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CLIMATE CHANGE IMPACTS ON HEALTH AND LIVELIHOODS: **PAKISTAN ASSESSMENT**

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CONTENTS

| | |
|--|-----------|
| EXECUTIVE SUMMARY | 4 |
| 1. CLIMATE | 6 |
| 1.1. GENERAL CLIMATE | 6 |
| 1.2. OBSERVED AND PROJECTED CLIMATIC CHANGES | 7 |
| 1.3. CLIMATIC VARIABILITY AND EXTREME WEATHER | 10 |
| 2. MOST AT-RISK POPULATIONS | 12 |
| 2.1. PEOPLE WITH DISABILITIES | 12 |
| 2.2. WOMEN AND CHILDREN | 12 |
| 2.3. FARMERS | 13 |
| 2.4. URBAN SLUM-DWELLERS | 13 |
| 2.5. MIGRANTS | 13 |
| 3. HOW WILL LIVELIHOODS BE AFFECTED BY CLIMATE CHANGE? | 15 |
| 3.1. COUNTRY LIVELIHOODS PROFILE | 15 |
| 3.2. AGRICULTURE | 17 |
| 3.3. NON-FARMING LIVELIHOODS | 19 |
| 3.4. PHYSICAL ASSETS (HOUSES AND WORKPLACES) | 19 |
| 4. HOW WILL HEALTH BE AFFECTED BY CLIMATE CHANGE? | 21 |
| 4.1. MORTALITY AND NON-COMMUNICABLE DISEASES | 21 |
| 4.2. VECTOR-BORNE DISEASES | 22 |
| 4.3. WATER, SANITATION AND HYGIENE | 23 |
| 4.4. MALNUTRITION | 25 |
| 4.5. DISPLACEMENT AND MIGRATION | 27 |
| 4.6. MENTAL HEALTH | 27 |
| 4.7. CRITICAL INFRASTRUCTURE AND HEALTH SYSTEMS | 28 |
| 4.8. SEXUAL, REPRODUCTIVE, MATERNAL, NEWBORN AND CHILD HEALTH | 28 |
| 5. LINKAGE BETWEEN CLIMATE IMPACTS ON HEALTH AND LIVELIHOOD | 32 |
| 6. EXISTING CAPACITIES, STAKEHOLDERS AND PROGRAMMES | 37 |
| 6.1. POLICY LANDSCAPE | 37 |
| 6.2. CAPACITIES | 39 |
| 7. RECOMMENDATIONS AND OPPORTUNITIES | 40 |
| REFERENCES | 45 |
| ANNEX A: NEAR-TERM CLIMATE CHANGE IN PAKISTAN BY 2020–2039 | 51 |
| ANNEX B: SUMMARY OF RELEVANT POLICIES FROM THE NATIONAL CLIMATE CHANGE POLICY PAKISTAN 2012 | 53 |
| ANNEX C: SUMMARY TABLE OF CLIMATE CHANGE IMPACTS ON LIVELIHOODS | 56 |

EXECUTIVE SUMMARY

The global climate crisis poses a number of threats to the well-being and prosperity of the people of the Islamic Republic of Pakistan. The country already witnesses several climate- and weather-related natural hazards due to its geographical diversity and a varied tropical, continental climate (hot summers and cold winters). Pakistan experiences recurring heatwaves and droughts, riverine and flash floods, landslides, and sea storms or cyclones. Climate change is expected to increase the frequency and intensity of these events as well as exacerbate people's vulnerabilities. It is projected that there will be significant increases in temperature across the country (high confidence) and especially in the snow-covered mountainous north, which will lead to faster glacial melt resulting in changes to the Indus River flows downstream. Heatwaves are likely to become more frequent and intense all over Pakistan, and the number of 'hot' days and nights are expected to increase significantly (high confidence). Changes in rainfall trends are not clear, though there may be some shifting of seasons (peak summer rain shifting to August and peak winter rains shifting to March) (likely). Extremely wet days are likely to increase across all of the country except in Sindh Province, which will experience more dry days (leading to the increased frequency of drought) (likely).

Climate change has the potential to trigger wide-ranging and strong negative feedback loops between livelihoods and health.

Pakistan is a low-middle income country that remains predominantly agrarian, although it is progressively industrializing its economy and over one-third of the population now resides in towns and cities. The country relies heavily on its climate-sensitive land, water and forest resources for livelihoods and food security. Agriculture remains an important source of employment for 42 per cent of the population. Almost 90 per cent of agriculture depends on irrigation from the glacier-fed River Indus and its tributaries. Climate change has hastened the pace of glacier melt, which will increase the incidence of glacier lake outburst floods (GLOF) and flash floods downstream. Faster glacier melt, higher temperatures, shifting seasons and erratic rainfall patterns are all altering the flow of the River Indus and this will increasingly affect agriculture-related activities, food production and livelihoods. Already, 39 per cent of the population experience multidimensional poverty, and the loss of livelihoods described in this report will have huge consequences on people's wellbeing and ability to afford healthcare.

Impacts to health (notably via heat exhaustion, malnutrition, the emergence of vector-borne diseases such as Dengue Fever, and the increased burden of waterborne diseases) will reduce people's ability to work and earn a livelihood. Migrants, internally displaced persons, and religious and ethnic minorities will be highly vulnerable as they are often marginalized to hazard-prone land and face barriers to accessing healthcare, including financial barriers due to informal employment. Climate change may potentially increase the number of child marriages,

premature births and domestic violence. Women and children will also be more vulnerable to malnourishment and malnutrition due to lower food production.

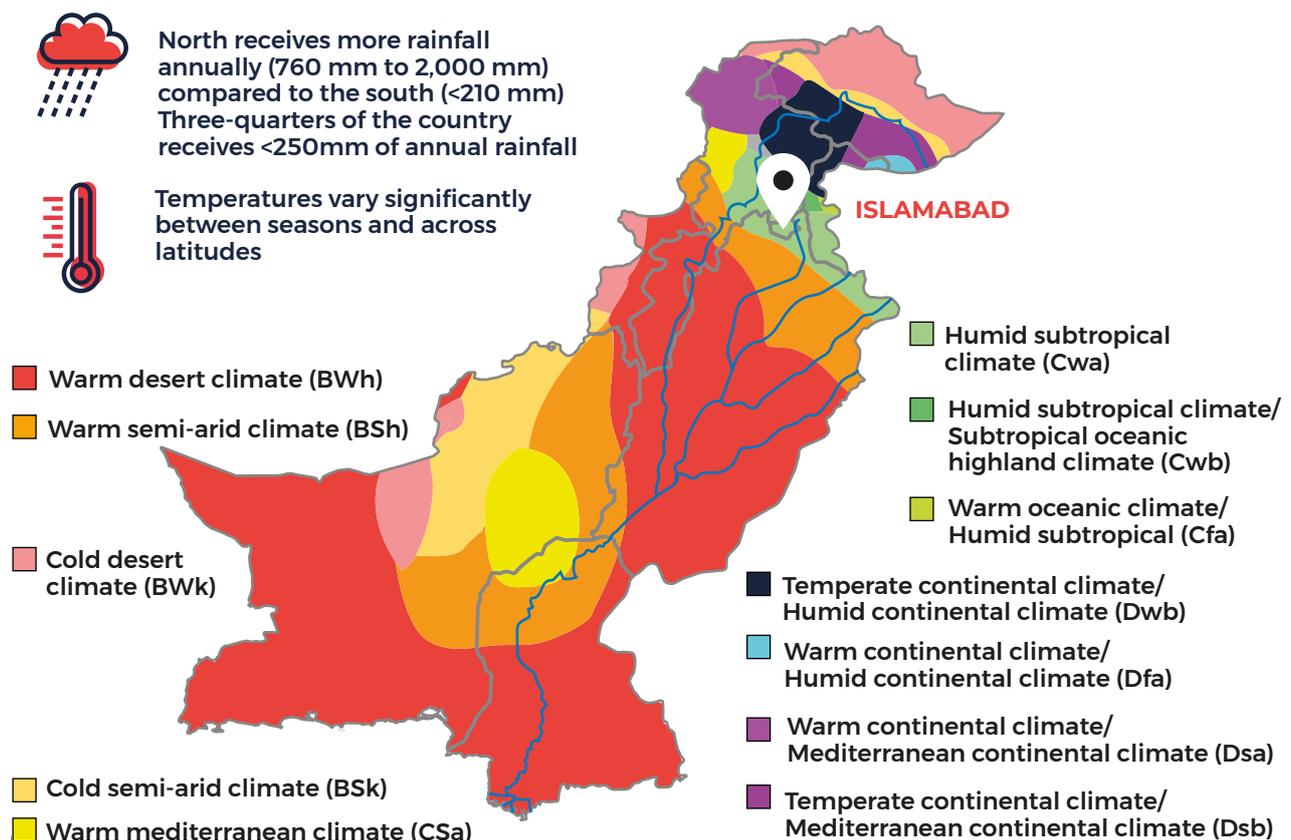
The urgency to act is clear. The purpose of the report is to act as a reference document on the likely impacts – direct and indirect – of the climate crisis on the wellbeing of people in terms of their health and livelihoods. The intention is that this report can act as a springboard for planning and implementing activities and programmes focused on climate action and adaptation. Some recommendations and opportunities for action have been offered, however, these should be considered as only a starting point to further complement and expand existing programmes and projects. Cross-sector and widespread collaboration between National Societies, government agencies and services, the private sector, NGOs, civil societies and our communities is key as no one organization alone can tackle the increased risks posed by climate change nor alleviate the exacerbated risks of vulnerable populations. Together, acting now, with the evidence at hand, it is possible to avert the most dire consequences of the climate crisis.

1. CLIMATE

1.1. GENERAL CLIMATE

Pakistan has a broadly tropical continental type of climate with great diversity in temperature and rainfall; most parts are arid to semi-arid (Asian Development Bank 2017). The rainfall season is generally divided into two spells, i.e., the winter and summer monsoons. Across the southern half of the country, the eastern areas mainly receive rainfall from the Southwest Monsoon in June–September, while the northern and western areas get rains mainly through westerly disturbances during the winter months of December–March (Asian Development Bank 2017). Since Pakistan is situated at the western end of the Southwest Monsoon, the length of the summer rainy season in Pakistan is considerably short with just one and half months of active rainy period (Safdar *et al.* 2019). However, the Southwest Monsoon accounts for around 60 per cent of the total annual rainfall of Pakistan (Asian Development Bank 2017). Three-quarters of the country receives less than 250mm of rainfall annually. The southern slopes of the Himalayas and the sub-mountain region in the north are the regions that see the strongest monsoon effects, and receive annual rainfall in the range 760–2,000 mm (Asian Development Bank 2017).

Figure 1. Climatic zones of Pakistan



The summer season (March–June) is extremely hot and humid, where the temperature reaches up to 49°C and even more across the plain areas. The winter (December–February) is colder and average temperatures lie in the range 4–20°C in most of the country (Ali *et al.* 2019). The transboundary Indus Basin covers 65 per cent of the country’s total area, which includes the provinces of Punjab, Khyber Pakhtunkhwa, most parts of the Sindh territory, and the eastern region of Balochistan (Asian Development Bank 2017). The Indus Basin receives annual average rainfall of around 230mm. Mean winter temperatures in December–February in the lower plain range between 14–20°C, and 2–23°C in the upper plain areas (Asian Development Bank 2017). During the summer months, the mean monthly temperature varies from 42–44°C in the lower plain, and 23–49°C in the upper plain areas (Asian Development Bank 2017). The Balochistan Plateau in the southwest receives less than 210mm of rainfall annually, with an average of 20–30mm per month (Asian Development Bank 2017).

