# Climate Change, Poverty and Environmental Crisis in the Disaster Prone Areas of Pakistan

Community-Based Research

Oxfam

## Acknowledgements



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# Contents

# Executive Summary

This study was commissioned by Oxfam GB to review the impact of climate change on Pakistan's rural communities. The findings of the study are remarkably consistent with global, regional & national climate change projections, and alarming.

It is now well established that emissions due to anthropogenic sources have, over the last 50–60 years, resulted in the excessive emission of greenhouse gases into the earth's atmosphere, increasing its temperature, causing global warming, and changing climate patterns. While climate change affects lives and livelihoods across the world, its impact is greatest on the rural poor, especially those households living in areas frequently struck by natural disasters[1], which can destroy the natural resource base of an area. The close dependence of the rural poor on natural resources makes them most vulnerable to the impact of climate change. Given that natural disasters are closely linked to changes in climate patterns, there is increasing need to study the impact of climate change on marginalized communities living in disaster-prone areas.

Like many poor developing countries Pakistan is the victim of climate change rather than a contributor, with its per capita emissions of greenhouse gas (GHG) falling far below the global average. The effects of climate change are being felt in many sectors and in and across ecosystems with adverse impacts on natural resources and the livelihoods that they support.

Pakistan is prone to a range of natural disasters, including cyclones, floods, drought, intense rainfall, and earthquakes. In Pakistan 40%[2] of the people are highly vulnerable and are frequently exposed to multiple disasters. This exposure to vulnerability is predicted to be exacerbated with impending impact of climate change. With variations in rainfall patterns, storms, floods and drought are predicated to increase and reach new locations, which had not earlier experienced them.

This study was commissioned with the aim of (i) reviewing community perceptions of the impact of climate change and, (ii) based on future climate change projections, recommending coping mechanisms for affected communities. For the purpose of this study, three geographically and climatically diverse districts were selected: (i) Badin (Sindh), (ii) Rajanpur (Punjab), and (iii) Khuzdar (Balochistan). Within these disaster-prone areas, three coastal villages in Badin, three flood-prone villages close to the Indus River in Rajanpur, and three intense drought-prone areas in Khuzdar were surveyed to assess community perception of the impact of climate change.

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[1] There is ultimately nothing "natural" about disasters. Droughts, floods etc are hazards; whether they create "disasters" i.e. considerable loss of life and/or assets, depends on many factors, especially human vulnerability. Even the occurrence of droughts and floods is only partially "natural" (e.g. triggered by extreme rainfall) – their severity and duration is linked to many socioeconomic or political factors like land and water use and management etc.

[2] Human Development in South Asia 2006 published by Mahbob-ul-Haq Human Development Centre; P 121.

Through its assessment reports, the Intergovernmental Panel on Climate Change (IPCC) projects different scenarios of climate change at global and regional levels. The Global change Impact Studies Centre (GCISC)– a Pakistani Research organization has also conducted research in Pakistan based on historical weather data, investigating past trends and modeling projections based on regional climate models. This report study the findings assessed and analysed by IPCC for South Asia including Pakistan. The results show a strong correlation among the IPCC's predictions, patterns modeled by Pakistani research organizations, and data gathered from community-level surveys conducted in the three selected areas. The results of a survey tool developed and administered after community-level pre-testing show that communities have experienced significant changes in climate as modeled by research organizations in Pakistan.

The findings of these community surveys clearly shows that environmental problems in the three districts under study are serious & growing, and climate change is exacerbating them or is likely to exacerbate them in the future. The predicted impacts of climate change will increase existing vulnerabilities, inequalities and exposure to hazards. Poor and marginalized communities tend to be those most vulnerable to climate change and least able to cope with weather-related disasters because of lack of access to information and resources to reduce their risk. Communities interviewed reported hotter temperatures and more erratic rain, and that crop-growing season has been shortened with worrying implications for food security. The findings of the research are summarized below:

<u>Climate changes and its impacts:</u>

- There has been an increase in the incidence, frequency, and intensity of extreme climatic events: more intense and heavier rainfall in coastal areas, more intense cyclones, more intense flooding in flood-prone areas along the Indus, and more pronounced droughts in the arid areas of Khuzdar.
- In coastal areas, the sea has intruded inland without this being due to a rise in sea level. The increased volume of "heated" water on the continental shelf could intensify cyclones in the Arabian Sea.
- In most areas, rainfall patterns have become very erratic, making it difficult for communities to predict local rainfall patterns.
- The duration of the cropping period has shrunk perceptibly in southern Punjab and Balochistan, with a forward shift in sowing time and an earlier harvest.
- Summers have become hotter and winters much warmer across the areas studied. In some areas, communities have noticed some degree of cooling during the monsoon season over the last 30 years.

<u>Environmental changes exacerbated by climate changes:</u>

- Fish and prawn catches in coastal areas (freshwater fisheries) have shrunk due to seawater intrusion and the increase in sea surges and

cyclones (which bring seawater into land depressions far inland). This implies that high-sea fishing remains the only solution, but few communities can afford the necessary equipment.

- In coastal areas, groundwater quality has deteriorated (become brackish).
- In the drought-prone areas of Khuzdar, the groundwater table is falling very rapidly.
- There has been widespread land degradation (salinity) in coastal areas.
- The area of rangeland available for the open grazing of livestock has shrunk, and the quality of grassland has deteriorated due to the scarcity of water resources.

