



Climate Risks and Food Security Analysis: A Special Report for Pakistan

Islamabad, December 2018



Climate Risks and Food Security Analysis: A Special Report for Pakistan

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The report was written and edited by SDPI and WFP Pakistan, with the collaboration of national, Regional Bureau and HQ colleagues, under the overall lead of Cristiano F. Mandra, including Sarah Hamidi, Qasim Shah, Iftikhar Abbas, Sarah Bashir, Thi Van Hoang, Imran Saqib Khalid, Krishna Pahari, Aman ur Rehman Khan, Krishna Krishnamurthy and Kurt Burja. The team gratefully acknowledges the contributions of our climate risk management interns, who provided coordination and administrative assistance.

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Above all, we sincerely thank all of the stakeholders who participated in the provincial and national consultation workshops which informed our analysis. Their inputs enhanced the report's preliminary results, validated findings and identified strategies for reducing risks in the medium- and long-term. Without their contributions, this report would have not been possible.

PREFACE BY THE FEDERAL MINISTER

The impacts of climate change are being felt across South Asia and Pakistan is no exception. In fact, it is regularly cited as one of the top ten countries affected by extreme climatic events. Recurrent floods and droughts across Pakistan in recent years are a testament to this. Research shows that such extreme events will become the norm in coming decades. As such, we need to have a strategy in place to manage these concerns. Furthermore, climate change will transform the way we manage our water, farm our agricultural lands and develop our urban areas.

The Government of Pakistan has highlighted the importance of dealing effectively with climate change in *Vision 2025* and our National Climate Change Policy. We recognize that climate change is a priority area that requires effective action by the Government. Moreover, we have adopted the Sustainable Development Goals as part of our national development agenda, within which climate action is an integral part.

It is in this context that the *Climate Risks and Food Security Analysis: A Special Report for Pakistan* highlights key interventions to attain food security in Pakistan, especially as we come to terms with a changing climate. The report provides a set of key policy recommendations to build adaptive capacity and reduce climate-related food insecurity among the most vulnerable communities.

I appreciate the collaborative initiative by the World Food Programme, the Sustainable Development Policy Institute and the Ministry of Climate Change, and hope that we can continue to work together to address the challenges posed by climate change.



Mushahid Ullah Khan
Federal Minister
Ministry of Climate Change
Government of Pakistan

STATEMENT BY THE PARLIAMENTARY SECRETARY

Attaining food and nutrition security is an integral facet of the Government of Pakistan's policies and plans. This report highlights the challenges posed by global climate change to the availability, access, utilization and stability of food systems in Pakistan. Research shows that climate change will result in rising temperatures and rainfall variability, particularly during the monsoon season. We have already begun to witness the impacts of climate change in the shape of regular floods, droughts and heat waves across the country. We have seen our northern areas impacted by glacial lake outburst floods (GLOFs). Such changes require a coherent, integrated response that brings together a varied set of stakeholders from the Government, civil society, academia and focal points from the international development sector.

It is in this context that this study highlights policy measures for achieving food security, especially as they relate to sustainable livelihoods. These measures will go a long way towards increasing food availability, enhancing food access, enabling food utilization and ensuring food stability at all levels.

The Ministry of Climate Change is already working with key stakeholders to ensure that the recommendations of this report are implemented. I would like to congratulate the teams from the World Food Programme, the Sustainable Development Policy Institute and the Ministry of Climate Change for working together on this important report.



Romina Khurshid Alam
Parliamentary Secretary
Ministry of Climate Change
Government of Pakistan

FOREWORD

Climate change is increasing the frequency and intensity of natural hazards worldwide. From floods to droughts, climate-related disasters threaten land, livestock, crops and food supplies. They deplete water tables, make it harder for people to access markets, and undermine attempts to increase agricultural productivity. Changing climate patterns disproportionately affect people living in fragile environments, with limited coping mechanisms, who are already at risk of hunger. When climate-related disasters strike, they can quickly spiral into full-blown food and nutrition crises. Without proper risk mitigation, disasters will continue to exacerbate food insecurity and malnutrition, fuelling competition for scarce resources, driving migration and heralding untold humanitarian catastrophes.

Climate change has been making itself felt in Pakistan over the past 30 years, reflected in a steady rise in temperatures and the variability of rainfall. As in other parts of Asia, weather patterns are increasingly erratic. Less rain falls along Pakistan's coasts and arid plains, prompting extended periods of drought. Year on year, the monsoon season is delayed in eastern Pakistan, with severe implications for agriculture. In 2010, record monsoon rains unleashed the worst wave of flooding to hit the country in living memory, affecting 20 million people and causing major structural and economic damage. The unprecedented frequency and scale of climate-related disasters is jeopardizing food and nutrition security.

It is clear that we need strong adaptation and mitigation efforts to prevent the worst impacts of climate change on hunger. The *Climate Risks and Food Security Analysis: A Special Report for Pakistan* is a strong step in this direction. The report aims to make people in Pakistan less vulnerable to food insecurity by shedding light on *who* the most vulnerable populations in the country are, and *what* interventions can help them manage and mitigate the climate-related risks they face. It discusses agro-ecological zones and explores the impact of climate change on livelihoods, especially in areas prone to climate risks. It also offers a preliminary vulnerability baseline to inform policies and programmes.

I hope that this report will encourage future studies on sustainable solutions to enhance the nexus between key green sectors, such as disaster risk reduction, agriculture, energy, food and nutrition security, water, the environment and forestry.

I commend the Federal Ministry of Climate Change for their leadership, and applaud the teams at the Sustainable Development Policy Institute and WFP's Programme and Policy Unit for their work on this landmark report. WFP and the Ministry of Climate Change will continue to work together to strengthen Pakistan's resilience to climate-related risks.



Finbarr Curran
Representative and Country Director
World Food Programme Pakistan

EXECUTIVE SUMMARY

Pakistan is one of the most vulnerable countries in the world to the impacts of climate change. The risks it faces are compounded by high rates of food and nutrition insecurity. As the climate continues to change, weather patterns grow more erratic and intense climate-related disasters more frequent, rates of food insecurity will rise even higher. Climate change is expected to have a significant impact on all facets of food security in Pakistan – i.e. availability, access, utilization and stability. It will take a severe toll on the vital agriculture sector, on which the livelihoods of half the population depend. Food security is a priority for the Government of Pakistan, as reflected in key policy documents such as the national development plan, *Vision 2025*. This means that addressing climate risks to food security must also be a priority.

The Ministry of Climate Change of Pakistan, the Sustainable Development Policy Institute (SDPI) and the World Food Programme (WFP) developed this report to analyse the impacts of climate variability on food security in Pakistan. *Climate Risks and Food Security Analysis (CRFSA): A Special Report for Pakistan* also identifies vulnerabilities in the country's ten agro-ecological zones, and provides recommendations for practitioners and policymakers. Its objectives are to:

- highlight the relationship between food security and climate variability in Pakistan, particularly related to changes in temperature and precipitation;
- understand the impact of climate change on agro-ecological zones in the country; and
- identify a set of policies to build adaptive capacity and reduce climate-related food insecurity in Pakistan's most vulnerable communities.

The report uses spatial analysis to identify food insecurity 'hot spots', employing long-term climate variables and food security indicators from global and national data sets. Comprehensive analysis of available literature enables the report to capture the impacts of climate change on food security by studying its effects on agricultural production. The analysis also makes use of local knowledge, gained through participatory consultations with provincial stakeholders, to inform climate vulnerability mapping across Pakistan's agro-ecological zones.

Key findings

Changing agro-ecological zones: Using agro-ecological zones and livelihoods within these zones as units of analysis offers a more logical way of undertaking climate risk analysis in Pakistan. There is an evident shift in climate trends within the country's agro-ecological zones, alongside shifting patterns of livelihoods in these areas. As such, there is a need to review and refine the classification of agro-ecological zones, taking into consideration the most up-to-date data available.

Climate trends and weather patterns: Since the 1960s, mean temperatures in Pakistan have risen by 0.35°C, at a steady average rate of 0.07°C per decade. The variability of rainfall has increased geographically, across seasons and annually over the past decades. Northern parts of the country are increasingly prone to torrential rainfall patterns, while rainfall is decreasing in coastal areas and arid plains. There is a marked increase in the variability of monsoon rains and a temporal shift in the monsoon season.

Climate impacts on food security: Shifting precipitation patterns drastically affect crops that depend on rainfall. Rising temperatures also have an impact on food production and associated variables, such as soil moisture and water availability. Higher temperatures and reduced water availability wreak havoc on livestock, while climate-related disasters disrupt market access and food supplies. As climate change causes agricultural production to decline, the incomes of agricultural households fall, while food prices rise. When staple foods become prohibitively expensive for the most impoverished, people turn to negative coping strategies – across Pakistan, economic constraints cause households to eat less, to eat less often and to opt for cheaper, less nutritious foods. This has serious consequences in terms of food insecurity, malnutrition and entrenched poverty.

Climate impact on livelihoods: Livelihoods in rural Pakistan are largely determined by local factors such as the climate, arable land and access to markets. Poor rural households which depend on small-scale, rainfed agriculture – often with low levels of livelihood diversification – are the most vulnerable to climate risks. Livelihoods are particularly at risk in arid and semi-arid areas, such as Sindh and southern Punjab, which are prone to both droughts and flash floods. They are also highly vulnerable in the country's mountainous northern regions, given their exposure to flood risks – in Khyber Pakhtunkhwa (KP), Gilgit-

Baltistan (GB), and Azad Jammu and Kashmir (AJK).

Hot spots of climate vulnerability: The report identifies areas in Pakistan's agro-ecological zones that are especially vulnerable to climate risks. To pinpoint these areas, the team employed an analytical framework recommended by the IPCC and rigorously analysed expert inputs gathered through provincial consultations. Climate vulnerability hot spots in Pakistan include arid or semi-arid areas in Sindh, Balochistan and Punjab; flood-prone areas in Sindh, Balochistan and Punjab; mountainous areas in KP, AJK, GB and parts of the Federally Administered Tribal Areas (FATA) where insecurity has affected the population's coping capacity.

Way forward: The frequency of extreme climatic events is increasing in Pakistan. Hazards, such as droughts and floods, can take a catastrophic toll on climate-sensitive livelihoods. Pakistan urgently needs climate risk management (CRM) measures to decrease and mitigate the impacts of climate risks on food security. These run the gamut from disaster risk reduction (DRR) measures to climate change adaptation (CCA), preparedness, mitigation and resilience building. Key examples include climate smart agriculture, livelihood diversification, initiatives to manage natural resources and the creation of climate resilient assets.

1. INTRODUCTION

Climate change poses critical development, economic and investment challenges, with its potential to wreak havoc on lives, ecosystems and local, national and global economies.¹ It is well-documented that climate change and related shocks adversely affect food security. Developing countries and, above all, poor people tend to be most at risk as they lack the resources and capacities to adapt, mitigate and cope.²

Pakistan is no exception; studies suggest that it is one of the countries most affected by the impacts of climate change.³ Changing climatic conditions are taking a toll on the country's ecological diversity. Pakistan's varied landscape ranges from high mountains to arid deserts, from forests to plateaus, from floodplains to river deltas – all home to a range of ecosystems on which local livelihoods depend. Figure 1 presents a general reference map of Pakistan, showing its administrative boundaries, topographic variations and population density, based on LandScan data.

Recurrent disasters, such as cataclysmal floods in 2010 and 2011 and prolonged drought in Sindh and Balochistan, compound hardships for the most vulnerable. Climate variability – marked by rising temperatures, changing precipitation patterns and constraints on water availability – also presents challenges for livelihoods and the overall economy, particularly in the vital agriculture sector. Overall, 42.3 percent of Pakistan's workforce, and 67 percent of the labour force in rural areas, is directly or indirectly associated with agriculture. Frequent climatic shocks have hit the agriculture sector hard, increasing food insecurity among affected communities.⁴ Their plight is all the more challenging given limited local capacity and resource constraints.

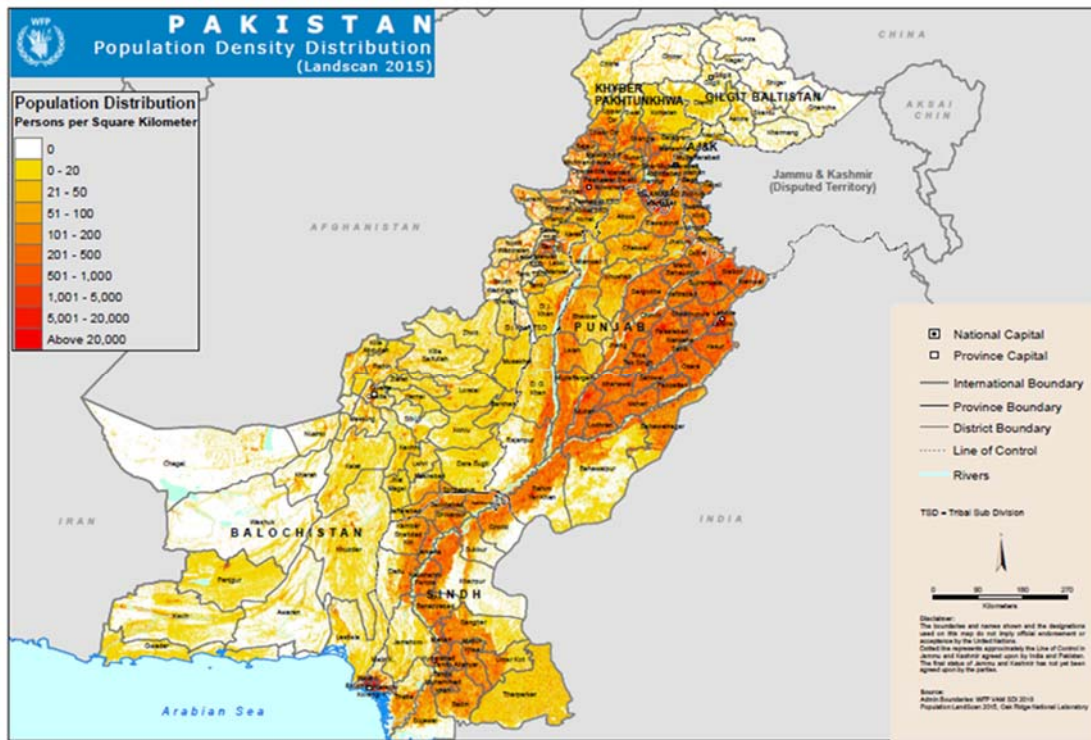
¹ Madzwamuze, M. 2010. *Climate Governance in Africa: Adaptation Strategies and Institutions*. Cape Town, Unity Press & Heinrich Boll Stiftung. Available at: https://www.boell.de/sites/default/files/assets/boell.de/images/download_de/Climate_Governance_in_Africa.pdf

² OECD. 2009. *Integrating Climate Change into Development Co-operation: Policy Guidance*. Paris, Organisation for Economic Co-operation and Development. Available at: https://www.oecd-ilibrary.org/development/integrating-climate-change-adaptation-into-development-co-operation-policy-guidance_9789264054950-en

³ Eckstein, D., Künzel, V. & Schäfer, L. 2017. *Global Climate Risk Index 2018*. Bonn, Germanwatch. Available at: <https://germanwatch.org/en/download/20432.pdf>

⁴ Ministry of National Food Security and Research, WFP, FAO & UNICEF. 2016. *The State of Food Security in Pakistan 2016*. [The report has been technically cleared by experts; however, it awaits official endorsement from the Ministry of National Food Security and Research].

Figure 1: Map of Pakistan's districts and population density



Source: WFP, 2017a. *Vulnerability Analysis and Mapping Unit, WFP Country Office Pakistan.*

This makes food security a serious concern for Pakistan. The Government accords the issue high priority, as reflected in key policy documents. These include Pakistan's national development plan, *Vision 2025*, which aims to reduce the proportion of the country's food insecure population from 60 to 30 percent by 2025.⁵

Against this backdrop, the *Climate Risks and Food Security Analysis: A Special Report for Pakistan* analyses the impacts of climate variability on livelihoods and food security in the country. Jointly developed by the Ministry of Climate Change, the Sustainable Development Policy Institute (SDPI) and the World Food Programme (WFP), the report identifies vulnerable groups and areas, highlights challenges to achieving food security in light of climate variables, and offers evidence-based policy recommendations.

The analysis relies on secondary data on climate variables and food security,

⁵ Government of Pakistan. 2014a. *Pakistan 2025: One Nation, One Vision*. Islamabad, Planning Commission, Ministry of Planning, Development & Reform. Available at: <https://www.pc.gov.pk/vision/visiondoc>

coupled with primary data from stakeholder consultations on climate vulnerabilities in Pakistan's agro-ecological zones.⁶

The report's findings are expected to serve as a preliminary vulnerability baseline which will be useful for policymakers, researchers, development practitioners and academics. The report provides a basis for further research on how to overcome food security challenges driven by climate change. At the policy level, its findings can support efforts to devise a climate-responsive strategy for Pakistan. These can also help development actors to design programmes that build the adaptive capacity of the most vulnerable people in Pakistan.

1.1 Objectives

The objectives of this report are to:

- analyse the interface between food security and climate change in Pakistan;
- present a vulnerability profile of the country by analysing climate impacts on livelihoods and food security, alongside the adaptation capacity of populations in different areas based on stakeholder consultations; and
- provide policy recommendations to enhance adaptive capacity and reduce climate-related food insecurity among the most vulnerable communities.

⁶ Agro-ecological zones are geographical areas with similar climatic conditions that determine their ability to support rainfed agriculture. For more information, see Annex IV.



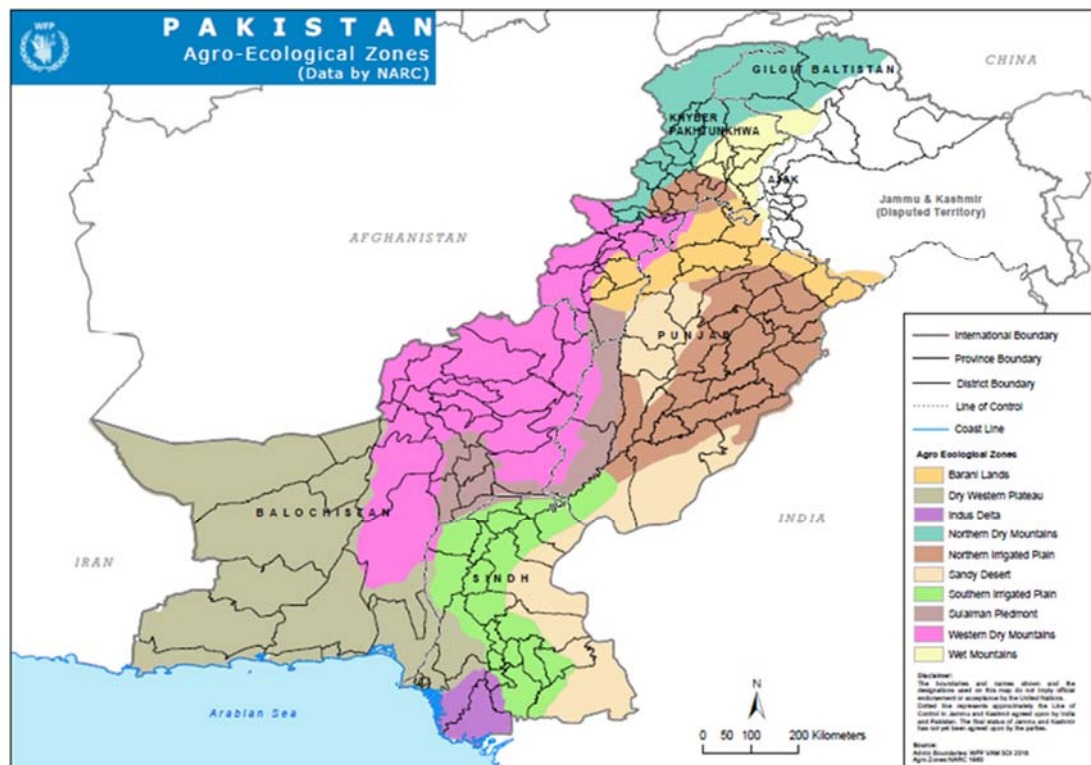
CHAPTER 2 METHODOLOGY

2. METHODOLOGY

The report draws on secondary data from existing datasets, paired with primary data from stakeholder consultations. To identify food insecurity 'hot spots', the team employed spatial analysis, using long-term climate variables and food security indicators from global and national datasets. The impacts of climate change on agricultural production – and by extension on food security – were determined by analysing literature on Pakistan, particularly on the application of production functions, in addition to other models and regression techniques.⁷

The report also relies heavily on stakeholder consultations to map vulnerabilities in agro-ecological zones. In this way, it makes use of local knowledge on climate vulnerabilities. Figure 2 presents a map of Pakistan's ten agro-ecological zones. The following sections outline the techniques used for the spatial analysis.

Figure 2: Agro-ecological zones in Pakistan



Source: WFP, 2017a.

⁷ Javed, S.A., Ahmad, M.A. & Iqbal, M. 2014. Impact of Climate Change on Agriculture in Pakistan: A District Level Analysis. *PIDE Climate Change Working Paper Series*, 3. Islamabad, Pakistan Institute of Development Economics. Available at: http://pide.org.pk/pdf/Climate_Change_3.pdf; Ahmad, M., Siftain, H. & Iqbal, M. 2014. *Impact of Climate Change on Wheat Productivity in Pakistan: A District Level Analysis*. Munich Personal RePEc Archive (MPRA) Paper. Available at: <https://mpra.ub.uni-muenchen.de/72859>

2.1 Spatial analysis

2.1.1 Climate trends

The report uses a range of data sources to identify where weather patterns have changed in Pakistan over the past 30 years, and how intense these changes have been. These sources include:

- point data collected by the Pakistan Meteorological Department (PMD);
- open source global datasets, such as data from the European Spatial Agency;
- WFP's existing dataset (including LandScan) of administrative boundaries, population density, topography and river flows; and
- satellite remote sensing analyses.

To create a seamless spatial map of climate variables, the team applied surface interpolation to the PMD point dataset. The data was interpolated over Pakistan's entire area using the inverse distance weighting (IDW) method. The findings were verified by comparing them with various global datasets.

A map of rainfall seasonality was also prepared for the 1982–2014 period. Seasonality is a parameter which describes how uniformly distributed rainfall is during a calendar year. The more concentrated rainfall is over time, the higher the seasonality. Seasonality is calculated for a particular year by comparing actual monthly rainfall, 'Xin', with monthly uniform rainfall – i.e. annual rainfall, 'Ri', divided by 12. The difference between the two is divided by annual rainfall. The formula for seasonality⁸ is:

$$Sli = \frac{1}{Ri} \sum_{n=1}^{n=12} \left| \left(Xin - \frac{Ri}{12} \right) \right|$$

Here, 'Ri' denotes the total annual precipitation for a particular year and 'Xin' represents the actual monthly precipitation for month 'n'. The various climate categories based on rainfall seasonality can be assessed by using the following values of the SI index. First, the seasonality indicator is determined for each year on record. Based on this, a multi-year average is calculated. Although higher seasonality tends to be predominant in drier regions, the relationship is complex, and variations in seasonal rainfall may lead to variable changes in

⁸ Walsh, R.P.D. & Lawler, D.M., 1981. Rainfall seasonality: description, spatial patterns and change through time. *Weather*, 36(7): 201–208.

seasonality. Decadal (10 day) data was used for this kind of mapping.

2.1.2 Vulnerability maps

The spatial analysis used to establish vulnerability employed a participatory mapping approach. The team used available local expertise in each province, before verifying findings by comparing them with existing datasets and literature. This approach is generally used in rapid appraisals and requires participatory consultations across provinces. To be credible, these consultations must involve diverse stakeholders from a range of sectors – from health to social services, disaster risk management and academia.

These provincial consultations offered rich insights on vulnerabilities at the local level. The advantage of using stakeholders' inputs for vulnerability mapping lies in these local insights, which provide exceptional detail on climate variability, livelihoods and seasonal calendars. Based on data from these consultations, a matrix was developed to determine the 'vulnerability score' of specific 'livelihood groups' in each agro-ecological zone. These livelihood groupings are not exhaustive and are based on stakeholders' local knowledge.

2.2 Vulnerability classifications by agro-ecological zones and livelihoods

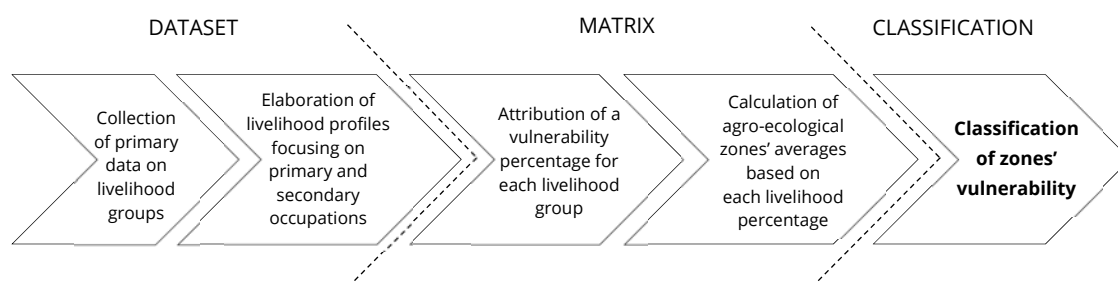
Vulnerability may be defined as the degree to which a system is susceptible to, or unable to cope with, the effects of climate change, including climate variability and extreme conditions. The report's vulnerability analysis is based on the Intergovernmental Panel on Climate Change's (IPCC) methodology. Here, vulnerability is a function of a livelihood's exposure to climate change, sensitivity and adaptive capacity.

Creating a matrix of 'vulnerability scores' for different livelihood groups in Pakistan's agro-ecological zone involved identifying the primary and secondary occupations of major livelihood groups. The team assessed these occupations against a set of vulnerability indicators and sub-indicators, using a binary system (0 = no, 1 = yes). Based on this assessment, a 'vulnerability percentage' was attributed to each livelihood group, enabling the calculation of 'vulnerability scores'. To pinpoint 'vulnerability zones', the results were classified from low (0-25 percent) to very high vulnerability (75-100 percent). Details on the vulnerability analysis matrix are provided in Annex 1.

To develop a methodology specifically focused on food security in the context of climate risks in Pakistan, the team selected indicators from existing literature and restricted the transversal scope of the vulnerability matrix. In recent years, several indicators have been formulated to assess social, institutional and infrastructure-related climate vulnerabilities. However, only economic factors were considered relevant for this study as they dictate people’s capacity to access food directly.

As a result, the analysis included indicators on exposure and sensitivity to climate variability, such as weather variability, extreme weather events and changes in weather patterns/intensity. It also employed economic indicators to determine the adaptive capacity of livelihood groups and agro-ecological zones in terms of coping with climate risks – such as dependency on rainfed agriculture, non-agricultural income, the diversification of occupations and crops, asset ownership and migration opportunities. Figure 3 illustrates the steps involved in developing the vulnerability matrix.

