343	-0.395*	-0.419*	-0.355	-0.321	-0.402*
	(0.265)	(0.259)	(0.311)	(0.320)	(0.259)	(0.256)	(0.307)	(0.232)	(0.233)	(0.222)	(0.251)	(0.232)	(0.238)	(0.221)
Conflicts														
Battles (12)	0.0334							-0.0298**						
	(0.0210)							(0.0128)						
Explosions-remote violence (12)		0.0347							-0.0319**					
		(0.0309)							(0.0162)					
Protests (12)			0.00227							-0.00871				
			(0.00329)							(0.00652)				
Riots (12)				0.0139							-0.415***			
				(0.0328)							(0.115)			
Strategic developments (12)					0.126**							-0.0722		
					(0.0525)							(0.0495)		
Violence against civilians (12)						0.0601*							-0.233***	
						(0.0335)							(0.0837)	
Conflicts (12)							0.00234							-0.00843
							(0.00256)							(0.00566)
Demographics														
Female head	-0.0935	-0.107	-0.105	-0.121	-0.0837	-0.107	-0.0996	0.487***	0.489***	0.485***	0.474***	0.486***	0.447**	0.484***
	(0.213)	(0.213)	(0.210)	(0.214)	(0.212)	(0.216)	(0.210)	(0.174)	(0.175)	(0.175)	(0.183)	(0.175)	(0.181)	(0.175)
Household size	0.0333*	0.0320*	0.0324*	0.0325*	0.0314	0.0320*	0.0325*	0.00989	0.00987	0.00798	0.00802	0.00968	0.00830	0.00847
	(0.0190)	(0.0186)	(0.0187)	(0.0184)	(0.0192)	(0.0190)	(0.0188)	(0.0207)	(0.0207)	(0.0208)	(0.0204)	(0.0207)	(0.0207)	(0.0207)
Human Capital														
Educated Head (Secondary or Higher)	0.210	0.205	0.221	0.208	0.220	0.195	0.222	-0.851***	-0.863***	-0.902***	-0.858***	-0.871***	-0.870***	-0.892***
	(0.186)	(0.186)	(0.173)	(0.183)	(0.185)	(0.189)	(0.176)	(0.253)	(0.255)	(0.245)	(0.264)	(0.258)	(0.262)	(0.245)
Unemployed head	0.519	0.497	0.511	0.510	0.497	0.518	0.518	0.573**	0.571**	0.556**	0.597**	0.579**	0.572**	0.552**
	(0.403)	(0.402)	(0.402)	(0.395)	(0.405)	(0.401)	(0.403)	(0.232)	(0.231)	(0.234)	(0.241)	(0.231)	(0.235)	(0.235)
Social Capital														
Migratory experiences in the HH	0.149*	0.157*	0.157*	0.159*	0.154*	0.154*	0.155*	-0.0512	-0.0595	-0.0658	-0.0767	-0.0585	-0.0785	-0.0634
	(0.0871)	(0.0881)	(0.0887)	(0.0874)	(0.0881)	(0.0880)	(0.0884)	(0.163)	(0.165)	(0.156)	(0.152)	(0.165)	(0.168)	(0.157)
Physical Capital														
HH agricultural land ownership	0.299*	0.303*	0.303*	0.307*	0.291*	0.289*	0.300*	-0.168	-0.167	-0.174	-0.220	-0.170	-0.174	-0.175
	(0.174)	(0.169)	(0.171)	(0.169)	(0.171)	(0.171)	(0.172)	(0.156)	(0.156)	(0.153)	(0.153)	(0.156)	(0.162)	(0.154)
Bank account	0.623***	0.610***	0.605***	0.608***	0.594***	0.600***	0.603***	-0.452**	-0.456**	-0.448**	-0.433**	-0.452**	-0.468**	-0.450**
	(0.182)	(0.186)	(0.185)	(0.185)	(0.187)	(0.187)	(0.186)	(0.186)	(0.186)	(0.184)	(0.191)	(0.186)	(0.193)	(0.184)
Location and Nutritional Status of the Household														
Rural HH	-0.538**	-0.539**	-0.534**	-0.535**	-0.531**	-0.524**	-0.530**	1.116***	1.146***	1.003***	0.925***	1.128***	1.031***	0.982***
	(0.268)	(0.262)	(0.261)	(0.250)	(0.262)	(0.265)	(0.263)	(0.207)	(0.210)	(0.216)	(0.231)	(0.217)	(0.206)	(0.216)
Number of stunted children in the household	-0.422**	-0.385**	-0.385**	-0.382**	-0.419**	-0.506***	-0.395**	0.0276	0.0258	0.0271	0.0353	0.0261	0.0221	0.0268
	(0.169)	(0.184)	(0.186)	(0.185)	(0.177)	(0.144)	(0.182)	(0.0795)	(0.0787)	(0.0797)	(0.0807)	(0.0787)	(0.0794)	(0.0799)
Economic Development and Well-Being of the Districts														
Total women with low BMI (district lev.)	-0.0357	-0.0358	-0.0703	-0.0291	-0.0878	-0.0893	-0.0855	0.0565	0.0598	0.0799	0.0312	0.0658	0.0842	0.0787
	(0.0684)	(0.0787)	(0.116)	(0.0952)	(0.0730)	(0.0844)	(0.112)	(0.0719)	(0.0720)	(0.0646)	(0.0702)	(0.0716)	(0.0719)	(0.0645)
Inequality ratio (district lev.)	-0.149**	-0.186***	-0.177***	-0.184***	-0.157***	-0.162***	-0.165***	0.00213	0.00342	0.000161	-0.00255	0.00287	0.00101	-4.46e-05
	(0.0607)	(0.0603)	(0.0571)	(0.0554)	(0.0576)	(0.0594)	(0.0558)	(0.00640)	(0.00634)	(0.00636)	(0.00935)	(0.00645)	(0.00677)	(0.00639)
Year of Migration FE	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
Region of Enumeration FE	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
Observations	12,639	12,639	12,639	12,639	12,639	12,639	12,639	11,344	11,344	11,344	11,344	11,344	11,344	11,344