Socio-economic Impacts:

- Traditional coping mechanisms used to deal with water shortages, declines in fish catch, and reduced agricultural produce are no longer enough to counter the immense impact of climate change.
- Seasonal out-migration has been observed in the areas studied, implying that incomes from traditional sources are no longer enough to support families.

This correlation of community perceptions with climate change, and the results of climate trend modeling strengthen our argument that it is possible to use future projections of climate change that are available through research carried out in Pakistan. The study concludes that there is a complex dynamics of climate changes in Pakistan - partly likely induced by global greenhouse gas emissions but also partly by local factors e.g. more bodies of water reflecting heat, fewer trees, degradation of land etc - and climate changes due to both influences interact with poverty that badly erodes the capacity of the environment to sustain development.

# 1 Introduction

Pakistan is prone to a range of natural disasters, including cyclones, floods, drought, intense rainfall, and earthquakes; the nature of the disaster depends on the area's geographical location.

The rapid industrialization and mechanization that has taken place since the Industrial Revolution of the 1850s has led to the excessive emission of greenhouse gases into the earth's atmosphere. This has had the effect of raising atmospheric temperatures at a much faster rate, causing global warming and disrupting the earth's climate. The economic impacts of these changes have now become evident, affecting in particular the lives and livelihoods of the rural poor across the world because of their close reliance on a natural resource base. Poor households who live in disaster-prone areas are affected most since the natural resource base on which they depend has become degraded due to many factors including the repeated onslaught of natural disasters.

Pakistan is vulnerable to climate change because it is located in a region where temperature increases are expected to be higher than the global averages. The land area is mostly arid and semi-arid and the Himalayan glaciers, which are reported to be receding, primarily feed its rivers and its economy is largely based on agriculture. The country faces risks of variability in monsoon rains, floods and extended droughts.

It is therefore necessary to address the linkage that exists between the impacts of climate change and Disaster Risk Reduction (DRR). Communities facing the impacts of disasters are at further risk and marginalized by the impacts of climate change. Hence, it is important to apprise, educate, and equip disaster-prone communities and government at all levels with the knowledge to cope with current changes, and future projections of climate change to help them adapt.

The Intergovernmental Panel on Climate Change (IPCC) is involved in projecting different scenarios of climate change at the global and regional level. Research has also been conducted in Pakistan by local research organization and scientists that look at past trends and models projections of future scenarios based on regional climate models.

**Objective**

To study the impacts and community perceptions of climate change on disaster-prone communities against the backdrop of research conducted on climate change, both internationally and locally, in order to lay the foundation for adaptation interventions.

## 1.1 Research Methodology

For the purposes of this study, three locations were selected, these include (i) Badin in Sindh, (ii) Rajanpur in southern Punjab, and (iii) Khuzdar in Balochistan (see Annex 1 for maps and Annex 2 for area profiles). Within these areas, small villages with marginalized communities that were strongly and solely dependent on the area's natural resource base for their livelihoods were selected. In these areas, any further

degradation of the natural resource base induced by climate change would have a direct negative impact on their livelihoods, pushing them further into poverty.

In Badin, the villages selected were coastal fishing communities prone to cyclones, sea surges, and seawater intrusion. In Rajanpur, the communities selected comprised small farmers with no alternative source of income who are most affected by flooding in their area. In Khuzdar, the communities selected were villages that practiced agriculture and subsistence livestock management and were prone to drought.

A research programme was developed and implemented to comprehensively and objectively investigate the impacts of climate change on the livelihoods of the identified/selected rural communities. In order to study the communities' perceptions of climate change, a survey tool was designed to acquire field data. The survey tool (survey form) was designed to investigate communities' perceptions of climate change in their area and the effects it has had on their surrounding physical environment, biological environment, and socioeconomic situation (i.e., their livelihoods over an extended period, about the last 30 years). Separate survey forms were developed and customized for the coastal area of Badin, the flood-prone area of Rajanpur, and the drought-prone area of Khuzdar (see Annex 3 for survey forms).

The orientation of the survey teams was conducted onsite, following which they were sent into the field to acquire data. Each team spent three to five days in the field, interacted with the communities selected, and collected the required data through focus group discussions and in-depth interviews of both male and female community members. For the purpose of the survey, respondents older than 50 were interviewed so that realistic and reasonable information dating back at least 30 years could be easily retrieved.

After collecting data from the field through sampling, all available research conducted globally, regionally, and locally was carefully examined, with trends recorded globally and regionally studied vis-à-vis the IPCC's publications. Local research on climate change was also carefully studied. For this purpose, the following research groups were consulted and their research findings incorporated into this study: the Global Change Impact Studies Centre (GCISC), Pakistan Meteorological Department (PMD), National Institute of Oceanography, and Karachi University's Department of Meteorology.

The GCISC investigates climate change trends in Pakistan based on weather data generated by the PMD. The GCISC then models this data to generate past trends across the climatic zones of Pakistan and use special models (discussed in detail in Annex 2) to make climate change projections for the short and long terms. The GCISC has shared with Oxfam past trends as well as future projections computed for the three areas being studied, i.e., Badin, Rajanpur, and Khuzdar.

The correlation between research on observed and modeled trends for Pakistan was studied to determine how climate change modeled data can be used to predict future impacts on communities and determine climate change adaptation measures across the three regions studied.