Figure 3: Steps for developing the vulnerability matrix



2.3 Scope and limitations of the study

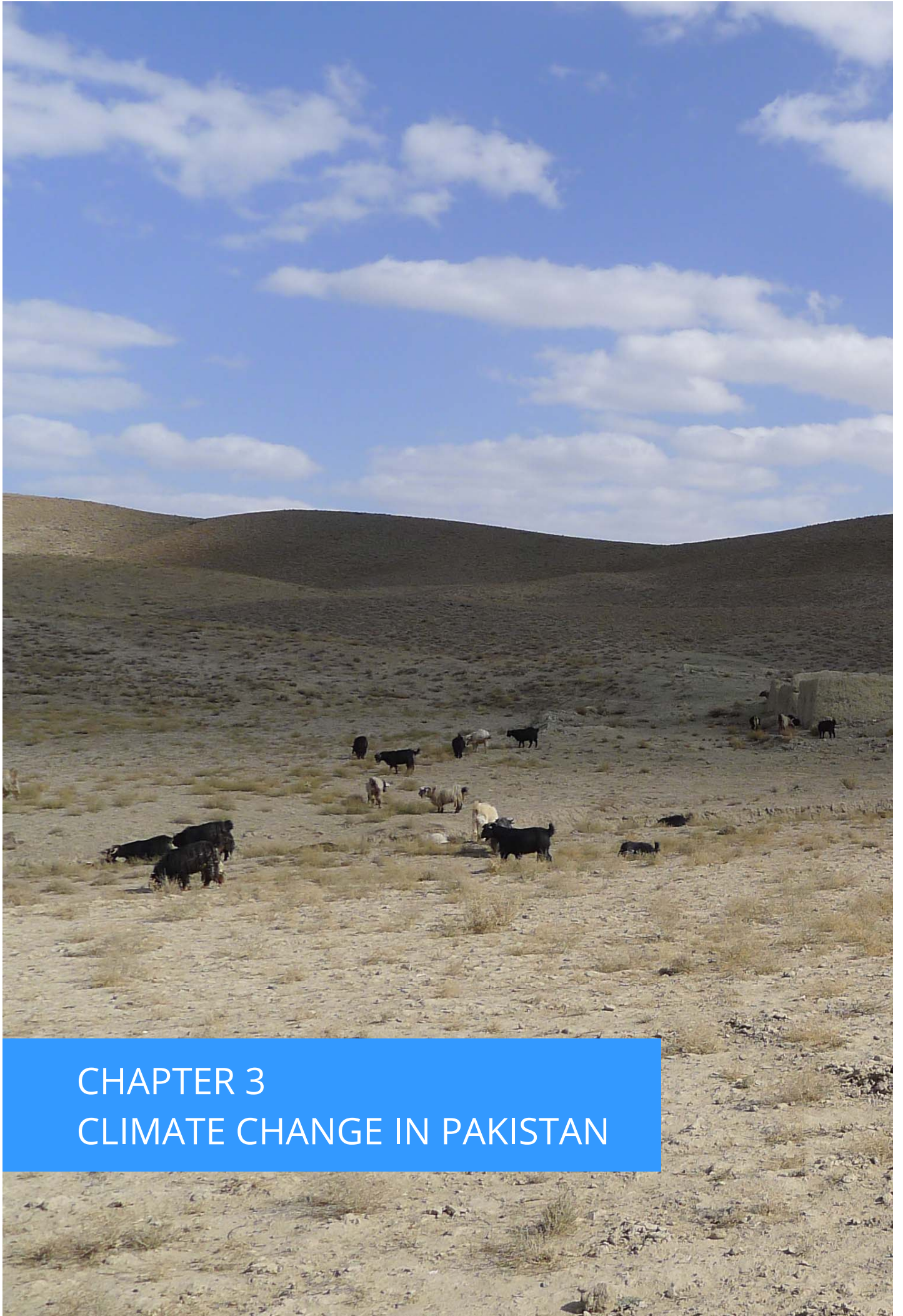
This report provides an overview of climate variability and its possible impacts on food security in Pakistan in the context of increasing climate risks, with a view to informing effective programming. It gauges climate trends by using long-term temperature and precipitation data. It analyses how climate change affects the four pillars of food security – availability, access, utilization and stability. It takes markets and livelihoods into account, while looking at how these change over time to adjust to a changing climate, particularly in rural areas. By analysing

these factors, the report offers an evidence-based climate vulnerability profile for Pakistan's agro-ecological zones.⁹

The report's vulnerability analysis is based on participants' inputs during stakeholder consultations. As such, the possibility of participant bias cannot be ruled out. Moreover, the study does not encompass an exhaustive list of livelihood activities within each agro-ecological zone.

To overcome these shortcomings and make the results more reliable, relevant secondary data was analysed. The findings of stakeholder consultations were compared to these sources to verify their accuracy. The report's findings are expected to encourage further in-depth research on ways to improve programming and help the most vulnerable communities in Pakistan to adapt to, and cope with, climate change.

⁹ The agro-ecological zones developed by the Pakistan Agriculture Research Council (PARC) in the 1980s are used as a point of reference in this report. The consultations held as part of this analysis revealed the need to update these zones, in order to respond effectively to the situation on the ground.



CHAPTER 3
CLIMATE CHANGE IN PAKISTAN

3. CLIMATE CHANGE IN PAKISTAN

As climate change gains pace around the globe, countries need strong adaptive capacities to deal with the threat.¹⁰ Pakistan is no exception. As discussed above, it is one of top ten countries most at risk from the negative impacts of climate change.¹¹ Its high rank on the *Global Climate Risk Index* is due to the immense loss of life and economic devastation suffered in the wake of floods, drought and heat waves between 1996 and 2015.

Located in the northern hemisphere, Pakistan's latitude range extends from 24°N to 37°N and its longitude from 61°E to 76°E. The country is classified into 11 geographical, ten agro-ecological and nine major ecological zones.¹² Given its size and diverse topography, the climate varies greatly across the country. While 75 percent of Pakistan's land area consists of arid zones, a comparatively small part has a humid climate.¹³ Its agricultural plains are situated at varying altitudes, from a few metres above mean sea level in the south, to over 3,000m above mean sea level in the north. Its lowland plains stretch along the Indus River, while high mountain ranges in the north and west – the Hindu Kush, Himalaya and Karakoram ranges – enhance precipitation activity on the windward side. Depending on the season, the leeward side is left barren. Topographic diversity influences temperatures, with cooler temperatures at higher altitudes and warmer temperatures in the lowlands. Rainfall follows the summer monsoon's trajectory from east to west, from India through the eastern belt of Pakistan; in winter, a western depression enters northwest Pakistan from Afghanistan.¹⁴

By global standards, little scientific research has been conducted on climate change modelling in Pakistan. Despite the issue's importance, there has been no comprehensive assessment of climate change projections at the sub-national level. A handful of studies have been undertaken about the region using different regional and global climate models.¹⁵ However, these rely on a single

¹⁰ OECD, 2009; Madzwamuze, 2010; Hulme, P.E. 2005. Adapting to climate change: is there scope for ecological management in the face of a global threat? *Journal of Applied Ecology*, 42(5): 784–794.

¹¹ Eckstein et al., 2017.

¹² Khan, M.A.A., Ramay, S.A., Munawar, Z. & Ahmed, V. 2011. *National Economic and Environmental Development Study (NEEDS): Pakistan*. Islamabad, Ministry of Environment & UNFCCC. Available at: <https://unfccc.int/files/adaptation/application/pdf/pakistanneeds.pdf>

¹³ Chaudhry, Q. & Rasul, G. 2004. Agro-climatic classification of Pakistan. *Science Vision*, 9(4): 59–66.

¹⁴ McSweeney, C., New, M. & Lizcano, G. 2010. *UNDP Climate Change Country Profiles: Pakistan*. Available at: <http://country-profiles.geog.ox.ac.uk>

¹⁵ Ibid; Haensler, A., Saeed, F. & Jacob, D. 2013. Assessing the robustness of projected precipitation changes over central Africa on the basis of a multitude of global and regional climate projections. *Climatic Change*, 121(2): 349–363. DOI: 10.1007/s10584-013-0863-8.

model approach that fails to capture the uncertainties inherent in the modelling system. Globally, the use of multi-model ensembles is preferred over the single model approach to generate more accurate future climate change projections.

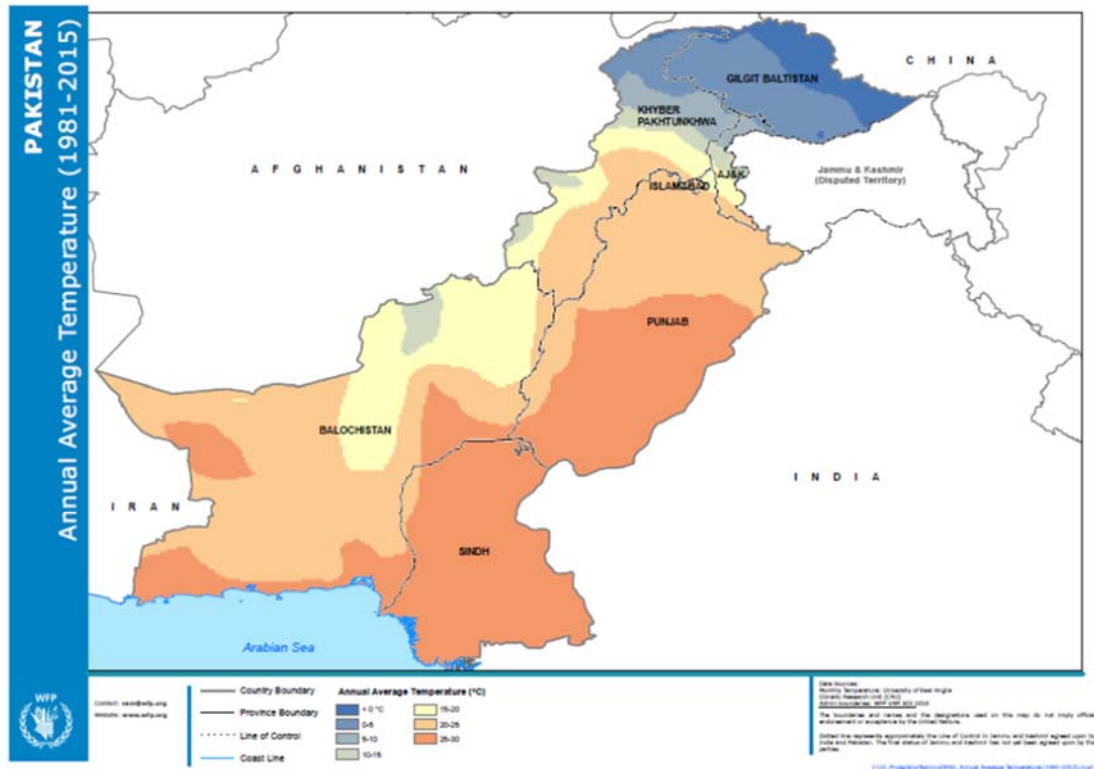
Research shows that Pakistan's mean annual temperature has risen, that the variability of rainfall has increased, and that climate-related natural disasters have become more frequent and intense over the past decades. Projections suggest that these trends will continue, resulting in more regular climate shocks, enhanced heat and water-stressed conditions, with severe implications for agricultural productivity and food security. A climate profile for Pakistan is urgently needed to inform policy action capable of ensuring that the country can withstand future disasters and adapt to the changing climate. To better understand climate vulnerabilities in the country, the following sections examine past climate trends, the impacts of extreme climate events in the past 20 years, and future climate projections.

3.1 Past climate trends

3.1.1 Temperature

Temperatures vary significantly across Pakistan as a result of its diverse topography. The mean average temperature recorded in the south – Sindh, Balochistan and Punjab – was over 24°C between 1981 and 2010. During the same period, the north and northwest registered an average temperature of 18°C (figure 4). Parts of the country have experienced some of the highest temperatures on record in the world.

Figure 4: Mean annual temperature in Pakistan, 1981–2015



Source: WFP. 2017b. *Vulnerability Analysis and Mapping Unit, WFP Headquarters.*

Studies indicate that Pakistan's mean average temperature has increased. Using a multi-modelling system¹⁶, Haensler et al. (2013) find that the mean annual temperature has risen across Pakistan by 0.6°C since the beginning of the twentieth century.¹⁷ Temperatures have risen by 0.35°C since the 1960s alone, at a rate of 0.07°C per decade. An above average increase is evident in the arid reaches of Sindh and southwest Balochistan. Using data from the Pakistan Meteorological Department, Sheikh et al. (2009) also identify an increasing trend in the mean annual temperature across the country. However, they observe a trend of decreasing temperatures during the monsoon season in all parts of Pakistan, with the exception of the Balochistan plateau.¹⁸

¹⁶ Mitchell, T. n.d. *Data: climate data-sets*. Norwich, Tyndall Centre for Climate Change Research. Available at: <https://crudata.uea.ac.uk/~timm/index.html>

¹⁷ Haensler et al., 2013.

¹⁸ Sheikh, M.M., Manzoor, N., Adnan, M., Ashraf, J. & Khan, A.M. 2009. *Climate Profile and Past Climate Changes in Pakistan*. GCISC-RR-01 Research Report. Islamabad, Global Change Impact Study Centre.

The Asian Development Bank predicts that the projected temperature increase in Pakistan will be more than the global average.¹⁹ Rising temperatures will result in enhanced heat waves, dry spells and water-stressed conditions, particularly in arid and semi-arid regions, leading to reduced agricultural productivity.²⁰ The Pakistan Meteorological Department already reports²¹ an increase in the length of heat waves across the country on annual basis, at a rate of 11 days per decade. In Sindh, heat wave episodes increased markedly between 1990 and 2011. Data suggests that, as a result of climate change, heat waves will continue to increase in Sindh.²² There is also a significant increasing trend of heat waves in northern, semi-arid and arid parts of Pakistan.²³ This implies that these areas may become vulnerable to future extremes (for more details, see section 3.2.2).

3.1.2 Rainfall

Annual levels of rainfall vary across Pakistan's diverse landscape. Northern areas receive more rain (1,000 mm per year) than the far drier south (200 mm).²⁴ There are no major changes in levels of overall annual rainfall; however, there is some variation in precipitation patterns and seasonality has shifted slightly in parts of Punjab and Sindh.

Trends in the past 20 years show a shift in rainfall towards the centre and south of the country, with a marginal increase in rain – so slight that this rise is virtually insignificant in the long-term. Haensler et al. (2013) find that total average annual precipitation in Pakistan increased slightly in the twentieth century.²⁵ While a considerable increase in rainfall (15-25 percent) is evident in the north, largely during the monsoon season, levels of precipitation declined in arid parts of

¹⁹ Asian Development Bank. 2017. *Climate Change Profile of Pakistan*. Metro Manila, Asian Development Bank. Available at: <https://www.adb.org/sites/default/files/publication/357876/climate-change-profile-pakistan.pdf>

²⁰ Government of Pakistan. 2013a. *Framework for Implementation of Climate Change Policy (2014-2030)*. Islamabad, Climate Change Division. Available at:

<http://www.gcisc.org.pk/Framework%20for%20Implementation%20of%20CC%20Policy.pdf>

²¹ Chaudhary, Q.Z., Mahmood, A., Rasul, G. & Afzaal, M. 2009. *Climate Change Indicators of Pakistan: Pakistan Meteorological Department Technical Report No. PMD-22/2009*. Islamabad, Pakistan Meteorological Department. Available at: <http://www.pmd.gov.pk/CC%20Indicators.pdf>

²² Pakistan Meteorological Department. 2012. *Climate Change in Pakistan Focused on Sindh Province*. Technical Report PMD-25/2012. Islamabad, Pakistan Meteorological Department. Available at: http://www.pmd.gov.pk/report_rnd.pdf

²³ Zahid, M. & Rasul, G. 2012. Changing trends of thermal extremes in Pakistan. *Climatic Change*, 113(3-4): 883-896.

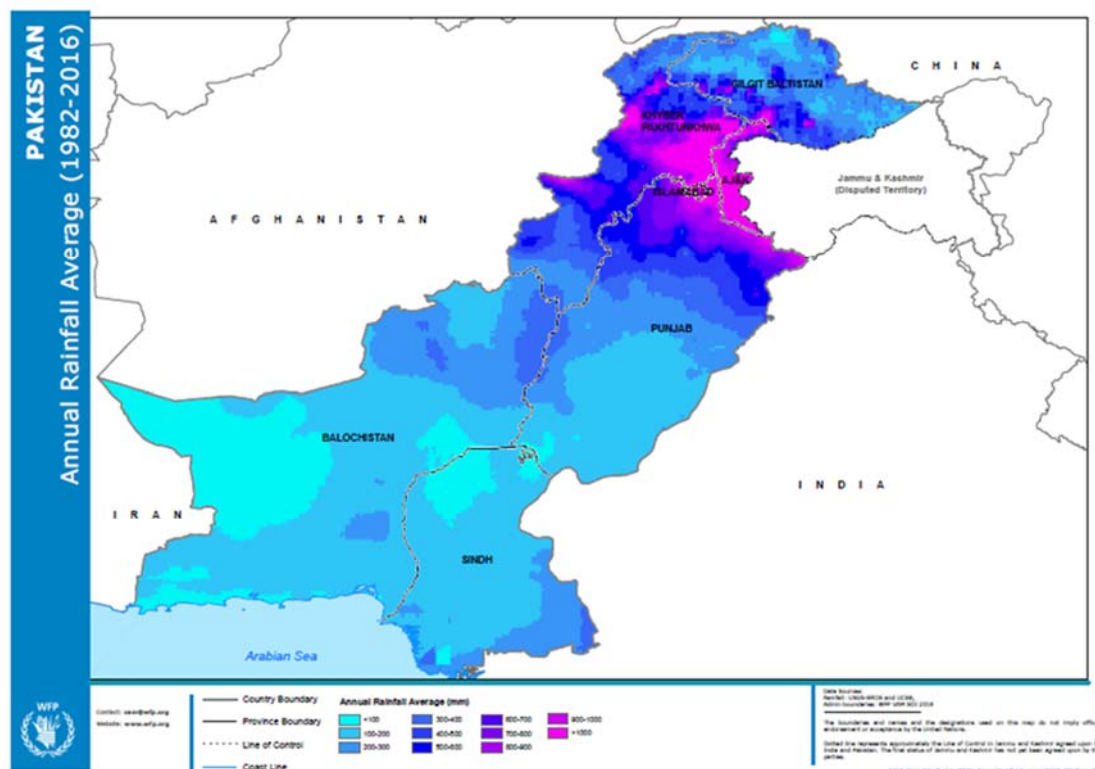
²⁴ WFP. 2017b. *Vulnerability Analysis and Mapping Unit*, WFP Headquarters. Rome, World Food Programme.

²⁵ Haensler et al., 2013.

southern Pakistan.²⁶ This may be attributed to drought in the late twentieth century.²⁷ Average annual rainfall has increased in Balochistan, Sindh and FATA, but remained constant in Khyber Pakhtunkhwa (KP) and Punjab (see figure 5). Decreasing levels of rainfall are apparent in Pakistan's coastal areas and arid plains.

Levels of precipitation in Punjab, Pakistan's breadbasket, have proved favourable for agriculture in general, as discussed in greater detail in chapter 5. However, research also affirms the increased frequency of extreme precipitation events in the country, particularly in its northern areas, Sindh and Balochistan.²⁸ Excessive rain over short periods of time prompts floods in Punjab, Sindh, parts of KP and Balochistan. Moreover, as no systemic changes are apparent in overall levels of precipitation, the numbers of hot days and hot nights are expected to rise significantly, prompting a projected decline in rice and wheat yields.²⁹

Figure 5: Average annual rainfall in Pakistan, 1982–2016



Source: WFP. 2017b. *Vulnerability Analysis and Mapping Unit*, WFP Headquarters.

²⁶ Haensler et al., 2013; Sheikh et al., 2009.

²⁷ Haensler et al., 2013.

²⁸ Zahid & Rasul, 2012.

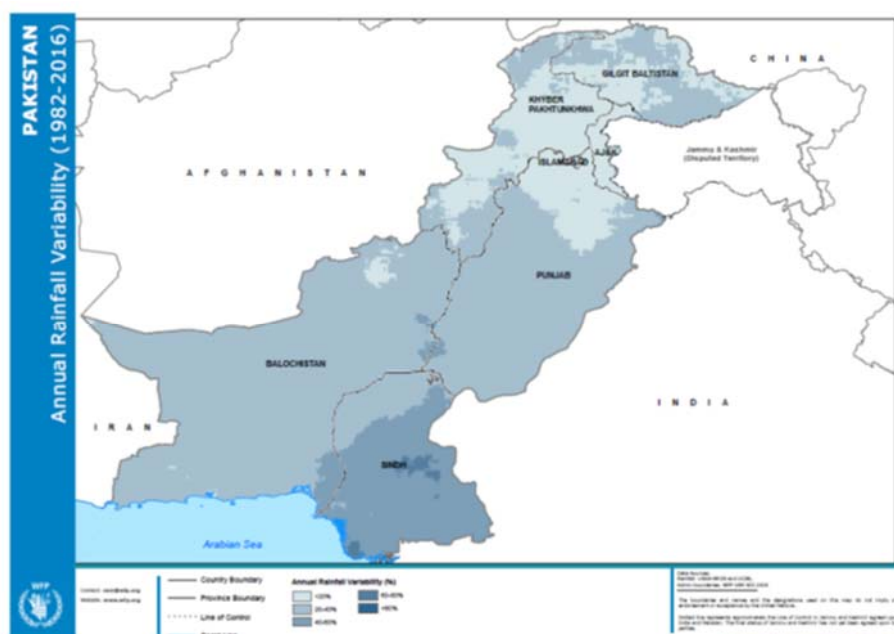
²⁹ Asian Development Bank, 2017.

3.1.3 Monsoon

The annual monsoon prompts a period of heavy rainfall during the summer in Pakistan. Monsoon variability has significant implications for the country's agrarian economy as monsoon rainfall varies on an inter-seasonal and inter-annual timescale. Figure 6 illustrates how southeast Pakistan has experienced the highest frequency of extreme rainfall events during the past 50 years, with over 50 mm of rain falling per day. This indicates an 'active' shift in the behaviour of the monsoon's southern belt. In the same area, the monsoon season's overall duration has decreased.

In the past 20 years, the start of the rainy season has been delayed by up to 30 days per decade in eastern parts of Pakistan. Shifting rainfall patterns delay the sowing period for various crops, which extends the lean season for farming households. As discussed in chapter 5, this causes food prices to rocket, triggering food insecurity among poor households dependent on agricultural livelihoods. The effect is particularly pronounced in rural areas, where few opportunities exist for livelihood diversification. Figure 6 also highlights the distribution of monsoon rainfall over the year. Until the monsoon arrives, the long dry season persists in most areas. Northern areas are the exception, with a shorter dry season and more rainfall overall.

Figure 6: Rainfall variability in Pakistan, 1982–2016

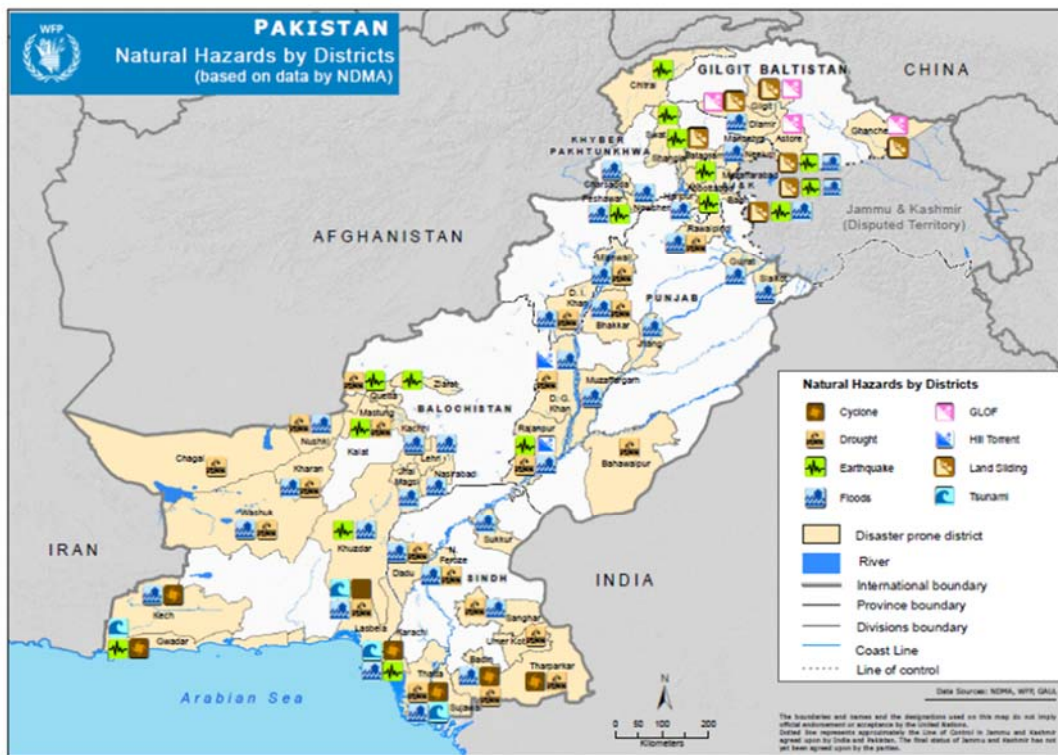


Source: WFP. 2017b. *Vulnerability Analysis and Mapping Unit, WFP Headquarters.*

3.2 Climate-related disasters in Pakistan: A historical perspective

Several climate catastrophes have beset Pakistan over the past 20 years. Compared to the period before 1995, the frequency and intensity of extreme climate events has increased.³⁰ While specific calamities cannot be attributed solely to climate change, the regularity and scale of natural disasters in Pakistan over the past decades point to the changing climate as a major causal factor. Figure 7 highlights districts that are prone to natural disasters, such as floods, glacial lake outburst floods (GLOFs), drought, landslides, earthquakes, hill torrents, cyclones and tsunamis. National studies predict that these events will occur with ever greater frequency in the coming decades.

Figure 7: Disaster-prone districts and types of disasters



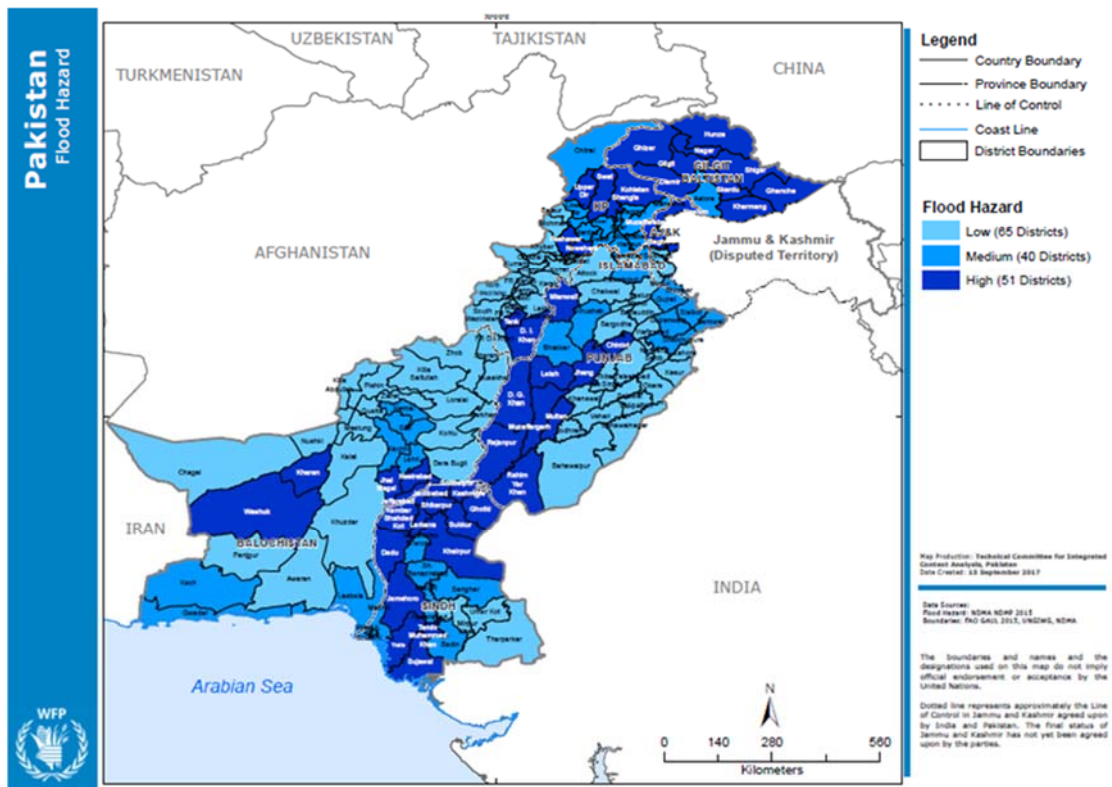
Source: WFP. 2017c. Integrated Context Analysis (ICA).

³⁰ Farooqi, A.B., Khan, A.H. & Mir, H. 2005. Climate change perspective in Pakistan. *Pakistan Journal of Meteorology*, 2(3): 11-21.

3.2.1 Floods

Floods are a major climate hazard in Pakistan (see figure 8). Flooding has occurred regularly in recent years, with devastating effects. 'Mega' floods in 2010 affected over 20 million people, while severe flooding in 2011 and 2012 wrought immense destruction in Sindh and Balochistan.³¹ Erratic monsoon rains in 2014 prompted floods in several of districts in Punjab, while numerous districts of KP were beset by flooding in 2015. The district of Chitral, KP, was gravely affected, as flash floods killed dozens and provoked significant long-term challenges for communities' livelihoods.

Figure 8: Flood hazard map of Pakistan



Source: WFP. 2017c. *Integrated Context Analysis (ICA)*.

³¹ Federal Flood Commission. 2016. *Annual Flood Report 2016*. Islamabad, Ministry of Water & Power. Available at: <http://mowr.gov.pk/wp-content/uploads/2018/06/Annual-Flood-Report-2016.pdf>

Recent floods have destroyed agricultural land, crops, household food stocks, livestock and livelihood assets, which curtailed livelihood opportunities and sparked outbreaks of disease. These effects compound food security and malnutrition among vulnerable households. Table 1 presents a summary of losses caused by floods in Pakistan since 1950.