Table 1. Seasonal calendar

| JAN | FEB | MAR | APR | MAY | JUN | JUL | AUG | SEP | OCT | NOV | DEC |
|-------------------|-----|------------------|-----|-----|----------------------------|-----|-----|-----|-----|-----|-----|
| Winter (cool dry) | | Summer (hot dry) | | | Summer (southwest) monsoon | | | | | | |

1.2. OBSERVED AND PROJECTED CLIMATIC CHANGES

| OBSERVED CHANGES | CLIMATE PROJECTIONS |
|---|--|
| <p>TEMPERATURE</p> <p>Temperature has been rising. Annual mean temperature has risen by 0.57°C in the past century. The warming trend has been accelerating since 1961 and both the maximum and minimum temperatures have increased – i.e., hot days have become hotter and cold days have got warmer. The hyper-arid plains, arid coastal areas and mountain regions of Pakistan have seen an increase of 0.6–1.0°C in the mean temperature during the period 1960–2007 (Asian Development Bank 2017).</p> | <p>TEMPERATURE</p> <p>Temperature is projected to continue to rise. By 2100, mean temperature is projected to rise in the range of 3–6°C (depending on the emission scenario) with a sharp increase after 2050 (Asian Development Bank 2017). This means the projected temperature rise in Pakistan is expected to be higher than the global average.</p> <p>Certain regions will show larger increases in temperature. The northern part (mostly the snow-covered areas) is predicted to show a larger increase in mean temperature compared to central and southern regions under all scenarios (Asian Development Bank 2017). The rise can be up to 10–12°C by 2100, especially for high emission scenarios (<i>ibid</i>).</p> |

OBSERVED CHANGES

RAINFALL

Historical rainfall has been variable. During 1960–2007, Pakistan observed a decrease of 10–15 per cent in winter and summer rainfall across the arid plains and coastal areas, while there was an increase of 18–32 per cent in the summer rainfall over the core monsoon region of Pakistan (Asian Development Bank 2017).

Overall, annual rainfall has increased by 61mm in Pakistan from 1901–2007. Summer monsoon rains and winter rain have also increased by 22.6mm and 20.8mm respectively (Asian Development Bank 2017).

SEA- LEVEL RISE

The sea is rising. Observed sea-level rise along the Karachi coast was 1.1mm per year in the past century (Asian Development Bank 2017), which is comparable to the Global Mean Sea Level (GMSL) of 1.4mm per year (Oppenheimer *et al.* 2019). However, during the period 2006–2015, the sea level rose at a rate of 3.6mm per year (high confidence) (Oppenheimer *et al.* 2019).

CLIMATE PROJECTIONS

RAINFALL

Pakistan’s rainfall projections do not indicate any systematic changing trends. However, by 2050, the summer rainfall peaks are predicted to shift towards August, while that of winter shifts towards March and will continue until 2100 (Asian Development Bank 2017).

Until 2050, the mean annual rainfall is predicted to increase in the range 2–4 mm per day for all emission scenarios, with the northeastern part of the country receiving the maximum rainfall. After 2050 and until the end of the century, the rainfall pattern will shift to northwest and southern regions (Asian Development Bank 2017).

SEA- LEVEL RISE

The sea will continue to rise. By 2100, GMSL will rise in the likely range of 0.61–1.10m relative to the 1986–2005 period under a high emission scenario (medium confidence) (Oppenheimer *et al.* 2019). For South Asia, the sea level is predicted to rise in the range of 0.42–1.12m by 2100, with a 90 per cent confidence level (Ahmed and Suphachalasai 2014).

Sea-level rise will impact Pakistan. Future sea-level rise will affect the low-lying coastal areas south of Karachi (Asian Development Bank 2017).

| OBSERVED CHANGES | CLIMATE PROJECTIONS |
|--|--|
| <p data-bbox="161 344 408 376">EXTREME EVENTS</p> <p data-bbox="161 394 762 703">Extreme heat days are increasing. There has been a significant increase in the number of heatwave days per year in Pakistan. Over the period 1980–2007, heatwave days have increased by 31 days (Asian Development Bank 2017). Since 1990, the increase in the heatwave events has noticeably increased (Asian Development Bank 2017).</p> <p data-bbox="161 725 762 918">Fewer cold days. Cold waves have decreased in northeastern and southern parts of the country, while the western and northwestern parts have observed a rise of 30–60 days in cold waves (Asian Development Bank 2017).</p> <p data-bbox="161 940 762 1249">Severe rainfall and droughts are region-specific. There is a high frequency of heavy rainfall events confined in the northeast region of the country (monsoon belt) (Ikram <i>et al.</i> 2016). The occurrence of droughts has been more pronounced in Sindh and Balochistan, whereas the southern part of Punjab has also experienced intense dry spells (Hina and Saleem 2019)</p> | <p data-bbox="799 344 1046 376">EXTREME EVENTS</p> <p data-bbox="799 394 1430 586">Heatwaves will become more frequent and intense all over Pakistan while cold waves will be a decreasing trend in terms of frequency and magnitude (Asian Development Bank 2017; Ali <i>et al.</i> 2019).</p> <p data-bbox="799 609 1353 721">The frequency of hot days and hot nights is expected to increase significantly (Asian Development Bank 2017).</p> <p data-bbox="799 743 1321 775">Heavy rainfall is expected to increase. Extremely wet days (99 percentile) and very wet days are also predicted to increase in most parts of Pakistan, except Sindh Province, leading to the increased tendency and magnitude of flooding (Ali <i>et al.</i> 2019). Dry days will increase during the summer season making normal wet days less frequent, which will result in the ground being drier and harder, unable to absorb excess water during the intense rainfall for a short time (Ikram <i>et al.</i> 2016).</p> <p data-bbox="799 1196 1430 1350">Periods of drought are expected. Consecutive dry days are also predicted to increase, more pronounced in Sindh Province, leading to drought (Ali <i>et al.</i> 2019).</p> |

1.3. CLIMATIC VARIABILITY AND EXTREME WEATHER

Variability is seen both in temperature and rainfall as Pakistan feels the effect of the El Niño Southern Oscillation (ENSO). Droughts are projected to increase in winter with the risk of more forest fires as temperatures rise and rainfall is reduced (Ministry of Climate Change 2012). Much of the rain will fall in summer, leading to flooding (GOP 2016). The northern mountain regions will witness more frequent flash floods and landslides because of an increase in both the frequency and intensity of rainfall and thunderstorms (Ministry of Climate Change 2012). Warmer temperatures will also lead to more rapid glacial melt. The Indus River Basin will witness changed seasonal river flow patterns where annual flows will initially increase and then decrease (Ministry of Climate Change 2012). The variable monsoon patterns will cause both floods and meteorological droughts and reduce water resources due to higher evaporation rates (Ministry of Climate Change 2012). The arid regions will face accelerated desertification while the coastal ecosystem will face a higher frequency of tropical cyclones, floods, salinity ingress and shoreline erosion (Ministry of Climate Change 2012).

Pakistan regularly experiences a range of extreme weather events and phenomena including cold waves, cyclones, droughts, floods and landslides. Cold waves occur in the winter in the higher altitude regions such as Balochistan and Kashmir, where compounding impacts of heavy snow, rainfall, landslides and below average temperatures in the winter months can have devastating effects on people and livestock. For instance, in January 2020, 106 people died from these impacts across the country, notably killed by avalanches and landslides that accompanied heavy rain and snow (IFRC 2020). Flash floods are also a common occurrence, notably occurring during the monsoon months, and can also result in landslides (Mahmood *et al.* 2016). Finally, droughts are a frequent longer term phenomena with potentially severe implications for food and water security as well as on health and sanitation systems. For instance, a drought developed in 2018–2019 and the Government of Pakistan estimated that over 5 million people were affected it (OCHA 2019). The drought was caused by erratic rainfall, a prolonged dry spell and a range of socioeconomic factors, such as migration and population growth, as well as the dominance of rainfed agriculture (Anjum *et al.* 2012; IFRC 2019).

“A major impact is happening on agriculture due to a shift in seasonal calendars. Pakistan has summer and winter seasons. The winter season is increasing in terms of months and summer is shorter in the north. In the south, it is the other way around – longer summer, shorter winter.” (KI 10)

SUMMARY: PAST CLIMATE TRENDS AND FUTURE CLIMATE PROJECTIONS

Pakistan will continue to experience significant temperature increases, which will be higher than the global average. The warming will be most pronounced in the mountainous, snow-covered north, which will lead to faster glacial melt resulting in an increase in glacial outburst floods, landslides, soil erosion and changes in the Indus River flows downstream. Heatwaves are likely to become more frequent and intense across Pakistan, and the number of 'hot' days and nights are expected to increase significantly (high confidence). Changes in rainfall trends are not clear, though there may be some shifting of seasons (peak summer rain shifting to August and peak winter rain shifting to March). Extremely wet days are likely to increase across the whole of the country, except in Sindh Province which will experience more dry days (leading to the increased frequency of drought). Sea-level rise will affect low-lying coastal areas in the south and especially the coastal city of Karachi.

RECOMMENDATIONS

1. Raise awareness of the main climate change stressors and shocks for the different regions, and provide communities with access to risk maps.
2. Work towards getting weather alerts, forecasts and climate projections to reach the 'last mile' so that people remain aware and prepared.
3. Use long-range forecasting to help those in Sindh Province cope with increased drought.
4. Prioritize sea-level rise adaptation measures for southern coastal towns and cities.

2. MOST AT-RISK POPULATIONS

2.1 PEOPLE WITH DISABILITIES

People with disabilities in Pakistan face unique challenges to livelihoods, accessibility and the risks of climate change. Disability rates in Pakistan are high, primarily due to the high prevalence of Polio in the country (Teherani and Pickering 2020). Persons with disabilities worldwide are two to four times more likely to die in a disaster (UNDP 2018). Because Pakistan is home to many people with disabilities, and because the country is prone to disasters, disabled people are particularly vulnerable to the health impacts of climate change.

2.2 WOMEN AND CHILDREN

In Pakistan, women and children are particularly vulnerable to the health impacts of climate change, largely due to insecure livelihoods and income poverty. During periods of food insecurity, drought or flooding, women and children are more likely to go hungry and face vulnerabilities (Climate Change Division 2013). This is also true for pregnant women and lactating mothers who face high levels of food insecurity and resulting malnourishment during heat stress and drought events – both of which are projected to increase due to climate change (Kunbher and Alam 2017). The resulting impacts on the children are especially severe and potentially lifelong (Arif *et al.* 2019). With regards to livelihoods, rural women mostly depend upon climate-sensitive natural resources for survival and their livelihoods as they are engaged in agriculture-related activities. Yet, “(women) do not enjoy equal authority, decision-making power and resources needed to adapt to climate change” (Climate Change Division 2013).

“The best part of the meal goes to the husband and then the children. Mothers eat last. This is true of urban and rural women.” (KI 11)

2.3 FARMERS

Climate change is likely to impact agricultural yields, land availability and crop seasons in Pakistan, making farmers especially vulnerable to the health and livelihood impacts of climate change. Over 80 per cent of the farmers are smallholders and about one-third of the land is rainfed (Arif *et al.* 2019). This is particularly true as changes in rainfall patterns and seasonal shifts in weather have resulted in climate irregularities that are making agricultural livelihoods challenging and unpredictable (Arif *et al.* 2019). This sector also faces low adaptive capacity, as these livelihood skills are not readily transferable (Malik *et al.* 2012). Livestock – an integral part of poor farmers’ livelihoods basket – are also highly vulnerable to heat stress, water scarcity and the reduced availability of fodder, besides depriving farmers of nutrition and immediate cash incomes (Rahut and Ali 2018).