## 1.2 Structure of Report

This report is structured as follows.

Chapter 1 provides an introduction to the study and outlines the methodology that was employed.

Chapter 2 presents an overview of the research that has been conducted in the area of climate change, including past trends and future predictions both internationally and locally. Based on the findings of this research, it has been possible to assess trends and predictions for the areas selected for study.

Chapter 3 discusses the results of climate change research carried out through community feedback that was obtained through a survey tool specifically designed for each geographical zone studied.

Chapter 4 correlates the scientific and community-level data on climate change by comparing the results of Chapters 2 and 3.

Chapter 5 recommends a set of climate change adaptation measures.

# 2 Climate Change Science and Observations

This chapter presents a review and analysis of secondary information and research carried out on climate change trends and predictions. For the purpose of regional research, findings assessed and analysed by IPCC for South Asia has been studied. The chapter then looks closely at the research conducted by climate change institutions based in Pakistan, in this case, the GCISC. Finally, the chapter looks in detail at the three areas that are the subject of this study: (i) the coastal areas of Badin, (ii) the arid flood-prone plains of Rajanpur, and (iii) the arid drought-prone areas of Khuzdar.

## 2.1 Global Trends in Climate Change

It is now well established that emissions due to anthropogenic sources during the last century have resulted in the excessive emission of greenhouse gases. This has raised the temperature of the earth's atmosphere at a much faster rate than in previous centuries, resulting in global warming, i.e., the warming of the earth's atmosphere (Box 1).

**Box 1: Global Trends in Climate Change**

During the last 150 years, the global average surface temperature has increased by 0.76°C.

The temperature increased by 1.22°C between 1955 and 2005.

The warmest decade was 1990 to 2000, while 1998 was the hottest year.

Over the next century, the global average surface temperature may increase by 1.4–5.8°C.

*Source: IPPC Fourth Assessment Report, 2007.*

These seemingly small changes in temperature can disrupt weather systems, resulting in shifts in weather pattern, such as changes in rainfall pattern and in the frequency and incidence of extreme weather events—floods, cyclones, droughts, and storms—the effects of which can be immense (Box 2).

**Box 2: Future Global Predictions for Climate Change**

Temperatures will increase by 0.2°C per decade for the next two decades.

Increased precipitation is likely at high latitudes, while decreases are likely in most subtropical regions (such as Pakistan).

Heat waves and heavy rainfall will become more frequent.

There will be a decrease in snow cover.

Due to past $CO_2$ emissions and future emissions, global temperatures will continue to warm the lower layers of the oceans, causing the sea level to rise even if emissions are controlled.

Summer precipitation is likely to decrease in South Asia, as well as during December to February.

There will be an increase in the inter-annual variability of daily precipitation in the Asian summer monsoon.

An increase of 10–20% in tropical cyclone intensity is likely for a rise in sea surface temperature of 2–4°C relative to the current threshold temperature.

Storm surge heights could increase as a result of stronger winds and increases in sea surface temperatures and low pressure.

*Source: IPPC Fourth Assessment Report, 2007.*

These changes in climatic conditions vary from region to region. In our region, this has already been seen as the increased incidence of torrential rain, snowstorms, floods, droughts, and cyclones (Box 3). As a result of these changes in climate, local economies have been seriously affected; communities that depend heavily on their natural resource base and have no alternative sources of income are affected most. This has a long-term impact on human life and wellbeing.

**Box 3: Trends in Climate Change for South Asia**

Past and present climate trends and variability appear as increasing surface air temperature, which is more obvious in winter than in summer.

Increasing trends in temperature have been observed across Asia in the range of 1–3°C.

The variability of rainfall has increased geographically, across seasons, and annually in Asia over the last few decades. Decreasing trends in rainfall patterns along Pakistan's coastal areas and arid plains have also been observed.

In Pakistan, the IPCC reports an increase of 0.6–1.0°C in mean temperature in the coastal areas since the early 1900s, and a 10–15% decrease in precipitation in the coastal belt and hyper-arid plains.

In Northern Pakistan, there has been an increase in summer and winter precipitation over the last 40 years.

*Source: IPPC Fourth Assessment Report, 2007.*

## 2.2 Climate Change Trends and Observed Impacts in South Asia

South Asia has seen an increase in the incidence of cyclones, floods, droughts, and storms. These have the potential to destroy crops, cause human and livestock fatalities, loss to infrastructure, and lead to large-scale human migration. The IPCC reports that the number of cyclones in South Asia has decreased since the 1970s although their intensity has increased. This was seen in the immense damages caused in coastal Sindh in 1999 and 2007. As a result, developing countries such as Pakistan are likely to suffer the economic impacts of climate change at a grassroots level, causing irreparable losses and being the least equipped or able to adapt to new climatic conditions.

Glaciers in Asia are melting faster than before, as reported in Central Asia, as temperatures increase more and more sharply. As a result of rapid glacial melting in the eastern and central Himalayas (the Northern Areas in Pakistan), glacial runoff and glacial lake outbursts causing mudflows and avalanches have increased. On the other hand, some Western glaciers are reported to be increasing due to more intense winters in these reaches. IUCN Pakistan is presently conducting research in this area that looks at the impacts of climate change on communities in the Northern Areas of Pakistan.[3]

As a result of rising global temperatures and sea surface temperatures (see Annex 2), the body of ocean water is slowly expanding, causing seawater intrusion into bays and inland deltas (see Box 4).