Robust standard errors in parentheses
*** Significant at the 1 percent level
** Significant at the 5 percent level
* Significant at the 10 percent level

BASELINE PROBIT MODEL ON TEMPERATURE ANOMALIES

VARIABLES	Out-migration (1)	Out-migration (2)	Out-migration (3)	Out-migration (4)	Out-migration (5)	Out-migration (6)	Out-migration (7)
Temperature Anomalies							
Temperature anomalies (12)	-5.803***	-5.494***	-5.048***	-5.227***	-5.524***	-5.335***	-5.114***
	(0.829)	(0.805)	(0.811)	(0.825)	(0.801)	(0.822)	(0.811)
Conflcts							
Battles (12)	0.0175**						
	(0.00741)						
Explosions-remote violence (12)		0.0208					
		(0.0131)					
Protests (12)			-0.00300*				
			(0.00169)				
Riots (12)				-0.0427			
				(0.0324)			
Strategic developments (12)					0.0378		
					(0.0274)		
Violence against civilians (12)						-0.0305	
						(0.0411)	
Conflicts (12)							-0.00191
							(0.00136)
Demographics							
Female head	0.330***	0.331***	0.326***	0.330***	0.331***	0.325***	0.326***
	(0.0966)	(0.0969)	(0.0969)	(0.0972)	(0.0970)	(0.0971)	(0.0970)
Household size	0.00718	0.00690	0.00779	0.00754	0.00673	0.00754	0.00768
	(0.0106)	(0.0105)	(0.0104)	(0.0104)	(0.0105)	(0.0103)	(0.0104)
Human Capital							
Educated Head (Secondary or Higher)	-0.0217	-0.0224	-0.0287	-0.0260	-0.0218	-0.0212	-0.0269
	(0.0833)	(0.0834)	(0.0828)	(0.0831)	(0.0834)	(0.0831)	(0.0829)
Unemployed head	0.420**	0.414**	0.409**	0.402**	0.410**	0.408**	0.408**
	(0.163)	(0.163)	(0.163)	(0.162)	(0.163)	(0.163)	(0.163)
Social Capital							
Migratory experiences in the HH	0.0720*	0.0785*	0.0878**	0.0877**	0.0779*	0.0872**	0.0881**
	(0.0433)	(0.0439)	(0.0430)	(0.0437)	(0.0441)	(0.0439)	(0.0432)
Physical Capital							
HH agricultural land ownership	-0.0199	-0.0231	-0.0209	-0.0254	-0.0247	-0.0221	-0.0220
	(0.0812)	(0.0813)	(0.0809)	(0.0813)	(0.0812)	(0.0811)	(0.0810)
Wealth Index (Poor HH)	0.0133	-0.00684	-0.0371	-0.0424	-0.00726	-0.0150	-0.0331
	(0.0923)	(0.0927)	(0.0925)	(0.0938)	(0.0927)	(0.0924)	(0.0926)
HH bank account	0.0800	0.0774	0.0852	0.0887	0.0744	0.0839	0.0833
	(0.0816)	(0.0814)	(0.0811)	(0.0808)	(0.0813)	(0.0809)	(0.0811)
Location and Nutritional Status of the Household							
Rural HH	0.283***	0.274***	0.220**	0.203**	0.282***	0.238***	0.228**
	(0.0917)	(0.0917)	(0.0895)	(0.0893)	(0.0912)	(0.0905)	(0.0896)
Number of stunted children in the household	-0.0789	-0.0792	-0.0798	-0.0773	-0.0791	-0.0787	-0.0799
	(0.0540)	(0.0539)	(0.0539)	(0.0536)	(0.0540)	(0.0537)	(0.0539)
Economic Development and Well-Being of the Districts							
Total women with low BMI (district lev.)	-0.126***	-0.127***	-0.0898**	-0.103**	-0.129***	-0.105**	-0.0978**
	(0.0389)	(0.0392)	(0.0416)	(0.0417)	(0.0387)	(0.0447)	(0.0416)
Inequality ratio (district lev.)	-0.00435	-0.00686	-0.0102	-0.0107	-0.00624	-0.00881	-0.00959
	(0.00610)	(0.00673)	(0.00677)	(0.00719)	(0.00650)	(0.00672)	(0.00670)
Constant	-2.094***	-2.022***	-1.863***	-1.845***	-2.031***	-1.965***	-1.894***
	(0.150)	(0.147)	(0.156)	(0.176)	(0.147)	(0.153)	(0.156)
Year of Migration FE	YES	YES	YES	YES	YES	YES	YES
Region of Enumeration FE	YES	YES	YES	YES	YES	YES	YES
Observations	12,639	12,639	12,639	12,639	12,639	12,639	12,639