“There is a high dependence on a single livelihood opportunity for sustenance, which can be highly impacted during climatic disasters” (KI 6)

2.4 URBAN SLUM-DWELLERS

Over 50 per cent of city dwellers in Pakistan live in slums and squatter colonies known as katchi abadi or ‘temporary population’ with inadequate housing facilities and poor sanitation facilities as well as a lack of adequate public toilets and solid waste management systems (UN HABITAT 2018). This makes them very vulnerable to extreme climate events like urban floods, cyclones, dust storms and the urban heat island effect (e.g., Lahore, Faisalabad, Quetta and Peshawar in 2012), winds at high speeds (e.g., Quetta in 2003, Hyderabad in 1993 and major cities in the Sindh Province in 2015) and even sea-level rise (e.g., the city of Karachi on the coast of the Arabian Sea). This vulnerability affects their health and livelihoods and pushes them further into poverty. Six of the ten major cities in Pakistan have double digit poverty rates (UN HABITAT 2018).

2.5 MIGRANTS

Pakistan has among the world’s largest number of migrant and displaced persons (UNHCR 2016). These are primarily refugees from the bordering conflict-ridden country of Afghanistan, internal migrants and Internally Displaced Persons (IDP). Within Pakistan, people migrate between rural areas or to urban areas looking for better economic opportunities or, in recent times, are pushed by climate change-induced extreme events and loss of livelihoods. Residents of districts like Quetta, Swat and Lower Dir that witness a higher rate of natural disasters or conflicts report

moving multiple times (IOM 2020). The majority of IDPs and refugees settle in rural areas because the costs of living are low here, or are settled by the Government in camps at a distance from urban centres (Malik *et al.* 2019). Despite being helped by the UN and other humanitarian agencies and nongovernmental organizations, these people continue to lack basic housing, food, medical facilities, adequate livelihood options and job security, and continue to be highly at-risk population groups (Malik *et al.* 2019).

SUMMARY: MOST AT-RISK POPULATIONS

In general, women, children, people with disabilities, urban informal settlers, smallholder farmers, refugees, migrants and IDPs are the most at risk to the impacts of climate change. For women and children this is because during periods of food insecurity, drought or flooding, children and then women eat last and are more likely to go hungry. Changes in rainfall patterns and seasonal shifts in weather have resulted in climate irregularities that are making agricultural livelihoods challenging and unpredictable, thus adversely impacting farmers. In cities, a substantial number of urban dwellers live in informal settlements, often in exposed locations which are hazard-prone, without proper sanitation or adequate water facilities. Migrants and IDPs have very low adaptive capacities. And these groups are not mutually exclusive; overlaps between them are especially concerning, such as poor women living in flood-prone coastal informal settlements.

RECOMMENDATIONS

1. The impacts of climate change are highly linked to geographic location, so local context-specific plans to deal with health and livelihood impacts are required.
2. Early warning alerts, climate change information and awareness-building interventions must be effective in reaching women, who live more secluded lives than men.
3. It is important to address the multiple vulnerabilities of people exposed to the impacts of climate change.
4. Prioritize for intervention households with more women and young children.
5. Support migrants and IDPs to help them build adaptive capacities to climate change-induced risks in health, water, sanitation and livelihoods.

3. HOW WILL LIVELIHOODS BE AFFECTED BY CLIMATE CHANGE?

Livelihoods are the collection of capabilities, assets and activities required for generating income and securing a means of living. Livelihoods are dynamic; and, depending on internal and external stressors, people may shift, adapt and transform their livelihoods. Some livelihoods, in particular, are more sensitive to a changing climate, such as irrigated agriculture, fishing and forestry in the context of Pakistan. According to the IPCC (2014), there is high confidence that climate change, climate variability, and climate-related hazard exacerbate other stressors, worsen existing poverty, heighten inequalities, trigger new vulnerabilities and typically have negative outcomes on livelihoods.

The following sections briefly outline: 1) the livelihood profiles of Pakistan; 2) how climate change is going to affect the major sectors of agriculture, fisheries and forestry (and, consequently, food security) as well as important non-agriculture livelihoods; and 3) the implications of climate change (extreme weather) for physical and financial assets owned by people.

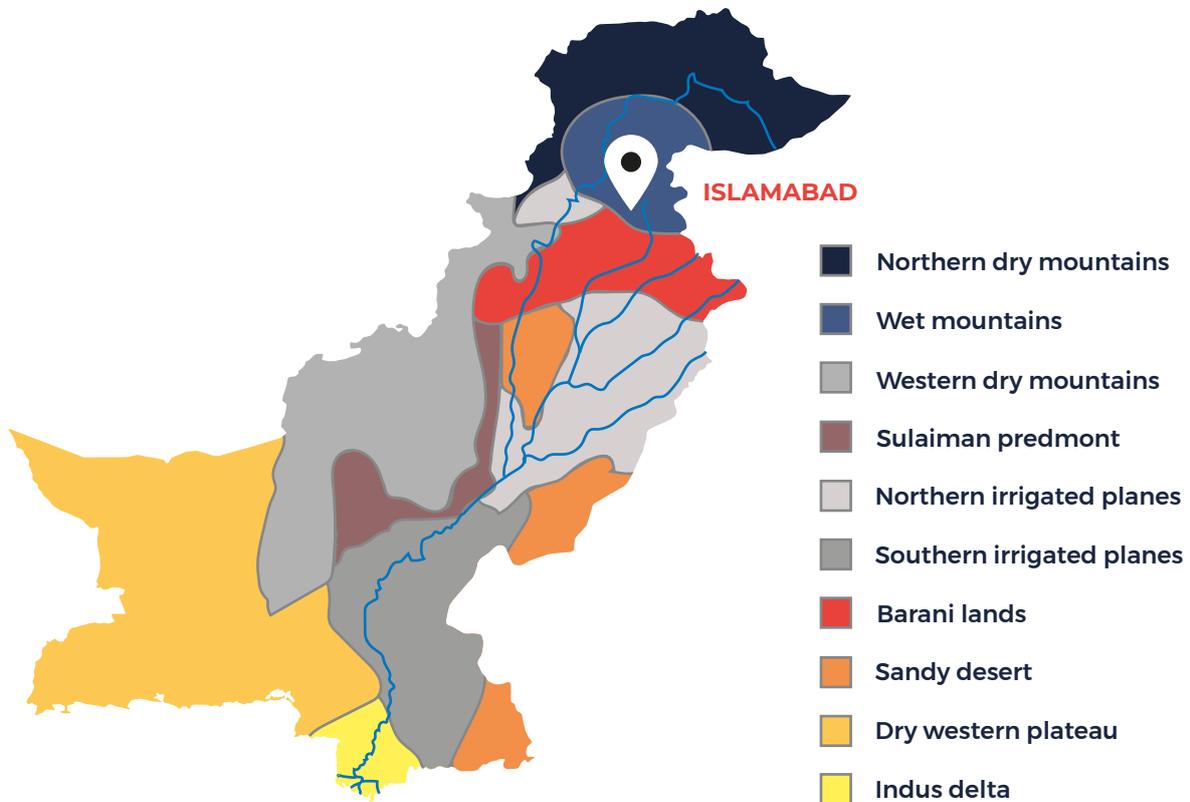
3.1. COUNTRY LIVELIHOODS PROFILE

Pakistan is a low-middle income country that remains predominantly agrarian, although it is progressively industrializing its economy. Pakistan depends heavily on its climate-sensitive land, water and forest resources for livelihoods and food security. Agriculture remains an important source of employment for 42 per cent of the population, and a high proportion of the population (60 per cent) holds “vulnerable employment” – which means low job security and limited access to social protection programmes (ILO 2018).



According to the Asian Development Bank, one-in-five (23 per cent) people lived in poverty in 2015 (ADB 2020). Heavy reliance on degraded land resources, alongside food insecurity and water scarcity issues make for unsustainable livelihoods (NIPS and ICF 2019).

Figure 2. Agro-ecological regions of Pakistan (Rasul and Hussain 2015)



Climatic shocks particularly affect women’s livelihoods. Whilst women take care of farming work when men migrate for better employment opportunities, they very seldom own or have decision-making rights over the productive assets (WFP 2020). A study revealed that only 44 per cent of women reported being able to make decisions about major household purchases (NIPS and ICF 2019) – thereby limiting their ability to respond to crisis situations. Women rarely own property (either houses or land), which limits their ability to rely on their asset base in times of emergencies or receive Government compensation if there are damages. Additionally, women also have limited access to information compared to men (MOHR 2020).

3.2. AGRICULTURE

Agriculture employs approximately 42 per cent of the population and contributes 21 per cent of GDP across the arid/semi-arid country (ILO 2017). Farmers engage in a combination of activities encompassing crop production, livestock management and non-timber forestry, all of which are climate-sensitive. As 90 per cent of agriculture depends on irrigation from the Indus River and its tributaries, the agriculture sector is highly vulnerable to changes in the availability (too little and too much) and timing of water resources (UNDP 2016). Flash floods and riverine floods are dependent on rainfall and will be influenced by increasing monsoon intensity and unpredictability as well as the faster rate of glacier melting under higher temperatures (Qaisrani *et al.* 2018). In 2010–2014, for instance, five flood events destroyed 10.63 million acres of crops, acutely affecting farmers' incomes and land fertility (GOP 2016). Although Pakistan has the most extensive continuous irrigation network in the world and a high level of flows (outside the drought regions), the country is still considered water stressed (UNDP 2016). This is mainly due to high demand for irrigation and poor water storage capacity. Furthermore, over one-quarter of cultivable land is already degraded due to water logging, salinization, flooding and erosion (Irfan *et al.* 2006; Climate Change Division 2013). Climate variability will aggravate these challenges (UNDP 2016). It is critical to monitor and manage river flows for a country so reliant on irrigation for agricultural purposes.

“There is a need to introduce different crops to be able to grow in the winter season and shorter seasonal crops are needed. But most people are still using the traditional seasonal calendar for crops.” (KI 10)

The mountain communities – mostly engaged in farming and allied activities – face several climate change-induced challenges. The changes in temperature and rainfall are impacting crops and livestock and also forests as the treelines are migrating northwards with increasing average temperatures. More extreme rainfall events are bringing more frequent landslides as also floods that damage crops and pastures (Shahzad *et al.* 2019). There is also a decline in some forest species, though very limited research has been carried out in this area (Asian Development Bank 2017). There are fewer diversified livelihoods available in the mountains and distress out-migration, more by men, has become one way of dealing with growing climate uncertainties, although migration is not perceived as an adaptation strategy by the Government of Pakistan.