**Box 4: Decrease in Agricultural Productivity**

The production of rice, maize, and wheat in Asia has declined in the last few decades.

Another study quoted by IPCC shows a 10% decrease in rice yield per 1°C increase in the growing season's minimum temperature.

In India, a 2–5% decrease in wheat and maize yields against 0.5–1.5°C rise in temperature is predicted using crop simulation modeling.

**Seawater Intrusion and Sea Level Rise**

Salt water from the Bay of Bengal has penetrated 100 km or more inland along tributary channels during the dry season.

IUCN[4] has also reported that seawater has intruded 54 km into the Indus delta along the course of the river, causing devastation to the coastal belt and mangroves.

Evidence of the impacts of climate-related factors on mangroves remains limited to the severe destruction of mangroves due to reduction of freshwater flows and saltwater intrusion in the Indus delta and in Bangladesh.[5]

3 Based on a meeting with IUCN Islamabad officials, the studies are ongoing and were not shared.
4 IUCN (2003). Environmental Degradation and Impacts on Livelihoods Sea Intrusion-A Case Study.
5 IUCN (2007). Valuing Coastal Ecosystems, Issue # 4, IUCN, April, 2007.

Asia's wetlands are increasingly threatened by warmer climates in recent decades. The precipitation decline and droughts in most delta regions of Pakistan, Bangladesh, India, and China have caused wetlands to dry up and severely degraded ecosystems.

It has not been possible to determine a direct link between biodiversity loss and climate change: other factors such as unsustainable development activities, environmental factors, land degradation, overgrazing and deforestation, pollution, over-fishing, hunting, species invasion, land-use change, climate change, and the overuse of freshwater seem to be in play. More research in this field is required to determine the linkage.

In South Asia, diarrhoea is widespread and is linked to poverty and lack of hygiene compounded by the effects of high temperatures on bacterial spread. Diarrhoeal diseases and outbreaks of other infectious diseases such as cholera, hepatitis, malaria, and dengue fever have been reported as being influenced by climate-related factors such as severe floods, droughts, sea surface temperatures, and rainfall in association with non-climatic factors. Lately, the incidence of cholera and diarrhoea has seen to increase. The outbreak of dengue fever across Pakistan, a disease not previously reported, is cause for concern and warrants further study although no detailed research has reported a link between the outbreak of dengue in Pakistan and climate change-related factors.

## 2.3 Research on Climate Change in Pakistan

The previous section has shown that, South Asia's climate has followed a warming trend over the last few decades as per the findings assessed and analysed by climate change. This section examines past trends and future predictions that have been studied by research groups working on climate change in Pakistan (see Annex 2).

Pakistan has only recently begun to conduct climate change research and modeling through the GCISC, which keeps track of current and future climate change trends, conducts research and modeling for local conditions, and analyzes the impacts of climate change on environmental receptors.

### 2.3.1 Emissions Scenarios

The GCISC has computed changes across various scenarios as done in IPCC reports. If we look towards the new century, a multitude of possibilities exist regarding global greenhouse gas emissions and sinks. These depend on drivers such as economic, social, demographic, and technological development, all of which vary and cannot be predicted with certainty. Hence, alternative scenarios have been developed in which different conditions have been preset: each scenario is a different picture of the world under the different behaviour of these drivers. After much research and discussion, the IPCC has decided on six different scenarios for which climate change modeling has been carried out.

### 2.3.2 A2 Scenario

The A2 scenario is the most well studied of all IPCC emissions scenarios. It assumes that no attempt is being made to address global warming. It takes into consideration a politically and socially diverse world, where economic growth has taken place without any attempts to bridge the gap between rich and poor countries, or to counter global warming and environmental degradation.

### 2.3.3 PRECIS Model

The GCISC has made some basic calculations concerning future climate change trends in Pakistan. It has examined the A2 scenario and computed projections using the regional climate model PRECIS. The PRECIS model was developed at the Hadley Centre in the UK and stands for "providing regional climates for impacts studies." The model focuses on a square (grid) of land that can be zoomed into at any location on the globe. The model takes into consideration the topography of that square of area and atmospheric conditions at that location to compute climate projections for that grid to a fine degree of precision, making it a very high-resolution model.

GCISC scientists have trained at the Hadley Centre in managing this model and adapting it for increasingly smaller grids. The grid considered for the purpose of our study measures 60 km by 60 km. Three such areas were studied: one located in Badin, the second in Khuzdar, and the third in Rajanpur. The data obtained at these locations is discussed below.

The GCISC has made some general projections by dividing Pakistan by latitude at 30°N (see Figure 1, Annex 2, courtesy of the GCISC), creating two regions: north and south Pakistan. It has then made predictions for temperature and precipitation changes for different scenarios over different time periods in the future for these two regions. It predicts that, in the 2080s (for a 30-year period extending till the end of the century), there will be an overall increase in temperatures across both northern and southern Pakistan. However, in the south, the increase will be 3.9°C above average, while in the north the increase will be about 4.5°C above average (see Box 5, Annex 2 for details). In relation to precipitation, rather large errors have occurred in the modeled results, making it difficult to draw any definite conclusions about changes in precipitation over time. There is, however, some indication that precipitation will increase in summer and decrease in winter in southern Pakistan.