Table 1: Damages and losses caused by floods in Pakistan, 1950–2012

S. No	Year	Direct losses (US\$ million)	Lives lost (number)	Villages affected (number)	Flooded area (km ²)
1	1950	488	2,190	10,000	17,920
2	1955	378	679	6,945	20,480
3	1956	318	160	11,609	74,406
4	1957	301	83	4,498	16,003
5	1959	234	88	3,902	10,424
6	1973	5,134	474	9,719	41,472
7	1975	684	126	8,628	34,931
8	1976	3,485	425	18,390	81,920
9	1977	338	848	2,185	4,657
10	1978	2,227	393	9,199	30,597
11	1981	299	82	2,071	4,191
12	1983	135	39	643	1,882
13	1984	75	42	251	1,093
14	1988	858	508	100	6,144
15	1992	3,010	1,008	13,208	38,758
16	1994	843	431	1,622	5,568
17	1995	376	591	6,852	16,686

S. No	Year	Direct losses (US\$ million)	Lives lost (number)	Villages affected (number)	Flooded area (km ²)
18	2010	10,000	1,985	17,553	160,000
19	2011	3,730	516	38,700	27,581
20	2012	2,640	571	14,159	4,746

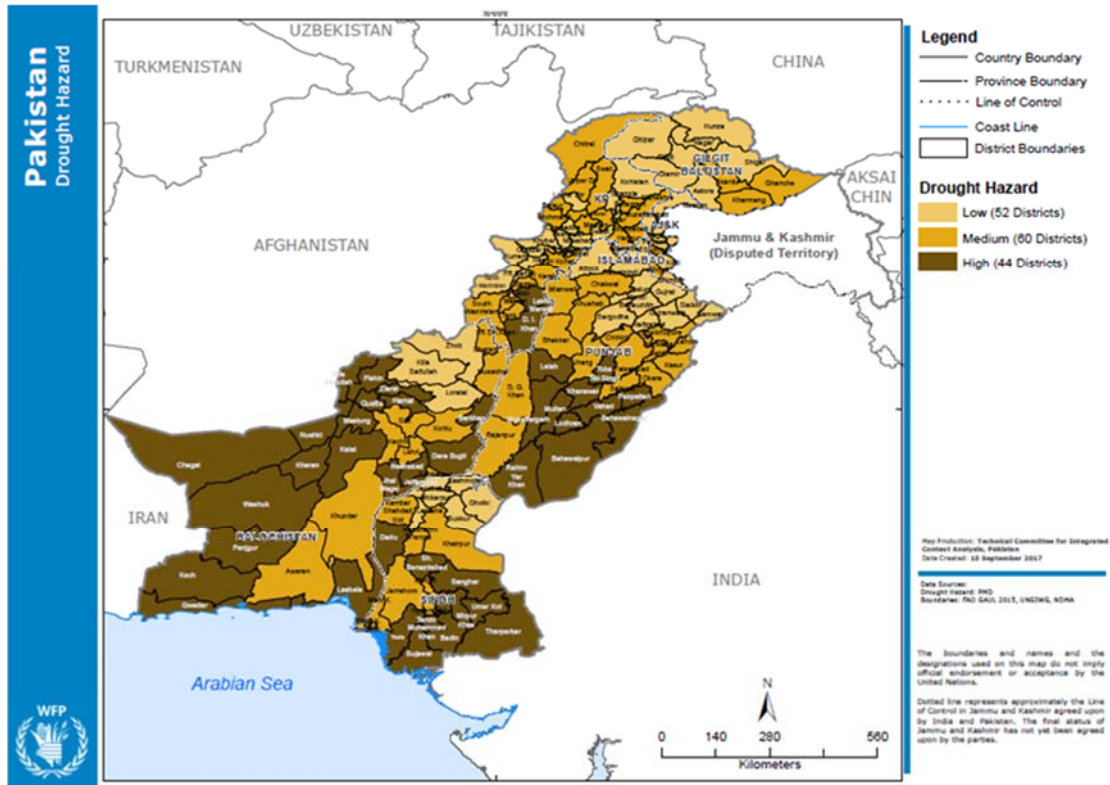
Source: Federal Flood Commission. 2016. Annual Flood Report 2016.

3.2.2 Drought

Droughts are estimated to occur in Pakistan once every 16 years. Severe heat waves beset the country with ever greater frequency; the most recent heat wave killed 1,000 people in Sindh in June 2015. Recurrent droughts have increased food insecurity among poor rural communities. Extreme heat degrades pastures, alters crop growth, hampers the sustainability of livestock herds and causes chronic water shortages.

Prolonged drought between 1999 and 2003 took a particular toll on agriculture and livestock, killing hundreds of thousands of animals in Balochistan, southern Punjab and the interior of Sindh. It devastated Pakistan's economy, causing its Gross Domestic Product (GDP) growth to fall and hampering food security. Figure 9 highlights the three levels of drought hazards, and drought-affected districts, based on data for the past 60 years (1951-2010).

Figure 9: Drought hazard map of Pakistan



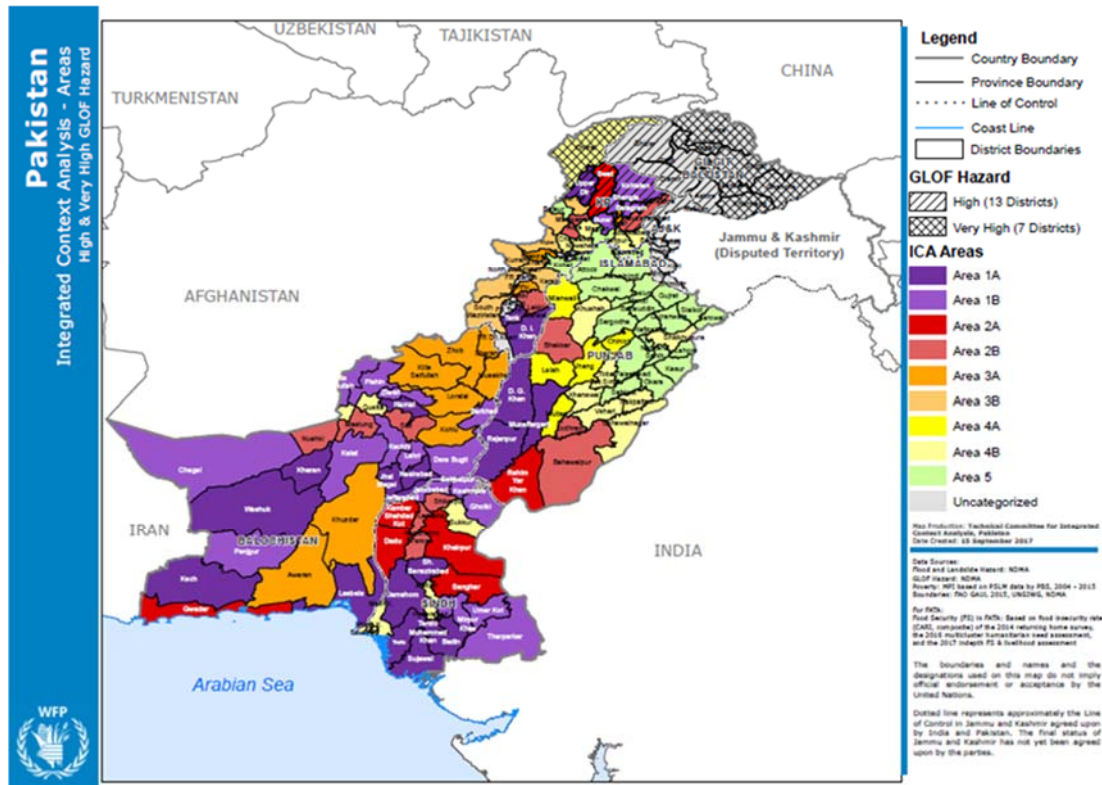
Source: WFP. 2017c. *Integrated Context Analysis (ICA)*.

3.2.3 Other factors

3.2.3.1 Glacial lake outburst floods (GLOFs)

The glaciers of the Hindu Kush-Himalayan-Karakoram range are a key source of Pakistan's water supplies. The area is considered a 'third pole' and a hot spot of climate change given the impact of rising temperatures on snow, the main source of water flows in Pakistan and the wider region. Glacial lake outburst floods (GLOFs), triggered by glacial melt, endanger lives and livelihoods in the mountainous reaches of northern Pakistan (see figure 10). The areas most affected by GLOFs – in KP, Gilgit-Baltistan (GB) and Azad Jammu and Kashmir (AJK) – are also prone to landslides and avalanches. As temperatures rise, the risk of GLOFs increases.

Figure 10: Glacial lake outburst flood (GLOF) hazard map (high and very high)

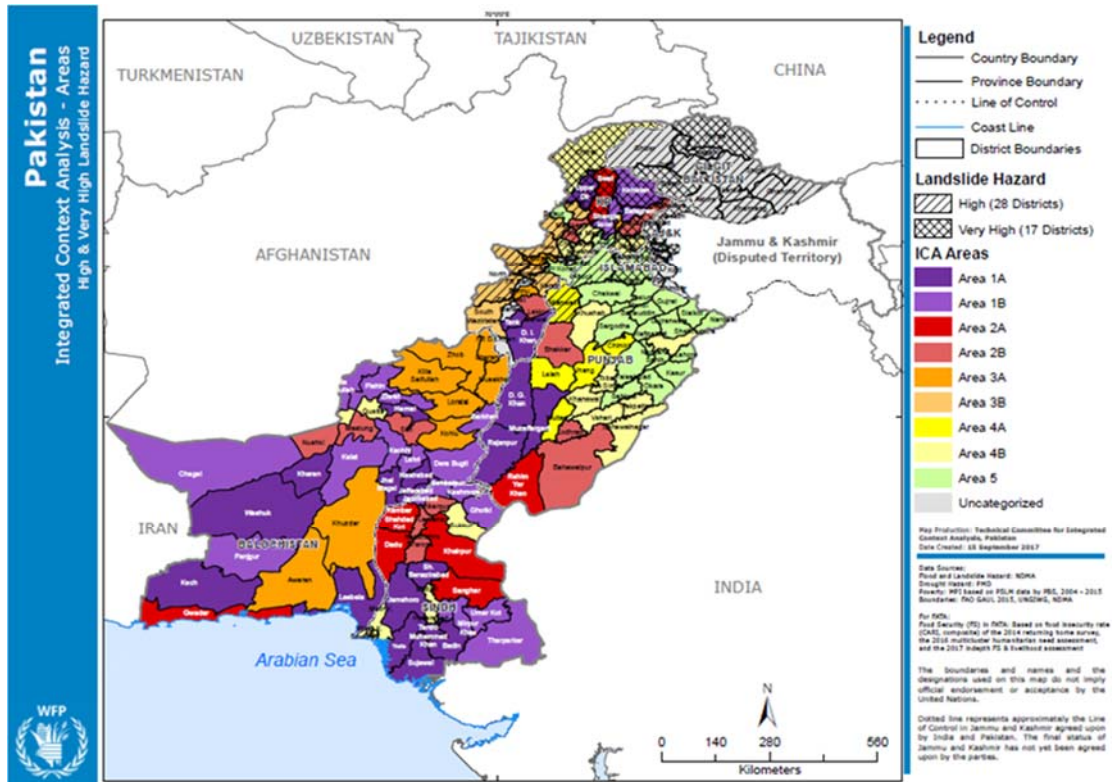


Source: WFP. 2017c. Integrated Context Analysis (ICA).

3.2.3.2 Landslides

Landslides – caused by torrential rains during the monsoon season – provoke severe devastation in mountainous parts of Pakistan. Pakistan’s northern mountain ranges are largely at risk of landslides as a result of rainfall and poor land management practices, such as poor construction, limited accessibility, a lack of land planning and deforestation. These areas are also prone to land degradation caused by soil erosion when the watershed is not properly conserved. The increasing frequency of extreme climate events, such as heavy precipitation over a short period of time, raises the risk of frequent, intense avalanches and landslides.

Figure 11: Landslide hazard map (high and very high)



Source: WFP. 2017c. *Integrated Context Analysis (ICA)*.

3.2.3.3 Cyclones and tropical storms

Tropical storms and cyclones are infrequent in the Arabian Sea. When they do reach Pakistan, they strike coastal Sindh. Cyclones generally occur between May and June, and between September and October, when the monsoon season is an important contributor to these hazards. Tropical storms that hit Pakistan have usually weakened by the time they make landfall and frequently turn towards India.

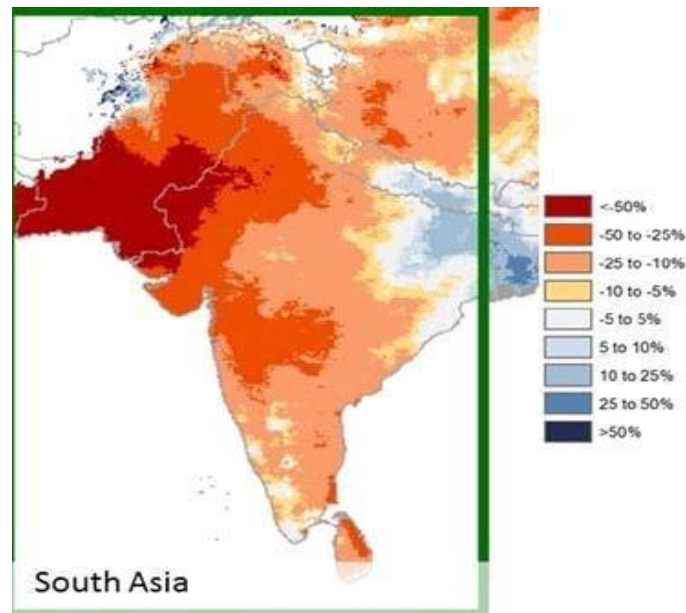
3.2.3.4 El Niño

El Niño refers to the warm phase of the El Niño Southern Oscillation (ENSO), a periodic variation in winds and sea surface temperatures in the tropical eastern Pacific Ocean. It involves the warming of the central and eastern tropical Pacific which takes place, on average, every three to seven years. During an El Niño

event, sea surface temperatures across the Pacific can rise by over 1–3°F, for anywhere between a few months to two years. El Niño affects global weather patterns, causing some areas to receive no rain at all, while others experience above average rainfall. This often results in a reversal of their normal weather patterns.³² El Niño is historically associated with lower than average rainfall during the summer in the northern hemisphere and across the Indian sub-continent.

Studies by the Pakistan Meteorological Department on annual and seasonal precipitation reveal that, during an El Niño event in 1998, precipitation dropped drastically across Pakistan. This triggered a severe drought that lasted until 2003.³³ The end of El Niño was followed by the increased frequency and intensity of precipitation events in the country. A recent El Niño event in March 2015 (see figure 12), active throughout 2015 and into early 2016, is believed to have been one of the strongest in the past 35 years. This had serious implications for food production and food security in Pakistan.

Figure 12: El Niño impacts on rainfall, July–September 2015



Source: WFP. 2015.

³² UNOCHA. n.d. *What are El Niño and La Niña?* Geneva, UN Office for the Coordination of Humanitarian Affairs. Available at: <https://www.unocha.org/es/themes/el-ni%C3%B1o/el-ni%C3%B1o-and-la-ni%C3%B1a>

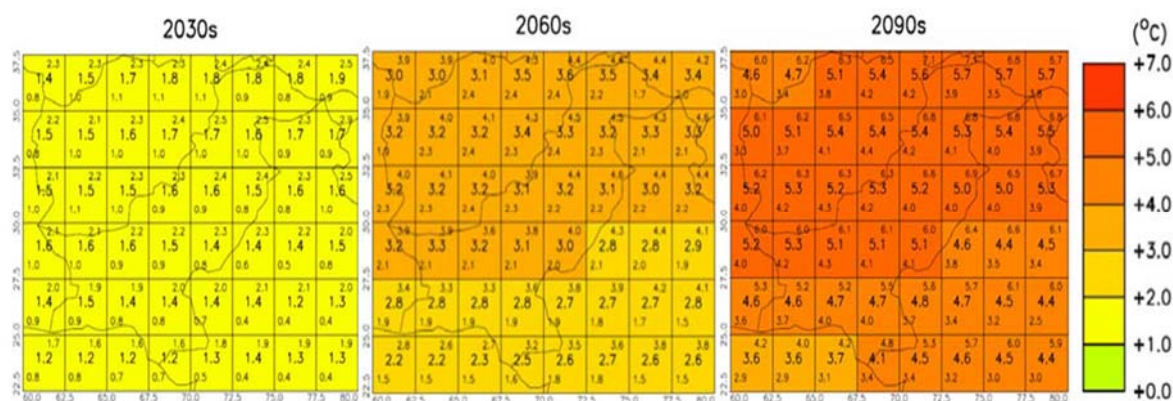
³³ Chaudhary, Q.Z., Mahmood, A., Rasul, G. & Afzaal, M. 2009. *Climate Change Indicators of Pakistan: Pakistan Meteorological Department Technical Report No. PMD-22/2009*. Islamabad, Pakistan Meteorological Department.

3.3 Future climate projections

The Intergovernmental Panel on Climate Change (IPCC) forecasts that climate change in Asia, particularly in South Asia, will manifest in the form of rising temperatures, precipitation extremes and a shift in the monsoon season.³⁴ It is likely that changes in precipitation at low latitudes will not substantially exceed natural variability, according to the Representative Concentration Pathways (RCP) 2.6 scenario.^{35, 36} By the mid-21st century, changes in the mean annual temperature will exceed 2°C in most parts of Pakistan, according to the RCP 8.5 scenario – this is well above the late twentieth century baseline.³⁷

Climate projections for Pakistan indicate an expected increase in temperatures between 1.4°C and 3.7°C by the end of the 2060s. Projections based on McSweeney et al. (2010) show a considerable increase in the frequency of ‘hot’ days and nights, and a decrease in ‘cold’ days and nights, as depicted in figure 13. These trends imply a significant change in temperatures, which will rise steadily over the course of this century, enveloping half of Pakistan’s territory.

Figure 13: Mean annual temperature projections for Pakistan (°C)



Source: McSweeney et al. 2010.

³⁴ IPCC. 2013. *Climate Change 2013: The Physical Science Basis. Contribution of Working Group I to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change*. Cambridge, Cambridge University Press. Available at: <https://www.ipcc.ch/report/ar5/wg1/>

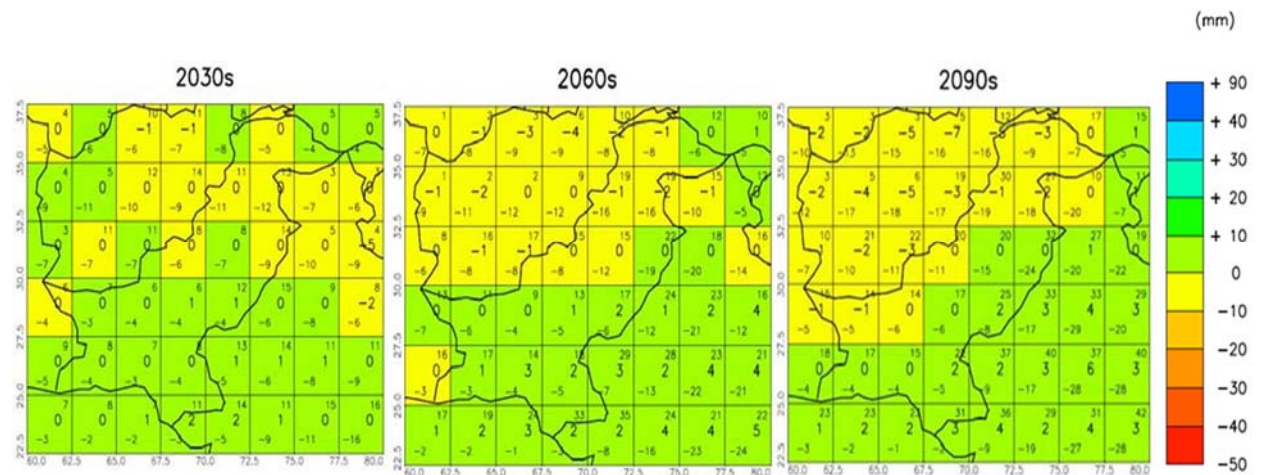
³⁵ The RCP 2.6 scenario assumes that greenhouse gas (GHG) emissions will decrease substantially if population growth rates are controlled, industrial emissions reduced, and bio-energy production gains pace.

³⁶ Van Vuuren, D.P., Edmonds, J., Kainuma, M., Riahi, K., Thomson, A., Hibbard, K., Hurtt, G.C. & Kram, T. 2011. The representative concentration pathways: An overview. *Climatic Change*, 109(1): 5–31. DOI:10.1007/s10584-011-0148-z.

³⁷ The RCP 8.5 scenario assumes high emissions, i.e. a ‘business as usual’ scenario.

Annual rainfall averages also reveal a wide range of positive and negative changes in precipitation (see figure 14). A decline in average rainfall is projected for the northern and western parts of Pakistan by the end of this century. The rest of the country will experience an increase in annual rainfall, of 10mm on average, from the 2030s onward.

Figure 14: Mean annual rainfall projections for Pakistan (mm)



Source: McSweeney et al. 2010.

Studies by ICIMOD indicate that the number and size of glacial lakes will increase as a result of glacial melt in the region.³⁸ Climate projections forecast that warming will be most rapid in northern parts of Pakistan, which will further reduce snow cover. These changes must be well-monitored to address the adverse impacts of decreased snow cover and the likelihood of frequent glacial lake outburst floods (GLOFs).

3.4 Managing climate risks

As this chapter shows, Pakistan's diverse climate is changing, with significant variations in temperatures and rainfall. The frequency of extreme weather patterns, ranging from drought to floods, highlights the country's vulnerability to climate change, with long-term implications for livelihoods, sustainable

³⁸ Vaidya, R.A. & Sharma, E. (eds.) 2014. *Research Insights on Climate and Water in the Hindu Kush Himalaya*. Kathmandu, International Centre for Integrated Mountain Development (ICIMOD). Available at: <http://lib.icimod.org/record/32171/files/FM-RIwater.pdf>

development and food security. Their sensitivity to climate variations puts agricultural livelihoods at risk, while declining crop yields threaten food availability and access. As chapters 4 and 5 will discuss, climate-related disasters wreak immediate devastation, prompting loss of life, livelihoods and assets. They also trigger lasting food and nutrition crises as communities resort to harmful coping strategies, such as selling productive assets, taking children out of school, eating less and opting for less nutritious food. Left without resources, communities exploit ecosystems in unsustainable ways, worsening environmental degradation and further reducing coping capacities. When the next hazard strikes, it is more likely to become a disaster. Throughout this downward spiral, food security deteriorates.

To address these challenges, there is a need for managing climate risk as part of our growth strategies. Pakistan's federal and provincial governments will need to formulate climate risk management and adaptation actions to secure sustainable livelihoods, agricultural production and climate-resilient development. Climate risk management (CRM) is the systematic process of using institutions and operational skills to implement strategies, policies and improved coping capacities to reduce the adverse impacts of climate shocks and stressors. While disaster risk management (DRM) is concerned with all types of imminent threats, CRM focuses on climate-related hazards and climatic changes, from the present to the distant future. This is an important distinction for policymakers and disaster risk reduction (DRR) practitioners looking to integrate CRM into their work. It means they must extend their understanding, methods and tools by:

- acquiring a deeper technical understanding of weather and climate risks and impacts;
- innovating their methods to model risk and reduce uncertainty;
- specifically addressing longer-term risks, which might occur in the next decades or by the end of the century; and
- addressing risks that emerge from gradual climatic changes, such as rising sea levels, desertification, salinization, or glacial melt.

Climate change adaptation (CCA) is a subcategory of climate risk management. CCA specifically seeks to limit the negative impacts of climate change and, like DRR approaches, can diminish the severity of climate change's effects. CCA activities may seek to transform human behaviour in ways that adapt to climatic changes, so as to maintain food security, public health and other socio-economic conditions. For instance, farmers may adapt their agricultural practices to a

decline in rainfall with drought-tolerant seeds. Similarly, coastal areas at risk of frequent, intense cyclones could be afforested with mangroves to reduce shoreline erosion, storm surge damage and salinization.

CCA also takes advantage of the potential benefits of a changing climate. For example, anticipating climate variations which favour certain crops gives farmers more cultivation options. Both actions to curb negative effects and harness positive effects proactively address a long-term future. Hazard tolerance is also an approach used in both CRM and DRM. In this case, nothing is done to reduce the severity or probability of the hazard; instead, efforts are made to increase the resilience of elements at risk.

Resilience is the ability of households, communities and nations to absorb and recover from shocks, while positively adapting and transforming their structures and means of living in the face of long-term stresses, change and uncertainty.³⁹ Thus, resilience ensures that shocks and stressors do not have long-lasting adverse development consequences. Effective climate change adaptation actions strengthen resilience. For instance, anticipating that water volume from snow melt will decrease due to higher temperatures, a mountain community may construct a check dam to capture water and lessen the risk of flash floods downstream, which reduces communities' exposure to hazards. Such measures are discussed in detail in chapter 5 with respect to Pakistan's agro-ecological zones and sustainable livelihoods.

Clearly, climate risk management and climate change adaptation are extremely important for Pakistan. The Ministry of Climate Change is engaged in managing climate-related risks and the *National Climate Change Policy 2012* provides a strong framework for developing action plans on adaptation and mitigation. The *Framework for Implementation of the Climate Change Policy (2014-2030)* focuses on current and anticipated climate risks to various sectors. The Ministry plans to implement adaptation actions in several spheres, including water resources, agriculture, livestock, health, forestry, biodiversity, disaster preparedness and vulnerable ecosystems. It also plans to take mitigation actions in other key sectors, such as energy, transport, agriculture, livestock, forestry, town planning, waste management and industry. Such decisive actions cannot come too soon for a country so at risk from the negative impacts of climate change.

³⁹ Mitchell, A. 2013. Risk and Resilience: From Good Idea to Good Practice. *OECD Development Cooperation Working Papers*, 13. Paris, OECD. Available at: <http://www.oecd.org/dac/conflict-fragility-resilience/docs/FINAL%20WP%2013%20Resilience%20and%20Risk.pdf>



CHAPTER 4 THE STATE OF FOOD SECURITY IN PAKISTAN

4. THE STATE OF FOOD SECURITY IN PAKISTAN

People are considered food secure⁴⁰ when they have physical and economic access, at all times, to sufficient, safe, nutritious food to maintain a healthy and active life.⁴¹ Despite Pakistan's strong agricultural base, food insecurity is widespread. According to *The State of Food Security in Pakistan*, 18 percent of Pakistanis are undernourished and 44 percent of households consume less than 2,350 Kcal per adult equivalent per day, the accepted normative standard set by Ministry of Planning Development & Reform.

Global sources offer even higher estimates. The *State of Food Security and Nutrition in the World* asserts that undernourishment affects 20 percent of Pakistan's population⁴², while the *Global Hunger Index 2017 (GHI)*⁴³ estimates that 22 percent are undernourished. The GHI also notes that 45 percent of Pakistani children under 5 suffer from stunted growth. It ranks Pakistan 106th of 119 countries, placing it among states with the highest incidence of hunger worldwide.⁴⁴

The Economist's *Global Food Security Index 2017* ranks Pakistan 77th of 113 countries, with an aggregate score of 47.8 out of 100 for food affordability, availability, quality and safety, alongside a fourth factor – natural resources and resilience (figure 15). Between 2016 and 2017, Pakistan's Food Security Index score improved marginally, rising by 0.7 points.⁴⁵ Among countries in South Asia, Pakistan only fares better than Afghanistan on this index. These statistics reflect the dire state of food security in the country.

⁴⁰ For a detailed definition of food security, see the glossary in Annex IV.

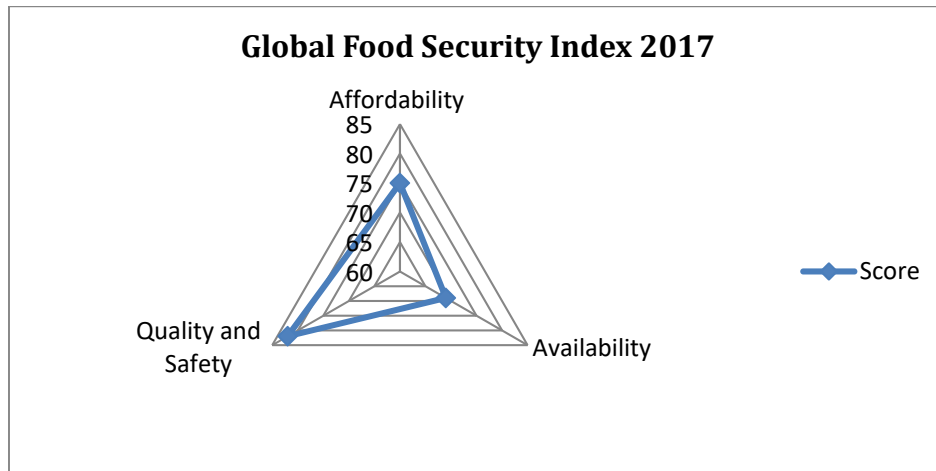
⁴¹ FAO & WFP. 2009. *The State of Food Insecurity in the World*. Rome, Food and Agriculture Organization.

⁴² FAO, IFAD, UNICEF, WFP & WHO. 2017. *The State of Food Security and Nutrition in the World 2017: Building resilience for peace and food security*. Rome, Food and Agriculture Organization. Available at: <http://www.fao.org/3/a-17695e.pdf>

⁴³ Calculated annually by the International Food Policy Research Institute (IFPRI), the GHI tracks hunger at the national, regional and global levels. It deliberates on the drivers of hunger, and on successes and failures in reducing hunger globally.