Several studies have attempted to model agricultural productivity under climate change in the future:

- With a +0.5–2°C rise in temperature, agricultural productivity will decrease by around 8–10 per cent by 2040 (Delahvi *et al.* 2015).
- A different modelling study suggested that the growing season may shorten by 14 days for a 1°C rise in temperature in the growing season in the northern mountainous region of Pakistan (ADB 2017).
- For the economically important cotton crops, studies suggest that a 1°C rise in temperature during the vegetative and flowering stages of growth could reduce yields by 24.14 per cent and 8 per cent respectively. Sindh was affected most by temperature pressures on cotton – which will have significant implications for the local economy (UNDP 2015)

Livestock rearing constitutes 53 per cent of the agricultural GDP and contributes 12 per cent to the total national GDP. It is dependent on climate-sensitive grasslands and rangelands, which are increasingly under pressure from longer and more frequent droughts, flash floods and a rise in temperature. Livestock rearing is an important agriculture-allied activity for 30–35 million rural farmers who earn about 40 per cent of their income through livestock (Climate Change Division 2013). There are regional differences with the highest proportion (87 per cent) of people rearing livestock being in the arid province of Balochistan (Asian Development Bank 2017). The direct effects of climate change on livestock include heat stress resulting in lower milk and meat production and reduced reproduction. Rising temperatures and water-related disasters increase the risk of zoonotic epidemics as well as the loss of livestock (UNDP 2016). Indirect climate-related pressures like lower fodder production, soil erosion and land degradation will also adversely affect the livestock sector (Asian Development Bank 2017).

Deforestation has been high in Pakistan due to several reasons, including clearing the area to grow crops, graze cattle, and obtain firewood and timber. Deforested areas are witnessing higher climate change-induced flash floods, land erosion and landslides (GOP 2016). Higher temperatures and longer dry days also increase the risks of forest fires (Ministry of Climate Change 2012).

Fishing. Sea-level rise threatens communities living in the Indus Delta of Sindh and Balochistan where they earn a living through fishing and subsistence farming (Asian Development Bank 2017). Sea-level rise is resulting in higher coastal erosion in both Provinces, and salinization is impacting water quality, degrading mangroves and reducing fish catch and shrimp productivity (Asian Development Bank 2017).

Food security

The impacts of climate change on food productivity pose a very serious challenge in a country where 60 per cent of the population is food insecure (especially in Khyber Pakhtunkhwa) and almost half of the women and children are malnourished (MoPDR 2018; WFP 2020). Rising average temperatures are projected to reduce cereal production by up to 20 per cent in the warmer southern parts of Pakistan, though there will be minor improvements in yield in the colder northern areas (UNDP 2016). Punjab and Sindh provinces – which together account for over 90 per cent of agricultural produce – are the most vulnerable to climate change impacts (UNDP 2016). The production of income-generating cash crops like cotton, maize, rice, sugarcane and wheat is expected to decline due to climate change (UNDP 2016). Livestock production is also projected to decline, by approximately 30 per cent (UNDP 2016). Sea-level rise, saline intrusion, mangrove destruction, more frequent extreme rainfall events and increased cyclonic activity threaten fish productivity, which contributes 50–80 per cent of the protein required by coastal people (Barange *et al.* 2018).

3.3. NON-FARMING LIVELIHOODS

Rural diversified livelihoods include farm and non-farm activities with the latter mostly including services, daily wage labour and construction (UN HABITAT 2018). Climate change impacts on farmers and the potential loss of livelihoods will reduce purchasing power and indirectly impact the non-farm sector as expansion in this sector is directly proportional to agricultural development (Arif *et al.* 2019). In cities, heat stress and urban floods are especially impacting people living in poor quality shelters with inadequate sanitation facilities.

3.4 PHYSICAL ASSETS (HOUSES AND WORKPLACES)

Physical assets have the potential to be affected by the wide range of extreme weather events projected to affect Pakistan. Sea-level rise is already impacting the homes of coastal communities as well as major cities like Karachi (Asian Development Bank 2017). The major floods that have hit Pakistan in the past decade have shown the vulnerability of houses, workplaces and infrastructure (ILO 2017). Events in 1995–2013 have caused average annual losses of almost 4 billion US dollars; 197,230 villages damaged or destroyed; 3.45 million houses damaged; and over ten million acres of crops destroyed (GOP 2016; UN HABITAT 2018). With population growth, development and climate change, it is likely that damages per disaster will increase (ILO 2017). The urban poor are especially vulnerable, as informal settlements and temporary shelters are often constructed in unoccupied floodplains (UNHABITAT 2014).

SUMMARY: HOW WILL LIVELIHOODS BE AFFECTED BY CLIMATE CHANGE?

Livelihoods in Pakistan are heavily dependent on climate-sensitive resources with agriculture, livestock rearing, forestry and fishing sectors employing about 42 per cent of the population and contributing to 21 per cent of the national GDP. Almost 90 per cent of agriculture depends on irrigation from the glacier-fed River Indus and its tributaries. Climate change has hastened the pace of glacial melt which will increase the incidence of glacier lake outburst floods (GLOF) and flash floods downstream. Faster glacial melt, higher temperatures, shifting seasons and erratic rainfall patterns are all altering the flow of the River Indus and this will increasingly affect agriculture-related activities, food production and livelihoods. Changes in temperature and precipitation are worsening droughts in arid and semi-arid provinces; while coastal habitations are facing sea-level rise, salinity ingress and increased cyclonic activities, deepening the fisheries production and worsening food security. Rural non-farm jobs are highly dependent on agricultural development and will be affected by a loss of farm-related livelihoods. In cities, heatwaves and urban floods are affecting the work potential of people. Informal settlements in the floodplains are especially vulnerable.

RECOMMENDATIONS

1. Raise awareness and knowledge among staff, volunteers and communities of the different climate change impacts on livelihoods across the varied agro-climatic zones – the high mountains, forested highlands and foothills, floodplains, arid and semi-arid regions and the coastal areas.
2. Ensure medium- to long-term livelihoods security among farming communities and fisherfolk.
3. Support climate-smart agriculture interventions, including livelihoods diversification.
4. Integrate water management and livelihoods security, especially in potentially water-stressed areas.
5. Expand livelihoods interventions with rural women, building on traditional knowledge and adopting innovative strategies.
6. Consider introducing weather alerts for farmers and fisherfolk.
7. Engage with the national meteorological service and local authorities to pilot impact-based forecasts and forecast-based interventions to help communities alleviate climate shocks.

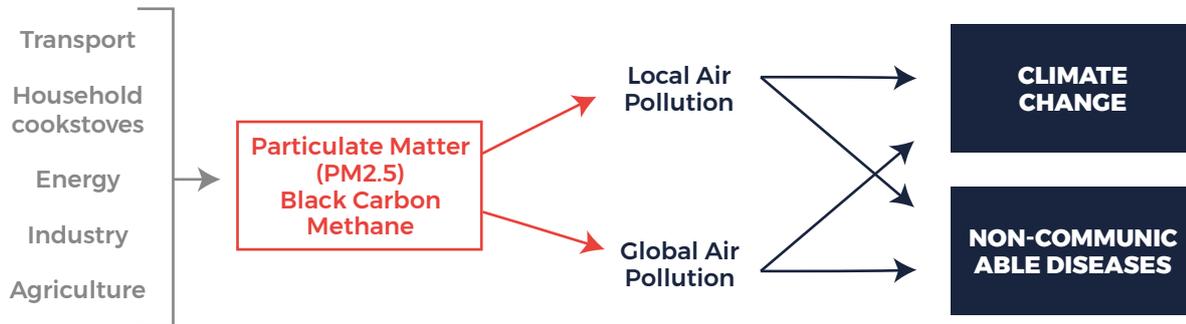
4. HOW WILL HEALTH BE AFFECTED BY CLIMATE CHANGE?

4.1. MORTALITY AND NON-COMMUNICABLE DISEASES

Heat-related morbidity and mortality is a significant concern in Pakistan, which already experiences hot summer temperatures that will be further exacerbated by the strong warming trend. The elderly are particularly at risk – under a high emissions scenario, heat-related deaths among those aged 65+ are projected to increase from ten deaths per 100,000 to approximately 63 deaths per 100,000 annually (WHO 2016). In addition to the elderly, children, the chronically ill, the socially isolated, and certain occupational groups (e.g. those working outside) are at increased risk of heat-related negative health outcomes (WHO 2016). A recent example is from the heatwave in Karachi in June 2015, which resulted in approximately 1,400 deaths. Reaching temperatures unseen for decades, heatwaves are becoming more intense as well as more common in Pakistan (Asian Development Bank 2017).

Noncommunicable diseases. Climate change is impacting noncommunicable diseases in Pakistan through several direct and indirect mechanisms. Energy sources contribute to climate change and local/household air pollution, but they are also responsible for many of the noncommunicable diseases that are prevalent in Pakistan. Outdoor air pollution, which can be found locally and globally, may increase mortality from respiratory infections, lung cancer and other cardiovascular diseases (WHO 2016). Annual mean particulate matter (PM_{2.5}) levels in Pakistan are above the recommended WHO guideline value of 10 µg/m³ (WHO 2016).

Indoor air pollution, occurring in the home or other indoor environments, is created by burning solid fuels (coal, firewood, agricultural waste, animal dung). Ninety-three per cent of households in Pakistan rely on these solid fuels for cooking; and 91 per cent of households use firewood as the primary source of heat (WFP 2020). Shifts in temperature may change household heating behaviours. This pollution results in an estimated 326,000 deaths per year (WFP 2020). Women and children are at particularly high risk of morbidity and mortality due to indoor air pollution as they typically spend more time indoors – approximately 34,000 children die each year from acute lower respiratory infections that are attributable to indoor air pollution (WHO 2016).

Figure 2: NCDs and climate change interaction

4.2. VECTOR-BORNE DISEASES

Vector-borne diseases pose significant health impacts and are highly sensitive to changing climatic conditions (temperature, precipitation, humidity), which exert a strong influence on the life cycles of the vectors (such as mosquitoes). Vector-borne diseases are also influenced by anthropogenic factors – which are not the focus of this report – such as population growth, urbanization and prevention and control measures.

“Dengue Fever is a tropical disease. We never had Dengue Fever, but in last 7–8 years, at the start of the summer season, Dengue Fever has increased in Karachi and Lahore” (KI 12)

Dengue Fever is currently active in Pakistan for approximately three months out of the year. Interestingly, though the geographic area which is considered suitable for Dengue Fever in Pakistan may change slightly, this transmission period is anticipated to remain constant through to 2070, regardless of a changing climate (WHO 2016). Evidence on whether the incidence of Dengue Fever will rise is mixed. Some sources indicate that there may be a slight reduction in vectorial capacity (the total number of potentially infectious bites from all mosquitoes biting a susceptible person on a single day) of Dengue Fever due to climate change (WHO 2016). Other sources suggest that increased temperatures may expand the favourable breeding site conditions (Asian Development Bank 2017). Further research is warranted as Dengue Fever outbreaks are of public health concern – the outbreak of Dengue Fever in 2019 lasted four months (July–November) and resulted in 47,120 cases and 75 deaths (WHO 2019).

Malaria incidence has historically been linked with flooding events in Pakistan. During the 2012 flooding in the country, the incidence of Malaria increased by two million cases during the four months following the floods – a dramatic increase compared to the 1.3 million cases over the whole year preceding the flooding (Malik 2012). The interaction between warmer temperatures and increased rainfall are known to positively influence Malaria transmission – trends that are expected under climate change – and, thus, the risk of a higher Malaria burden in Pakistan is possible.

4.3. WATER, SANITATION AND HYGIENE

This section covers the main health issues related to Water, Sanitation and Hygiene (WASH) and how they will be impacted by climate change. Water is also related to vector-borne diseases which are explored in section 4.2.