Robust standard errors in parentheses
*** Significant at the 1 percent level
** Significant at the 5 percent level
* Significant at the 10 percent level

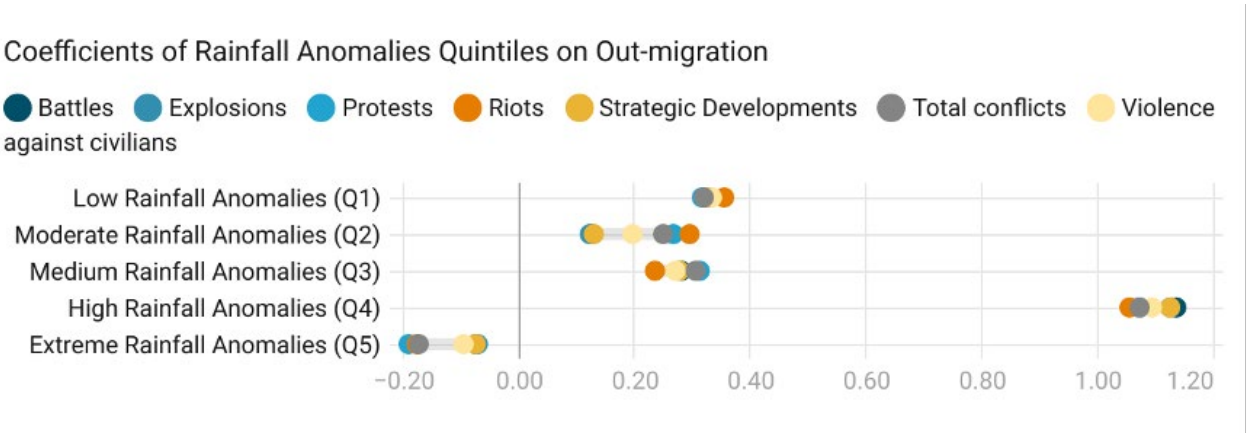
SUMMARY TABLE – RAINFALL ANOMALIES

	General Category	Variables	Out-migration (1)	Out-migration - Poorest (2)	Out-migration - Richest (3)
Variables of Interest	*Climate Anomaly*	Rainfall Anomalies (12)	***		
		Positive Rainfall Anomalies (12)	***		
		Low Rainfall Anomalies (Q1)	***		
		Extreme Rainfall Anomalies (Q5)	ns	*	ns
	Conflicts	Battles (12)	ns	**	ns
		Explosions-remote violence (12)	ns	**	ns
		Protests (12)	**	ns	ns
		Riots (12)	*	***	ns
		Strategic developments (12)	ns	ns	**
		Violence against civilians (12)	ns	***	*
		Conflicts (12)	*	ns	ns
	Interactions	Battles (12) x Rainfall anomalies (12)	***		
		Explosions-remote violence (12) x Rainfall anomalies (12)	***		
		Protests (12) x Rainfall anomalies (12)	ns		
		Riots (12) x Rainfall anomalies (12)	*		
		Strategic developments (12) x Rainfall anomalies (12)	**		
		Violence against civilians (12) x Rainfall anomalies (12)	ns		
		Conflicts (12) x Rainfall anomalies (12)	ns		
Controls	*HH Demographics*	Female head	***	***	ns
		Household size	ns	ns	*
	HH Human Capital	Educated Head (Secondary or Higher)	ns	***	ns
		Unemployed head	**	**	ns
	HH Social Capital	Migratory experiences in the HH	**	ns	*
	HH Physical Capital	HH agricultural land ownership	ns	ns	*
		Wealth Index (Poor HH)	ns		
		HH bank account	ns	**	***
	Location and Nutritional Status of the Household	Rural HH	***	***	**
		Number of stunted children in the household	*	ns	***
	Economic Development and Well-Being of the Districts	Total women with low BMI (district lev.)	**	ns	ns
		Inequality ratio (district lev.)	ns	ns	***

Highly Positive
Positve
Negative
Highly Negative

*** Significant at 1 percent
** Significant at 5 percent
* Significant at 10 percent

COEFFICIENT PLOT OF POSITIVE RAINFALL ANOMALIES QUINTILES



SUMMARY TABLE – TEMPERATURE ANOMALIES

	General Category	Variables	Out-migration (4)
Variables of Interest	*Climate Anomaly*	Temperature Anomalies (12)	***
	Conflicts	Battles (12)	**
		Explosions-remote violence (12)	ns
		Protests (12)	*
		Riots (12)	ns
		Strategic developments (12)	ns
		Violence against civilians (12)	ns
		Conflicts (12)	ns
	Interactions	Battles (12 months) x Temperature anomalies (12)	**
		Explosions-remote violence (12 months) x Temperature anomalies (12)	***
		Protests (12 months) x Temperature anomalies (12)	***
		Riots (12 months) x Temperature anomalies (12)	***
		Strategic developments (12 months) x Temperature anomalies (12)	ns
		Violence against civilians (12 months) x Temperature anomalies (12)	ns
		Conflicts (12 months) x Temperature anomalies (12)	***
Controls	*HH Demographics*	Female head	***
		Household size	ns
	HH Human Capital	Educated Head (Secondary or Higher)	ns
		Unemployed head	**
	HH Social Capital	Migratory experiences in the HH	**
	HH Physical Capital	HH agricultural land ownership	ns
		Wealth Index (Poor HH)	ns
		HH bank account	ns
	Location and Nutritional Status of the Household	Rural HH	***
		Number of stunted children in the household	ns
	Economic Development and Well-Being of the Districts	Total women with low BMI (district lev.)	***
		Inequality ratio (district lev.)	ns