⁴⁴ IFPRI. 2017. *2017 Global Hunger Index: The Inequalities of Hunger*. Washington D.C. & Dublin, International Food Policy Research Institute. Available at: <http://www.ifpri.org/publication/2017-global-hunger-index-inequalities-hunger>

⁴⁵ The Economist Intelligence Unit. 2017. *Global Food Security Index 2017*. London, The Economist Intelligence Unit. Available at: <http://foodsecurityindex.eiu.com/Country/Details#Pakistan>

Figure 15: Pakistan's score on the *Global Food Security Index 2017*

Source: *The Economist Intelligence Unit. 2017. Global Food Security Index 2017.*

There are significant disparities in food security between Pakistan's provinces and administrative areas. Households are comparatively more food *insecure* in the Federally Administered Tribal Areas (FATA) (69 percent), GB (68 percent), KP (49 percent), Balochistan (63 percent) and Sindh (52 percent) than those in Punjab (37 percent) and Islamabad Capital Territory (ICT) (32 percent).⁴⁶

Food insecurity in Pakistan exists in the context of high poverty rates, rapid population growth, transitioning consumption patterns, slow progress towards adopting new agricultural technologies, limited arable land, growing water scarcity and a changing climate.⁴⁷ The multiplier effect of these factors shapes the country's high levels of food insecurity and deprivation.

This complex situation hampered Pakistan's progress on the Millennium Development Goals (MDGs) between 2000 and 2015. In turn, insufficient progress on the MDGs poses challenges to Pakistan's ability to achieve the Sustainable Development Goals (SDGs) by 2030. Achieving zero hunger (SDG 2), climate action (SDG 13) and water security (SDG 6) are essential for ensuring food security. As discussed in the introduction, the Government has committed to the SDGs. It is working to localize SDG targets and announced a national zero hunger programme in 2012, in line with the UN Secretary-General's zero hunger challenge. Food security is also an integral part of Pakistan's national development plan, *Vision 2025*.

⁴⁶ Ministry of National Food Security and Research, WFP, FAO & UNICEF, 2016.

⁴⁷ Government of Pakistan. 2014b. *Pakistan Economic Survey 2013-14*. Islamabad, Ministry of Finance. Available at: http://www.finance.gov.pk/survey_1314.html

To comprehensively assess the challenges facing Pakistan, this chapter analyses the four facets of food security:

- **food availability**, i.e. the physical availability or existence of food through a country's own production, imports and aid;
- **food access**, i.e. socio-economic, political and cultural access to food;
- **food consumption and utilization**, i.e. the use and assimilation of food; and
- **food system stability**.

The interface between these facets and climate change is explored in detail in chapter 5.

4.1 Food availability and agriculture

Food availability refers to the physical availability of food in a country. It is determined by the country's total food production, stocks, aid and net trade in food items.⁴⁸ This section discusses the interplay between agriculture and food availability in Pakistan.

Agriculture accounts for 19.8 percent of Pakistan's GDP. As noted in the introduction, the sector employs 42.3 percent of the total labour force, and 67 percent of the rural workforce is directly or indirectly involved in agricultural activities. Clearly, the sector is central to the national economy and people's livelihoods.⁴⁹ It also caters to the food demands of the country's rapidly growing population. Variations in agriculture significantly impact livelihoods, which, in turn, directly affect food security, especially among the rural poor.⁵⁰

As agriculture in Pakistan depends on the availability of water for irrigation, production is concentrated in the Indus River Basin. Crop production and livestock management are the two prime contributors to the agriculture sector, representing value added in agriculture of 34.9 percent and 58.3 percent, respectively.⁵¹ Minor contributions derive from fishing (2.1 percent) and forestry (2.3 percent).⁵²

⁴⁸ Ministry of National Food Security and Research, WFP, FAO & UNICEF, 2016.

⁴⁹ Government of Pakistan. 2016b. *Pakistan Economic Survey 2015-16*. Islamabad, Ministry of Finance. Available at: http://www.finance.gov.pk/survey_1516.html

⁵⁰ Arif, M. 2007. *Agriculture and Food Security in Pakistan: Thematic Paper*. Lahore, South Asia Partnership Pakistan. Available at: http://sappk.org/wp-content/uploads/publications/eng_publications/Agriculture_and_Food_Security.pdf

⁵¹ Government of Pakistan. 2017. *Pakistan Economic Survey 2016-17*. Islamabad, Ministry of Finance. Available at: http://www.finance.gov.pk/survey_1617.html

⁵² Ibid.

Wheat, rice, cotton, sugarcane and maize constitute 23.9 percent of value added in the agriculture sector, and account for 4.7 percent of Pakistan's GDP.⁵³ Wheat is the country's major *Rabi* crop, while prime *Kharij*⁵⁴ crops include cotton, sugarcane, rice and maize. As Pakistan's main staple, wheat contributes 60 percent of the population's daily caloric intake.⁵⁵ It dominates all other crops in both production and acreage. Pakistan is the ninth leading wheat producing country in the world.⁵⁶ However, production fluctuates from year to year as a result of unpredictable seasonal changes, variable water availability and salinity. Rice accounts for 3 percent of value added in the agriculture sector and represents 0.6 percent of GDP.⁵⁷ Rice production totalled 6,849,000 metric tonnes in 2017, surpassing targets of 6,838,000 metric tonnes.⁵⁸ In addition to wheat and rice, other crop-based sources of food include cereals, vegetables, fruits and tubers.

Livestock are also an important source of food across Pakistan. In mountainous areas where agricultural production is more complex, many people rely primarily on livestock to meet their food needs. Eight million households in the country are involved in livestock management, which accounts for 35 percent of their income.⁵⁹ In 2016, Pakistan's livestock sector produced 56 million tonnes of milk, 4 million tonnes of meat and 4 billion eggs.⁶⁰ Pakistan is the fourth leading producer of milk in the world, even though milk production is largely informal.⁶¹ Given the scale of livestock production, Pakistan earns significant foreign exchange earnings by exporting livestock and livestock by-products.⁶²

In recent years, Pakistan has been self-sufficient in major food crops. Negative growth in the agriculture sector caused by a decline in crop yields was last

⁵³ Ibid.

⁵⁴ There are two main crop growing seasons in Pakistan. Winter crops (*Rabi* meaning spring) are sown in October-December and harvested in March-April. Summer crops (*Kharij* meaning autumn) are sown over a longer period – beginning in February for sugarcane and lasting until July-August for maize – and are harvested between September-December, with the exception of sugarcane that can last until the spring.

⁵⁵ Pakistan Agricultural Research Council. 2014. *Wheat in Pakistan: A Status Paper*. Islamabad, PARC National Coordinator Wheat. Available at: http://www.parc.gov.pk/files/parc_pk/january-15/Status%20Papers/status%20paper%20Wheat%20in%20Pakistan.pdf

⁵⁶ FAO. 2016. *Pakistan at a Glance*. Islamabad, Food and Agriculture Organization. Available at: <http://www.fao.org/pakistan/fao-in-pakistan/pakistan-at-a-glance/en>

⁵⁷ Government of Pakistan, 2017.

⁵⁸ Ibid.

⁵⁹ Government of Pakistan, 2017.

⁶⁰ Ibid.

⁶¹ Suleri, A. 2017. Zero political power for zero hunger in Pakistan: How food security is undermined by political power plays. *Perspectives: Political Analysis and Commentary (Heinrich Bol Stiftung)*, 5: 34–36. Available at: <https://www.sdpi.org/publications/files/Zero-political-power-for-zero-hunger-in-Pakistan-How-food-security.pdf>

⁶² Government of Pakistan, 2017.

observed in 2000-2001. Although production dipped in 2015-2016, with serious implications for food availability, the latest figures reveal positive trends.⁶³ According to the *Pakistan Economic Survey 2017*, the production of major crops increased between 2016 and 2017 – wheat by 0.5 percent, rice by 0.7 percent, sugarcane by 12.4 percent and maize by 16.3 percent. Figure 16 provides a snapshot of trends in the agriculture sector, using 2005-2006 as a base year.

Figure 16: Percentage of agricultural growth (using 2005-2006 as a base year)

Sector	2010-11	2011-12	2012-13	2013-14	2014-15	2015-16	2016-17 (P)
Agriculture	1.96	3.62	2.68	2.50	2.13	0.27	3.46
Crops	0.99	3.22	1.53	2.64	0.16	-4.97	3.02
i) Important Crops	1.50	7.87	0.17	7.22	-1.62	-5.47	4.12
ii) Other Crops	2.27	-7.52	5.58	-5.71	2.51	0.59	0.21
iii) Cotton Ginning	-8.48	13.83	-2.90	-1.33	7.24	-22.12	5.59
Livestock	3.39	3.99	3.45	2.48	3.99	3.36	3.43
Forestry	4.76	1.79	6.58	1.88	-12.45	14.31	14.49
Fishing	-15.20	3.77	0.65	0.98	5.75	3.25	1.23

Source: Pakistan Bureau of Statistics
P: Provisional

Source: Government of Pakistan. 2017. *Pakistan Economic Survey 2016-17*.

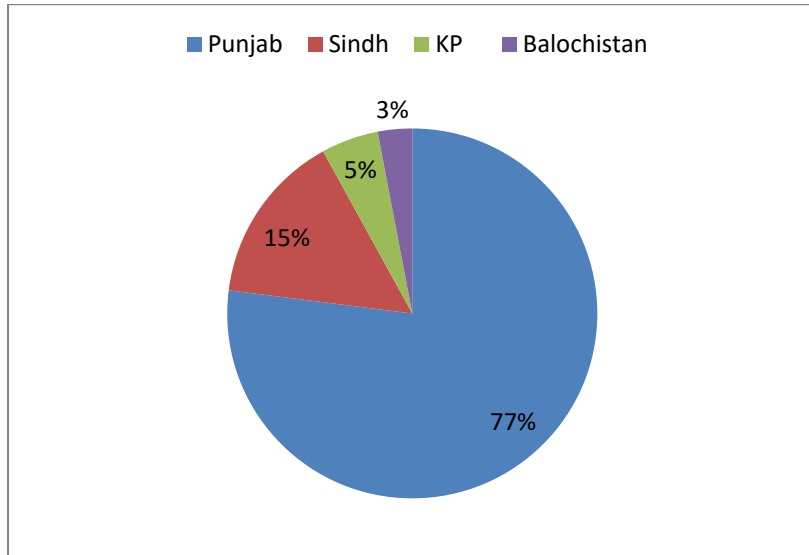
The agriculture sector has certain distinctive characteristics that affect its productivity. Khan (2017) reports that two-thirds of farms in Pakistan are small farms that cover less than five acres, while one-third of farms are fragmented.⁶⁴ This can restrict opportunities to benefit from economies of scale in terms of purchasing inputs and harvesting crops. It also depends upon labour conditions and, often, inefficient water management and irrigation practices.

In addition to overall variations in production, there are significant geographic disparities in food production. Punjab and Sindh are self-sufficient in the production of cereals and other crops, as figures 17 and 18 show – in fact, they produce surplus crops. However, local production in other parts of the country is far from sufficient to meet the population's needs. Figure 19 for example, illustrates differences in wheat production per capita across Pakistan.

⁶³ Ibid.

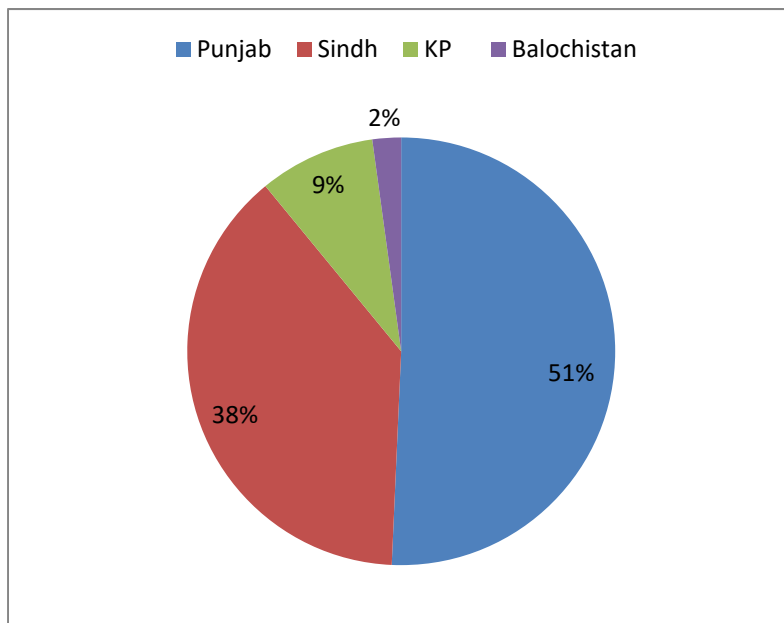
⁶⁴ Khan, M.J. 2017. *Agriculture and Textile Sector: Challenges and Way Forward*. Punjab Economic Research Institute Policy Brief. Lahore, PERI, Planning & Development Department Punjab. Available at: https://peri.punjab.gov.pk/policy_briefs

Figure 17: Wheat production by province, 2014–2015



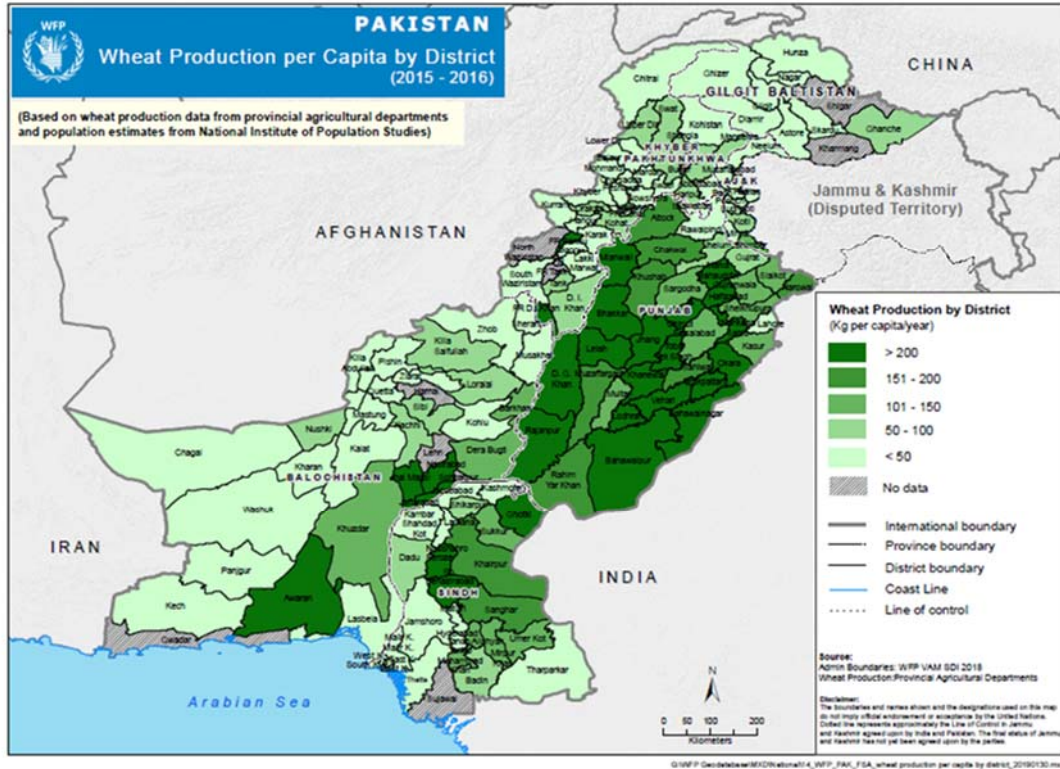
Source: Ministry of National Food Security and Research, WFP, FAO and UNICEF. 2016. *The State of Food Security in Pakistan 2016*.

Figure 18: Rice production by province, 2014–2015



Source: Ministry of National Food Security and Research, WFP, FAO and UNICEF. 2016. *The State of Food Security in Pakistan 2016*.

Figure 19: Wheat production per capita by district, 2015–2016

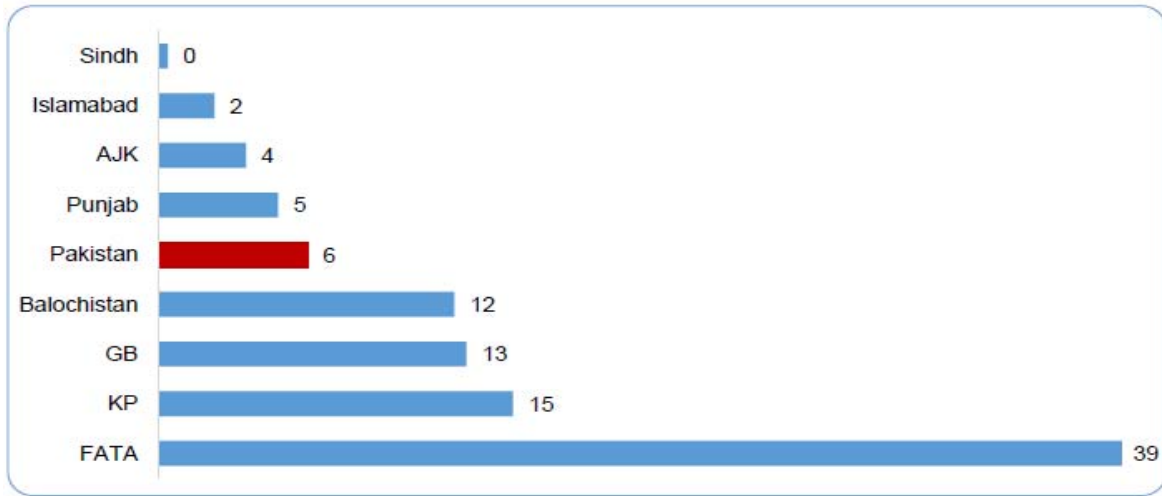


Source: WFP. 2017a.

Markets play an important role in providing households with food and other goods, alongside their role as a source of livelihoods and income. On average, households in Pakistan spend 49 percent of their monthly income on food. This highlights the importance of markets for food security.⁶⁵ Research shows that a small fraction of the population, 6 percent, report inadequate food availability in markets. Compared to the national average, a higher proportion of households in FATA, KP, GB and Balochistan report inadequate food availability in nearby markets (see figure 20).⁶⁶

⁶⁵ Ministry of National Food Security and Research, WFP, FAO & UNICEF, 2016.

⁶⁶ Ibid.

Figure 20: Inadequate food availability in markets by province (%)

Source: Ministry of National Food Security and Research, WFP, FAO and UNICEF. 2016. *The State of Food Security in Pakistan 2016*.

4.2 Food access

If available food is not accessible to the population, food security cannot be achieved. Access to food is ensured when all people possess the economic means to access sufficient food to fulfil their nutritional and dietary requirements.⁶⁷ Despite growing levels of food production, economic access to food remains a major challenge in Pakistan.

A household's access to food is a measure of its income, food distribution and the market prices of food items. Poverty tends to be the biggest barrier to access to food. Official estimates consider 29.5 percent of Pakistan's population 'poor' with reference to the revised national poverty line⁶⁸ of PKR 3,030.32.⁶⁹ However, multidimensional poverty is estimated to affect 38.8 percent of the population when severe deprivations in education, health and living standards are considered.⁷⁰ Poverty is most prevalent in eastern Sindh, western Balochistan and pockets of KP and Punjab. FATA and GB, while not covered in UNDP et al.'s

⁶⁷ Arif, 2007.

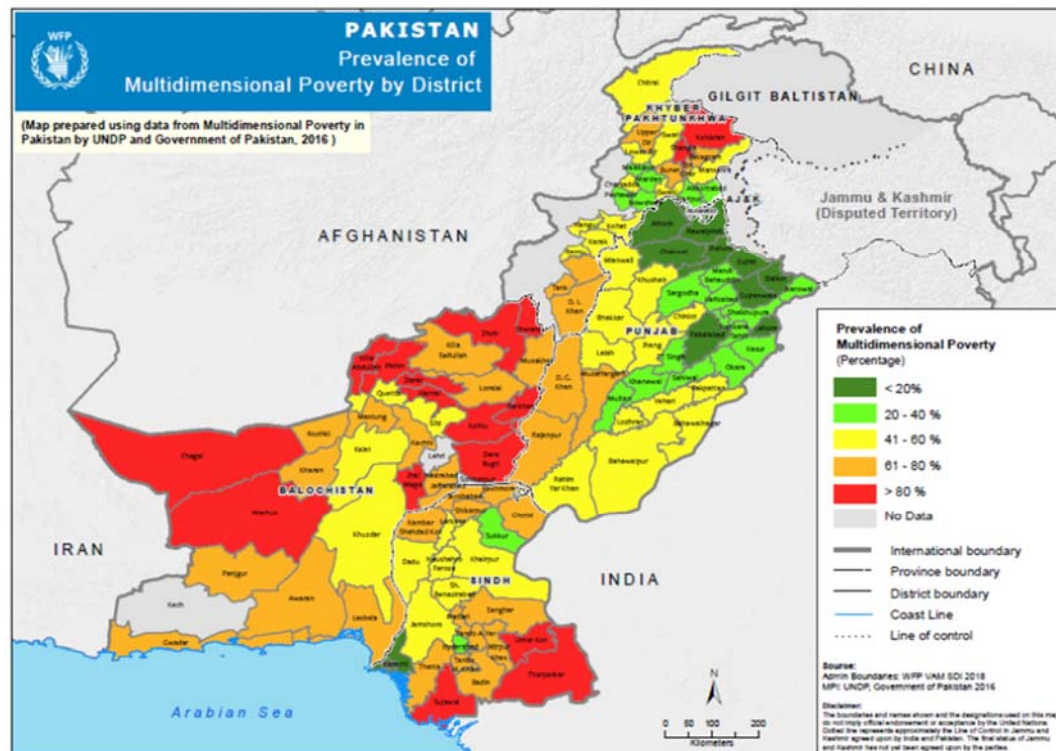
⁶⁸ The Government of Pakistan revised the country's poverty line – from PKR 2,259.40 to PKR 3,030.32 per adult equivalent per month – following a considerable decline in poverty rates over time.

⁶⁹ Planning Commission, Ministry of Planning, Development & Reform. 2016. *Pakistan's Revised Poverty Line*. Islamabad, Government of Pakistan.

⁷⁰ UNDP, OPHI & Planning Commission. 2016. *Multidimensional Poverty in Pakistan*. Islamabad, UNDP/Ministry of Planning Development & Reform. Available at: <http://www.ophi.org.uk/wp-content/uploads/Multidimensional-Poverty-in-Pakistan.pdf>

Multidimensional Poverty Index, also have extremely high rates of poverty, as do areas in AJK (see figure 21).

Figure 21: Prevalence of multidimensional poverty by district



Source: WFP. 2017a.

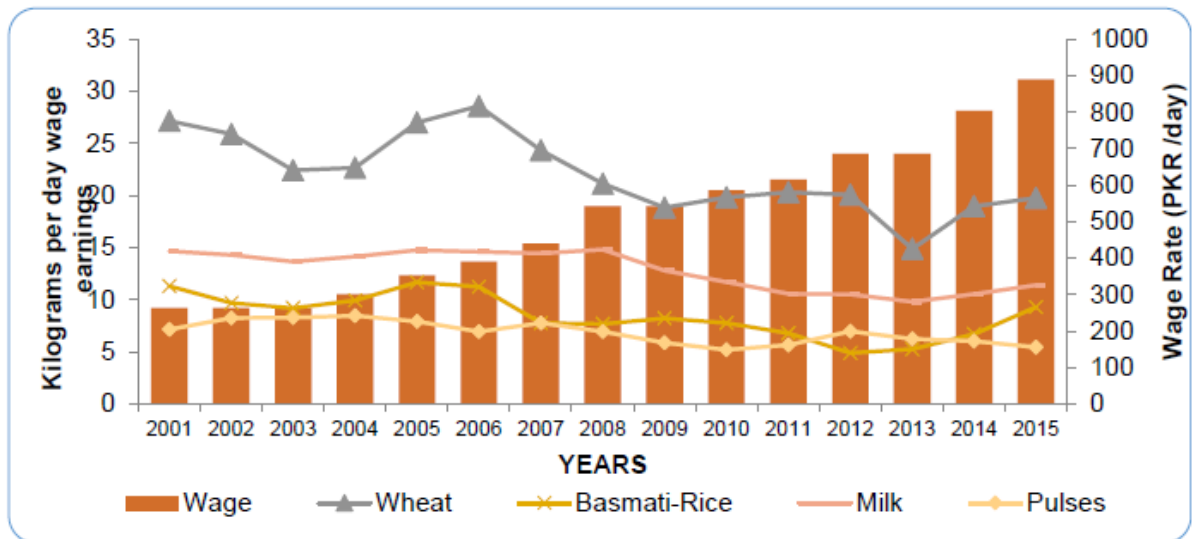
More than half of the households in Pakistan derive their principle income from informal, insecure, low earning livelihoods, such as wage labour and activities related to agriculture. Low incomes, coupled with high unemployment rates, negatively impact people's access to food.⁷¹ The poor state of education has a similar effect, as it prevents people from securing decent employment and the resources needed to acquire food. Households headed by an educated person fare significantly better on food security than those headed by individuals without an education.⁷²

⁷¹ Suleri, A.Q. & Haq, S. 2009. *Food Insecurity in Pakistan*. Islamabad, SDC, SDPI & WFP. Available at: <https://documents.wfp.org/stellent/groups/public/documents/ena/wfp225636.pdf>

⁷² Ministry of National Food Security and Research, WFP, FAO & UNICEF, 2016.

Food prices in Pakistan have risen steadily since 2008. Based on estimates from periodic *Pakistan Economic Surveys*, wheat prices rose by 19.3 percent between 2004 and 2016.⁷³ During the past 15 years, the price of wheat flour increased by 12.3 percent, basmati rice by 13.4 percent, milk by 12.5 percent and pulses by 12.1 percent. Over the same period, the incomes of skilled workers rose by 9.3 percent and of unskilled workers by 11.3 percent. Figure 22 illustrates the accessibility of food among skilled workers between 2001 and 2015. When rising food prices are not matched by a proportionate rise in incomes, people’s access to food is severely restricted. Poorer households are most affected, as they already spend a greater proportion of their income on food.⁷⁴

Figure 22: Food accessibility among skilled workers



Source: Ministry of National Food Security and Research, WFP, FAO and UNICEF. 2016. *The State of Food Security in Pakistan 2016*.

Alongside affordability, access to food is also determined by the economy’s socio-political structure and a range of related factors – such as national policies, gender, ethnicity and the rural-urban divide.⁷⁵ Political instability and extreme weather events similarly hamper access to food, with a particular impact on the poor.

⁷³ Government of Pakistan. 2016b. *Pakistan Economic Survey 2015-16*. Islamabad, Ministry of Finance. Available at: http://www.finance.gov.pk/survey_1516.html

⁷⁴ Ministry of National Food Security and Research, WFP, FAO & UNICEF, 2016.

⁷⁵ Arif, 2007.

4.3 Food consumption and utilization

From a public health perspective, the consumption, absorption and utilization of food is a major facet of food security. This parameter is based on the nutritional value of food and the energy requirements of a healthy individual.⁷⁶ This relates not only to solid food intake, but also to the availability of clean drinking water and proper sanitation – both integral to health and well-being. Household food processing techniques, immunization, hygiene, care practices, individual health status and literacy rates also influence food consumption and utilization.

Roughly half of Pakistan's population is energy deficient, consuming fewer calories than those required for a healthy life. The mean caloric consumption in Pakistan is 2,360 Kcal per capita per day, slightly higher than the threshold of 2,350 Kcal set as the daily requirement by the national Planning Commission.⁷⁷ However, this does not imply that all individuals consume equally; 44 percent of the population consumes less than the minimum requirement of 2,350 Kcal per adult equivalent per day. Caloric intake is lowest in FATA, where 69 percent of the population consumes less than 2,350 Kcal per adult equivalent per day, followed by GB (68 percent), Balochistan (63 percent), AJK (55 percent), Sindh (51 percent) and KP (49 percent). By contrast, the proportion of people who consume less than the daily caloric requirement in Punjab (37 percent) and ICT (32 percent) is lower than the national average.⁷⁸

Dietary diversity is limited in Pakistan, especially among poor and marginalized groups who follow a fixed pattern of food intake and consume a narrow variety of nutrients.⁷⁹ Overall, 35 percent of households have low dietary diversity, consuming fewer than five of the seven major food groups. The average Pakistani derives 47 percent of his or her energy from cereals, and 37 percent from wheat. One-sixth of the population receive 60 percent of their energy from staples, suggesting that diets are heavily cereal-based.⁸⁰ As noted above, households spend half (49 percent) of their monthly expenditure on food, on average, a proportion which increases among the poor.⁸¹

⁷⁶ Ibid.

⁷⁷ Government of Pakistan. 2014a.

⁷⁸ Ministry of National Food Security and Research, WFP, FAO & UNICEF, 2016.

⁷⁹ Ibid.