Water supply

Pakistan has made rapid progress in expanding its water supply: improved drinking water is now accessible to 91 per cent of the population (ILO 2017). However, UNICEF (2019) found that an estimated 70 per cent of people still drink contaminated water (typically contaminated with bacterial), even though it may be from an “improved” source. This is reflected in the high prevalence of waterborne diseases. With an ageing water infrastructure and inadequate water storage facilities (GOP 2016), the water stress that Pakistan faces as a result of climatic and non-climatic factors is substantial (Climate Change Division 2013).



improved drinking **91%** of the population



70% of people still drink **CONTAMINATED** water even if ‘improved’



There is no concept of drinking water directly from the tap. Everyone filters water.” (KI 1)

Climate change impacts are likely to complicate water supply by leading to issues with water quality and water quantity. Firstly, drought conditions and a lack of rainfall may cause decreases in water availability which, in turn, concentrates pollutants in the water and may force households to shift to low-quality alternative water sources (Liu and Chan 2015). Secondly, more frequent floods and heavy rainfall may flush pollutants (especially increasing urban runoff) into groundwater sources, increasing pollution intensity (Ahmed and Suphachalasai 2014; Ministry of Climate Change 2012). These floods may also cause landslides and negative impacts on water infrastructure in the community (Shah *et al.* 2020). Thirdly, higher temperatures will increase microbial growth (IPCC 2018). And, finally, the coastal zones of Pakistan are vulnerable to climate change as sea-level rise and saltwater intrusion negatively impacts agricultural zones, local water supply, and community infrastructure (Weeks and Harrison 2020).

Sanitation

Access to sanitation is lower compared to drinking water, as 70 per cent of households use an improved toilet facility. Sanitation access is markedly higher in urban (88 per cent) compared to rural (58 per cent) areas (NIPS and ICF 2019). However, 25 million people still practice open defecation in Pakistan (UNICEF Pakistan 2019), which has negative implications for environmental pollution and health. Climate-resilient sanitation and, in particular, infrastructure prepared for floods and heavy rainfall are crucial in Pakistan, considering the projected increase in these disasters. Unsafe disposal of human waste increases environmental exposure to pathogens, increasing the risk of waterborne diseases.



Sanitation access is markedly higher in **URBAN** **(88%)**
 compared to **RURAL** areas **(58%)**

Poor water and sanitation still cause over 53,000 deaths among children under five years of age in Pakistan through diarrhoeal diseases (UNICEF Pakistan 2019). The occurrence of waterborne diseases varies greatly across Pakistan's regions and seasons, yet climate change is expected to increase exposure to these diseases through the pollution of water sources and limiting access to clean drinking water. The proportion of diarrhoeal deaths due to climate change could rise from 11.7 per cent to approximately 17 per cent by 2050 (WHO 2016). This is projected to lead to an additional 5,639 diarrhoeal-related deaths in children by the year 2030 (WHO 2016). A disease of particular concern is Cholera, which re-emerged after the extreme floods in 2010 and resulted in 1,218 cases in the 2014 flood (Ahmed and Suphachalasai 2014). More frequent flooding events may increase the risk of cholera (Naseer and Jamali 2014).

The proportion of **DIARRHEAL DEATHS** due to climate change will rise from

11.7% to approximately **17%** by 2050

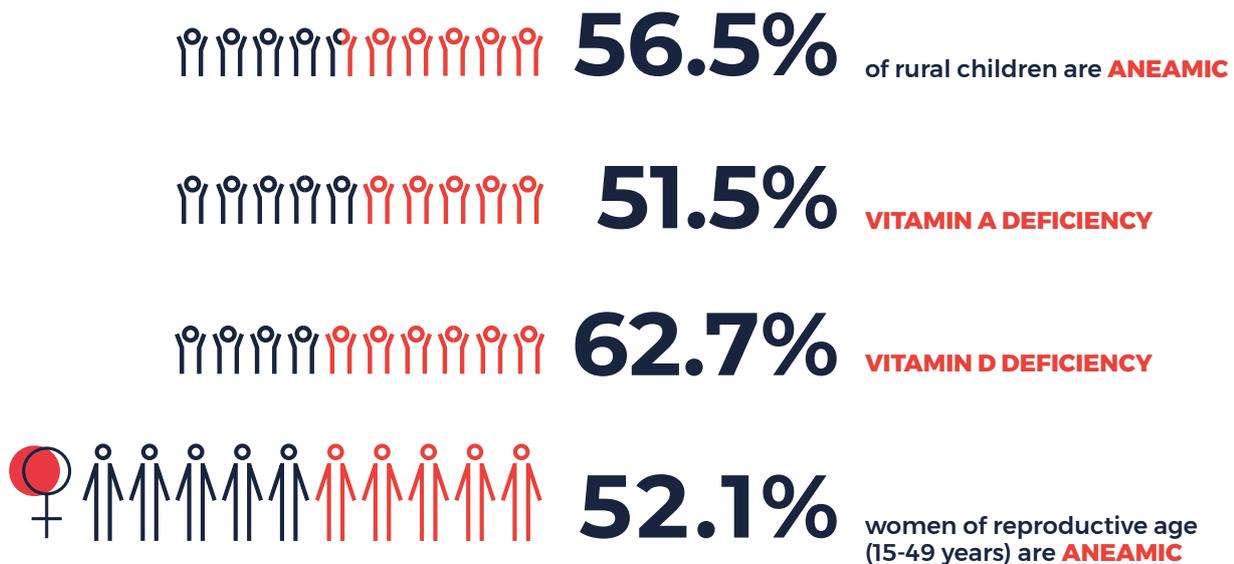
“Sewage is mixed during flooding causing Cholera and Dysentery and other waterborne diseases.” (KI 1)

4.4. MALNUTRITION

Climate change-induced malnutrition and, in particular, undernutrition are already occurring and will continue, particularly in areas that are currently food insecure across the globe (IPCC 2018). The IPCC predicts that climate change will have a “substantial negative impact” on food security issues, including: “(1) per capita calorie availability; (2) childhood undernutrition, particularly stunting; and (3) undernutrition-related child deaths and DALYs lost”.

“Nutrition and food insufficiency is the main driver of health issues related to CC – impacting women especially.” (KI 5)

Figure 4:



Pakistan scores 24.6 in the Global Hunger Index, which places it at the lower end of the ‘serious’ severity scale. Globally, Pakistan ranks 88 out of 107 countries in terms of hunger (Global Hunger Index 2020). Despite this relatively high ranking, it is on track to meet its Global Nutrition Targets. However, the impacts of climate change on food security may undermine this progress as food availability decreases – households are already highly vulnerable to increases in food prices and spend the majority of their income feeding the family.

The nutritional status of children and adults varies across the regions and districts of Pakistan. Compared to the South Asian average, Pakistan has worse nutrition indicators in terms of both chronic and acute malnutrition. In general, rural households are more food insecure and, therefore, face a greater risk of undernourishment than urban households. In region-specific studies, it was found that dietary diversity is low

and heavily cereal-based, lacking in protein consumption (WFP 2020). Micronutrient deficiencies are prevalent in rural Pakistan – more than half of the children are anaemic (56.5 per cent), suffer from vitamin A deficiency (51.5 per cent) and have vitamin D deficiencies (62.7 per cent) (WFP 2020). Half of women (52.1 per cent) of reproductive age (15–49 years) are anaemic (Development Initiatives 2020).

The staple crops that Pakistan relies on, such as rice and cereals, are highly climate sensitive. Crop failures could contribute to the further deterioration of the already concerning prevalence of chronic undernutrition (measured by the number of children under five years old who are stunted) across Pakistan. Nearly two-in-five (37.6 per cent) children under five years old are stunted (NIPS and ICF 2019; Development Initiatives 2020). Stunting is lowest in urban areas and highest in rural areas that have faced significant historical violence and conflict, such as Khyber Pakhtunkhwa (NIPS and ICF 2019).

During times of food shortages, negative coping strategies include reducing the number of meals per day and reducing portion sizes, eating less desirable or less expensive food, borrowing food or relying on help from friends or relatives (WFP 2020). All these factors contribute towards important nutrition and health impacts from climate change.

Women, in particular, bear the heaviest burden of food insecurity and the knock-on nutritional impacts. During periods of food shortages they reduce their consumption so that children and male household members have more to eat (WFP 2020). Furthermore, women and young girls face higher health and nutrition risks due to their heavy manual workloads, high birth rates, lack of access to sanitation and restrictions on their movement and consequently access to healthcare (WFP 2020).

Table 2: Available data on the prevalence of stunting, wasting and underweight children under five years old in Pakistan from 2013–2020

| PREVALENCE (UNDER 5) | | | | |
|-----------------------------|-------------|-------------|-------------|--------------------------------|
| | 2013 | 2018 | 2020 | SOUTH ASIA AVERAGE 2018 |
| Stunting | 45% | 40% | 37.6% | 32% |
| Wasting | 10.5% | 7% | 7.1% | 14% |
| Underweight | 31.6% | 23% | - | - |

Source: WFP 2020, NIPS and ICF 2019, Global Nutrition Report 2020

4.5. DISPLACEMENT AND MIGRATION

Climate change is likely to increase both internal and external migration in Pakistan. Already, Pakistan is seeing climate change-induced displacement due to heat stress and flooding, both of which negatively impact agricultural livelihoods (Mueller *et al.* 2014; Fahad and Wang 2020). In 2016, Pakistan saw over one million people permanently displaced due to natural hazard-related disasters (Bennett *et al.* 2017), a number that is likely to grow due to climate change. Temporary displacement due to natural hazards is common in Pakistan, as was seen during the floods of 2010, where 20 million people were displaced from their homes (Ministry of Climate Change 2012). Heatwaves and more frequent floods threaten to deepen health challenges for migrants and IDPs as healthcare facilities are not expanded to cater for the additional influx of people (Malik *et al.* 2019). Migrants are also often in low-paid jobs and face difficulties in affording healthcare.

There is very little available data on health and IDPs. A seven-year longitudinal assessment on the health status of Afghan refugees and a 2–4-year assessment on the health of IDPs in Khyber Pakhtunkhwa revealed that, among Afghan refugees, cardiovascular and respiratory tract infections were most common, followed by skin diseases and diarrhoea. Skin diseases were most common followed by respiratory infections among IDPs. Significantly, among Afghan refugees, women carried a higher disease burden than men (Malik *et al.* 2019).

“There is a lot of rural to urban migration, especially of small landholding farmers who are not able to make ends meet. They then move to urban areas. When they move to urban areas, they do not have any skills for urban jobs. For men they can still find labour jobs (but for women it is difficult).” (KI 12)

4.6. MENTAL HEALTH

Though climate change directly impacts migration in Pakistan, there are also complex interconnections between climate, conflict and migration, which can result in severe impacts on the mental health of migrants. IDPs due to climate change may not only be suffering from the effects of destroyed livelihoods and migration, but also of conflict. It means that this group of IDPs is at a very high risk of developing mental health issues, with women and children at particularly high risk (Shah and Wadoo 2009).

Children are particularly vulnerable to the mental health effects of displacement induced by climate change. Following the 2010 floods in Pakistan, approximately 70 per cent of affected children had severe or moderate mental health problems attributable to the flood. Importantly, these children’s mental health was severely impacted by the psychological state and reaction of their parents to the floods (Save

the Children 2011). This is consistent with a finding from a 2015 survey conducted by IOM on migrant health in Pakistan, which found that mental health and stress were the biggest health challenges faced by migrants (IOM 2015). This longitudinal study reveals that, among Afghan refugees, a higher number of women compared to men were treated for psychological disorders. This finding demonstrates the importance of mental health resources for impacted families, as well as preventative resources for at-risk communities. There remains much scope for work to explore the mental health implications of climate change in the general population and particularly in vulnerable groups such as the displaced.