## 2.4 Coastal Areas of Badin

The coastal areas of Badin were studied for climate change trends and future projections.

### 2.4.1 Past Trends

According to the GCISC, the coastal area of Badin lies in Region VI (coastal Pakistan) as shown in Figure 2, Annex 2.

The temperature trends recorded for the coastal areas and modeled by the GCISC show that, apart from a slight cooling trend noticed during the monsoon season (June–September), the area has warmed up throughout the year. This degree of warming has been highest in October–November, less in April and May, and lowest in December–March (see Box 6, Annex 2). Changes in precipitation in the coastal areas for 1951–2000 show a decrease in annual rainfall, a decrease in monsoon rainfall, and no change in the extent of winter precipitation (see Box 6, Annex 2).

This correlates with the IPCC's 4th assessment report, which predicts warming along the coastal belt, with warmer winters and an increase in both summer and winter temperatures (Box 3, Annex 2), and intense precipitation events, but a decrease in annual average precipitation.

### 2.4.2 GCISC Projections

Based on the GCISC's modeling, projections have been made for various future scenarios. The GCISC has modeled projections for Badin for a 30-year period starting in the 2080s under the A2 scenario. An increase of 3.98°C above the average annual temperatures has been computed; the increase above average is greater in winter than summer (see Box 7, Annex 2).

### 2.4.3 Rise in Sea Level

Sea level rise (SLR) has been observed along coastal areas globally, with a more pronounced SLR in the Maldives islands and other coastal regions of Southeast Asia. Melting land ice, along with the thermal expansion of ocean waters (as a result of increasing sea surface temperatures), contribute to the average increase in sea levels along coastal areas. The trend followed through the 20th century has been an SLR of 1.1 mm/year,[6] although recent research predicts a rate of 1.7± 0.3 mm/year.[7] With the vertical rise in sea level occurs an associated horizontal spreading of water, known as "beach loss." This has been observed to be greater in sandy coastal areas than rocky coasts. Research shows that a horizontal beach loss of 2 m along sandy beaches over a 10-year period[8] has been observed, corresponding to an assumed SLR rate of 1.1 mm/year.

The coast of Sindh stretches for some 350 km from the Rann of Kutch in the east to the mouth of the Hub River in Balochistan. The coast is divided into two parts: the Indus delta/creek system and the Karachi coastline. A very significant degree of seawater intrusion has been observed along the coast of Sindh, and has had a strong impact on communities residing in coastal villages.

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6 Warrick, R. A., C. L. Provost, M. F. Meier, J. Oerlemans, and P. L. Woodworth, 1996. Changes in sea level, in *Climate Change 1995: The Science of Climate Change*, 359-405

7 Church, J. A., and N. J. White (2006), A 20th century acceleration in global sea-level rise, Geophys. Res. Lett., 33

8 Kahn et. al Sea Level variations and geomorphological changes in the coastal belt of Pakistan, Marine Geodesay, 2002, 25: 159-174

There is more than one interrelated reason for this degree of seawater intrusion. Key reasons for this ingress include the occurrence of two major cyclones (1999 and 2005), reduced discharge from the river Indus, and the thermal expansion of the ocean body. We cannot solely attribute this ingress to low river discharge since the coastal stretch along Sindh is far greater an area than the amount of water that can be pushed out by the river at its mouth.

An increased volume of water on the continental shelf implies that there is a greater volume of shallow water that can be rapidly heated up as a result of high atmospheric temperatures. As a result, when a cyclone generated in the Arabian Sea reaches such warm coastal waters, it gathers more speed before hitting the coast, causing greater devastation.[9]

The increased mass of water along the coast of Badin, as a result of seawater intrusion, SLR, and previous storm surges, could also increase the likelihood of further storm surges and devastating high-intensity cyclones along the coastal areas of Sindh in the future. The cyclone that hit the coast of Badin in 1999 (2A) hit areas deep inland: this was the result of a storm surge. Satellite images show that these areas still have ponds of saltwater, which has severely degraded the land and affected agriculture.[10]

## 2.5 Flood-Prone Arid Areas in Rajanpur

The second area studied was the flood prone arid area of Rajanpur. Unlike the coastal belt of Pakistan, this area has not been examined so far from the perspective of climate change.

### 2.5.1 Past Trends

According to the GCISC, Rajanpur lies in Region III: central and southern Punjab (Figure 2, Annex 1).

The trends recorded for this area shows that, apart for a slight cooling trend noticed during the monsoon season, there has been a heating effect throughout the remaining year. There has been an increase in annual precipitation for the period 1951–2000, with further increases during the monsoon season (June–September) and winter (December–March) (see Box 8, Annex 2).

These observations correlate well with the IPCC's 4th assessment report, which records an increase in both summer and winter temperatures. However, precipitation intensity has been observed to increase so far. This appears to contradict climate models that predict a likely decline in precipitation as climate changes in the future. The Global Circulation Models (GCMs) that climate scientists run on computers are good at

9 Climate Change Challenges in Asia and Pakistan. R.K. Pachauri, Chairman, IPCC, Presentation made at Islamabad 13 January 2008.