⁸⁰ FAO. 2013. *Pakistan: Review of the wheat sector and grain storage issues*. Rome, Food and Agriculture Organization/World Bank Cooperative Programme. Available at: <http://www.fao.org/docrep/018/i3251e/i3251e.pdf>

⁸¹ WFP. n.d. *Pakistan*. Islamabad, World Food Programme. Available at: <http://www1.wfp.org/countries/pakistan>

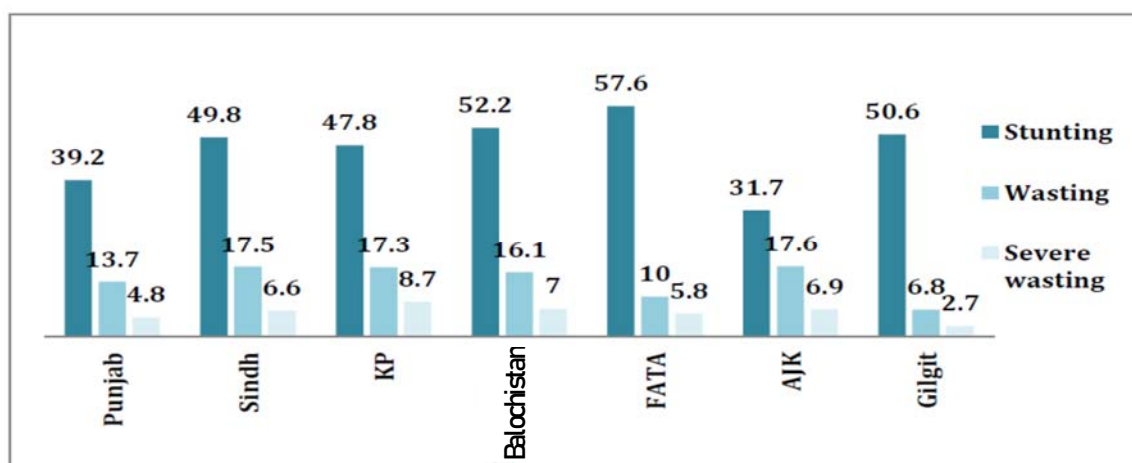
4.3.1 Malnutrition

Simply put, malnutrition means poor nutrition. It is as much about people not consuming enough food as it is about not consuming sufficiently nutritious food. Malnutrition results from deficiencies, excesses or imbalances in a person's intake of energy and/or macro- and micronutrients. In many cases, malnutrition is an outcome of food insecurity.

According to the *National Nutrition Survey 2011*, Pakistan is facing a serious crisis of malnutrition – a crisis that is among the worst in the world and which has not improved for decades. Fifteen percent of children under five suffer from acute malnutrition, the highest rate in South Asia. Moreover, 43.7 percent of children under five – 10 million children – are 'stunted' or chronically malnourished, a rate considered 'critical' by WHO thresholds.

Alarming, stunting rates are getting worse in Pakistan, rising from 36.3 percent in 1994 to 41.6 percent in 2001. Stunting is more widespread in rural areas (46.3 percent) than in urban centres (36.9 percent). Levels of stunting peak at 57.6 percent in FATA, followed by Balochistan, GB and Sindh, where over half of all children are stunted.⁸²

Figure 23: Children's health status by province

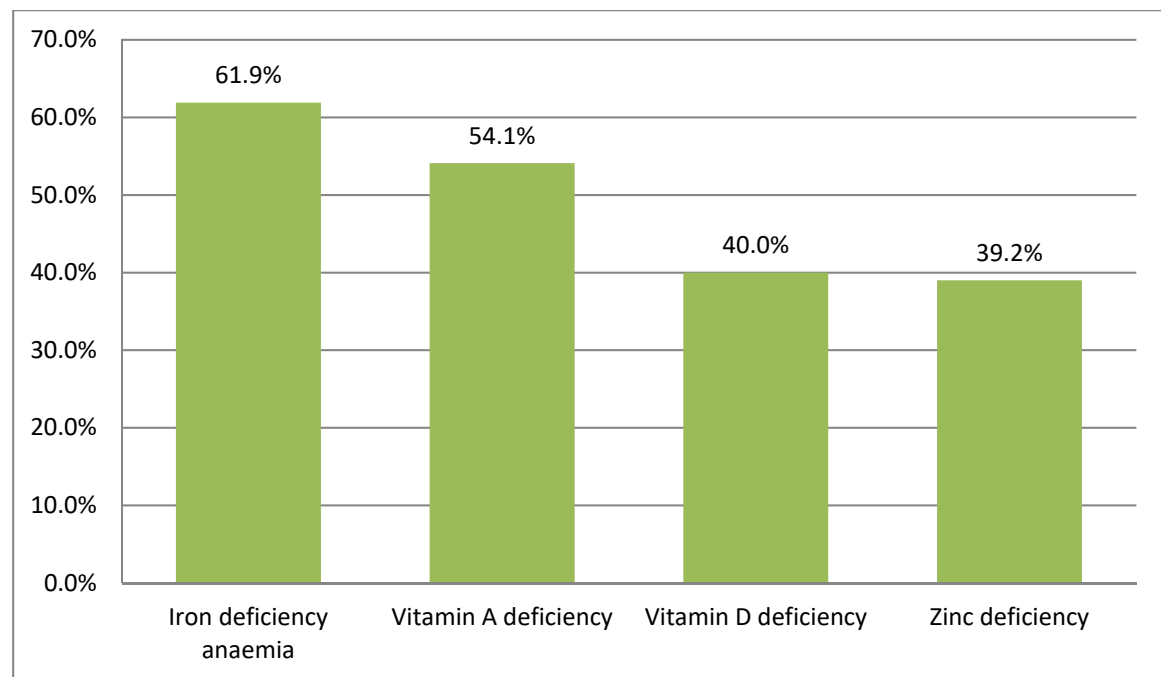


Source: Ministry of Planning, Development & Reform, UNICEF and Agha Khan University. 2012. *National Nutrition Survey (NNS) 2011*.

⁸² Ministry of Planning, Development & Reform, UNICEF & Agha Khan University. 2012. *National Nutrition Survey (NNS) 2011*. Islamabad, Government of Pakistan.

Severe micronutrient deficiencies exist in Pakistani children under the age of five. The *National Nutrition Survey 2011* found that 61.9 percent of children are deficient in iron, 54.1 percent in vitamin A, 40 percent in vitamin D and 39.2 percent in zinc. Malnutrition is also widespread among women of reproductive age, particularly in terms of iron deficiency that causes anaemia.⁸³ This affects foetal growth and leads to stunting in children.

Figure 24: Vitamin and mineral deficiencies among children



Source: Ministry of Planning, Development & Reform, UNICEF and Agha Khan University. 2012. *National Nutrition Survey (NNS) 2011*.

Nutritional intake and proper hygiene practices are linked to a household's level of education. Pakistan's overall literacy rate (58 percent) is low, and women's literacy rate is even lower (47 percent).⁸⁴ This poses particular challenges for nutrition as women in Pakistan tend to be responsible for household food selection and preparation.

⁸³ Ibid.

⁸⁴ Government of Pakistan. 2015. *Pakistan Economic Survey 2014-15*. Islamabad, Ministry of Finance. Available at: http://www.finance.gov.pk/survey_1415.html

4.4 Food system stability

To ensure food security, people must have *stable* access to adequate quantities of nutritious food at all times. Periodic disruptions in food access cause nutritional status to deteriorate, thus hampering food security.⁸⁵ Food stability requires demand and supply side interventions and involves all three dimensions of food security – availability, access and utilization.

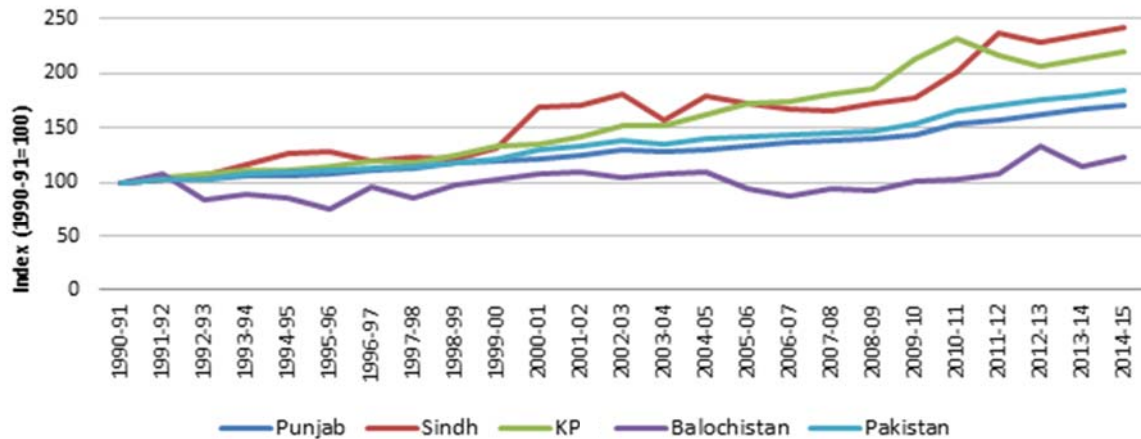
Structural changes in Pakistan’s economy are affecting the agriculture sector’s share of national GDP. This share is declining faster than the proportion of the population which relies on agriculture for their livelihoods. At the same time, new livelihood opportunities are emerging in the burgeoning service and industrial sectors. To capitalize on these opportunities, Pakistan’s population requires higher levels of technical education in order to understand, to adequately service and to support food systems.

To feed its rapidly growing population, Pakistan will need to increase food production proportionally.⁸⁶ Yet, recorded growth in crop yields – particularly for wheat (1.9 percent) – is not commensurate with the population growth rate (2.4 percent). Disparities also exist at the provincial level, as illustrated in figure 25. The fact that agricultural output per land unit is not aligned with population growth has serious implications for sustainable long-term agricultural production and, therefore, for food security in Pakistan. There is also a need for more resilient agricultural practices and greater investment in the green sector. Furthermore, communities at risk of hazards are insufficiently aware of improved technologies and techniques. They would benefit from investments in adapting their agriculture practices to increasing extreme weather variability; this, in turn, would enhance their resilience to disasters.

⁸⁵ FAO. 2008. *An Introduction to Basic Concepts of Food Security. Food Security Information for Action: Practical Guides*. Rome, Food and Agriculture Organization.

⁸⁶ Ahmad, M. & Farooq, U. 2010. The State of Food Security in Pakistan: Future Challenges and Coping Strategies. *Pakistan Development Review*, 49(4): 903–923.

Figure 25: Trends of population pressure on cropped area, by province



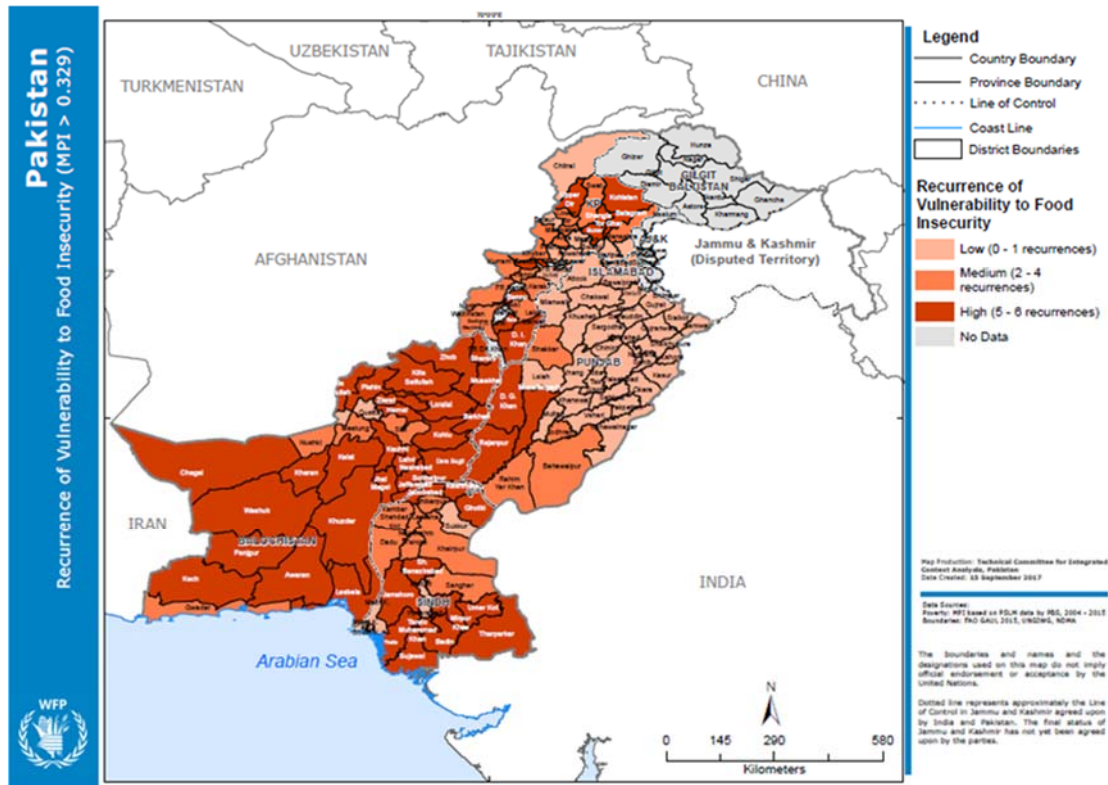
Source: Pakistan Bureau of Statistics. *Agriculture Statistics of Pakistan (Various Issues)* and *Population Estimates from Population Census, 1998*.

Household resilience, in the face of extreme weather events and other shocks, is a key aspect of food stability. Floods, earthquakes, droughts and price hikes are the main shocks that affect households in Pakistan. Figure 26 illustrates the recurrence of vulnerability to food insecurity in Pakistan, based on data from the *Pakistan Social and Living Standards Measurement Survey (PSLM)* between 2004-2005 and 2014-2015.⁸⁷ According to WFP's *Integrated Context Analysis*, the most food insecure parts of the country are drought-prone areas of Sindh and Balochistan, flood-affected districts in Sindh, Balochistan and Punjab, remote mountainous areas in northern Pakistan, and crisis-affected areas in FATA. These are also the areas with high incidence of *recurrence* in food insecurity.⁸⁸

⁸⁷ Pakistan Bureau of Statistics. 2004-2015. *Pakistan Social and Living Standards Measurement Survey (PSLM)* (various issues). Islamabad, Government of Pakistan. Available at: <http://www.pbs.gov.pk/content/pakistan-social-and-living-standards-measurement>

⁸⁸ WFP. 2017c. *Integrated Context Analysis (ICA) on Vulnerability to Food Insecurity and Natural Hazards, Pakistan 2017*. Islamabad, World Food Programme & National Disaster Management Authority. Available at: <https://geonode.wfp.org/documents/7444>

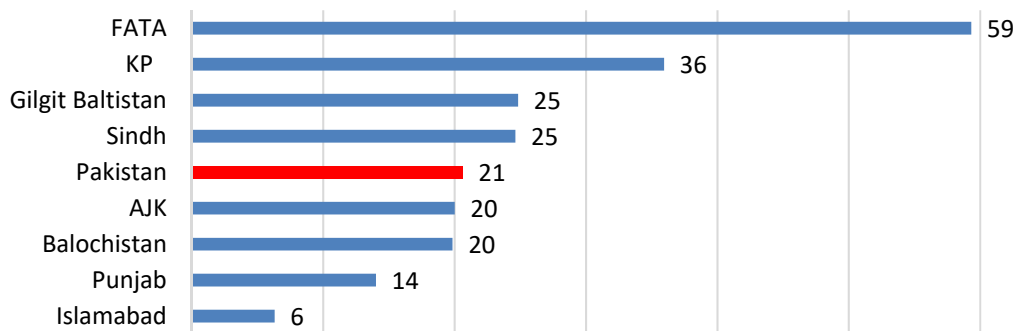
Figure 26: Recurrence of vulnerability to food insecurity



Source: WFP. 2017c. Integrated Context Analysis (ICA).

Twenty-one percent of households in Pakistan report being affected by a shock between 2013 and 2016 – such as a natural disaster, price hikes, insecurity, the death of a breadwinner, or crime.⁸⁹ The proportion of households that have experienced shocks is highest in FATA (59 percent) and KP (36 percent), followed by GB and Sindh (25 percent each), as figure 27 illustrates. Floods are the predominant shocks recorded in GB, parts of Sindh and Punjab.

⁸⁹ Ministry of National Food Security and Research, WFP, FAO & UNICEF, 2016.

Figure 27: Percentage of households that experienced shocks, 2013–2015

Source: Ministry of National Food Security and Research, WFP, FAO and UNICEF. 2016. *The State of Food Security in Pakistan 2016*.

Price hikes compel people to spend more on food than on non-food items. Faced with rising food prices and other shocks, the most common food-based coping strategies are reliance on less expensive – and often less nutritious – food, and to limit food intake by reducing the size of meals or skipping meals altogether.⁹⁰

Other negative coping strategies used by households vulnerable to food insecurity and undernutrition include taking on debt by borrowing money and, in severe cases, selling productive assets. All of these strategies decrease their resilience to future shocks. Different livelihood coping strategies are categorized into stress, crisis and emergency strategies. In the long-term, spending on non-food items declines, such as on health care and education, and preference is given to essential food items. This traps households in a vicious cycle of poverty.

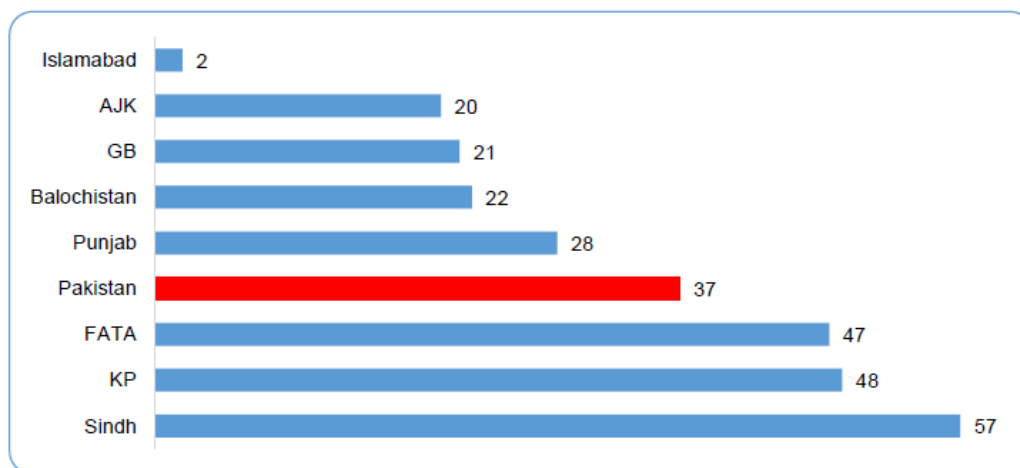
Across Pakistan, 37 percent of households report adopting food-based coping strategies. As figure 28 illustrates, such strategies are most prevalent in Sindh (57 percent), KP (48 percent) and FATA (47 percent), and least prevalent in ICT (1.9 percent).⁹¹ The most common coping strategy, practiced by 31 percent of households, is reliance on less desirable or less expensive foods. This is followed by a range of practices categorized as stress strategies: borrowing food or seeking help from friends and relatives (19 percent), borrowing money (18 percent), purchasing food on credit (15 percent), reducing the number of meals eaten per day (14 percent) and reducing the size of meals (14 percent). Among 8 percent of households, adults or mothers report consuming less to ensure that food is available for children or male family members. This is a significant

⁹⁰ Suleri & Haq, 2009.

⁹¹ Ministry of National Food Security and Research, WFP, FAO & UNICEF, 2016.

expression of intra-household disparities – including gender disparities – in access to food.⁹²

Figure 28: Proportion of households that practice food-based coping strategies (%)



Source: Ministry of National Food Security and Research, WFP, FAO and UNICEF. 2016. *The State of Food Security in Pakistan 2016*.

While 3 percent of households report adopting stress strategies, 23 percent rely on more extreme coping mechanisms, categorized as crisis strategies (17 percent) and emergency strategies (4 percent). These include selling household assets (5 percent), selling their last female animal (4 percent), consuming seed stock reserved for the next planting season (3 percent), selling domestic or productive assets (3 percent) and taking children out of school (3 percent).⁹³

As this chapter shows, challenges abound across all four facets of food security in Pakistan – availability, access, utilization and stability. Unchecked, food insecurity may threaten the nation’s social fabric by inciting unrest driven by hunger and the entrenched poverty that hunger perpetuates. Despite the complexity of prioritizing limited resources to meet a range of development challenges, it is clear that Pakistan needs evidence-based, action-oriented policies to stem the tide of food insecurity.

⁹² Ibid.

⁹³ Ministry of National Food Security and Research, WFP, FAO & UNICEF, 2016.



CHAPTER 5 FOOD SECURITY AND CLIMATE INTERFACE

5. FOOD SECURITY AND CLIMATE INTERFACE

Food security in Pakistan is highly sensitive to climate events. Changing weather patterns and climate-related disasters have a devastating effect on agriculture, the availability of food, access to food, its utilization and the stability of food systems. Even slight changes in the start of the rainy season, for example, can damage yields, prolong the lean season and increase people's market dependency. Agriculture-related livelihoods are the first to be affected by the changing climate, with particularly dire effects in rural areas where few options exist for income diversification.

The impact of climate change on agriculture may arguably be most critical for developing countries in tropical regions. Their populations rely significantly on agriculture and climate-dependent resources, poverty limits their capacity to anticipate and adapt to climate change, and rapid population growth already poses serious challenges for food security. Current projections of the impact which climate change will have on tropical crop yields, although negative on average, remain largely uncertain; there is need for more consistent, large-scale, quantitative assessments.

Rising carbon dioxide and other greenhouse gas (GHG) emissions – the main driver of global climate change – may increase the production of certain crops, such as rice, soybeans and wheat. However, the changing climate will affect the length and quality of the growing season. Farmers may experience increasing damage to their crops, caused by the rising frequency of intense droughts, flooding or fires. This will have major repercussions for food access and the stability of food supplies.

Existing evidence demonstrates the negative impact of climate change on agriculture in Pakistan. For instance, Javed et al. (2014) argue that climate change has reduced overall agricultural yields in the country. Their research analyses the impact of different climate variables on agricultural output and revenue per hectare, concluding that Pakistan's agriculture sector is significantly negatively affected by climate change and weather shocks. As discussed below, climate variables have both linear and non-linear impacts on Pakistan's agriculture sector.⁹⁴

There needs to be focus on addressing the impacts of climate change in

⁹⁴ Javed et al., 2014.

Pakistan. As discussed above, the country is regularly identified as one of the countries most negatively affected by climate change. Pakistan only produces 0.8 percent of global emissions, which means that it is not a main contributor to global warming. Therefore, the focus in Pakistan should be on adapting to the changing climate by strengthening the resilience of the population and relevant systems. Strengthening resilience for food security and nutrition needs to be a development priority, with a focus on vulnerable groups, particularly poor people and those living in at-risk or disaster-prone rural and urban areas. There is a clear need to enhance their resilience at various levels and across a range of livelihood systems. This will require investments at the individual, household, community, institutional (local, sub-national, state) and ecosystem levels. Efforts must also consider people's different social identities – such as gender, poverty levels, age, disability, minority status, etc. – in different local contexts.

Resilience can be increased by building absorptive, adaptive and transformative capacities.⁹⁵

- **Absorptive capacity** is the ability of a system to prepare for, mitigate or prevent negative impacts, using predetermined coping responses to preserve and restore essential basic structures and functions. This includes coping mechanisms used during periods of shock. Examples of absorptive capacity include early harvests and delaying debt repayments.
- **Adaptive capacity** is the ability of a system to adjust, modify or change its characteristics and actions to moderate potential future damage and to take advantage of opportunities. In this way, it can continue to function without major qualitative changes in function or structural identity. Examples of adaptive capacity include livelihood diversification, the involvement of the private sector in delivering basic services, and introducing drought resistant seeds.
- **Transformative capacity** is the ability to create a fundamentally new system so that shocks no longer have any impact. This can be necessary when ecological, economic or social structures make an existing system untenable. Examples of transformative capacity include the introduction of conflict resolution mechanisms, urban planning measures, and actions to stamp out corruption.

⁹⁵ OECD. 2014. *Guidelines for Resilience Systems Analysis: How to analyse risk and build a roadmap to resilience*. Paris, Organisation for Economic Co-operation and Development. Available at: <https://www.oecd.org/dac/conflict-fragility-resilience/Resilience%20Systems%20Analysis%20FINAL.pdf>

To enhance resilience, it is important to understand what impacts climate change has on all four aspects of food security discussed in chapter 4 – availability, access, utilization and stability. While food availability is primarily concerned with production, the others represent the non-production components of food security. The focus of recent food security research has been on availability, with less attention accorded to access, utilization and stability. This may be because the impacts of climate change on production can be easily measured, while the other aspects of food security are multidimensional and links to climate variability are more difficult to gauge. The following sections examine the impacts of climate change – particularly changing temperatures and precipitation patterns – on food production and availability, access, utilization and stability in Pakistan.

5.1 Temperature and food security interface

5.1.1 Temperature and food production/availability

Rising temperatures will have long-term impacts on food production and food security in Pakistan. Research shows that crop growth, development and yields are affected by climate change due to their linear and non-linear responses to climate variables. For example, as Wheeler et al. (2000) note, “the rate of many development processes is a positive linear function of temperature between a base temperature (at and below which the rate of a particular process is zero) and an optimum temperature, and a negative linear function of temperature between this optimum and a ceiling temperature (Roberts and Summerfield, 1987). Many development processes of crop plants conform to these relationships.”⁹⁶

Climate variables can have positive and negative effects on agricultural livelihoods. Thus far, the impact of climate variables – such as temperature – on food production has been positive in Pakistan.⁹⁷ Yet, research shows that, as temperatures continue to increase, climate variables will have significant negative impacts on agriculture in the country. Historical data-based crop and

⁹⁶ Wheeler, T.R., Craufurd, P.Q., Ellis, R.H., Porter, J.R. & Vara Prasad, P.V. 2000. Temperature variability and the yield of annual crops. *Agriculture, Ecosystems and Environment*, 82(2000): 159–167. Available at: <http://www-personal.ksu.edu/~vara/wheeler-tr-ae00.pdf>

⁹⁷ PIDE & IDRC. 2014. Impact of climate change on wheat productivity in Pakistan: A district level analysis. *PIDE Climate Change Working Paper Series*, 1. Islamabad, Pakistan Institute of Development Economics. Available: <https://mpr.ub.uni-muenchen.de/72859/>

climate models suggest that, for every for every 1°C increase in temperature, between 4 to 5 million tonnes of wheat are lost in South Asia.⁹⁸

Long-term average temperatures vary between areas and seasons, both in terms of their magnitude and direction.⁹⁹ Heat has a particularly devastating effect on crops and livestock in dry areas with low water availability. For example, in the remote district of Tharparkar in Sindh, food security has deteriorated because of heat stress and water shortages. Short-term extreme temperatures can also significantly reduce crop yields, a challenge for Pakistan where the mean temperature is rising and intense heat waves are becoming more frequent.

As discussed in section 4.1, wheat is Pakistan's most important *Rabi* crop; as the country's staple, it is vital for food security. Wheat is grown by 80 percent of farmers and provides 37 percent of the population's energy.¹⁰⁰ The *Rabi* season is characterized by low temperatures and low levels of rainfall. Wheat responds to an optimal temperature; when temperatures rise beyond this range, wheat growing processes flatten and decrease.¹⁰¹ Using agronomic crop models to predict the impacts of climate change on wheat in Pakistan's different climatic zones, Sultana et al. (2009) conclude that rising temperature will cause wheat yields to decrease in arid, semi-arid and sub-humid zones.¹⁰² Munir Ahmad et al. (2014) also find that climate change has a significant negative impact on wheat productivity in Pakistan, although its effects differ across the crop's growth stages.¹⁰³ For example, a long-term increase in temperatures by 1^o C during the vegetation stage enhances wheat productivity by 6.4 percent; during the maturity stage, rising temperatures seem to have no significant impact on crop yields. However, a long-term rise in temperatures harms wheat crops during the germination and tillering stages. In response to a 1^o C rise in mean temperature, crop yields fall significantly, by 7.4 percent. The changing climate also forces farmers to delay sowing wheat by 2-3 weeks around the country.

⁹⁸ WFP. 2015. *El Niño: Implications and Scenarios for 2015*. Rome, World Food Programme. Available at: <http://documents.wfp.org/stellent/groups/public/documents/ena/wfp276236.pdf>

⁹⁹ Javed et al., 2014.

¹⁰⁰ FAO, 2013.

¹⁰¹ Porter, J.R. & Semenov M.A. 2005. Crop responses to climatic variation. *Philosophical Transactions B, Royal Society*, 360(1463): 2021–2035. Available at: <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC1569569>

¹⁰² Sultana, H., Ali, N., Iqbal, M.M. & Khan, A.M. 2009. Vulnerability and adaptability of wheat production in different climatic zones of Pakistan under climate change scenarios. *Climatic Change*, 94(1):123–142.

¹⁰³ Ahmad, M., Nawaz, M., Iqbal M., & Javed, S. 2014. *Analysing the Impact of Climate Change on Rice Productivity in Pakistan*. Munich Personal RePEc Archive (MPRA) Paper 72861. Available at: https://mpra.ub.uni-muenchen.de/72861/3/MPRA_paper_72861.pdf

Rice is another important cereal crop, grown during the *Kharif* season across Sindh and Punjab. It is important both as a source of food, and as a cash crop. Rice production relies on stable supplies of water during the hot summer months. As summer temperatures rise steadily and water availability decreases across the rice growing areas of Sindh and Punjab, rice production will decline.¹⁰⁴

Warming will also affect agricultural production in colder parts of Pakistan. Optimal growing temperatures depend on a number of environmental variables. Air temperatures that surpass 30°C are associated with reduced yields of rainfed crops. Such high temperatures reduce yields by accelerating crop development prematurely, damaging plant cells and aggravating water loss.