4.7. CRITICAL INFRASTRUCTURE AND HEALTH SYSTEMS

In Pakistan, a majority of the population has access to either Government-sponsored healthcare (62 per cent) or private facilities (36 per cent) (WFP 2020). Yet households have major challenges accessing these available services due to the distance and cost as well as a lack of equipment and personnel at the facilities (WFP 2020).

These issues are particularly relevant to women, who have limited decision-making power due to socio-cultural norms as well as poor access to resources (NIPS and ICF 2019). In Pakistan, women are required to be accompanied by a male companion and must have permission from their household to travel to a healthcare facility (WHO 2007). In addition, women often prefer, or are required, to consult with female care providers; yet females are far less likely to work in healthcare in Pakistan (WHO 2007). These challenges result in disproportionate barriers to accessing healthcare for women, putting them at increased risk of health impacts.

“Women and children do not leave villages and have to rely on the nearest healthcare facility.” (KI 11)

4.8. SEXUAL, REPRODUCTIVE, MATERNAL, NEWBORN AND CHILD HEALTH

Climate change already is, and will continue to, affect men and women as well as boys and girls differently. Key areas of concern from global studies have shown how climate change is altering the dynamics and risk of negative maternal health outcomes, forced child marriages, human trafficking, sexual exploitation and gender-based violence (Castañeda Carney *et al.* 2020; Women Deliver 2021). However, considerable gaps in research and evidence that links climate change and sexual and reproductive health rights exist both globally (Women Deliver 2021) and in Pakistan.

Some key trends bear consideration with regards to sexual, reproductive, maternal, newborn and child health and climate change:

- **Accessing sexual and reproductive healthcare services:** Extreme weather or climate-related disasters (such as landslides, floods etc.) may cut people off from accessing services (such as antenatal care) and supplies (Women Deliver 2021). Furthermore, women already face a number of socio-cultural and economic barriers to accessing healthcare and a study estimated that one-in-three women may not seek medical help because they do not have permission from a male member of the family (WHO 2007).
- **Reproductive health:** Studies have shown that 14 per cent of women of reproductive age die as a result of infectious and parasitic diseases; and complications during pregnancy lead to 12 per cent of maternal deaths (NIPS and ICF 2020).
- **Maternal health:** Pregnant and lactating women will face additional health, hygiene and sanitation problems due to climate change-induced food and water insecurity, heatwaves and a rise in extreme events. The emergence of vector-borne diseases like Dengue Fever, especially in cities, and the shifting incidence of vector-borne and waterborne diseases due to changes in temperature and precipitation will especially affect this group of people. Migrants and IDPs typically stay in areas that already have a high incidence of Malaria and, therefore, migrant women are especially at risk (Malik *et al.* 2019)
- **Newborn and child health:** Neonatal and child morbidity and mortality rates remain high with 18 deaths per 1,000 live births and a mortality rate of 39 per 1,000 live births in children under-five, with the primary drivers being poverty, illiteracy, lack of women's empowerment and high fertility rates (Memon *et al.* 2020).

“Women in rural areas do not have access to maternal healthcare and need to be accompanied by a male figure from their household. He may not be available because he is out when she needs to visit a health facility. For women in rural areas, the need to be accompanied makes it very difficult for them to access healthcare.” (KI 9)

SUMMARY: HOW WILL HEALTH BE AFFECTED BY CLIMATE CHANGE?

Changes in temperature and precipitation will lead to heat stress and the higher incidence of vector-borne diseases among rural and urban populations. This will especially affect reproductive health, children, the elderly and those living or working in poorly ventilated structures and/or in densely populated areas. More extreme events like floods and droughts, especially accompanied by higher temperatures, longer dry days and more frequent extreme rainfall events, will cause a higher incidence of vector-borne and waterborne diseases. Migrants and IDPs will be highly vulnerable, even as out-migration may increase due to climate change. A changing climate may potentially increase the number of child marriages, premature births and domestic violence. Women and children will be more vulnerable to malnourishment and malnutrition due to lower food production.

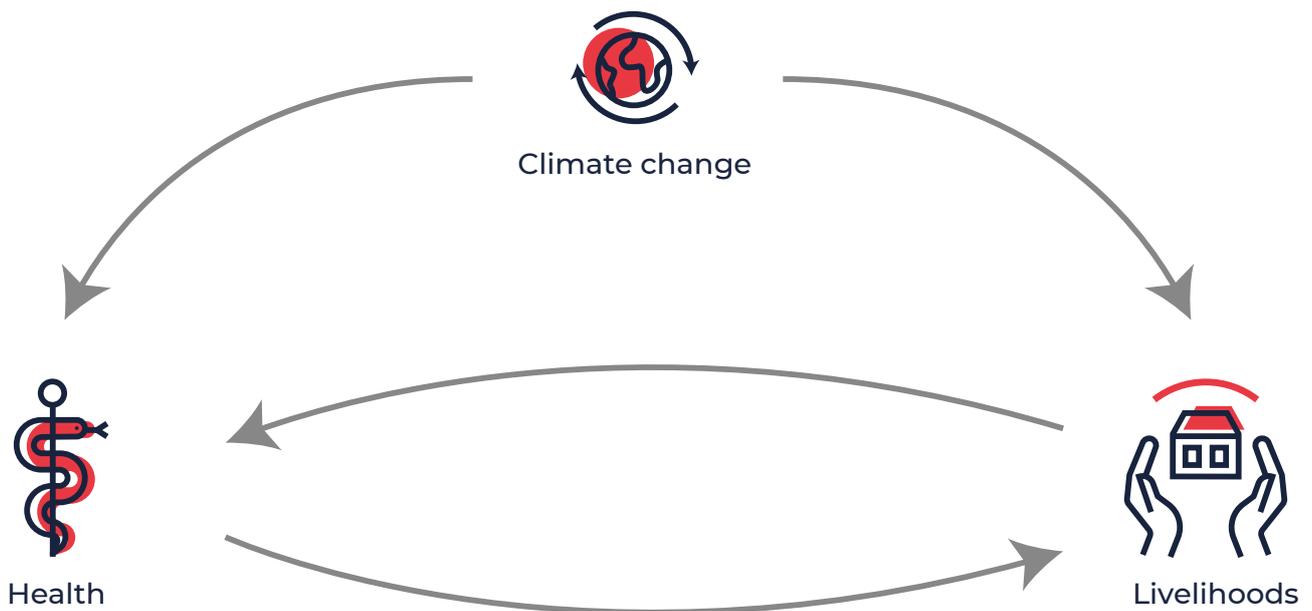
RECOMMENDATIONS

1. Assess changes in vector-borne and waterborne diseases relating to new vectors and seasonal shifts.
2. Focus on high-risk groups including migrants and IDPs, newborns, infants and young children, pregnant and lactating women, the elderly and those living in unhygienic and densely populated areas within cities.
3. Promote nature-based solutions and effective traditional methods for heat mitigation at the individual, household and community levels.
4. Promote awareness generation and behavioural change to improve water and sanitation facilities.
5. Engage with authorities to help augment the healthcare infrastructure and surveillance services for high-risk groups of people, factoring in climate change impacts.
6. Ensure linkages of health interventions with food and water security.



5. LINKAGE BETWEEN CLIMATE IMPACTS ON HEALTH AND LIVELIHOOD

Several of the specific linkages between climate change, health and livelihoods have been discussed in this paper. Climate change has the potential to affect health and livelihoods in a negative feedback loop. When climate change negatively affects livelihoods, people do not have sufficient money to ensure good health and pay for healthcare, causing a spiralling of acute or chronic conditions; likewise, when climate change negatively affects health, people may be unable to work and thereby earn sufficient money to pay for the healthcare they need, further reducing their ability to get better. A popular idiom in South Asia says: *jaan hai to jahan hai* – “the world exists when life exists” where ‘life’ denotes a healthy, well-provisioned existence.



“When you lose livelihoods, health is also compromised. If there are medical problems, people tend to go to a local medic or self-medicate.” (KI 12)

“When poor people do not have health insurance, it impacts their livelihoods because they will then not go to available healthcare services and delay going to hospital. This will then affect their ability to work. Even middle-income groups do not have enough income security and avoid going to hospital, due to high hospital bills.” (KI 6)

More frequent and longer **heatwaves** will lead to health and hygiene impacts and hamper productivity. Heatwaves will particularly affect outdoor workers in both rural and urban areas (ILO 2017). By 2025, over 5 per cent of potential work hours, in the shade and at moderate work intensity might be lost due to rises in temperature (ILO 2017; UNDP 2016). Heatwaves will also affect workers' health with increased heat stress and exhaustion and an interaction with noncommunicable diseases. Together, the negative health impacts and reduced working hours will affect incomes, particularly impacting low-income groups, those with insecure jobs and wage labourers.

Changes in temperature leading to **faster glacier melt** and the consequent riverine floods downstream in the River Indus will lead to soil erosion, loss of soil fertility, loss of livelihoods and low food production – all of which will have multitude health and WASH impacts. These include a higher incidence of waterborne diseases and lower food security, resulting in worsening malnourishment and malnutrition. Poor health outcomes will, in turn, affect productivity. Extreme events like intense rainfall events and cyclonic activities will also lead to loss of livelihoods with adverse health and WASH outcomes.

Longer dry days and **longer and more frequent droughts** may result in the higher incidence of vector-borne diseases and affect food productivity, which may lead to a reduced ability to work. Sea-level rise, salinization and a rise in cyclonic activity are already threatening coastal livelihoods, resulting in lower marine food consumption, potentially exacerbating malnourishment and malnutrition in these areas.

“*Labourers were affected by the heatwave in Karachi and several could not survive it.*”

“*Rural areas lack livelihood diversification. They have livestock and agriculture. Prolonged drought leads to more malnourishment. People have less produce, less to sell.*”
(KI 9)

In cities, the urban heat island effect, extreme rainfall events and urban floods will affect both the health and livelihoods of inhabitants. Coastal cities like Karachi will face additional pressures from sea-level rise and coastal storms. With a rise in climate change-induced disasters and loss of livelihoods in rural areas, cities will attract more IDPs, putting pressure on available healthcare services and livelihood opportunities. Working on urban resilience often requires a change of land use and addressing the legal rights of high-risk communities to ensure their medium- to long-term adaptation to climate change-induced stresses and shocks.

SUMMARY: WHAT ARE THE KEY LINKAGES BETWEEN CLIMATE CHANGE, HEALTH AND LIVELIHOODS?

Climate change impacts on health and livelihoods connect in a negative loop with adverse effects in one leading to adverse effects on the other. Climate change trends and projections like rising temperatures, erratic rainfall patterns, more frequent extreme events and sea-level rise impact both the well-being and productivity of people. Those who suffer the health consequences are not able to earn as much, while people who suffer livelihood losses are unable to eat well to build their immunity and are unable to afford healthcare. Cities will probably witness higher numbers of IDPs due to climate change stresses and shocks, putting pressure on the already inadequate healthcare services and livelihood opportunities.