10 Khan, T. Rabani, M.M., Natural Hazards and Mitigation Measures in the Coastal Areas of Northern Indian Ocean Region: An Overview. Proc of Workshop on the Protection of Coast and Environment, Nov. 2005 Izmir, Turkey.

modelling temperatures, but are at this time are less accurate at modelling precipitation due to the huge number of influences on rainfall, such as local topography

### 2.5.2 GCISC Projections

The GCISC model predicts a very high increase of 5.0°C above the average annual temperatures for Rajanpur in the 2080s. Heating is predicted during both summers and winters, with summers being hotter than winters. Precipitation projections for Rajanpur show an increase above the annual average level, with an increase in summer, but a decrease in winter (see Box 9, Annex 2).

### 2.5.3 Research on Agriculture

Climate change research on past trends and projections for agricultural yield for Pakistan have shown that there may be adverse impacts on crop productivity as the climate changes in the future. Research groups at the GCISC have studied crop productivity under various controlled scenarios,[11] simulating scenarios of increasing temperature, increasing carbon dioxide concentrations, and varying water conditions. On the whole, wheat productivity is projected to be adversely affected by increasing temperatures in arid, semi-arid, and sub-humid climate zones, while in humid zones; the productivity of wheat is projected to have increase.

Data for crop yields over the past 30 years have, however, shown a per acre increase in crop yield, both in irrigated and rain-fed areas. This increase is attributed to the introduction of new high-yield varieties of crops, an increase in mechanized farming, wider use of fertilizers, improved pest control, and access to new, more versatile seed varieties which can be sown at varying times, depending on when weather conditions are optimal. How far this improvement can be maintained in the face of accelerating climate change is a major issue.

The IPCC's 4th assessment report documents a study carried out in India (see Box 4, Chapter 2) in which a decrease in wheat production was reported with increasing temperatures when crop simulation modeling was performed.

With an increase in temperatures, there is a strong likelihood that the productivity of wheat might be negatively affected, although the extent and magnitude of this impact will depend on environmental conditions. This implies that there will be some reduction in wheat yields in the coming decades.

As computed by the GCISC, future temperatures indicated for the 2080s show an overall increase in temperature across both northern and southern Pakistan.

The duration of the growing season is also projected to decrease by about 14 days in the semi-arid areas of southern Punjab.[11] This implies that agricultural production in rain-

11 Iqbal, M.M., et al., Climatic Change (2009) 94:123-142. Vulnerability and Adaptability of wheat production in different climatic zones of Pakistan under climate change scenarios.

fed areas is likely to be more affected by temperature increases, which will also lead to increased pressure on water resources.

A caveat worth keeping in mind is that this section has only taken into consideration changes in temperature and precipitation while examining the case of agricultural yields. Climate change brings with it subtle changes in climate, e.g., changes in rainfall pattern within a season. This, when taken into account, could translate into a far more intense and significant impact on agricultural yields and practices.

## 2.6 Drought-Prone Areas of Khuzdar

The third area studied as part of this assignment was the arid, drought-prone area of Khuzdar. Annual rainfall in Khuzdar is less than 250 mm/year. The intensity and frequency of droughts has increased all over Pakistan, but particularly in Balochistan. Khuzdar lies in an arid zone and is prone to being hyper-arid. Based on research conducted by APN between 1999 and 2005, ten different initiatives were launched to study the effects of climate change. As part of this project, drought was also studied for various parts of Pakistan. It was reported that droughts are normal in areas such as Khuzdar, but that the frequency, severity, and duration of droughts had increased over the last 25–30 years. In addition to water scarcity, droughts were accompanied by sandstorms, which increase erosion in dry areas and have an adverse impact on soil fertility.

### 2.6.1 Past Trends

The GCISC has broadly studied climate trends for the period 1951–2000. Khuzdar falls in Region V (a): Balochistan Plateau East (see Figure 2, Annex 2). The trends recorded show an overall average annual warming in the area (see Box 11, Annex 2). Precipitation trends show an annual increase across Khuzdar, both in summers and winters.

The data on temperature correlate with the IPCC's 4th assessment report, which report an increase in summer temperatures and a smaller increase in winter temperatures. The data on precipitation do not correlate as the IPCC reports a decline while the GCISC reports an increase across Khuzdar. This can be partly explained by the difficulty that GCMs have in modelling precipitation.

*Note:* Also presumably the increase in rainfall is anyway very small, as this is a nearly hyper-arid area, so "increase" in practice means very little significance.

### 2.6.2 GCISC Projections

Based on GCISC's modelling, projections have been made for various scenarios for Khuzdar. Predictions for the 2080s show an increase of 5.04°C above average annual temperatures, with an increase in both summers and winters, and a greater increase in the winters (see Box 11, Annex 2). The precipitation projection for Khuzdar also shows an increase above the annual average, with an increase in the summers but a sharp decline in predicted rainfall in the winters.

The Khuzdar area supports subsistence rain-fed/well-irrigated agriculture, where wheat is the main crop. Based on the results of the IPCC's study in India[12] and the GCISC, wheat yields in this dry arid area are likely to fall while water resources will also be further reduced.

## 2.7 Discussion on Findings

This chapter has discussed broad trends in climate change observed over the last 50 years, and projected future trends for the region, as very little research has been conducted that is of direct relevance to Pakistan. For this purpose, the IPCC's assessment reports have been studied.