Higher temperatures are ruinous for livestock. As noted in section 4.1, livestock account for 58.3 percent of the value added of Pakistan's agriculture sector. Livestock management employs eight million households, most of whom live in rural areas.¹⁰⁵ Research shows that heat stress in cattle – both due to specific extreme events and over time – decreases their chances of survival, productivity, food intake, weight and fertility.¹⁰⁶ As livestock suffer and die due to rising temperatures, the production of milk and other livestock products will fall sharply, with dire implications for small farmers and the national economy. Greater heat will also curtail physical human labour, an indispensable part of food production. While farmers may be used to hot weather, higher temperatures and heat waves will deal a severe blow to their food production capacities.

5.1.2 Temperature and food access

As climate change causes agricultural production to decrease, it exacerbates the economic drivers of food insecurity and reduces people's access to food. Lower agricultural output means lower incomes for vulnerable, agriculture-dependent rural households. In addition to having less produce to sell, they have less produce of their own to meet their nutritional needs. Temperature variations that harm livestock and alter the length of the crop growing season, alongside

¹⁰⁴ Siddiqui, R., Samad, G., Nasir, M. & Jalil, H.H. 2014. *The impact of climate change on major agricultural crops: Evidence from Punjab, Pakistan*. Islamabad, Pakistan Institute of Development Economics. Available at: <http://www.pide.org.pk/psde/pdf/AGM28/Rehana%20Siddiqui%20Ghulam%20Samad%20Muhammad%20Nasir%20and%20Hafiz%20Hanzla%20Jalil.pdf>

¹⁰⁵ Government of Pakistan. 2017. *Pakistan Economic Survey 2016-17*. Islamabad, Ministry of Finance. Available at: http://www.finance.gov.pk/survey_1617.html

¹⁰⁶ Dash, S., Chakravarty, A.K., Singh, A., Upadhyay, A., Singh, M. & Yousuf, S. 2016. Effect of heat stress on reproductive performances of dairy cattle and buffaloes: A review. *Vet World*, 9(3): 235–244.

extreme events – such as drought in rainfed areas – adversely impact farmers' net incomes. Landless agricultural labourers, who depend solely on agricultural wages, will be particularly hard hit. Declining agricultural productivity will increase poverty and, in turn, limit food access for the rural and urban poor.

The cotton sector is a good example of what is at stake for Pakistan as rising temperatures affect incomes and, therefore, economic access to food. Cotton crop production accounts for 1 percent of Pakistan's GDP and 5.2 percent of value added in agriculture. The sector employs 40 percent of the industrial labour force and cotton exports account for US\$ 12 billion per year in foreign exchange earnings.¹⁰⁷ A significant proportion of the population in Sindh and southern Punjab are dependent on cotton. It is a major cash crop for farmers and a source of livelihood for men and women who work in the cotton fields. They engage in various tasks, including cotton picking – a task generally carried out by women. Heat waves and higher temperatures will harm cotton crops, the bellwether of Pakistan's economy, with disastrous effects on incomes across the agricultural value chain; this in turn, will hamper food access.¹⁰⁸

Declining crop yields and livestock productivity also mean that food prices will rise in many areas. Higher food prices, lower incomes and Pakistan's high poverty rates will make purchasing nutritious foods prohibitively expensive for poor households. Research shows that price rises cause a significant decline in the consumption of all food groups, which reduces nutrient intake. The country's poorest people, who already spend most of their income on food, will continue to adopt negative coping strategies – such as eating less, relying on lower quality food and cutting spending on non-food items, including health care and education. This sets the scene for food and nutrition crises, paired with growing inter-generational poverty.

5.1.3 Temperature and food utilization

A rise in temperatures is likely to affect food use and nutrition by reducing food availability and crop yields, alongside access to food in the context of rising prices and falling agricultural incomes. According to Lloyd et al. (2007), climate

¹⁰⁷ Government of Pakistan, 2017.

¹⁰⁸ Raza, A. & Ahmad, M. 2015. Analysing the Impact of Climate Change on Cotton Productivity in Punjab and Sindh, Pakistan. *PIDE Climate Change Working Paper Series*, 9. Islamabad, Pakistan Institute of Development Economics. Available at: http://www.pide.org.pk/pdf/Climate_Change_9.pdf

change will have a significant impact on undernutrition.¹⁰⁹ Experts predict an increase in severe stunting of 62 percent in South Asia and 55 percent in east and southern sub-Saharan Africa by 2050.¹¹⁰ Studies show a negative relationship between childhood stunting at the household level and weather variables – such as temperature, rainfall, seasonality and extreme events, including floods and droughts.¹¹¹

For example, higher temperatures affect food safety, which can cause diarrheal diseases that affect nutrient absorption and provoke malnutrition. Evidence from Peru suggests a link between higher temperatures and diarrheal diseases; for every 1°C rise in temperature, research finds an 8 percent increase in diarrheal illnesses among Peruvian adults and children.¹¹² Rising temperatures also increase naturally-occurring bio toxins in many crops, which can contaminate staple foods consumed by people and used as fodder for animals. Greater levels of bio toxins are likely to increase malnutrition and food insecurity.¹¹³

As discussed above, heat stress will directly harm livestock's survival rates, health, fertility and productivity. Indirectly, rising temperatures threaten livestock fodder and, therefore, animals' growth and productive capacities. This will cause a decline in the production of key livestock products, such as milk, with important repercussions for nutrition.

Rural women will be particularly affected as safe water supplies dry up due to rising temperatures. Women in Pakistan tend to be responsible for collecting water for household use. Fewer water sources will compel them to expend more time and energy collecting water, with implications for their own well-being and the time they can accord to proper infant and child feeding practices. A lack of water may also cause people to rely on unsafe sources, increasing the risk of

¹⁰⁹ Lloyd, S.J., Kovats, R.S. & Chalabi, Z. 2007. Climate Change, Crop Yields, and Under-nutrition: Development of a Model to Quantify the Impact of Climate Scenarios on Child Under-nutrition. *Environmental Health Perspectives*, 119(12):1817-1823.

¹¹⁰ IPCC. 2014a. *Climate Change 2014: Impacts, Adaptation and Vulnerability*. Cambridge: Cambridge University Press. Available at: <https://www.ipcc.ch/report/ar5/wg2/>

¹¹¹ Phalkey, R.K., Jan, C.A., Marx, S., Hofle, B. & Sauerborn, R. 2015. Systematic review of current efforts to quantify the impacts of climate change on undernutrition. *Proceedings of the National Academy of Sciences United States of America*, 112(33): E4522-E4529.

¹¹² Checkley, W., Epstein, L.D., Gilman, R.H., Figueroa, D., Cama, R., Patz, J.A. & Black, R.E. 2000. Effect of El Niño and ambient temperature on hospital admissions for diarrhoeal diseases in Peruvian children. *Lancet*, 355(9202): 442-50.

¹¹³ Tirado, M.C. & Meerman, J. 2012. Climate Change and Food and Nutrition Security. In B. Thompson & M.J. Cohen, eds. *The Impact of Climate Change and Bioenergy on Nutrition*, p. 43-60. Dordrecht, Springer/Rome, Food and Agriculture Organization. Available at: <http://www.fao.org/3/a-as502e.pdf>

diarrheal diseases manifold.

5.1.4 Temperature and food system stability

By affecting all three facets of food security – availability, access and utilization – rising temperatures will diminish the stability of food systems in Pakistan. Sections 5.1.1–5.1.3 show that, as temperatures rise, crop yields and livestock productivity are expected to fall. This decline in agricultural productivity will reduce incomes from agricultural livelihoods, impeding access to nutritious food. Higher temperatures will also increase the incidence of diseases, aggravating malnutrition. Together, these effects will cause long-term food stability in Pakistan to decrease.

5.2 Precipitation and food security interface

5.2.1 Precipitation and food production/availability

While temperatures are expected to increase almost everywhere in the world, climate-induced rainfall patterns will vary considerably from region to region, influenced by topographical differences and proximity to bodies of water. Water is essential for plant growth; therefore, fluctuating precipitation patterns have a significant impact on agriculture. Changes in atmospheric circulation make it difficult to predict the impact of climate change on regional precipitation. Nevertheless, researchers agree that precipitation will increase in higher latitudes and decrease in lower latitudes.¹¹⁴

The trend of more intense, frequent and erratic rainfall has negative effects on crop yields and can affect the suitability of certain crops. Rainfed agriculture is the norm in 60 percent of Asia; this makes the region highly sensitive to any shift in precipitation patterns.¹¹⁵ South Asia's dependence of agriculture means that any change in the pattern of monsoon rains – in their timing, frequency and intensity – will have serious repercussions for livelihoods and food security. For instance, the delayed onset of the rainy season, coupled with less rain overall, can substantially reduce crop yields. As agriculture is vital to Pakistan, studies suggest that the country is extremely vulnerable to changing rainfall patterns.¹¹⁶

¹¹⁴ IPCC. 2007. *Climate Change 2007: Impacts, Adaptation, and Vulnerability*. Cambridge: Cambridge University Press. Available at: <https://www.ipcc.ch/report/ar4/wg2/>

¹¹⁵ WFP, 2015.

¹¹⁶ Ali, S., Liu, Y., Ishaq, M., Shah, T., Abdullah, Ilyas, A. & Ud Din, I. 2017. Climate Change and Its Impact on the Yield of Major Food Crops: Evidence from Pakistan. *Foods*, 6(6): 39.

Annual precipitation is increasing in South Asia, as are extreme events during the wet season. These trends are expected to continue, and projections indicate that rainfall variability will increase. This means more severe dry spells, longer droughts and more intense flooding, posing clear threats to food security. In 2002, a drought in India reduced rice production by 15 percent. Typhoon Haiyan in 2013 rendered great swathes of land in the Philippines unsuitable for rice cultivation. In 2008, Cyclone Nargis left 20,000 hectares of farm land in Myanmar unfit for planting.¹¹⁷ Floods in Pakistan in 2010 caused the loss of 0.5 million tonnes of wheat, while flooding in 2011 affected 881,000 hectares of crop growing land.¹¹⁸ Rainfall also hampers the production of beans, an important source of protein in South Asia.¹¹⁹

During the monsoon season, climate projections anticipate more rainfall, extreme rainfall events and dry spells throughout the 21st century.¹²⁰ The monsoon season is expected to start slightly earlier, and end slightly later than usual. These fluctuations in the onset and retreat of the annual monsoon creates uncertainty for farmers on when to sow seeds – a major challenge for rural livelihoods, crop production and food availability.

In terms of rainfall's effects on specific crops, Munir Ahmad et al. (2014) find a non-linear relationship between normal precipitation and rice productivity, which does not apply to the effect of temperatures on rice.¹²¹ Rice yields are significantly enhanced by normal precipitation. Extreme precipitation events reduce crop yields during the second stage of rice production; however, they increase the yield of Basmati rice during two other stages of production. While precipitation has a positive impact on wheat productivity during the germination and tillering stages, incremental rains have a very low impact on wheat yields.

5.2.2 Precipitation and food access

Variability in precipitation patterns, like rising temperatures, negatively affects access to food in Pakistan. For example, southern Punjab and Sindh suffered immense cotton crop losses following frequent and untimely rainfall, long overcast periods and high temperatures between August and October 2015.

¹¹⁷ WFP, 2015.

¹¹⁸ National Disaster Management Authority. 2011. *Annual Report 2011*. Islamabad, Government of Pakistan. Available at: <http://www.ndma.gov.pk/publications/AR2011.pdf>

¹¹⁹ WFP, 2015.

¹²⁰ Ibid.

¹²¹ Ahmad, M., Nawaz, M., Iqbal M., & Javed, S. 2014.

Cotton production dropped by 27.8 percent in 2015, while cotton ginning recorded negative growth of 21.3 percent, compared to positive growth of 7.2 percent in 2014.¹²² This blow to cotton ginning – which accounts for 2.3 percent of value added in Pakistan’s agriculture sector – meant major challenges for livelihoods and incomes, with ripple effects for food access. The case of cotton also highlights how the production of different crops is interlinked; climate change’s impacts on one crop have a knock on effect for other crops. For example, late wheat harvests caused by unseasonal rain delay the late cotton sowing period in Sindh and Punjab. The late sowing of cotton raises the danger of infestation by white fly and pink bollworm, which contributed to drastically reducing cotton yields in 2015.

Excessive rainfall that causes floods, and low levels of rainfall that lead to drought, both affect how people access food. Economic losses caused by floods are well-documented. Severe floods in 2010 caused US\$10 billion worth of damage in Pakistan.¹²³ By destroying infrastructure, supply routes and roads, for example, floods limit people’s physical access to market food supplies. They curtail livelihoods dependent on these markets, such as those of traders. Farm losses prompted by extreme climate events trigger job losses and reduce incomes, devastating local purchasing power and limiting economic access to food. Frequent disasters disproportionately harm poorer households and vulnerable groups, including women, children and the elderly. Poor households are the first to minimize spending on food, restricting the access of the most vulnerable.

As discussed in section 4.1, Punjab and Sindh are self-sufficient in crop production and produce surplus crops which fulfil food requirements in other parts of the country. By contrast, most districts in Balochistan, GB, FATA and KP do not produce sufficient food for their populations. Many communities depend on imports from other areas and rely on markets for their food needs; thus, functioning markets play a key role in food security. As noted above, Pakistani households spend 49 percent of their monthly expenditures on food; proportional spending increases among poorer households.¹²⁴ On average, households are market dependent for 79 percent of their cereals, 92 percent of vegetables, 50 percent of milk and 70 percent of meat intake. Market

¹²² Government of Pakistan, 2017.

¹²³ Federal Flood Commission, 2016.

¹²⁴ Ministry of National Food Security and Research, WFP, FAO & UNICEF, 2016.

dependency for cereals rises to 96 percent in AJK and 89 percent in FATA.¹²⁵

This makes people vulnerable to price volatility and markets disruptions, both of which occur in the aftermath of disasters. For instance, floods damage supply routes and limit market food stocks, while landslides disrupt supply lines in mountainous regions. Such market disruptions cause food shortages and rising prices, limiting food access for the poor and those in remote areas.

5.2.3 Precipitation and food utilization

As rainfall variability causes yields to decline, decreases small-scale producers' incomes and drives up food prices, households will reduce the quantity and quality of the food they consume. As discussed in section 5.1.3, negative coping strategies abound among poor, vulnerable households – such as a reduction in health expenditure – with dire implications for nutrition. Researchers predict a relative increase in moderate stunting from 1 to 29 percent by 2050, and a 62 percent rise in severe stunting in South Asia.¹²⁶

Floods take a toll on water and sanitation infrastructure. By contaminating drinking water supplies in rural and urban areas, they set the scene for waterborne illnesses – such as malaria, typhoid and diarrheal diseases that worsen malnutrition. Rural women are most affected, causing serious challenges for household hygiene, nutrition and child feeding practices. Floods also increase health hazards for animals – from food shortages to plant toxicity, dehydration, infection and zoonotic diseases.¹²⁷ This has a domino effect on livestock productivity and, ultimately, food security.

5.2.4 Precipitation and food system stability

Shifting precipitation patterns and the growing frequency of extreme events, such as floods and landslides, will hamper food stability in Pakistan. As in the case of rising temperatures, sections 5.2.1–5.2.3 demonstrate the negative impact that rainfall variability will have on food availability, agricultural livelihoods, access to food, its utilization and nutrition – the building blocks of stable food systems.

¹²⁵ Ibid.

¹²⁶ IPCC, 2014a.

¹²⁷ Agriculture Victoria. 2018. *Animal health after floods*. Melbourne, Victoria State Government. Available at: <http://agriculture.vic.gov.au/agriculture/emergencies/recovery/livestock-after-an-emergency/animal-health-after-flood>

5.3 Sources of income and livelihood diversification

Households are less vulnerable to the impacts of climate change when they do not rely on a single source of livelihood, such as agriculture or unskilled labour; those with diverse livelihoods are significantly more resilient. Yet, agriculture is a primary or secondary source of livelihood for 40 percent of Pakistan's households¹²⁸, who either cultivate their own land or work as agricultural wage labourers. Programmes to diversify livelihoods are needed to enhance people's resilience to climate shocks, especially in rural areas.

According to *The State of Food Security in Pakistan*, 28 percent of households rely on regular employment as their primary source of livelihood, 25 percent on agriculture and 16 percent on unskilled wage labour. At the provincial level, wage labour is the main source of income for 26 percent of households in FATA, 19 percent in KP and 18 percent in Punjab. Households in Sindh (32 percent), Balochistan (31 percent) and Punjab (24 percent) are more reliant on agriculture. Within the poorest quintile, 62 percent of households depend on one of these two livelihood strategies – 33 percent on farming, including small-, medium- and large-scale farming, livestock management, fishing and agricultural labour, and 29 percent on wage labour, both skilled and unskilled. The mean number of livelihood sources for Pakistani households is 1.6. While 54 percent of households nationwide only have one source of livelihood, this figure rises to 75.9 percent in Balochistan.¹²⁹

To build resilience by diversifying livelihoods, WFP is shifting from direct food aid towards *Food Assistance for Assets* (FFA) – interventions that strengthen resilience by engaging locals in asset creation. Communities work for food or cash, building productive assets that increase their capacity to withstand future shocks and provide opportunities for livelihood diversification. Communities own and maintain these assets themselves, which makes them sustainable. Typical FFA interventions focus on soil and water conservation; irrigation and water development schemes; flood control; clearing land to restore agricultural potential, increase crop production and diversify food sources; creating community food reserves; rehabilitating social infrastructure; improving physical access by building roads and bridges; forestry and agro-forestry activities; alternative energy; and training on managing natural or physical assets. By

¹²⁸ Ministry of National Food Security and Research, WFP, FAO & UNICEF, 2016.

¹²⁹ Ibid.

engaging in FFA initiatives, communities become independent of food assistance, produce surplus food and diversify their livelihoods.

5.4 Climate vulnerability analysis and agro-ecological zones

Taking stock of the diverse climate, topography, ecology and livelihoods in different parts of Pakistan, this report's climate vulnerability analysis uses agro-ecological zones as an entry point to analyse livelihood vulnerability and local populations' coping capacities. This analysis is based on stakeholder consultations conducted in each province with officials from key organizations related to the climate, livelihoods and food security. Their insights, supported by recent research, underscore the need to revisit these agro-ecological zones, updating their categorization with current information to improve programme design.

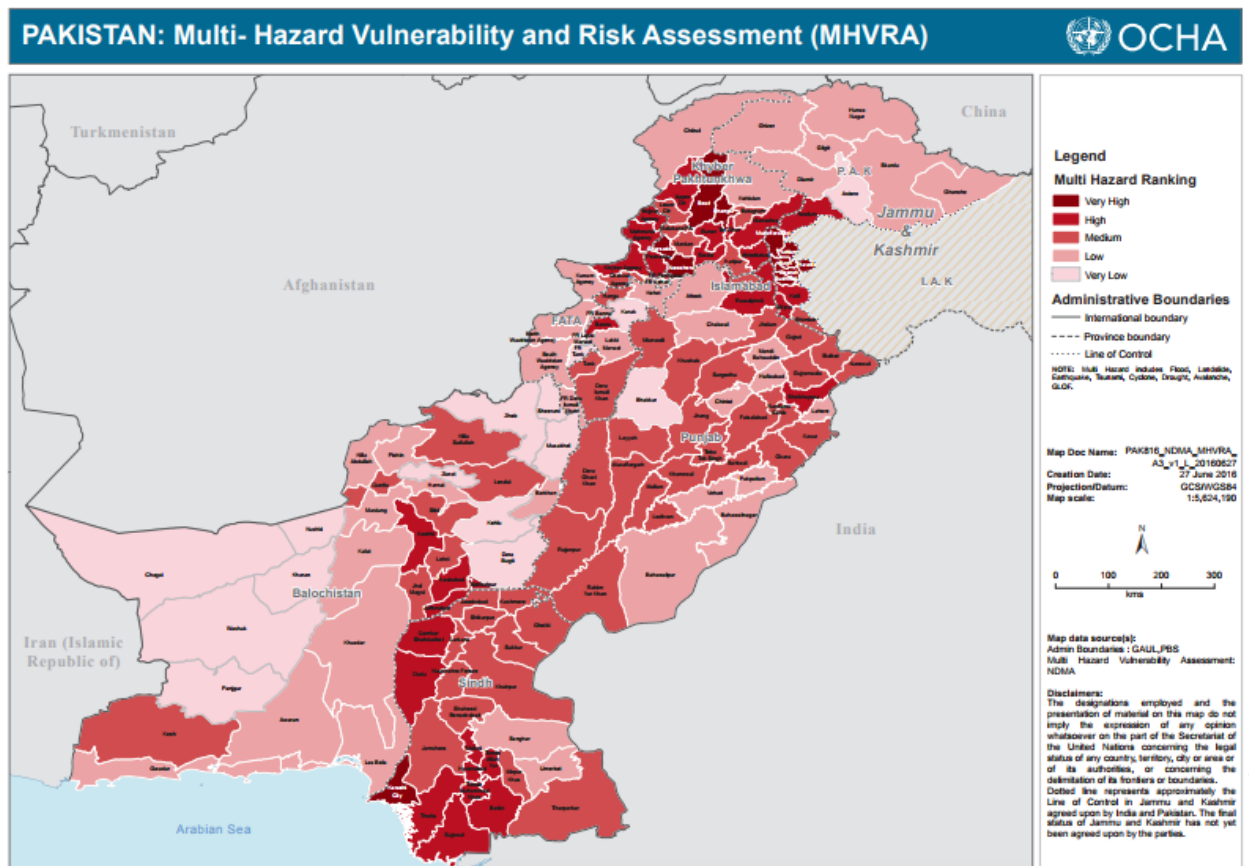
The matrix in table 2 provides a summary of the vulnerability analysis. It outlines climate characteristics and risks in each agro-ecological zone, livelihoods and food security in these areas, overall vulnerability to climate change and suggested measures. As the table demonstrates, extreme events and adverse climatic changes negatively affect food security. Figure 29 presents a map of climate vulnerability categories based on the analysis. It highlights the parts of Pakistan that are hot spots of climate vulnerability – drought-prone areas in Sindh and Balochistan; flood-prone areas in Sindh, Balochistan and Punjab; mountainous areas in GB, KP and AJK; and FATA, where resilience is curtailed by prolonged insecurity.

Climate vulnerability is a function of exposure; the sensitivity of livelihoods to the climate; and capacity, which depends on factors such as livelihood diversification, assets and food security. Areas with strong capacity are relatively less vulnerable, even when they are exposed to climate shocks. For instance, Punjab's economy, livelihoods, food security and institutional capacity may render it less vulnerable to the impacts of floods.

Table 2: Climate vulnerability profiles of agro-ecological zones

Agro-ecological zone	Province	Climate characteristics and risks	Livelihoods and food security	Vulnerability (districts)	Suggested measures
Wet mountains	KP	Both humid and arid, with hot to mild summers and cold winters; 235mm rainfall in summer and 116mm in winter. The Neelum river area is prone to floods.	Agriculture, poultry, forestry (non-timber forest products), aquaculture and mining-related livelihoods. Seasonal migration is common.	Mansehra, Battagram and Abbottabad are highly vulnerable	Flood forecasting and structural measures
	Punjab and KP	Rainfall has increased over the years, posing risk of landslide and floods and affecting livelihoods	Livestock, tourism, horticulture and wage labour-related livelihoods. Remittances are a major source of income.	Attock, Murree and Kohat are moderately vulnerable	Flood control measures, natural resource management and water storage
	AJK	Erratic rainfall often causes havoc for communities	Livestock, agriculture and timber logging-related livelihoods	Poonch, Haveli, Sudhanoti, Neelum, Muzaffarabad and Hattian Bala are highly vulnerable	Flood protection and landslide prevention measures
Northern dry mountains	KP and FATA	Torrential rains and glacial lake outburst floods (GLOFs) are potential climate risks	Forest-based livelihoods; seasonal migration is widespread. High food insecurity	Orakzai, Hangu, Malakand, Upper Dir and Lower Dir are highly vulnerable	Community capacity building, flood protection, land use and forest management
	GB	Cool temperatures; erratic, torrential rainfall patterns	Agriculture and livestock-related livelihoods; very little production. High food insecurity	Ghizer, Gilgit, Hunza-Nagar, Astore and Skardu are highly vulnerable	Land stabilization and livelihood support
Western dry mountains	KP and FATA	Semi-arid highlands with mild short summers, long cold winters; prone to flash floods and drought	Mining, livestock, horticulture and government jobs	Lakki Marwat, Bannu, Karak are the most vulnerable districts	Livelihood support, and the provision of basic services and facilities
	Balochistan	Semi-arid uplands with mild short summers and long cold winters; flash floods and droughts are common hazards	Agriculture, livestock rearing, mining and government jobs	Relatively less vulnerable to climate risks; good resilience due to livelihood diversity	Community organizations, livelihood diversification
Dry western plateau	Balochistan	Arid tropical area with a long-lasting dry season, hot summers (38–44°C) and cold winters (3–6°C); droughts are common	Mining and cottage industry-related livelihoods	Chagai, Kharan and Washuk are highly vulnerable; coastal areas in the south are less vulnerable	Drought monitoring and livelihood support
Sulaiman Piedmont	Punjab and Balochistan	Northeastern mountain belt; hot arid climate with temperatures of up to 50°C in the summer and mild winters (0–22°C); drought prone	Agriculture, livestock, fisheries, handicrafts and transport-related livelihoods	Dera Ghazi Khan and Rajanpur are vulnerable to climate risks; Lehri, Kachhi, Jhal Magsi and Nasirabad are less vulnerable	Flood management, drought monitoring and livelihood support

Figure 29: Multi-hazard vulnerability map of Pakistan



Source: UNOCHA, 2016.

The stakeholder consultations provided the following important insights on climate vulnerabilities in Pakistan's ten agro-ecological zones:

Changing precipitation: Rainfall patterns have changed over the past 20-30 years, with significant geographic variations. For instance, while the intensity of rainfall in arid parts of Sindh has decreased, it is believed to have increased in Sukkur and nearby districts. Precipitation appears to have increased in parts of Balochistan and FATA, but remained unchanged in KP and Punjab. Extreme events caused by excessive rainfall are noted in Punjab, KP and AJK. A delay in the onset of the monsoon season is evident, by as much as 30 days in eastern parts of the country. Consultations suggest that the monsoon is of a shorter duration than in the past.

Impact on farmers: Variations in the monsoon, and increased risks of floods and droughts, are observed in the Indus River Basin and its tributaries in Punjab and Sindh, where Pakistan's agricultural production is concentrated. So far, rainfall in

Punjab has been generally favourable for agriculture production. Yet, changing rainfall patterns delay the sowing of crops. As discussed, this extends the lean season, increases food prices and aggravates food insecurity, particularly in rural areas. Farmers who depend on rainfed agriculture, such as those in FATA and GB, are greatly affected by rainfall variability.

Impacts on livelihoods: A range of livelihoods around the country are affected by climate change. Along Balochistan's coasts, for instance, rising sea temperatures are depleting fish stocks; fishermen must travel further out to sea for their daily catch. In response, people are turning to casual wage labour and seasonal migration to cities. Livelihoods dependent on crops and livestock – as most rural livelihoods are in Pakistan – are being damaged by drought in Sindh, and landslides and glacial lake outburst floods (GLOFs) in northern Pakistan.

Mountain vulnerabilities: Consultations suggest that mountain communities are increasingly vulnerable to hazards, such as landslides and glacial lake outburst floods. This is in line with ICIMOD's findings on the growing number and size of glacial lakes in South Asia, prompted by glacial melt in the Hindu Kush range.¹³⁰

Living with climate change: Households are adopting diverse measures to cope with the erratic, unpredictable effects of a changing climate. For example, people in the dry western mountains of Balochistan and KP are diversifying their livelihoods, branching out by becoming part of the cottage industry, working in trade and producing handicrafts instead of relying exclusively on agriculture and livestock. In Sindh's Tharparkar district and neighbouring areas, growing numbers of people are turning to seasonal migration. Farmers in some areas are adopting farming techniques that are less water intensive.

¹³⁰ Vaidya, R.A. & Sharma, E. (eds.) 2014.



CHAPTER 6 CONCLUSIONS AND RECOMMENDATIONS

6. CONCLUSIONS AND RECOMMENDATIONS

Food security in Pakistan is highly sensitive to climate risks. This report has examined recent climate trends and future projections; the state of food availability, access, utilization and stability; and the relationship between climate trends and all four facets of food security. Its climate vulnerability analysis draws on the expert knowledge of local officials to better understand the challenges that climate change poses to livelihoods and food security in the country's ten agro-ecological zones. The report's findings affirm that climate variability is making people in Pakistan more vulnerable to food insecurity. Climate risks are real; managing them effectively should be an integral part of national food security strategies. This chapter summarizes the report's key findings, before turning to recommendations for action.