Highly Positive
Positve
Negative
Highly Negative

*** Significant at 1 percent
** Significant at 5 percent
* Significant at 10 percent

BASELINE NEGATIVE BINOMIAL REGRESSION ON IN-MIGRATION

VARIABLES	Battles (12) (1)	Protests (12) (2)	Riots (12) (3)	Conflicts (12) (4)	Battles (12) (5)	Protests (12) (6)	Riots (12) (7)	Conflicts (12) (8)	Battles (12) (9)	Protests (12) (10)	Riots (12) (11)	Conflicts (12) (12)	Battles (12) (13)	Protests (12) (14)	Riots (12) (15)	Conflicts (12) (16)
General In-migration																
In-migration	0.0328*	0.0422***	0.0573***	0.0431***					0.00327	0.00588	0.0197**	0.00908				
	(0.0189)	(0.00847)	(0.0107)	(0.00817)					(0.0116)	(0.00666)	(0.00924)	(0.00672)				
Specific In-migration																
Climate-Conflict In-migration					-0.142***	0.0530*	0.245**	0.00623					-0.171**	-0.0455	0.183*	-0.0842
					(0.0313)	(0.0293)	(0.0960)	(0.0254)					(0.0839)	(0.0525)	(0.0968)	(0.0518)
Economic In-migration					0.188	0.229**	0.288**	0.225**					0.0683	0.0648	0.0894**	0.0628
					(0.119)	(0.112)	(0.141)	(0.111)					(0.0485)	(0.0524)	(0.0439)	(0.0468)
Familiar-Marital In-migration					-0.0158	-0.0368	-0.0298	-0.0283					-0.0103	-0.00716	0.00855	0.00101
					(0.0296)	(0.0329)	(0.0402)	(0.0321)					(0.0262)	(0.0171)	(0.0153)	(0.0148)
Educational In-migration					0.0369	0.107	0.0372	0.0682					-0.200	-0.166	-0.271**	-0.211**
					(0.136)	(0.0762)	(0.0993)	(0.0783)					(0.154)	(0.117)	(0.110)	(0.0965)
Economic Development and Well-Being of the Districts																
Number of very rich HH per district									-0.00375	-0.000303	-0.000543	-0.000125	-0.00393	-0.00120	-0.00143	-0.000843
									(0.00726)	(0.00328)	(0.00427)	(0.00342)	(0.00777)	(0.00365)	(0.00442)	(0.00373)
Inequality ratio									-0.00265	0.00427	-0.000614	0.00374	-0.00370	0.00335	-0.00192	0.00285
									(0.00879)	(0.00550)	(0.00761)	(0.00554)	(0.00886)	(0.00549)	(0.00766)	(0.00555)
Number of HH with agricultural land									0.0214**	0.00550	0.0112**	0.00655	0.0195**	0.00421	0.00967**	0.00533
									(0.00837)	(0.00616)	(0.00562)	(0.00563)	(0.00843)	(0.00551)	(0.00481)	(0.00491)
Number of stunting women per district									0.00509	0.0151**	0.0135*	0.0120*	0.00808	0.0175**	0.0161**	0.0145**
									(0.00919)	(0.00759)	(0.00721)	(0.00691)	(0.00907)	(0.00734)	(0.00651)	(0.00657)
Conflicts																
Ongoing conflicts									0.00742***	0.00650***	0.00757***	0.00697***	0.00706***	0.00631***	0.00742***	0.00675***
									(0.00195)	(0.00132)	(0.00132)	(0.00136)	(0.00203)	(0.00133)	(0.00134)	(0.00136)
Constant	0.684**	3.290***	1.472***	3.603***	0.604*	3.225***	1.379***	3.533***	-0.495	2.108***	0.160	2.487***	-0.563*	2.074***	0.105	2.435***
	(0.317)	(0.219)	(0.249)	(0.213)	(0.320)	(0.178)	(0.208)	(0.173)	(0.311)	(0.153)	(0.212)	(0.150)	(0.313)	(0.153)	(0.201)	(0.148)
Region of Enumeration FE	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
Observations	221	221	221	221	221	221	221	221	221	221	221	221	221	221	221	221

Robust standard errors in parentheses
*** Significant at the 1 percent level
** Significant at the 5 percent level
* Significant at the 10 percent level