RECOMMENDATIONS

- 1.** Include climate change impacts on both health and livelihoods in community-based vulnerability and capacity assessments.
- 2.** Support adaptation interventions for both health (including WASH) and livelihoods among high-risk communities to prevent the loss in one adversely affecting the other under a changing climate.
- 3.** Engage with local authorities and as an auxiliary to the Government to help make required changes in land use plans, policies, programmes and laws to build long-term resilience to climate change among urban-based at-risk groups.

CITY ASSESSMENT: KARACHI

Karachi is a major coastal city with over 16 million inhabitants and acts as the capital of the Sindh Province. It faces a number of challenges and inequalities that the climate crisis will exacerbate. As one of the city-level key informants remarked:

“High-profile people can reach hospitals but low and medium classes try to treat health risks with home remedies” (K12).

A high degree of unplanned urbanization and poorly constructed buildings place 50 per cent of the population (World Bank 2016) at high risk of the adverse health impacts of a changing climate. Poorer daily wage labourers are often crowded into high-rise buildings that lack air conditioning or adequate ventilation; and, as a result, will suffer as days and nights become hotter (K11; K12).

Residents may face multiple hazards simultaneously or in succession, which can, over time, compound the impacts of any one hazard. As a key informant explained:

“People are living in unventilated, hot high-rise buildings in slum areas, and the flats on lower floors also experience flooding” (K12).

Flooding in the city is an urgent public health problem as the drainage system is inadequate and there is poor solid waste management.

“Water and sanitation are huge issues in the city and there is a dire need to work on water issues.” (K11)

In August 2020, the rains that caused flooding in the city were the heaviest recorded for 90 years (NEEDS 2020). Floodwater frequently mixed with sewage, triggering outbreaks of waterborne diseases such as diarrhoea and, of particular concern, Cholera (K11; Kii2; NEEDS 2020).

Contaminated and stagnant waters are perfect breeding grounds for vector-borne diseases like Dengue Fever and Malaria (Fazal and Hotez 2020), which have also been on the rise in the city and in Pakistan more generally (Ilyas *et al.* 2019).

Additionally, drinking water is a big issue as most residents in Karachi depend on buying filtered drinking water as tap water is contaminated with lead (World Bank 2016). City-level key informants remarked that “there is no concept of drinking tap-water” (KI1). If livelihoods are affected, then access to clean water may become even more difficult for households.

The most popular sources of livelihoods include working in textile factories, street vending and providing household and office help (KI1, KI2). Small business owners are affected by loss of assets and income when there is inner-city flooding, which may damage their stalls or cause street blockages deterring customers (NEEDS 2020).

There is a lack of city-level assessment on the climate impacts on health and livelihoods. Although there are Government ministries set up to monitor health impacts, no central health surveillance has taken place (KI1, KI2). This has led to fragmented efforts as organizations like the World Bank are seen conducting research. But, overall, there is a lack of baseline data in order to monitor and track the impacts of climate change on health (KI2).

Government initiatives have been focused on early warning efforts and awareness-raising initiatives. Each June, public messages are communicated on staying safe in heatwaves and initiatives like drinking water-stations are managed inside the city areas during hotter days (KI1, KI2). Awareness programmes on the impacts of climate change are conducted so that city dwellers can identify climate-related threats and are able to seek Government assistance (KI2). On a larger scale, although the Government had mandated the formation of a Climate Change Department in each province in 2015, this was not followed by many climate-related initiatives (KI2). Most Government intervention has taken a backseat due to a lack of funding and resources (KI2).

6. EXISTING CAPACITIES, STAKEHOLDERS AND PROGRAMMES

6.1. POLICY LANDSCAPE

The Ministry of Climate Change is the main Government body overseeing climate change issues in Pakistan. Climate and health-related adaptation policies focus on providing access to healthcare for the most vulnerable communities; building capacities to reduce vulnerabilities; sensitizing and educating both public and healthcare professionals on the climate impacts on health; ensuring access to medication and good drinking water at an affordable price; and upgrading disease outbreak monitoring and forecasting systems as preventive measures in the future (Ministry of Climate Change 2012).

Table 2: Brief overview of the main climate policy documents

| POLICY | DESCRIPTION OF CLIMATE-LIVELIHOODS-HEALTH FOCUS |
|--|---|
| Clean Development Mechanism (CDM) Initiative | CDM is a protocol put forth by the Kyoto Protocol of the United Nations Framework Convention on Climate Change (UNFCCC), which was ratified in Pakistan in 1997 and implemented in 2005. CDM facilitates the component of carbon trading in development activities. |
| Reducing Emissions from Deforestation and Forest Degradation (REDD+) Initiative | REDD+ is an international climate policy initiative that aims to reduce global carbon emissions through initiatives, implemented in Pakistan in 2015 (Zahid 2018). |
| Pakistan’s National Climate Change Policy (NCCP) 2012 | Provides a framework for addressing present and future climate change-related impacts. The policy is shaped in terms of sectors focusing on adaptation policies for water resources, agriculture and livestock, human health, forestry, biodiversity, vulnerable ecosystems, disaster preparedness and socioeconomic measures including poverty and gender (Ministry of Climate Change 2012). |
| Framework for Implementation of Climate Change Policy (2014–2030) | A policy created by the then Climate Change Division of the Government of Pakistan, which enlists details of sectoral activities to be carried out in the priority or short-term schedules (Climate Change Division 2013). |

| POLICY | DESCRIPTION OF CLIMATE-LIVELIHOODS-HEALTH FOCUS |
|---|--|
| Pakistan’s Intended Nationally Determined Contribution (INDC) | Prioritizes building both a climate-resilient society and economy by mainstreaming climate change in most socioeconomically vulnerable sectors. INDC estimates that Pakistan’s greenhouse gas (GHG) emissions in 2030 would be at 1,603 mt CO ₂ -equivalent and intends to reduce its 2030 GHG emissions by 20 per cent (Ministry of Climate Change 2016). |
| National Adaptation Plan (NAP) – under development with the UN Environment Programme (Asian Development Bank 2017) | Will give guidelines to implementing agencies on adopting a more coordinated approach towards factoring climate change into policies. Will help to prioritize adaptation needs vis-à-vis different sectors at the sub-national and national levels. The allocation of financial resources is done at the sub-national level. Based on the INDC, the total estimated figure is 7–14 billion US dollars per year. |

The NCCP also emphasizes the integration of poverty reduction measures in economic plans to address the poverty-climate nexus and ensure a sustained development process that focuses on the needs of the poorest population (Ministry of Climate Change 2012). The NCCP also places importance on mainstreaming gender perspectives in climate change initiatives, both nationally and regionally. In particular, reducing the vulnerability of women in rural areas with their roles in providing water, food and energy is emphasized. Further work on understanding gender-differentiated impacts, women’s role in decision-making, and creating gender-sensitive adaptation vulnerability criteria are also listed (Ministry of Climate Change 2012).

Other adaptation policy measures mentioned concern forestry, biodiversity and various vulnerable ecosystems, including mountain areas, rangelands and pastures, arid and hyper-arid areas, coastal and marine ecosystems, and wetlands. A summary of the relevant policies can be found in Annex B.

6.2. CAPACITIES

The section below is based on key informant interviews that were conducted with National Society members and climate and health experts.

GOVERNMENT

STRENGTHS

- Pakistan has prominent and ambitious goals to address climate change impacts and environmental concerns.
- Pakistan’s highly considered social protection programme (Benazir Income Support Programme (BISP) targets the poorest 149 districts in the country as a means to address poverty and women’s empowerment.



CHALLENGES

- Limited implementation of policies due to a need for finances and better data.
- Low focus on climate impacts on health. Limited Government health facilities with qualified health professionals. Limited access to affordable healthcare facilities.
- Underdeveloped early warning and forecasting systems, especially tied to health impacts and repercussions on livelihoods. Lack of awareness and knowledge among the general public on the impacts and threats of climate change.

PAKISTAN RED CRESCENT SOCIETY

- Plans to integrate climate strategies into programmes.
- Partnerships with other National Societies like the Red Cross Society of China and Kuwait Red Crescent Society as well as donor agencies like UNDP have led to initiatives such as cash grants for people affected by droughts, early warnings of GLOFs and flash floods.
- Current initiatives such as awareness-raising programmes are in place and the National Society is focused on women, women-led households and the elderly as well as transgender and chronically ill people.



- Not using any weather forecasting tools used for health surveillance systems.
- Climate connection to livelihoods is missing.
- Insufficient staff for new climate projects and lack of adequate resources.
- Need to work towards a better social safety net for all, particularly the most vulnerable people.

7. RECOMMENDATIONS AND OPPORTUNITIES

RECOMMENDATION 1: Invest in community-based early warning systems in collaboration with the national hydro-meteorological service

Gap: A gap exists in early warnings issued by the Pakistan Meteorological Department not reaching local level for various reasons, including the non-functioning of all district-level disaster management authorities, limited communication channels, and English being used as the medium of communication, instead of the local language (Asian Development Bank 2017).

“Pakistan does not have early warning systems – if we could implement more early warning or forecasting data to predict floods, that would be very helpful. Understanding when a flood is about to hit can at least save the people even if some infrastructure cannot be saved.” (KI 9)

Opportunity for action: 1) collaborate formally with the national hydro-meteorological service¹ for information and capacity building on understanding and disseminating impact-based forecasts and alerts; 2) adopt a differentiated and tailored early warning approach to reach different population groups, especially women within each group; 3) undertake behavioural change approaches so that vulnerable and exposed community groups of men and women are able to absorb and act upon the early warnings; 4) plan a funding strategy for up-scaling Early Warning Early Action through various innovative ways, including, for example, forecast-based financing (FbF) and/or piloting automatic weather station(s) at the community-level to collect ground-level weather data to help communities monitor seasonal variations and act accordingly.

RECOMMENDATION 2: Prioritize medium- to long-term livelihoods security of food producers in different agro-climatic zones.

Gap: There is an urgent need to promote climate-smart agriculture, ideally with district-level adaptation plans, to tackle the related issues of poverty, hunger, desertification and migration (Arif *et al.* 2019).

Opportunity for action: 1) enhance the knowledge and capacities on climate change impacts on food security and livelihoods in different agro-climatic zones; 2) prioritize working with and sharing data – weather forecasts and climate projections, community-based data on vulnerabilities and capacities, and resilient farm-based inputs and practices; 3) collaborate with government agencies, universities and research institutions to promote nature-based solutions to increase soil and water fertility for better food production, find innovative methods of diversifying livelihoods to prevent climate change-induced migration, improve the marine ecosystem through the plantation of mangroves and innovative fish production strategies², and secure women’s livelihood options with special attention to migrant women; 4) work with local authorities to create opportunities for unskilled rural workers, for example, in local food processing and non-farm services, involving both men and women; and 5) prioritize areas such as Khyber Pakhtunkhwa from where rates of out-migration are high.

RECOMMENDATION 3: Build resilience on the health, WASH and livelihoods of migrants and IDPs in cities

Gap: Climate change is a strong driver of internal migration and displacement, and migrants and IDPs continue to be vulnerable to developmental and socioeconomic challenges (Malik *et al.* 2019).

“With a shortage of housing for migrants, the unplanned city is growing in all directions. It affects everything, including a lack of resources for migrants. We are strapped for resources in the longer term as well.” (KI 1)

Opportunity for action: 1) build knowledge on the linkages between climate change and migration through research and community engagement in selected areas; 2) prioritize migrants and IDPs for building resilience to climate change-induced disasters in rural and urban areas; 3) work with local authorities to improve health, WASH and livelihood opportunities for migrants and IDPs; 4) link Recommendations 2 and 3 through a programmatic approach to build resilience in the places of origin of IDPs as well as in their destinations; 5) engage with and influence local authorities and government agencies to prioritize urban resilience plans, ensuring that the voices and concerns of migrants and IDPs as well as other marginalized groups are represented on different decision-making and implementation platforms.