6.1 Climate trends

Mean temperatures in Pakistan have risen by 0.6°C since the beginning of the twentieth century, at a steady rate of 0.07°C per decade. A sharper rise is evident in arid parts of Balochistan and Sindh. Average annual rainfall is far heavier in the north (1000 mm) than in the south (200 mm). While there are no major changes in the amount of annual rainfall, variability has increased and seasonality has shifted in parts of Punjab and Sindh. Trends reveal a shift in rainfall towards the centre and south of the country with a slight increase in rain, and a decrease in rainfall in coastal areas and arid plains. The frequency and intensity of climate-related disasters – such as floods, glacial lake outburst floods (GLOFs), drought and landslides – has increased in recent decades.

6.2 Food security

Although Pakistan has a strong agricultural base, food insecurity is widespread. Eighteen percent of Pakistanis are undernourished and 44 percent of households consume less than 2,350 Kcal per adult equivalent per day, the normative standard set by Government. Variations in agricultural production are apparent in recent years and there are significant geographic disparities in food production, prompting heavy reliance on markets in many areas. On average, households in Pakistan already spend half their monthly income on food.

With food prices increasing steadily since 2008, access to food is severely restricted when climate-related shocks cause prices to rise sharply. Challenges abound in terms of food utilization, including low levels of dietary diversity and high levels of malnutrition. The stability of food systems is curtailed by challenges to food production/availability, access and consumption, compounded by the challenge of feeding a rapidly growing population.

6.3 Food security and climate interface

6.3.1 Food production/availability

Food production in Pakistan responds differently to changes in climate variables. A positive relationship exists between wheat and high temperatures, and between rice and greater rain. However, as temperatures continue to climb and rainfall becomes erratic, they affect other variables central to crop production – such as soil moisture, water availability and the timings for sowing and harvesting. As such, these climatic changes threaten food production.

For example, variations in rainfall and rising temperatures affect *when* crops can be sowed and harvested. The late sowing of wheat results in late harvests in Punjab, Pakistan's breadbasket. This extends the lean season for farmers, drives up prices and prompts food insecurity. Late wheat harvests, in turn, affect the sowing period for cotton, one of Pakistan's major cash crops. The late sowing of cotton raises the danger of infestation by pests – which reduced cotton yields in 2015 with severe economic consequences. Flash floods and delays in the start of the rainy season impact yields in Punjab, where 90 percent of crops depend on irrigation. In parts of Punjab, KP and Sindh, food production losses have been caused by untimely rain in March and April, the harvest season for wheat.

6.3.2 Food access

Low levels of food production curtail access to food; not only is there less food available, but rising prices limit poorer people's purchasing power. This is compounded among agriculture-dependent households, whose incomes decrease as food outputs decline. Alongside the climate's effects on economic access to food, climate-related disasters affect physical access. For instance, disasters damage roads and infrastructure, disrupt markets, cut off supplies and cause the loss of livestock – all of which prevent access to food. Areas that rely

on imports, such as Balochistan and FATA, are especially vulnerable.

6.3.3 Food utilization

Higher food prices and increasing poverty among agriculture-dependent households lead to lower levels of food consumption. As people opt for eating less, and rely on less nutritious foods, malnutrition abounds. Rising temperatures and climate-related disasters, particularly floods, increase the prevalence of waterborne diseases – malaria, typhoid and diarrheal diseases which worsen malnutrition – alongside zoonotic diseases that harm livestock.

6.3.4 Livelihoods

Agriculture is highly vulnerable to climate risks – a major concern as agriculture is the main source of livelihood for most rural Pakistani households. Landless or land-poor farmers are highly vulnerable, notably those who depend on rainfed farming or lack diverse sources of income. Thus, climate adaptive agriculture and livelihood diversification is vital for addressing the impacts of climate change.

6.3.5 Climate vulnerability hot spots

Climate vulnerability is a function of exposure to climate risks, the sensitivity of livelihoods to the climate, and coping capacity. The most vulnerable areas are those which are exposed to climate hazards, in which populations depend on climate-sensitive livelihoods, and in which high levels of food insecurity exist. This report identifies hot spots of climate vulnerability in Pakistan – drought-prone areas of Sindh and Balochistan; flood-prone areas in Sindh, Balochistan and Punjab; mountainous areas in GB, KP and AJK; and parts of FATA. Predictably, these are areas in which the prevalence of food insecurity is also high. Vulnerability is lower in areas where coping capacity is stronger, even when exposed to climate extremes. For example, food-insecurity prone districts in Punjab are less vulnerable to climate risks due to their institutional response capacity, diversified livelihoods and a relatively positive food security situation.

6.3.6 Agro-ecological zones as a unit of climate analysis

The report demonstrates that Pakistan's agro-ecological zones can be used as a

logical entry point for climate vulnerability analysis. Although they offer a strong basis for analysis, provincial consultations suggest that updating these classifications will enable more precise zoning and effective responses.

6.2.7 Recommendations

Based on this report's findings and consultations with local experts, the following recommendations for improving food security by managing climate risks in Pakistan are put forth for a range of stakeholders:

Food security component	Climate risks and recommendations
Food availability	<p data-bbox="432 815 1433 869">Temperature variations</p> <ul data-bbox="432 904 1433 1879" style="list-style-type: none"> <li data-bbox="432 904 1433 1084">• Use smartphones to connect farmers with agriculture institutes and disaster management authorities. This will reduce risks by ensuring that farmers' receive early warnings and weather updates when temperatures are expected to rise. (<i>Short-term¹³¹: Pakistan Meteorological Department, Provincial Disaster Management Authorities</i>) <li data-bbox="432 1084 1433 1227">• Revisit agro-ecological zones and identify vulnerable areas in agricultural systems that are prone to increasing heat-related crop failure. (<i>Medium-term¹³²: National Disaster Management Authority, Pakistan Meteorological Department</i>) <li data-bbox="432 1227 1433 1370">• Regulate the responsible use of chemical inputs to cope with temperature-induced stress in plants, and temperature-related outbreak of pests during critical stages of crop growth. (<i>Medium-term: Provincial Agriculture Research & Extension Wings</i>) <li data-bbox="432 1370 1433 1478">• Develop and disseminate new heat-tolerant crop varieties. (<i>Medium-term: National Agriculture Research Centre, Provincial Agriculture Research & Extension Wings</i>) <li data-bbox="432 1478 1433 1621">• Raise awareness of best practices in cattle husbandry, feed delivery, sprinklers, shade and air flows to ensure that livestock are not harmed by rising temperatures and heat stress. (<i>Medium-term: Provincial Livestock & Dairy Departments</i>) <li data-bbox="432 1621 1433 1765">• Establish Climate Change Units in crop research institutes; these should devise adaptive strategies for addressing the projected impacts of climate change on agriculture. (<i>Medium-term: Provincial Planning & Development Departments, Ministry of Climate Change</i>) <li data-bbox="432 1765 1433 1879">• Identify the possibilities for adopting new breeds of cattle and raising local breeds that can cope with hot environments. (<i>Long-term¹³³: Provincial Livestock & Dairy Departments</i>)

¹³¹ Short-term refers to 6-18 months.

¹³² Medium-term refers to 18-36 months.

¹³³ Long-term refers to more than 36 months.

Food security component	Climate risks and recommendations
Food availability	<p>Drought</p> <ul style="list-style-type: none"> • Revisit agro-ecological zones to identify drought-prone areas and study the impacts of drought severity on food security conditions. <i>(Medium-term: National Disaster Management Authority, Pakistan Meteorological Department)</i> • Develop and disseminate drought-resistant crop and fodder varieties. <i>(Medium-term: Agriculture Extension & Research Wing, Provincial Livestock & Dairy Departments)</i> • Introduce best practices for conserving soil and water. <i>(Medium-term: National Agriculture Research Council, Provincial Agriculture Extension & Research Wings)</i> • Develop and introduce short rotation crops and hybrid crop varieties. <i>(Medium-term: National Agricultural Research Centre, Provincial Agriculture Research & Extension Wings)</i> • Develop new mechanisms to increase the practice of crop residue management for conserving agricultural land in drought-prone areas <i>(Medium-term: Provincial Agriculture Research & Extension Wings)</i> • Introduce interventions that support forestry and agro-forestry development. <i>(Medium-term: Provincial Forest Departments)</i>
	<p>Floods</p> <ul style="list-style-type: none"> • Strengthen embankments in vulnerable areas to reduce the danger of crop losses caused by floods. <i>(Short-term: District Administrations, Provincial Irrigation Departments)</i> • Vaccinate livestock in climate vulnerability hot spots to prevent and reduce the spread of disease. <i>(Short-term: Provincial Livestock & Dairy Departments)</i> • Revisit agro-ecological zones and map flood-prone areas within these zones. <i>(Medium-term: National Disaster Management Authority, Pakistan Meteorological Department, Provincial Irrigation Departments)</i> • Identify and create water storage points – such as divergence canals to divert flood water, or ‘sponge cities’ that retain rain and flood water for use within their boundaries. <i>(Medium-term: Provincial Irrigation Departments, Provincial Planning & Development Departments, District Development Authorities)</i> • Rehabilitate field watercourses after floods with the participation of local communities. <i>(Medium-term: Provincial Irrigation Departments)</i>

Food security component	Climate risks and recommendations
Food access	<p>Temperature variations</p> <ul style="list-style-type: none"> • Identify and propose mechanisms to strengthen innovative skills among farmers, thereby enabling them to supplement their incomes. <i>(Medium-term: Provincial Agriculture Research & Extension Wings)</i> • Use alternative fuels and green technologies – such as biogas, solar power, fuel efficient stoves – to meet demands for increased cold storage capacity. <i>(Long-term: Academia, Pakistan Council of Renewable Energy Technologies)</i>
	<p>Drought</p> <ul style="list-style-type: none"> • Increase the financial stability of drought-affected farmers through cash transfers, such as transfers through the Benazir Income Support Programme (BISP). <i>(Short-term: Ministry of Planning, Development & Reform)</i> • Introduce a weather index-based micro-insurance product to meet the needs of vulnerable communities and extend financial social safety nets. <i>(Short-term: Provincial Food Ministries, State Bank of Pakistan)</i> • Introduce low-cost, indigenous technologies to enhance resilience and reduce climate risk among vulnerable groups, particularly smallholders. <i>(Medium-term: National Agricultural Research Centre, Provincial Agriculture Research & Extension Wings)</i>
	<p>Floods</p> <ul style="list-style-type: none"> • Strengthen government regulations on effective market and price monitoring systems, particularly to mitigate the impact of floods. <i>(Short-term: District Administrations)</i> • Store food cakes and livestock feed for use in emergencies. <i>(Short-term: Provincial Livestock & Dairy Departments)</i> • Ensure the availability of food banks and proper mechanisms to promote community-managed food banks. <i>(Medium-term: Provincial Food Departments)</i> • Ensure physical access to roads, bridges and transport infrastructure for commuters. <i>(Medium-term: District Administrations, District Development Authorities, Municipal Authorities)</i>

Food security component	Climate risks and recommendations
Food utilization	<p>Temperature variations</p> <ul style="list-style-type: none"> • Promote preventive measures for coping with heat stress, especially among vulnerable groups, including children, women, the elderly and livestock. <i>(Medium-term: District Administration Authorities)</i> • Enhance people's awareness of the need to store food safely to prevent it from spoiling, and the importance of avoiding the use of spoiled food. <i>(Short-term: Provincial Food Departments)</i> • Develop new credit schemes to support the purchase of necessary equipment – such as refrigerators or coolers – to protect food from spoiling. <i>(Long-term: Provincial Food Departments, State Bank of Pakistan)</i>
	<p>Drought</p> <ul style="list-style-type: none"> • Ensure a stable supply of water in climate vulnerability hot spots. <i>(Medium-term: Water and Sanitation Authority, Municipal Corporations)</i> • Ensure the availability of essential community infrastructure, such as latrines, canteens and grain stores. <i>(Short-term: District Administrations, Provincial Health Departments)</i>
	<p>Floods</p> <ul style="list-style-type: none"> • Provide people with water purifying tablets. <i>(Medium-term: Provincial Food Departments)</i> • Ensure the availability of clean drinking water after floods in order to reduce the spread of diseases in humans and animals – including diarrhoeal diseases, malaria and zoonotic diseases. <i>(Medium-term: District Administration Authorities)</i> • Ensure the availability of vaccinations and medicines in vulnerable areas to treat illnesses in animals and humans following flooding. <i>(Short-term: Ministry of Health, Provincial Livestock & Dairy Departments, Basic Health Units)</i>

Food security component	Climate risks and recommendations
Food stability	<p>Temperature variations</p> <ul style="list-style-type: none"> • Enhance the capacity of agriculture research institutes to identify the impacts of climate change on crop growth and devise appropriate adaptation measures. <i>(Medium-term: Provincial Planning & Development Departments)</i> • Develop models to assess the impacts of climate change and devise adaptation measures specific to each agro-ecological zone. <i>(Medium-term: Provincial Disaster Management Authorities, Ministry of Climate Change)</i> • Conduct research to better understand the relationship between heat stress in livestock and pain, aggression and malaise. <i>(Long-term: Provincial Livestock & Dairy Departments)</i>
	<p>Drought</p> <ul style="list-style-type: none"> • Promote the conservation and sustainable management of irrigation water. <i>(Long-term: Provincial Irrigation Departments)</i> • Integrate sustainable solutions from disaster risk management (DRM) programmes, social safety net (SSN) programmes and agricultural development interventions to develop climate change adaptation initiatives. <i>(Long-term: Provincial Agriculture Research and Extension Wings, Provincial Disaster Management Authorities)</i>
	<p>Floods</p> <ul style="list-style-type: none"> • Devise comprehensive, citizen-focused early warning systems and weather updates; and use new technologies, such as smartphones, to circulate updates. <i>(Short-term: Federal Flood Division, Provincial Disaster Management Authorities, Pakistan Meteorological Department)</i> • Create a weather index-based micro insurance product that meets the needs of vulnerable communities and extends financial social safety nets. <i>(Short-term: Provincial Food Departments, State Bank of Pakistan)</i> • Integrate disaster risk insurance with existing social protection schemes – such as the Benazir Income Support Programme (BISP) or the Prime Minister’s National Health Programme – to ensure that vulnerable households receive timely monetary compensation. <i>(Long-term: Ministry of National Food Security, Ministry of Planning, Development & Reform)</i>

BIBLIOGRAPHY

- Agriculture Victoria.** 2018. *Animal health after floods*. Melbourne, Victoria State Government. Available at: <http://agriculture.vic.gov.au/agriculture/emergencies/recovery/livestock-after-an-emergency/animal-health-after-flood>
- Ahmad, M. & Farooq, U.** 2010. The State of Food Security in Pakistan: Future Challenges and Coping Strategies. *Pakistan Development Review*, 49(4): 903–923.
- Ahmad, M., Nawaz, M., Iqbal M, & Javed, S.** 2014. *Analysing the Impact of Climate Change on Rice Productivity in Pakistan*. Munich Personal RePEc Archive (MPRA) Paper 72861. Available at: https://mpra.ub.uni-muenchen.de/72861/3/MPRA_paper_72861.pdf
- Ahmad, M., Siftain, H. & Iqbal, M.** 2014. *Impact of Climate Change on Wheat Productivity in Pakistan: A District Level Analysis*. Munich Personal RePEc Archive (MPRA) Paper. Available at: <https://mpra.ub.uni-muenchen.de/72859>
- Ali, S., Liu, Y., Ishaq, M., Shah, T., Abdullah, Ilyas, A. & Ud Din, I.** 2017. Climate Change and Its Impact on the Yield of Major Food Crops: Evidence from Pakistan. *Foods*, 6(6): 39. DOI: 10.3390/foods6060039.
- Arif, M.** 2007. *Agriculture and Food Security in Pakistan: Thematic Paper*. Lahore, South Asia Partnership Pakistan. Available at: http://sappk.org/wp-content/uploads/publications/eng_publications/Agriculture_and_Food_Security.pdf
- Asian Development Bank.** 2017. *Climate Change Profile of Pakistan*. Metro Manila, Asian Development Bank. Available at: <https://www.adb.org/sites/default/files/publication/357876/climate-change-profile-pakistan.pdf>
- Chaudhary, Q.Z., Mahmood, A., Rasul, G. & Afzaal, M.** 2009. *Climate Change Indicators of Pakistan: Pakistan Meteorological Department Technical Report No. PMD-22/2009*. Islamabad, Pakistan Meteorological Department.
- Chaudhry, Q. & Rasul, G.** 2004. Agro-climatic classification of Pakistan. *Science Vision*, 9(4): 59–66.

Checkley, W., Epstein, L.D., Gilman, R.H., Figueroa, D., Cama, R.I., Patz, J.A. & Black, R.E. 2000. Effect of El Niño and ambient temperature on hospital admissions for diarrhoeal diseases in Peruvian children. *Lancet*, 355(9202): 442–50.

Dash, S., Chakravarty, A.K., Singh, A., Upadhyay, A., Singh, M. & Yousuf, S. 2016. Effect of heat stress on reproductive performances of dairy cattle and buffaloes: A review. *Vet World*, 9(3): 235–244.

Eckstein, D., Künzel, V. & Schäfer, L. 2017. *Global Climate Risk Index 2018*. Bonn, Germanwatch. Available at: <https://germanwatch.org/en/download/20432.pdf>

FAO & WFP. 2009. *The State of Food Insecurity in the World*. Rome, Food and Agriculture Organization.

FAO & WFP. 2015. *The State of Food Insecurity in the World*. Rome, Food and Agriculture Organization.

FAO, IFAD, UNICEF, WFP & WHO. 2017. *The State of Food Security and Nutrition in the World 2017: Building resilience for peace and food security*. Rome, Food and Agriculture Organization. Available at: <http://www.fao.org/3/a-l7695e.pdf>

FAO. 2008. *An Introduction to Basic Concepts of Food Security. Food Security Information for Action: Practical Guides*. Rome, Food and Agriculture Organization.

FAO. 2013. *Pakistan: Review of the wheat sector and grain storage issues*. Rome, Food and Agriculture Organization/World Bank Cooperative Programme. Available at: <http://www.fao.org/docrep/018/i3251e/i3251e.pdf>

FAO. 2016. *Pakistan at a Glance*. Islamabad, Food and Agriculture Organization. Available at: <http://www.fao.org/pakistan/fao-in-pakistan/pakistan-at-a-glance/en>

Farooqi, A.B., Khan, A.H. & Mir, H. 2005. Climate change perspective in Pakistan. *Pakistan Journal of Meteorology*, 2(3): 11-21.

Federal Flood Commission. 2016. *Annual Flood Report 2016*. Islamabad, Ministry of Water & Power. Available at: <http://mowr.gov.pk/wp-content/uploads/2018/06/Annual-Flood-Report-2016.pdf>

GCISC. 2018. *Global Change Impact Studies Centre*. Islamabad, GCISC. Available at: <http://www.gcisc.org.pk>

Government of Pakistan. 2013a. *Framework for Implementation of Climate Change Policy (2014-2030)*. Islamabad, Climate Change Division. Available at: <http://www.gcisc.org.pk/Framework%20for%20Implementation%20of%20CC%20Policy.pdf>

Government of Pakistan. 2013b. *Pakistan Economic Survey 2012-13*. Islamabad, Ministry of Finance. Available at: http://www.finance.gov.pk/survey_1213.html

Government of Pakistan. 2014a. *Pakistan 2025: One Nation, One Vision*. Islamabad, Planning Commission, Ministry of Planning, Development & Reform. Available at: <https://www.pc.gov.pk/vision/visiondoc>

Government of Pakistan. 2014b. *Pakistan Economic Survey 2013-14*. Islamabad, Ministry of Finance. Available at: http://www.finance.gov.pk/survey_1314.html

Government of Pakistan. 2015. *Pakistan Economic Survey 2014-15*. Islamabad, Ministry of Finance. Available at: http://www.finance.gov.pk/survey_1415.html

Government of Pakistan. 2016a. *Minimum Cost of the Diet (MCoD) Pakistan*. Islamabad, Planning Commission, Ministry of Planning, Development & Reform. Available at: https://reliefweb.int/sites/reliefweb.int/files/resources/mcod_pakistan_july_2016.pdf

Government of Pakistan. 2016b. *Pakistan Economic Survey 2015-16*. Islamabad, Ministry of Finance. Available at: http://www.finance.gov.pk/survey_1516.html

Government of Pakistan. 2017. *Pakistan Economic Survey 2016-17*. Islamabad, Ministry of Finance. Available at: http://www.finance.gov.pk/survey_1617.html

Haensler, A., Saeed, F. & Jacob, D. 2013. Assessing the robustness of projected precipitation changes over central Africa on the basis of a multitude of global and regional climate projections. *Climatic Change*, 121(2): 349–363. DOI: 10.1007/s10584-013-0863-8.

Hulme, P.E. 2005. Adapting to climate change: is there scope for ecological management in the face of a global threat? *Journal of Applied Ecology*, 42(5): 784–794.

IFPRI. 2015. *2015 Global Hunger Index: Armed Conflict and the Challenge of Hunger*. Bonn, Washington, D.C. & Dublin, International Food Policy Research Institute. Available at: <http://www.ifpri.org/publication/2015-global-hunger-index-armed-conflict-and-challenge-hunger>

IFPRI. 2016. *2016 Global Hunger Index: Getting to Zero Hunger*. Bonn, Washington D.C. & Dublin, International Food Policy Research Institute. Available at: <http://www.ifpri.org/publication/2016-global-hunger-index-getting-zero-hunger>

IFPRI. 2017. *2017 Global Hunger Index: The Inequalities of Hunger*. Washington D.C. & Dublin, International Food Policy Research Institute. Available at: <http://www.ifpri.org/publication/2017-global-hunger-index-inequalities-hunger>

IPCC. 2007. *Climate Change 2007: Impacts, Adaptation, and Vulnerability*. Cambridge: Cambridge University Press. Available at: <https://www.ipcc.ch/report/ar4/wg2/>

IPCC. 2013. *Climate Change 2013: The Physical Science Basis. Contribution of Working Group I to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change*. Cambridge, Cambridge University Press. Available at: <https://www.ipcc.ch/report/ar5/wg1/>

IPCC. 2014a. *Climate Change 2014: Impacts, Adaptation and Vulnerability*. Cambridge: Cambridge University Press. Available at: <https://www.ipcc.ch/report/ar5/wg2/>

IPCC. 2014b. *The Fifth Assessment Report of the Intergovernmental Panel on Climate Change*. Geneva, IPCC. Available at: http://unfccc.int/science/workstreams/cooperation_with_the_ipcc/items/8732.php

Javed , S.A., Ahmad, M.A. & Iqbal, M. 2014. Impact of Climate Change on Agriculture in Pakistan: A District Level Analysis. *PIDE Climate Change Working Paper Series*, 3. Islamabad, Pakistan Institute of Development Economics. Available at: http://pide.org.pk/pdf/Climate_Change_3.pdf

Khan, M.A.A., Ramay, S.A., Munawar, Z. & Ahmed, V. 2011. *National Economic and Environmental Development Study (NEEDS): Pakistan*. Islamabad, Ministry of Environment & UNFCCC. Available at:

<https://unfccc.int/files/adaptation/application/pdf/pakistanneeds.pdf>

Khan, M.J. 2017. *Agriculture and Textile Sector: Challenges and Way Forward*. Punjab Economic Research Institute Policy Brief. Lahore, PERI, Planning & Development Department Punjab. Available at:

https://peri.punjab.gov.pk/policy_briefs

Kreft, S., Eckstein & Melchior, I. 2016. *Global Climate Risk Index 2017*. Bonn, Germanwatch. Available at: <https://germanwatch.org/en/12978>

Lloyd, S.J., Kovats, R.S. & Chalabi, Z. 2007. Climate Change, Crop Yields, and Under-nutrition: Development of a Model to Quantify the Impact of Climate Scenarios on Child Under-nutrition. *Environmental Health Perspectives*, 119(12):1817-1823.

Madzwamuze, M. 2010. *Climate Governance in Africa: Adaptation Strategies and Institutions*. Cape Town, Unity Press & Heinrich Boll Stiftung. Available at: https://www.boell.de/sites/default/files/assets/boell.de/images/download_de/Climate_Governance_in_Africa.pdf

McSweeney, C., New, M. & Lizcano, G. 2010. *UNDP Climate Change Country Profiles: Pakistan*. Available at: <http://country-profiles.geog.ox.ac.uk>

McSweeney, C., New, M., Lizcano, G. & Lu, X. 2010. The UNDP Climate Change Country Profiles Improving the Accessibility of Observed and Projected Climate Information for Studies of Climate Change in Developing Countries. *Bulletin of the American Meteorological Society*, 91: 157–166.

Ministry of Climate Change. 2012. *National Climate Change Policy*. Islamabad, Government of Pakistan. Available at: <http://www.nrsp.org.pk/gcf/docs/National-Climate-Change-Policy-of-Pakistan.pdf>

Ministry of National Food Security and Research, WFP, FAO & UNICEF. 2016. *The State of Food Security in Pakistan 2016*. [The report has been technically cleared by experts; however, it awaits official endorsement from the Ministry of National Food Security and Research].

Ministry of Planning, Development & Reform, UNICEF & Agha Khan University. 2012. *National Nutrition Survey (NNS) 2011*. Islamabad, Government of Pakistan.

Mitchell, A. 2013. Risk and Resilience: From Good Idea to Good Practice. *OECD Development Cooperation Working Papers*, 13. Paris, OECD. Available at: <http://www.oecd.org/dac/conflict-fragility-resilience/docs/FINAL%20WP%2013%20Resilience%20and%20Risk.pdf>

Mitchell, T. n.d. *Data: climate data-sets*. Norwich, Tyndall Centre for Climate Change Research. Available at: <https://crudata.uea.ac.uk/~timm/index.html>

National Disaster Management Authority. 2011. *Annual Report 2011*. Islamabad, Government of Pakistan. Available at: <http://www.ndma.gov.pk/publications/AR2011.pdf>

OECD. 2009. *Integrating Climate Change into Development Co-operation: Policy Guidance*. Paris, Organisation for Economic Co-operation and Development. Available at: https://www.oecd-ilibrary.org/development/integrating-climate-change-adaptation-into-development-co-operation-policy-guidance_9789264054950-en

OECD. 2014. *Guidelines for Resilience Systems Analysis: How to analyse risk and build a roadmap to resilience*. Paris, Organisation for Economic Co-operation and Development. Available at: <https://www.oecd.org/dac/conflict-fragility-resilience/Resilience%20Systems%20Analysis%20FINAL.pdf>

Pakistan Agricultural Research Council. 2014. *Wheat in Pakistan: A Status Paper*. Islamabad, PARC National Coordinator Wheat. Available at: http://www.parc.gov.pk/files/parc_pk/January-15/Status%20Papers/status%20paper%20Wheat%20in%20Pakistan.pdf

Pakistan Bureau of Statistics. 1990 – 2015. *Agriculture Statistics of Pakistan* (various issues). Islamabad, Government of Pakistan. Available at: <http://www.pbs.gov.pk/content/agriculture-statistics>

Pakistan Bureau of Statistics. 1998. *Population Census 1998*. Islamabad, Government of Pakistan.

Pakistan Bureau of Statistics. 2004–2015. *Pakistan Social and Living Standards Measurement Survey (PSLM)* (various issues). Islamabad, Government of Pakistan. Available at: <http://www.pbs.gov.pk/content/pakistan-social-and-living-standards-measurement>

Pakistan Meteorological Department. 2012. *Climate Change in Pakistan Focused on Sindh Province*. Technical Report PMD-25/2012. Islamabad, Pakistan Meteorological Department. Available at: http://www.pmd.gov.pk/report_rnd.pdf

Phalkey, R.K., Jan, C.A., Marx, S., Hofle, B. & Sauerborn, R. 2015. Systematic review of current efforts to quantify the impacts of climate change on undernutrition. *Proceedings of the National Academy of Sciences*, 112(33): E4522–9.

PIDE & IDRC. 2014. Impact of climate change on wheat productivity in Pakistan: A district level analysis. *PIDE Climate Change Working Paper Series*, 1. Islamabad, Pakistan Institute of Development Economics. Available: <https://mpra.ub.uni-muenchen.de/72859/>

Planning Commission, Ministry of Planning, Development & Reform. 2016. *Pakistan's Revised Poverty Line*. Islamabad, Government of Pakistan.

Porter, J.R. & Semenov M.A. 2005. Crop responses to climatic variation. *Philosophical Transactions B, Royal Society*, 360(1463): 2021–2035. Available at: <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC1569569>

Raza, A. & Ahmad, M. 2015. Analysing the Impact of Climate Change on Cotton Productivity in Punjab and Sindh, Pakistan. *PIDE Climate Change Working Paper Series*, 9. Islamabad, Pakistan Institute of Development Economics. Available at: http://www.pide.org.pk/pdf/Climate_Change_9.pdf

Sheikh, M.M., Manzoor, N., Adnan, M., Ashraf, J. & Khan, A.M. 2009. *Climate Profile and Past Climate Changes in Pakistan*. GCISC-RR-01 Research Report. Islamabad, Global Change Impact Study Centre.