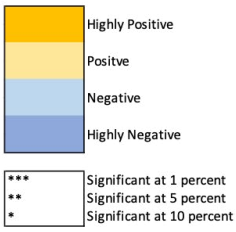
BASELINE NEGATIVE BINOMIAL REGRESSION ON IN-MIGRATION AND CLIMATE ANOMALIES

VARIABLES	Battles (12) (1)	Protests (12) (2)	Riots (12) (3)	Conflicts (12) (4)	Battles (12) (5)	Protests (12) (6)	Riots (12) (7)	Conflicts (12) (8)	Battles (12) (9)	Protests (12) (10)	Riots (12) (11)	Conflicts (12) (12)
Specific In-migration												
Climate-Conflict In-migration	-0.171**	-0.0454	0.188*	-0.0835	-0.175**	-0.0536	0.186*	-0.0909*	-0.173**	-0.0458	0.188*	-0.0845
	(0.0839)	(0.0526)	(0.103)	(0.0519)	(0.0854)	(0.0515)	(0.0996)	(0.0518)	(0.0861)	(0.0522)	(0.0996)	(0.0517)
Economic In-migration	0.0572	0.0627	0.0659	0.0584	0.0836	0.0758	0.0850*	0.0732	0.0763	0.0685	0.0804*	0.0651
	(0.0483)	(0.0521)	(0.0405)	(0.0464)	(0.0540)	(0.0537)	(0.0439)	(0.0483)	(0.0523)	(0.0531)	(0.0432)	(0.0473)
Familiar-Marital In-migration	-0.0158	-0.00843	0.00114	-0.00153	-0.00181	0.000645	0.00664	0.00760	-0.00662	-0.00572	0.00590	0.00196
	(0.0262)	(0.0177)	(0.0142)	(0.0154)	(0.0241)	(0.0170)	(0.0144)	(0.0148)	(0.0252)	(0.0171)	(0.0143)	(0.0149)
Educational In-migration	-0.193	-0.167	-0.272***	-0.210**	-0.203	-0.181	-0.269**	-0.226**	-0.202	-0.165	-0.271***	-0.212**
	(0.155)	(0.116)	(0.0946)	(0.0931)	(0.145)	(0.126)	(0.108)	(0.102)	(0.155)	(0.120)	(0.104)	(0.0975)
Economic Development and Well-Being of the Districts												
Number of very rich HH per district	-0.00302	-0.000961	0.000271	-0.000382	-0.00561	-0.00262	-0.00105	-0.00212	-0.00463	-0.00153	-0.000902	-0.00105
	(0.00679)	(0.00360)	(0.00403)	(0.00361)	(0.00755)	(0.00369)	(0.00429)	(0.00374)	(0.00738)	(0.00368)	(0.00425)	(0.00372)
Inequality ratio	-0.00319	0.00353	-0.000835	0.00323	-0.00484	0.00173	-0.00154	0.00139	-0.00428	0.00294	-0.00111	0.00258
	(0.00926)	(0.00554)	(0.00825)	(0.00570)	(0.00811)	(0.00487)	(0.00780)	(0.00495)	(0.00847)	(0.00528)	(0.00796)	(0.00539)
Number of HH with agricultural land	0.0188**	0.00436	0.0106**	0.00556	0.0194**	0.00269	0.0102**	0.00407	0.0196**	0.00382	0.0105**	0.00512
	(0.00788)	(0.00529)	(0.00462)	(0.00471)	(0.00851)	(0.00575)	(0.00502)	(0.00514)	(0.00839)	(0.00546)	(0.00495)	(0.00490)
Number of stunting women per district	0.00754	0.0172**	0.0145**	0.0140**	0.00901	0.0191**	0.0157**	0.0159**	0.00837	0.0177**	0.0158**	0.0147**
	(0.00899)	(0.00703)	(0.00593)	(0.00619)	(0.00892)	(0.00764)	(0.00642)	(0.00676)	(0.00900)	(0.00738)	(0.00633)	(0.00655)