RECOMMENDATION 4: Engage with the development of the National Adaptation Plan (NAP) to bring the concerns and needs of vulnerable people centre-stage

Gap: The development of the NAP is a slow and complex process; there is an urgent need to engage with it to ensure the inclusion of the most vulnerable groups of people.

“The Directorate of Urban Policy & Strategic Planning (P&D Department) was engaged in climate change interventions in 2015, when all provinces had to form a Climate Change Department. Not much has happened after that. (KI 2)

Opportunity for action: 1) build capacities and map different policies and programmes relating to climate change across sectors to better understand the adaptation policy environment from the perspective of vulnerable, at-risk groups; 2) engage with national and sub-national platforms on adaptation to strengthen and contribute people’s voices and concerns to the process, including both men and women; 3) undertake required field research to inform the NAP process; 4) get involved as a resource agency for developing and implementing the NAP at the national and sub-national levels; and 5) draw upon the knowledge and experiences of other National Societies on their engagement with the NAP.



RECOMMENDATION 5: Collaborate with universities and research institutions to build climate-smart best practices in food security, livelihoods, and health security at the community level.

Gap: Despite the climate change-related policies and programmes of the Government, there is very little data and research available on the resilience of communities that are dependent upon climate-sensitive natural resources at the national and sub-national levels (Asian Development Bank 2017).

“Despite the River Indus, Pakistan faces water shortages. Much of the mortality is due to waterborne diseases and there is still open defecation.”

Opportunity for action: 1) adopt an integrated water management and livelihoods security approach to build the resilience of communities to water-related issues, especially in potentially water-stressed areas;. 2) engage and collaborate with knowledge institutions to research and pilot food- and water-security interventions; 3) generate awareness and build knowledge on the links between climate change, livelihoods, health, and water and sanitation; 4) adopt innovative ways of behaviour change and communication, for example, food and water champions in communities; 5) link food production with the needs of a nutritional ‘basket’ of foods and focus, in particular, on the nutritional needs of women and girls; and 6) engage with authorities, planners and decision-makers to share field-level evidence, data and best practice on food and water security to strengthen and influence adaptation plans, including the development of the NAP.

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ANNEX A

NEAR-TERM CLIMATE CHANGE IN PAKISTAN BY 2020–2039³

Basic climatology. For monthly temperature (average, minimum and maximum) there is a general increase projected by 2020–2039 by 0.90–1.31°C under RCP2.6 and up to 1.08–1.55°C per month under RCP8.5. Projections for monthly and annual rainfall are uncertain because models have difficulty simulating future changes in the South Asian monsoon as well as the dynamics of the El Niño Southern Oscillation. The overall trend does suggest a slight increase in monthly precipitation nationally, albeit with regional differences – with Punjab projected to receive slightly more rainfall under RCP8.5 whereas Baluchistan may see monthly decreases.

Climatic extremes. In the next twenty years, projections under RCP2.6 and RCP8.5 show little change in the number of days with more than 20mm of rain and the percentage of rain falling during ‘very wet days’. However, projections do suggest the amount of rain falling during events with a 10- and 25-year return period (extreme rainfall events) will increase generally, especially in the eastern regions (Punjab and Sindh), despite some regional decreases in the west of Baluchistan and central Pakistan.

In line with the drastic increase in temperature already affecting Pakistan in the next 20 years, there are shifts projected in temperature extremes. Besides a general increase in the maximum daily temperatures, the number of hot days (temperatures exceeding 35°C) will increase rapidly throughout the 21st century. Furthermore, the frequency of extremely hot days (temperatures exceeding 40°C) is projected to increase by a mean of 11.57 days (RCP2.6 mean) to 15.62 days (RCP8.5 mean) in the next twenty years already.

Agricultural conditions. As a result of rising temperatures, there may be a longer growing season in the cold mountainous regions in the north, increasing regionally by 10–16 days (mean, solely based on temperature). As annual rainfall may increase slightly, the duration of dry spells is projected to decrease slightly by approximately four days (RCP2.6 and RCP8.5). For the duration of wet spells, projections are inconclusive. However, as temperatures rise rapidly in Pakistan evaporation increases too – resulting in an overall drying of the climate. The Mean Drought Index is projected to decrease by -0.3 SPEI (RCP2.6 and RCP8.5 mean), with a

3 Projections in this Annex are based on the AR5 CMIP5 dataset used by the IPCC, sourced from the World Bank Climate Portal – supplied under the Creative Commons 4.0 license. For more information, please refer to the Methodology section.

particularly strong drying trend along the border regions with Afghanistan (the eastern region) and in central Pakistan. The annual probability of a severe drought (defined as a SPEI below -2) will increase by 16–17 per cent (RCP2.6 and RCP8.5 mean) nationally.

SUMMARY OF KEY POINTS:

- 1.** While rainfall projections remain uncertain, the rapid rise in temperature in Pakistan will increase the risk and severity of droughts across the country already in the next 20 years. These droughts will affect an already vulnerable country, particularly in the more arid provinces in the east.
- 2.** Extremely hot days become more frequent and more intense across the country.
- 3.** The rainfall trends across Pakistan remain uncertain, covering general trends, seasonality and extreme events. There is an overall slight increase in annual rainfall projected while extreme events will become more intense.

ANNEX B:

SUMMARY OF RELEVANT POLICIES FROM THE NATIONAL CLIMATE CHANGE POLICY PAKISTAN 2012

WATER RESOURCE POLICIES

Water storage infrastructure (“Assess and address the needs for additional water storage and distribution infrastructure” among others)

Water conservation strategies (“Ensure water conservation, reduce irrigation system losses and provide incentives for the adoption of more efficient irrigation techniques” among others)

Integrated water resource management (“Ensure that, in making water allocations (within gross national availability) to various sectors in the medium- to long-term, due consideration is given to changes in sectoral demands caused by climate change” among others)

Legislative framework

Enhancing capacity

Awareness-raising

AGRICULTURE AND LIVESTOCK POLICIES

Promote feed conservation techniques and fodder banks in arable areas

Encourage farmers, particularly in rainfed areas, to avoid monoculture and, instead, plant a variety of heat- and drought-resistant low delta crops, so as to reduce the risk of crop failure

HEALTH POLICIES

Assess the health vulnerabilities of communities in areas most likely to be affected by the adverse impacts of climate change, and build their capacities to reduce these vulnerabilities

Ensure that appropriate measures to address health-related climate change issues are incorporated into national health plans

Inform, sensitize, educate and train health personnel and the public about climate change-related health issues

Ensure that preventive measures and resources such as vaccines, good quality medication and clean drinking water are available to the general public easily and cost effectively, particularly during climate-related extreme events

Upgrade and extend disease outbreak monitoring and forecasting systems to counteract possible climate change-health impacts and support prior planning for effective interventions

POVERTY POLICIES

Integrate the poverty-climate change nexus into economic policies and plans

Ensure the implementation and expansion of national population planning strategies and programmes, as the population explosion is likely to significantly exacerbate the impact of climate change

Enhance general awareness of the problems of unchecked population growth and the demands it places on natural resources

Strengthen community-level climate change adaptation measures to prepare communities for enhanced and efficient natural resources management

Improve the access of poor communities to appropriate technologies for crop production, integrated pest management and credit facilities for agricultural development

Ensure that the development process is sustainable and caters to the needs of the poor

WOMEN AND GENDER POLICIES

Mainstream gender perspectives into climate change efforts at national and regional levels

Take steps to reduce the vulnerability of women from climate change impacts, particularly in relation to their critical roles in rural areas in providing water, food and fuel

Recognize women’s contribution in the use and management of natural resources and other activities impacted by climate change

Undertake a comprehensive study of the gender-differentiated impacts of climate change, with a particular focus on gender difference in capabilities to cope with climate change adaptation and mitigation strategies in Pakistan

Develop gender-sensitive criteria and indicators related to adaptation and vulnerability, as gender differences in this area are most crucial and most visible

Develop and implement climate change vulnerability-reduction measures that focus particularly on women’s needs

Incorporate an appropriate role for women into the decision-making process on climate change mitigation and adaptation initiatives

Develop climate change adaptation measures on local and indigenous knowledge, particularly that held by women

RELATED POLICIES AND MINISTRIES

Government of Pakistan’s National Climate Change Policy

National Policy on Disaster Risk Reduction

Draft National Water Policy

Draft National Flood Protection Plan-IV.

National Climate Change Policy and National Disaster Risk Reduction Policy, 2012

National Adaptation Plan (NAP), Nationally Appropriate Mitigation Actions (NAMAs), future national communications to the UNFCCC

The Ministry of Climate Change is responsible for supervising and controlling several attached departments and implementation agencies, namely: Global Change Impact Studies Centre (GCISC), National Disaster Management Authority (NDMA), Pakistan Environmental Protection Agency (Pak-EPA) and Zoological Survey Department of Pakistan (ZSD). It also has specialized wings to deal with matters relating to the environment and forestry

At the operational level, frequent interaction is maintained with the Pakistan Meteorological Department (PMD), Pakistan Agricultural Research Council (PARC), Federal Flood Commission (FFC), Indus River System Authority (IRSA), Water and Power Development Authority (WAPDA), National Energy Conservation Centre (ENERCON), Alternate Energy Development Board (AEDB) and many private-sector organizations.



ANNEX C

SUMMARY TABLE OF CLIMATE CHANGE IMPACTS ON LIVELIHOODS

| CLIMATE CHANGE TRENDS | PHYSICAL IMPACT | IMPACTS ON RURAL LIVELIHOODS | IMPACTS ON URBAN LIVELIHOODS |
|------------------------------------|--|---|--|
| Temperature rise | Glacial melt shift – change in river flows | Riverine floods and drought as a consequence of the unpredictable timing of meltwaters | Flooding in urban areas, or food price shocks as crops are damaged elsewhere |
| | Heatwaves | Cereal production, in particular wheat crops, affected; livestock suffering from heat stroke; outside workers affected by heat stress | Outside workers affected by heat stress |
| | Higher evapo-transpiration | Water loss from agricultural fields and risk of drought-induced crop failure | Water scarcity challenges; impact on the transportation of agricultural products affects urban food security and prices |
| | Proliferation of plant pests and diseases | Crop losses due to outbreaks | Impact on agricultural products affects urban food security and prices |
| Monsoon rains unpredictable | Flash flooding in hilly regions | Damage to crops, infrastructure and basic services | Impact on the transportation of agricultural products affects urban food security and prices; risk of urban flash flooding |
| | Landslides in mountainous regions | Damage to crops, infrastructure and basic services | Impact on the transportation of agricultural products affects urban food security and prices |

| CLIMATE CHANGE TRENDS | PHYSICAL IMPACT | IMPACTS ON RURAL LIVELIHOODS | IMPACTS ON URBAN LIVELIHOODS |
|-----------------------|--|---|--|
| Sea-level rise | Delta inundation | Loss of habitat, cropland and livelihoods | Loss of habitat; threat to coastal megacities and transport systems |
| | Higher exposure to storm surges and coastal flooding | Short- and long-term damage to cropland due to saltwater intrusion; loss of livestock; houses damaged | Houses damaged; disruption of food supply; risk of water source contamination. |