The next step is to study the predictions made by research groups studying climate change in Pakistan. There appears to be a good correlation between the IPCC's broad predictions and the results of climate change modelling performed by the GCISC for the three geographical areas studied in this report. However, there still remains some ambiguity in predictions concerning precipitation trends. The GCISC is presently working on modifying models that look at rainfall patterns and projections.

Having established an overall picture of past and future trends in climate change, we can now compare these observed trends with community perceptions documented in the field.

The nature of the correlation between past trends in and actual community perceptions of climate change will help determine whether or not modelling results for future trends can be used to predict future impacts on communities.

12 See Box 4 Chapter 2.

# 3 Impacts of Climate Change on Communities

The aim of this section is to test the truth of the results of the climate change research through community feedback obtained through a survey tool (see Annex 3) specifically designed for each geographical zone studied.

Poor households are most vulnerable to climate change; those settled in disaster-prone areas are even more susceptible to the adverse impact of climate change. Poor communities are intricately dependant on their natural resource base, and have few other sources of income available to them. This natural resource base is the first to be destroyed by natural disasters that might be triggered by climate change. Such communities are worst hit by the accompanying economic impacts.

In this chapter, data collected in the field has been studied in detail and feedback obtained through focus group discussions and in-depth interviews with selected community members. The chapter is structured according to the main heads in the format of the survey tool used to collect information from the selected communities (see Annex 3).

## 3.1 Coastal Areas of Badin

The coastal area studied for the effects of climate change and community perceptions thereof lies in the district of Badin. Badin lies on the coast of the Arabian Sea with the Rann of Kutch to the south, the district of Hyderabad to the north, the district of Thatta to the west, and Mirpurkhas and Tharparker districts to the east. Badin consists of five talukas (tehsils): Badin, Matli, Tando Bago, Golarchi and Talhar. The total area of the district is 6,726 square kilometres. The villages that were surveyed included Sheikh Kheerio Mallah, Allah Bachiayo Mallah, and Khamoon Mallah, all of which lie in union council Bhugra Memon, tehsil Badin. All three villages are coastal areas and comprise fishing communities.

Union council Bhugra Memon is the lowest-lying area of the district, and is situated along the coast of the Arabian Sea. All three surveyed villages comprise fishing communities that traditionally practiced some sustenance agriculture, but do so no longer as water in the area has become highly saline due to the area's close proximity to the Arabian Sea and the left bank outfall drain system. Due to this, the groundwater is also brackish in many villages. The main sources of livelihood are fishing and rearing livestock. The main source of drinking water is irrigation canal and underground water obtained via hand pumps, although the quality of the latter is rapidly declining. Health facilities in the area are poor, with no health centres in the surveyed villages; people have to travel to larger villages to obtain access to health centres. The social infrastructure of these villages is poor: some of the villages inland are electrified, but the villages surveyed did not have access to electricity, natural gas, or schools. Please see Annex 1 for the map and Annex 2 for a detailed description of the background environment.

### 3.1.1 Physical Environment

#### *3.1.1.1 Sea Level Intrusion and SLR*

The communities of the three villages reported that the sea level has risen and water has now intruded into their villages. Villagers recall that, 30 years ago, the sea was not within sight and they had to walk a considerable distance to reach the sea. Due to intrusion of seawater, flooding has occurred which has affected the natural environment of the area. The soil has become saline and villagers can no longer grow crops on these plots of land, which now lie barren.

> Thirty years ago, the sea was roughly 50 km away from our village. Over the years it has shifted nearer and nearer and is now only about 5 km away.
>
> *Resident of Bhugra Memon, District Badin*

#### *3.1.1.2 Groundwater*

The groundwater table was 16 or 17 feet deep in the 1970s and up to the 1980s. It suddenly rose to a very high level, and can now be found at a shallow depth of only 3 ft. People used to utilize groundwater for domestic use, which was potable and of good quality. The communities are aware that the level of groundwater is linked to the intrusion of the sea inland.

The quality of groundwater in the 1970s was of palatable quality, and referred to as "sweet" by the communities. As the water table gradually rose, it became brackish and is no longer fit for drinking. The dug wells that were being used by communities can no longer be used for domestic or livestock purposes. People are now forced to use surface water bodies to fulfil the demand for water for domestic consumption.

#### *3.1.1.3 Surface Water*

The quality of surface water used by the communities has also deteriorated over the last 30 years. In the past, communities traditionally used water from freshwater lakes and even from the irrigation system for domestic consumption. The quality of lake water and canal water has also deteriorated. The large number of sugar factories situated in the district dispose of their effluent in these freshwater lakes and also into some canals. The typical wastewater stream from a sugar mill has a very high BOD, i.e., it takes up all the oxygen in the water, killing all aquatic life, and creating septic conditions by generating foul-smelling hydrogen sulphide, which in turn can precipitate iron and any dissolved salts, turning the water black and highly toxic. The communities of these villages have now shifted to using water for domestic purposes from the Mirwah canal.

> We had many sources of drinking water 20 or 30 years ago. There were freshwater lakes and well water. Now the water has become brackish and we can no longer use it. The only source left for our livestock and us is the Mirwah canal. Its water is not clean as all the factories dispose of their waste in the canal. This is making our children sick.
>
> *Bachoo Mallah*, District Badin

#### *3.1.1.4 Agriculture*

Thirty years ago and earlier, communities of these coastal fishing villages and other villages along the coastal areas practiced agriculture in addition to fishing. The common crops grown by these communities were wheat and rice. They found that supplementary agriculture was profitable, and that during the season when there was a ban on fishing, the income from agriculture would more than compensate for the associated loss in income.