Conflicts												
Ongoing conflicts	0.00696***	0.00627***	0.00729***	0.00668***	0.00740***	0.00641***	0.00738***	0.00686***	0.00711***	0.00633***	0.00745***	0.00676***
	(0.00184)	(0.00132)	(0.00116)	(0.00134)	(0.00200)	(0.00134)	(0.00133)	(0.00138)	(0.00205)	(0.00136)	(0.00129)	(0.00138)
Climate Anomalies												
Positive Rainfall Anomalies	0.202	0.0500	0.439**	0.0986								
	(0.280)	(0.138)	(0.189)	(0.129)								
Positive Temperature Anomalies					0.289	0.244**	-0.0913	0.217*				
					(0.251)	(0.116)	(0.203)	(0.114)				
Negative Rainfall Anomalies									0.139	0.0635	-0.164	0.0400
									(0.258)	(0.123)	(0.201)	(0.120)
Constant	-0.626*	2.055***	-0.0979	2.398***	-0.716**	1.971***	0.139	2.344***	-0.632*	2.052***	0.156	2.421***
	(0.335)	(0.148)	(0.230)	(0.144)	(0.327)	(0.164)	(0.207)	(0.156)	(0.330)	(0.166)	(0.203)	(0.157)
Region of Enumeration FE	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
Observations	221	221	221	221	221	221	221	221	221	221	221	221

Robust standard errors in parentheses
*** Significant at the 1 percent level
** Significant at the 5 percent level
* Significant at the 10 percent level

SUMMARY TABLE – MIGRATION AND CONFLICTS

	General Category	Variables	Battles (12) (1)	Protests (12) (2)	Riots (12) (3)	Conflicts (12) (4)
Variables of Interest	***General In-migration***	In-migration	ns	ns	**	ns
	Specific In-migration	Climate-Conflict In-migration	**	ns	*	*
		Economic In-migration	ns	ns	**	ns
		Familiar-Marital In-migration	ns	ns	ns	ns
		Educational In-migration	ns	ns	**	**
Controls	***Economic Development and Well-Being of the Districts***	Number of very rich HH per district	ns	ns	ns	ns
		Inequality ratio	ns	ns	ns	ns
		Number of HH with agricultural land	**	ns	**	ns
		Number of stunting women per district	ns	**	**	**
	Lagged Conflicts	Ongoing conflicts	***	***	***	***
	Climate Anomalies	Positive Rainfall Anomalies	ns	ns	**	ns
		Negative Rainfall Anomalies	ns	ns	ns	ns
		Positive Temperature Anomalies	ns	**	ns	*



Annex 3: Hotspots of vulnerability co-occurrence: detailed methodology

Methods for spatial analysis to generate maps

For both primary and additional vulnerability indicators, raster map layers were created to show a) the total number of indices classified as 'high' (i.e., hotspots) and b) the breakdown of which indicators showed geographical hotspots. Steps in the analysis are laid out below.