Siddiqui, R., Samad, G., Nasir, M. & Jalil, H.H. 2014. *The impact of climate change on major agricultural crops: Evidence from Punjab, Pakistan*. Islamabad, Pakistan Institute of Development Economics. Available at: <http://www.pide.org.pk/psde/pdf/AGM28/Rehana%20Siddiqui%20Ghulam%20Samad%20Muhammad%20Nasir%20and%20Hafiz%20Hanzla%20Jalil.pdf>

Suleri, A. 2017. Zero political power for zero hunger in Pakistan: How food security is undermined by political power plays. *Perspectives: Political Analysis and Commentary (Heinrich Bol Stiftung)*, 5: 34–36. Available at:

<https://www.sdpi.org/publications/files/Zero-political-power-for-zero-hunger-in-Pakistan-How-food-security.pdf>

Suleri, A.Q. & Haq, S. 2009. *Food Insecurity in Pakistan*. Islamabad, SDC, SDPI & WFP. Available at:

<https://documents.wfp.org/stellent/groups/public/documents/ena/wfp225636.pdf>

Sultana, H., Ali, N., Iqbal, M.M. & Khan, A.M. 2009. Vulnerability and adaptability of wheat production in different climatic zones of Pakistan under climate change scenarios. *Climatic Change*, 94(1):123–142.

The Economist Intelligence Unit. 2017. *Global Food Security Index 2017*. London, The Economist Intelligence Unit. Available at:

<http://foodsecurityindex.eiu.com/Country/Details#Pakistan>

Tirado, M.C. & Meerman, J. 2012. Climate Change and Food and Nutrition Security. In B. Thompson & M.J. Cohen, eds. *The Impact of Climate Change and Bioenergy on Nutrition*, p. 43–60. Dordrecht, Springer/Rome, Food and Agriculture Organization. DOI:10.1007/978-94-007-0. Available at: <http://www.fao.org/3/as502e.pdf>

UNDP, OPHI & Planning Commission. 2016. *Multidimensional Poverty in Pakistan*. Islamabad, UNDP/Ministry of Planning Development & Reform. Available at: <http://www.ophi.org.uk/wp-content/uploads/Multidimensional-Poverty-in-Pakistan.pdf>

UNEP. 2013. *The Environment and Climate Change Outlook of Pakistan*. Islamabad, United Nations Environment. Available at:

<http://www.uncclearn.org/sites/default/files/inventory/unep25082015.pdf>

UNICEF. 2015. *Progress Report 2013-2015: Improve Access to Sanitation*. Islamabad, United Nations Children's Fund. Available at:

https://www.unicef.org/pakistan/Improve_Access_to_Sanitation.pdf

UNOCHA. 2016. *Multi-Hazard Vulnerability and Risk Assessment (MHVRA) 27 June 2016*. Islamabad, UN Office for the Coordination of Humanitarian Affairs.

UNOCHA. n.d. *What are El Niño and La Niña?* Geneva, UN Office for the Coordination of Humanitarian Affairs. Available at:
<https://www.unocha.org/es/themes/el-ni%C3%B1o/el-ni%C3%B1o-and-la-ni%C3%B1a>

Vaidya, R.A. & Sharma, E. (eds.) 2014. *Research Insights on Climate and Water in the Hindu Kush Himalaya*. Kathmandu, International Centre for Integrated Mountain Development (ICIMOD). Available at:
<http://lib.icimod.org/record/32171/files/FM-RIwater.pdf>

Van Vuuren, D.P., Edmonds, J., Kainuma, M., Riahi, K., Thomson, A., Hibbard, K., Hurtt, G.C. & Kram, T. 2011. The representative concentration pathways: An overview. *Climatic Change*, 109(1): 5–31.

Walsh, R.P.D. & Lawler, D.M. 1981. Rainfall seasonality: description, spatial patterns and change through time. *Weather*, 36(7): 201–208.

WFP. 2014. *Integrated Food Security Phase Classification (IPC)*. Rome, World Food Programme.

WFP. 2015. *El Niño: Implications and Scenarios for 2015*. Rome, World Food Programme. Available at:
<http://documents.wfp.org/stellent/groups/public/documents/ena/wfp276236.pdf>

WFP. 2017a. Vulnerability Analysis and Mapping Unit, WFP Country Office Pakistan. Islamabad, World Food Programme.

WFP. 2017b. Vulnerability Analysis and Mapping Unit, WFP Headquarters. Rome, World Food Programme.

WFP. 2017c. *Integrated Context Analysis (ICA) on Vulnerability to Food Insecurity and Natural Hazards, Pakistan 2017*. Islamabad, World Food Programme & National Disaster Management Authority. Available at:
<https://geonode.wfp.org/documents/7444>

WFP. n.d. *Pakistan*. Islamabad, World Food Programme. Available at:
<http://www1.wfp.org/countries/pakistan>

Wheeler, T.R., Craufurd, P.Q., Ellis, R.H., Porter, J.R. & Vara Prasad, P.V. 2000. Temperature variability and the yield of annual crops. *Agriculture, Ecosystems and Environment*, 82(2000): 159–167. Available at: <http://www-personal.ksu.edu/~vara/wheeler-tr-ae00.pdf>

World Bank. 2013. *World Development Indicators (WDI) 2013: Pakistan*. Washington, D.C., World Bank. Available at:
<https://data.worldbank.org/country/Pakistan>

World Bank. 2015. *World Development Indicators (WDI) 2015: Pakistan*. Washington, D.C., World Bank. Available at:
<http://databank.worldbank.org/data/reports.aspx?source=world-development-indicators>

Zahid, M. & Rasul, G. 2012. Changing trends of thermal extremes in Pakistan. *Climatic Change*, 113(3-4): 883–896. DOI: 10.1007/s10584-011-0390-4.

ANNEXES

Annex I Vulnerability analysis matrix

Livelihood zone	Exposure		Sensitivity	Potential Impacts	Adaptive capacity						Total vulnerability	
	Weather variability	Extreme weather events	Changes in weather patterns and/or intensity		Stable non- farm income	Irrigated productivity systems	Asset ownership	Migration opportunities	Diversification of crops or farm activities	Diversification of occupation	15%	85%
Livestock-subsistence agriculture				100%							15%	85%
Primary occupation (livestock)	1	1	1		0	0	1	1	0	1		
Secondary occupation (subsistence agriculture)	1	1	1		0	0	0	n/a	0	n/a		
TOTAL				100%							15 %	85%

Annex II Pakistan agro-ecological zones

In 1980, the Pakistan Agricultural Research Council (PARC) classified the country's territory into ten agro-ecological zones, based upon a survey and a review of available literature on physiographic characteristics, climate, soil and other factors that affect agriculture. These agro-ecological zones are briefly described as follows:

Agro-ecological zone I (Indus Delta) comprises areas in the districts of Thatta, Badin and Hyderabad, in the province of Sindh. With an arid tropical marine climate, the zone has moderately hot summers and mild winters. Soils in the area are rich with clay and silt. Irrigation enables the cultivation of rice, sugarcane, pulses, bananas and other fruits. During winter, clover, lentils and legumes are grown.

Agro-ecological zone II (southern irrigated plain) covers areas in the districts of Hyderabad, Badin, Tharparkar, Sanghar, Dadu, Khairpur, Larkana, Nawabshah, Jacobabad, Sukkar, Rahim Yar Khan, Sibi and Shikarpur, in the province of Sindh. The arid sub-tropical continental climate is characterized by hot summers and mild winters. Soils in the area are calcareous, silt loam and silt clays, with weak structures and good porosity. In terms of land use, canal irrigated agriculture predominates. Cotton, wheat mustard, sugarcane and clover are the main crops grown along the lower banks of the Indus River. Rice, wheat, chick peas and clover are grown on the right bank, while sorghum is grown in areas where water is scarce.

Agro-ecological zone III A (sandy deserts) comprises areas in Tharparkar, Khairpur, Nawabshah, Sanghar, Rahim Yar Khan, Bahawalpur and Bahawalnagar in the province of Sindh – including the Thar and Cholistan deserts, which form part of the great Indus Desert. The area's arid (desert) sub-tropical climate is marked by very hot summers and mild winters. While livestock grazing is the main form of land use, certain crops are grown – mainly guar/cluster beans, millet and castor beans. In the southeast, where rainfall averages 300mm per year, wheat is also an important crop. Wheat is grown on loamy soils, while castor beans are grown on sandy loam soils.

Agro-ecological zone III B (sandy deserts) comprises the sandy deserts that stretch across the districts of Muzaffargarh, Mianwali and Sargodha, in southern Punjab. The climate ranges from arid to semi-arid sub-tropical continental. The northern part of this zone, with rainfall of between 300mm and 350mm per year,

is largely used for chick pea cultivation. In some areas, canal irrigation is used to grow cotton, sugarcane, guar/cluster beans, millet and wheat.

Agro-ecological zone IV A (northern irrigated plain) encompasses the flood plains and bar uplands that cover most of the province of Punjab and parts of the districts of Peshawar and Mardan in KP. Mean annual rainfall ranges from 300–500 mm in the east and 200–300 mm in the southwest. Characterized by an arid to semi-arid sub-tropical continental climate – and sandy, loam-clay and loam soils – this is the principle area of agricultural production in Pakistan. A number of major canal irrigated crops are grown, as are many minor crops. Key crops include wheat, rice, sugarcane, oilseed and millet in the north; and wheat, cotton, sugarcane, maize, citrus and mangoes in the centre and south. Pears, plums, tobacco and ground nuts are also grown in KP.

Agro-ecological zone IV B (northern irrigated plain) encompasses the alluvial valleys of Peshawar and Mardan, in the province of KP, traversed by the Kabul, Swat and Kalapani rivers. The semi-arid (steppe) sub-tropical climate is marked by little rain (20–30 mm), both in winter and summer. Soils are silt clay and clay loam. The area's principle crops include sugarcane, maize, tobacco, wheat and berseem clover. Sugar beet has recently been introduced. Fruit orchards – typically of pears and plums – cover considerable areas. In the region's dry northern reaches, wheat, millet, chick peas and ground nuts are also grown.

Agro-ecological zone V (*barani* areas) includes parts of the districts of Dera Ismail Khan and Bannu in the province of KP, and the districts of Mianwali, Attock, Abbottabad, Rawalpindi, Jhelum, Gujrat, Gujranwala and Sialkot in Punjab. The *barani* zone (literally meaning 'rainfed' in Urdu) spans a salt range, the Pothohar Plateau and the Himalayan Piedmont plains. A small, narrow belt along the foot of the mountains is nearly humid, with hot summers and cold winters. Southern areas, however, are hot and semi-arid. A large proportion of the zone comprises gullied land. Key crops include wheat, rice, maize, millet, sorghum, oilseeds pulses and fodder.

Agro-ecological zone VI (wet mountains) spans areas in the districts of Rawalpindi and Murree in Punjab, and Hazara and Mansehra in KP. Given its high mountains and plateaus, the zone's climate is undifferentiated – with several climate types existing over relatively short distances, varying as a function of elevation and exposure. One-quarter of the terrain is used for the rainfed cultivation of crops, principally maize, wheat and rice. Fruit orchards – of apples, plums, peaches and apricots – also abound.

Agro-ecological zone VII (northern dry mountains) comprises areas in the districts of Gilgit and Chitral in KP, parts of the Federally Administered Tribal Areas, the Swat valley, the Karakorum Mountains and spurs of the Hindu Kush, which border the syntaxial bends of the Himalayas. Enclosed by high mountains, the area's valleys are extremely arid, with mild summers and cold winters. The zone is rich in crops, fruits and nuts. Characteristic crops include maize, wheat, rice, finger millet, barley, buckwheat, and several kinds of temperate fruits and nuts.

Agro-ecological zone VIII (western dry mountains) lies to the south of the Safed Koh mountain range and to the west of the Indus River. It spans the districts of Kohat and Bannu in KP, parts of the Federally Administered Tribal Areas, and the districts of Zhob, Loralai, Kalat, Sibi, Quetta and Kachhi in Balochistan. Most of the zone has a semi-arid highland climate, with mild summers and cold winters. Key crops include wheat, maize, alfalfa and temperate fruits.

Agro-ecological zone IX (dry western plateau) comprises mountainous areas, inter-mountain basins and plateaus stretching across the districts of Karachi and Dadu in Sindh, and Makran, Kharan, Chagai and Lasbela in Balochistan. The zone's arid (desert) tropical climate is characterized by a constant dry season. Soils in the plains are deep, strongly calcareous silt loam. In the lower hills and higher plains, the soil is gravelly. Fruits, vegetables and wheat are grown wherever water is available from springs or *kareez* (traditional irrigation systems). Other crops include sorghum, millet and castor beans.

Agro-ecological zone X (Sulaiman Piedmont) comprises the piedmont plains of the Sulaiman range in Balochistan and southern Punjab, sloping towards the Indus River. The climate of the region is arid, hot and sub-tropical. In terms of land use, torrent water cultivation is used to grow wheat, sorghum, millet and chick peas. Rice is grown in a narrow strip that forms the junction between the piedmont and the river plains.

Annex III List of participants in consultations meetings

S. No	Name	Designation	Organization
1	M. Abbas	Health and Nutrition Specialist	Health Department, Gilgit, GB
2	M. Bilal Afridi	PhD scholar	Department of Environmental Sciences, University of Peshawar
3	Bilal Ahmed	-	Forestry Department, Planning & Development Department (P&DD)
4	Dr Hussain Ahmed	Director	Environment Protection Agency (EPA), KP
5	Dr Iftikhar Ahmed	Professor	Balochistan University
6	Khalil Ahmed	Data Control Officer	Gilgit, GB
7	Khurshid Ahmed	Deputy Director	Agriculture Department
8	Major (R) Manzoor Ahmed	Administrator	Himalayan Conservation and Rural Support Programme (HCRSP)
9	Dr Masood Ahmed	Focal Person, Nutrition	Health Department
10	Mir Naseer Ahmed	Forestry Faculty	-
11	Tanveer Ahmed	DPA (Ops)	Provincial Disaster Management Authority (PDMA), Sindh
12	Muhammad Shahbaz Akhtar	Executive Engineer	Irrigation Department, Sindh
13	Ghulam Aksar	Planning Officer	Planning & Development Department (P&DD)
14	Shahid Ali	Enterprise Analyst	Gilgit, GB
15	Syed M. Ali	Conservation for wildlife Northern circle Swat	Wildlife Department , KP
16	Yousaf Ali	Chief, Agriculture	Agriculture Section, Planning & Development Department (P&DD)
17	Zahid Ali	Assistant	District Disaster Management Authority (DDMA), Gilgit, GB
18	Dr Masood Arshad	Director	World Wildlife Fund (WWF) Pakistan
19	Sardar Arshad	Assistant Director	Environment Protection Agency (EPA)
20	Rukhsana Asghar	Director, Fisheries (Marine)	Fisheries Department , Government of Pakistan
21	Dr Arshad Ashraf	Principal Scientific Officer, NARC	National Agriculture Research Council (NARC) and Pakistan Agriculture Research Council (PARC)
22	Salman Aslam	AD Environment	Environment Department
23	Assamuddin	Regional Programme Officer	Gilgit, GB
24	Rubina Aziz	Joint Secretary	Save The Nature
25	Ali Anwar Babar	Deputy Director	Minorities Department, Sindh
26	Zaheeruddin Babar	-	Gilgit, GB
27	Mumtaz Ahmed Baber	-	-
28	Dr Irfan Ahmed Baig	Associate Professor	Department of Economics, PMAS Arid University
29	Shehzad Baig	Research Officer	Planning & Development Department (P&DD), GB
30	M. Abdul Basit	Chief	Food Department
31	Dr Liaquat Ali Bhutto	Deputy Director	Agriculture Department, Sindh
32	Rubina Bugti	Field Supervisor	Organization for Community Services and Development (OCSD)

S. No	Name	Designation	Organization
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34	Naseem Butt	-	UN Women
35	Nisar Hussain Channar	Deputy Director, Sukkur	Provincial Disaster Management Authority (PDMA), Sindh
36	Anser Mahmood Chattar	Deputy Director	Fisheries Department
37	Ahmad Dir	-	Pakistan Red Crescent/ Pakistan Red Cross Society (PRCS), Gilgit
38	Ashar Farooq	Rangeland Management Officer	Pakistan Forest Institute
39	M. Amjad Ghani	HAO	UNOCHA
40	Syeda Sana Gillani	Assistant Director	Environment Protection Agency (EPA), AJK
41	Ali Haider	Assistant Director	Water and Sanitation Extension Programme (WASEP)
42	Syed Asad Hamdani	DFO Reforestation	Neelum Forests
43	Dr Shaista Hameed	Head, Botany Department	SBK Women University, Balochistan
44	Iman ul haq	-	Agriculture Department, Balochistan
45	Samina Hayat	Research Officer	Gilgit, GB
46	Imtiaz Hussain	Research Officer	Gilgit, GB
47	Nasir Hussain	Field Assistant	Environment Protection Agency (EPA), Gilgit, GB
48	Shabir Hussain	Liaison Officer	Fair trade
49	Syed Jarrar Hussain	Scientific Officer	Environment Protection Agency (EPA), Gilgit, GB
50	Syed Zahid Hussain	-	GLOF Project, Gilgit
51	Qurban Hussian	Director, Planning and Evaluation	Livestock & Dairy Department (L&DD), Punjab
52	Inam ullah	Managing Director	Mountain Fruit Company
53	Bilal Iqbal	Senior Scientific Officer	National Agriculture Research Council (NARC)
54	Jalal-ud-din	Project Manager	Sustainable Development
55	Muhammad Saleem Jalbani	Assistant Chief	Planning & Development Department (P&DD), Sindh
56	Neelofur Jamil	Head, Environmental Sciences	Sardar Bahadur Khan (SBK) Women University, Balochistan
57	Muhammad Kaleemullah	Head, Forestry Research & Education	Forest & Wildlife Department, Balochistan
58	Raja Mirza Karim	-	Gilgit, GB
59	Dr Saif Kashif	Chairman	University of Veterinary and Animal Sciences (UVAS), Lahore
60	Dr M. Jamal Khallak	Professor	Agricultural University Peshawar, KP
61	Abdul Sattar Khan	Chief Executive Officer	SAYYA Foundation
62	Amanullah Khan	Deputy Director	Food Department
63	Attaullah Khan	-	World Wildlife Fund (WWF)
64	Dr Bushra Khan	Associate Professor	University of Peshawar
65	Fateh Khan	Assistant Director	Environment Protection Agency (EPA), Balochistan
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70	Mohammad Bashir Khan	Director General, Flood Project ADB	Planning & Development Department (P&DD)
71	Nafas Khan	Agriculture Analyst	Gilgit, GB
72	Nazish M. Khan	Planning Officer	Planning & Development Department / Provincial Disaster Management Authority (PDMA), Sindh
73	Shabbir Ahmad Khan	Manager	Mountain Fruit Company
74	Tauseef Khan	Monitoring & Reporting Officer	Islamic Relief
75	Zeb Alam Khan	Information Management Officer	World Food Programme (WFP), Public Information Reports Unit (PRU)
76	Zubair Ahmad Khan	Manager	Diaper Poverty Alleviation Programme (DPAP), Chilas, GB
77	M. Iqbal Khell	Senior Officer Irrigation	Irrigation Department
78	Rehana Khilji	-	UN Women
79	Imran Lagari	Humanitarian Affairs Officer	United Nations Office for the Coordination of Humanitarian Affairs (UNOCHA)
80	Aleem Lashari	Director Operations	Provincial Disaster Management Authority (PDMA), Sindh
81	Dr Ashfaq Maan	Professor and Head of Department	University of Agriculture (UAF), Faisalabad
82	Kazi Ayaz Mahesar	Provincial Coordinator	UNESCO
83	Tahir Mahmood	Social Welfare Officer	Social Welfare Department
84	Dhano Mal	Adviser Officer	Irrigation Department, Sindh
85	Adnan Malik	Deputy Director	Livestock Department
86	Aijaz Ahmed Memon	Assistant Director, Fisheries	Livestock & Fisheries Department, Sindh
87	Tahir M. Minhas	Director General	Provincial Disaster Management Authority (PDMA), Balochistan
88	Asif Raza Mir	CEO	Environment Conservation Organization (ECO)
89	Noorani Mir	Livelihood Officer	World Wildlife Fund (WWF), Gilgit
90	Sajjad Mohammad	Agriculture Sector Specialist	Federally Administered Tribal Areas (FATA) Secretariat
91	Kamran Naqvi	Urban Specialist	International Union for Conservation of Nature (IUCN)
92	Farzana Naseem	Assistant Director	Environment Protection Agency (EPA), Sindh
93	Karim Nawaz Balouch	District Director Agriculture, DI Khan	Agriculture Department, KP
94	Abdul Qadar	-	Forestry Department
95	Abdul Qayyum	-	Public Health Engineering Department (PHED), Balochistan
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98	M. Yousaf Quershi	Officer	Wildlife Department
99	Nasir Rafique	Chief Director	Industries & Commerce, Punjab Model Bazaars Management Company (PMBMC)
100	Syed Abdul Rasheed	-	Pakistan Meteorological Department (PMD)
101	Rashid-ud-din	-	RML, Gilgit, GB
102	Mian Akhlaq Rasool	CEO	Azad Jammu and Kashmir Rural Support Programme (AJKRSP)
103	Dr Mohammad Mohsin Raza	Deputy Director, Livestock	Livestock & Diary Department, Punjab
104	Dr Zahoor Razai	Director, Quality	University of Balochistan
105	Abdul Razzak	Sponsorship Officer	Islamic Relief
106	M. Abdul Rehman	Assistant Director	Livestock Department, Balochistan
107	Sadaqat	-	World Health Organization (WHO)
108	Saida Begum	Intern	WWF Pakistan
109	Salahuddin	Additional Secretary	Social Welfare Department
110	Dr Aman ullah Salarzai	Director	Agriculture, Service Training Academy, Balochistan
111	Nazish Saqib	HR Coordination	Association for Gender Awareness and Human Empowerment (AGHAE)
112	Anjum Sardar	Deputy Secretary	Food Department, Punjab
113	Rukhshanda Shafiq	Deputy Director	Social Welfare Department, Punjab
114	Naeem Shah	Chief MET Office	Pakistan Meteorological Department (PMD)
115	Syed Naveed Shah	Admin Officer	Glacial lake outburst floods (GLOF) Project, Gilgit
116	Syed Wajid Ali Shah	Deputy Director	Food Department
117	Khurram Shahid	CEO	Sustainable Development Organization (SDO)
118	Dr Bushra Shams	Gender Advisor	UN Women
119	Waqar Shams	Provincial Coordinator	UNESCO
120	Dr Shazia	OP Officer	WHO
121	Muhammad Sohail	-	Fisheries Department
122	Assia Soomro	DPA (Operations)	Provincial Disaster Management Authority (PDMA), Sindh
123	Hooriya Syeda	PO Punjab	UN Women
124	Palwasha Tareen	-	SBK Women University, Balochistan
125	Abdul Wali	Assistant Director	Environment Protection Agency (EPA), Balochistan
126	Muhammad Waris	ADT	Farm Water Management, Punjab Irrigated Agriculture Productivity Improvement Project (PIPIP)
127	Afsar Ullah Wazir	Chief Conservator of Forest Malakand Region Saidu Sharif	Forestry Department, Khyber Pakhtunkhwa
128	Hafiz Qaisar Yasin	Deputy Director	Agriculture Department, Punjab
129	Nowsher Yousaf	PhD scholar	Department of Environmental Sciences
130	Alam Zeb	Senior Meteorologist	PAK Meteorological Department (PMD), KP

Annex IV Glossary

Agro-ecological zones: Geographical areas exhibiting similar climatic conditions that determine their ability to support rainfed agriculture. FAO describes them as land resource mapping units, defined in terms of their climate, landform, soil and/or land cover, with a specific range of potentials and constraints for land use. These zones are influenced by latitude, elevation, temperature, seasonality, and the amount and distribution of rainfall during the growing season.

Climate change (CC): change in the state of the climate that can be identified by changes in the mean and/or the variability of its properties, and that persists for an extended period, typically decades or longer, as defined by the Intergovernmental Panel on Climate Change (IPCC). Climate change may be due to natural internal processes or external forces, or due to persistent anthropogenic changes in the composition of the atmosphere or in land use.

Climate change adaptation (CCA): A subset of climate risk management (see below) that seeks to effect adjustments in natural or human systems to reduce harm by or exploit benefits from climate change. It is defined by the IPCC as the adjustment in natural or human systems in response to actual or expected climatic stimuli or their effects, which moderates harm or exploits beneficial opportunities.

Climate change mitigation (CCM): An anthropogenic intervention to reduce the anthropogenic forcing of the climate system. According to the IPCC, it includes strategies to reduce greenhouse gas sources and emissions and enhancing greenhouse gas sinks.

Climate risk: A risk that results from climatic changes which affect natural and human systems and regions.

Climate risk management (CRM): The improved management of climate variability across all relevant sectors. According to the World Bank, its starting point is to determine vulnerability to the current climate conditions, including variability and weather extremes. The next step is to assess how vulnerabilities might change as a result of climate change, or in the context of other changes, such as population growth and shifting trade patterns. In this way, climate risk management focuses on the pressing issues of the here and now, while factoring in projected changes. This large, growing body of work bridges the spheres of climate change adaptation, disaster risk management (DRM) and development, among many others.

Climate variability: Long-term averages and variations in weather conditions, measured over a period of several decades.

Disaster: A serious disruption of the functioning of a community or a society involving widespread human, material, economic or environmental losses and impacts, which exceeds the ability of the affected community or society to cope using its own resources.

Disaster risk management (DRM): A systematic process of using administrative directives, organizations, and operational skills and capacities to implement strategies, policies and improved coping capacities in order to lessen the adverse impact of hazards and the possibility of disaster. DRM aims to avoid, lessen or transfer the adverse effects of hazards through activities and measures for prevention, mitigation and preparedness.

Disaster risk reduction (DRR): The practice of reducing disaster risks through systematic efforts to analyse and manage the causal factors of disasters, including through reduced exposure to hazards, lessened vulnerability of people and property, wise management of land and the environment, and improved preparedness for adverse events.

Food security: When all people, at all times, have physical, social and economic access to sufficient, safe and nutritious food that meets their dietary needs and food preferences for an active and healthy life. Food security comprises three dimensions: sufficient availability of food; adequate access to food; and appropriate utilization of food. It also entails a cross-cutting dimension – stability.

Food availability: The amount of food that is physically present in a country or area through all forms of domestic production, commercial imports and food aid.

Food access: People's ability to regularly acquire adequate amounts of food through a combination of their own stock and home production, purchases, barter, gifts, borrowing and food aid.

Food insecurity: When people lack secure access to sufficient amounts of safe and nutritious food for normal growth and development, and an active and healthy life. Food insecurity may be caused by the lack of availability of food, insufficient purchasing power, inappropriate distribution, or inadequate use of food at the household level.

Food stability: The ability to obtain food over time. To be food secure, a population, household or individual must have stable access to adequate food at all times. They should not risk losing access to food as a consequence of sudden shocks or cyclical events. The concept of stability, therefore, refers to both the availability, access and utilization dimensions of food security.

Food utilization: (a) Households' use of the food to which they have access, and (b) individuals' ability to absorb nutrients – i.e. the conversion efficiency of food by the body.

Livelihood: A means of making a living, encompassing people's capabilities, assets (natural, physical, human, social, financial and political) and activities to secure the necessities of life – food, shelter, health, education and income. A livelihood is sustainable when it enables people to cope with, and recover from, shocks and stresses (such as natural disasters and economic or social upheavals) and enhance their well-being and that of future generations without undermining the natural environment or resource base.

Malnutrition: The condition that develops when the body does not acquire the nutrients, vitamins and minerals it needs to function properly. Malnutrition can result from an insufficient, excessive or unbalanced diet, or from the inability to absorb foods. According to WHO, malnutrition includes (i) undernutrition, i.e. when a person does not get enough food to eat, causing them to be wasted (acute malnutrition) and/or stunted (chronic malnutrition); micronutrient deficiencies, i.e. when a person does not get enough important vitamins and minerals in their diet; and overweight and obesity, i.e. when a person eats too many calories, often coupled with a lack of exercise. Malnutrition increases the risks of ill health, poor development, infectious and non-communicable diseases.

Resilience: The ability of households, communities and nations to absorb and recover from shocks, whilst positively adapting and transforming their structures and means for living in the face of long-term stresses, change and uncertainty.

Seasonality: A characteristic of a time series in which the data experiences regular and predictable changes that recur every calendar year. Any predictable change or pattern in a time series that recurs or repeats over a one-year period can be said to be seasonal.

Spatial analysis: The process of examining the locations, attributes and relationships of features in spatial data through overlay and other analytical techniques in order to address a question or gain useful knowledge.

Undernourishment: The condition in which an individual's habitual food consumption is insufficient to provide the amount of dietary energy required to maintain a normal, active, healthy life. (See also undernutrition, defined above under malnutrition).

Vulnerability to climate change: The degree to which geophysical, biological and socio-economic systems are susceptible to, and unable to cope with, adverse impacts of climate change, as defined by the IPCC. Vulnerability is a function of the character, magnitude and rate of climate variation to which a system is exposed, its sensitivity and its adaptive capacity.



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