VARIABLE SELECTION BASED ON SPATIAL VARIABILITY

Nine primary vulnerability variables were tested for sufficient spatial variation across the livelihood zones. However, only variables with sufficient spatial variation (CV>=10%) were included in the analysis. Additional vulnerability variables were selected based on available data for indicators of interest identified by the WFP Country Office. They were then tested for sufficient spatial variation and either included or excluded from the analysis in the same way as the primary vulnerability variables. An exception was made for food security data, which was always included regardless of spatial variation; this was due to the limited number of food security datasets available and the necessity to represent food security in some respect to accurately capture overall vulnerability. All primary and additional variables considered for Pakistan, including whether they were included or excluded from the analysis, are shown in Table 3.

BINARIZATION OF VARIABLES

For the included continuous data variables, a binary score of 1 was allocated if any one metric exceeded the 80th percentile of values within the livelihood zones (indicating a negative outcome); the map shows the sum of these binary layers. Any dataset inputs which were already binary (only applicable for additional variables) were always included where data was present and relevant to WFPs programs. Exceptions were made in limited circumstances; i.e., all Hunger Map food consumption scores (a continuous dataset) for Pakistan were extremely high (minimum 49.65) and therefore all values were categorized as 'high' (i.e., 1), as opposed to only those above the 80th percentile.

AGGREGATION INTO MAP FIGURES

The hotspots maps seen in Figures 21-24 created using sets of these binary raster layers. Figure 21 shows the number of included primary variables allocated 'high' vulnerability in any given cell. Figure 23 shows the same for the included additional variables. Figure 22 is based on the sum of three further binary layers, each of which was calculated as the maximum value of all included binary layers in a given grouping of primary variables (food security & nutrition; inequality; and health). Figure 24 shows the combination of additional variables directly, without the use of any further intermediate layers. If part of a map displays 'no areas of high vulnerability', this means that none of the indicators we included were binarized as 1 (high vulnerability) due to the values in the given cell/s being below a predetermined threshold for 'high' vulnerability. As previously mentioned, this threshold is the 80th percentile of the values for a particular indicator for all cells within the livelihood zones, with the higher percentiles corresponding to greater vulnerability. All of the variables which have been included in the spatial analysis are presented as 'included' in table 1.

AVERAGE VALUES FOR ALL VARIABLES FOR EACH LIVELIHOOD ZONE, VARIABLE INCLUSION/EXCLUSION FROM FIGURES 21-24 WITH REASONS, AND DATA SOURCES

Variable grouping	Variable	Dry western plateau in SW Balochistan	Northern dry mountains in KP province	Sandy deserts in SE Sindh	Southern irrigated plains in SE Sindh	Western dry mountains in NW Balochistan	Included / excluded from maps for Pakistan	Data source
Primary variables								
Food insecurity & nutrition	FEWSNET food insecurity (current situation, 1=minimal to 5=famine), 2020	NA	NA	NA	NA	NA	No data for country	FewsNet: Famine Early Warning Systems Network [1]
	WFP Hunger Map food consumption score (mean), Sep'19-Jun'21	58.5	49.6	57.3	57.3	49.6	Included	
	Wasting prevalence in under 5s (%), 2000-2019	WFP Hunger Map [155]	11.2	17.6	17.5	14.1	Included	Institute for Health Metrics and Evaluation Viz Hub: Local burden of disease [156]
	Stunting prevalence in under 5s (%), 2000-2019	50.3	46.3	48.4	48.1	47.7	Excluded (Insufficient variation)	Institute for Health Metrics and Evaluation Viz Hub: Local burden of disease [156]
	Underweight prevalence under 5s (%), 2000-2019	38.9	27.8	44.8	44.7	34.3	Included	Institute for Health Metrics and Evaluation Viz Hub: Local burden of disease [156]
Gender and educational inequality	Education, female (mean years in 15-49 year olds), 2000-2017	2.03	2.27	2.02	2.04	2.19	Included	Institute for Health Metrics and Evaluation Viz Hub: Local burden of disease [156]
	Education, male (mean years in 15-49 year olds), 2000-2017	5.02	4.74	5.01	4.83	5.10	Excluded (Insufficient variation)	Institute for Health Metrics and Evaluation Viz Hub: Local burden of disease [156]
	Education gender gap (mean years in 15-49 year olds), 2000-2017	3.00	2.47	2.99	2.79	2.91	Included	Calculated from Institute for Health Metrics and Evaluation Viz Hub: Local burden of disease [156]

Variable grouping	Variable	Dry western plateau in SW Balochistan	Northern dry mountains in KP province	Sandy deserts in SE Sindh	Southern irrigated plains in SE Sindh	Western dry mountains in NW Balochistan	Included / excluded from maps for Pakistan	Data source
Health	Diarrhea prevalence (%), 2000-2017	34.6	32.9	32.0	30.8	30.4	Included	Institute for Health Metrics and Evaluation Viz Hub: Local burden of disease [156]
	Falciparum incidence (incidence rate), 2019	0.07219	1.09579	0.03318	0.00437	0.21115	Included	Malaria Atlas Project [157]
	Vivax incidence (incidence rate), 2019	1.670	1.266	1.544	0.904	1.745	Included	Malaria Atlas Project [157]
	Under 5 mortality (per 1000 live births), 2000-2017	1.36	12.44	5.41	16.22	3.37	Included	Malaria Atlas Project [157]
Additional variables								
N/A	Net out-migration (number of people), 2010	20,250	51,393	15,036	-117,684	-78,698	Included	WorldPop: Migration Flows [158]
	Mean soil pH at 30cm depth (pH * 10), 2019		69.1	78.6	78.5	76.7	Excluded (Insufficient variation)	Soil Grids [159]
	Mean soil organic carbon at 30cm depth (dg/kg), 2019		414.0	63.9	66.2	105.5	Included	Soil Grids [159]
	Total area of irrigated land (ha), 2005		3,425,330	15,026,554	12,684,579	1,558,106	Excluded) (not specific to country)	FAO AQUASTAT [160]
	Conflict events (number of events), 2018-2021 n.b. Table shows fatal and non-fatal events; map shows fatal events only		1,062	423	1,302	529	Included	ACLED Dashboard [161]
	Active fires (count), 2019		32	32	165	29	Excluded) (not specific to country)	NASA Earthdata: Fire Information for Resource Management System (FIRMS) [162]
	Ethnic group diversity (number of dominant groups coexisting), 2010		8	3	2	3	Excluded) (not specific to country)	Georeferencing of ethnic groups (GREG) database [163]
	Ethnic group type (dominant group category), 2010		402.8	101.4	52.9	129.7	Excluded) (not specific to country)	Malaria Atlas Project [164]

Variable grouping	Variable	Dry western plateau in SW Balochistan	Northern dry mountains in KP province	Sandy deserts in SE Sindh	Southern irrigated plains in SE Sindh	Western dry mountains in NW Balochistan	Included / excluded from maps for Pakistan	Data source
N/A	Time to nearest city (minutes), 2015		402.8	101.4	52.9	129.7	Excluded) (not specific to country)	Malaria Atlas Project [164]
	Human appropriation of net primary productivity (% reduction), 2000		51.0	19.9	-68.8	38.8	Excluded) (not specific to country)	Plutzar et al., 2016 [165]
	Access to improved water source (% of population), 2000-2017		90.7	93.4	93.7	91.0	Excluded (Insufficient variation)	Institute for Health Metrics and Evaluation Global Health Data Exchange: Low- and Middle-Income Country Drinking Water and Sanitation Facilities Access Geospatial Estimates 2000-2017 [166]

Photo credits

COVER FRD

PAGE 6 Rice packaging site. ©CIAT, Neil Palmer.

PAGE 18 WFP/Mahira Afzal

PAGE 23 WFP/Saniya Bashir

PAGE 44 WFP/Mahira Afzal

PAGE 49 WFP/Saniya Bashir

PAGE 53 Rice growing. ©CIAT, Neil Palmer.

PAGE 54 Road in dry canyon, Karakorum mountains, Hunza Valley. ©www.freepik.com

PAGE 67 Pakistani Rupees, Pakistani currency notes. ©www.freepik.com

PAGE 87 Sunset, Karakorum mountains. ©www.freepik.com

PAGE 90 WFP/Saniya Bashir

PAGE 101 A beautiful Pakistani local decorated truck running on dangerous mountain road in the Karakoram highway, Pakistan. View from windshield. ©www.freepik.com