> In the old days (30 years ago) the land here used to be under cultivation. We grew wheat, tomatoes, and watermelon. But now, because of repeated flooding and heavy rains, and the cyclone of 1999, the seawater has intruded inland, making the water brackish and leaving the land degraded. We can no longer grow anything.
>
> *Bhaagi,* District Badin

Seawater intrusion has greatly reduced the physical area of land for any use, be it agriculture, livestock rearing, or forestry. Water availability for both agricultural and domestic purposes has also drastically decreased, and finally, due to the intrusion of seawater into the creeks, the high groundwater table has made the land saline and in some areas even waterlogged, hence unfit for agricultural purposes and rendered barren. As a result, for the last 25 years, communities in these coastal villages have been forced to completely abandon agriculture.

#### *3.1.1.5 Temperature*

Communities have observed that, over the last 30 years, the temperature of the area has increased such that an overall perceptible increase in temperature has been observed all year round. Summers have become significantly hotter, while winters have also become warmer. Communities have noticed that they no longer need to wear sweaters during the winters; while in summers the intensity of the heat has increased. In the opinion of the communities, this has happened due to the fact that tree cover has decreased dramatically, especially since the 1999 cyclone, and they are completely surrounded by large expanses of water, which reflect the heat, making their villages much hotter. The communities are now buying less fuel wood in the winters and feel comfortable in normal clothing.

> I am not wearing a sweater anymore, and it's January.
>
> *Bachoo Mallah, 61*, District Badin

#### *3.1.1.6 Rainfall*

Communities related that the rainfall pattern had altered perceptibly. About 30 years ago, there would be about one intense rainfall event per year. In the opinion of the communities, such an event would cause localized flood in the villages, an event that is commonly called a "rainstorm." Other than one such event, light rain would still occur. Over the last 20 years, the incidence of intense rainfall events has increased, the number of heavy rainfall events has increased to four to five events per year, while light rain also occurs occasionally.

> We have tried to collect rainwater in a pool so that we have freshwater for domestic use.
>
> *Misri, 60 (District Badin)*

### 3.1.2 Biological Environment

The abundance and variety of migratory bird species that visited the Indus delta region every year appears to have declined. Thirty years ago, birds would frequently visit these wetlands in large numbers, resting there on their onward flight to warmer lands in the winters. Now, due to the shrinking of freshwater lakes that previously dotted the delta, migratory birds no longer frequently visit the area as much. They stay where they can find freshwater and are not seen by the communities in the villages. Thirty years ago, they were enough in number for some community members to hunt.

Wildlife that was common to this area included wild boar, snakes, and jackals. Communities have observed that the population of these animals has decreased to a noticeable extent.

> Many exotic birds used to come to the freshwater lakes. Since these lakes have become brackish, these birds no longer visit.
>
> *Allah Bachaio, 62 (District Badin)*

The number of trees and greenery has also significantly decreased in the area. Some previously abundant trees have disappeared from these villages altogether. Mangroves (tamar) can only be seen where there is deeper seawater, but their density is very sparse. Communities report that, 20 to 30 years ago, their villages supported a significant growth of mangroves. The number deceased slowly as the villagers used the wood for fuel, but the final blow came with the cyclone of 1999, which tore down the remaining mangroves and altered the balance of salt and freshwater in the creeks that is essential for the germination and growth of mangroves. In addition to the heavy decline in mangrove density, other local species have also dwindled in number due to the heavy intrusion of seawater and flooding in the creeks. Local tree species that have declined and, in some villages, even disappeared include *jaar*, *neem*, *kando*, and *lano*.

### 3.1.3 Socioeconomic Environment

#### *3.1.3.1 Fishing*

The communities that were interviewed were all fishing communities. Although the mainstay of their economy is fishing, 30 years ago they also grew rice in limited quantities to supplement their income from fishing—especially during the spawning season—when there is a government-imposed ban on fishing. However, as mentioned above, communities can no longer continue with agriculture due to the degradation of agricultural land.

Fish yields have decreased from up to 120 kg/person/day 30 years ago to only 5 or 6 kg/person/day at present. The income from fishing has fallen significantly and communities have become forced to migrate temporarily to agricultural areas in the northern parts of Badin to work as agricultural labour.

Due to the reduction in incomes, and to provide food for their families, communities have been forced to fish off-season. They do not sell this catch, as there is no other source of livelihood. Previously, they practiced supplementary agriculture that provided them with grain and compensated for reduced incomes during off-season.

Although prawns now fetch a higher price than they did 30 years ago, prawn fishing has declined. Previously, areas in which freshwater mixed with seawater were accessible and numerous, and used as fishing grounds. Since the cyclone of 1999, and following sea surges and floods, these freshwater ponds have been separated by huge expanses of seawater that has forced its way into the delta and become trapped in land depressions. Where communities could previously reach these freshwater lakes by land, they now require powerful motorboats that are able to navigate deeper waters and access prawn breeding grounds. Such boats are, however, expensive and most people cannot afford them. Poverty, exacerbated by the cyclone and repeated floods, has limited communities to fishing upstream, which is polluted by toxic effluents from the Badin sugar industry.

Mehar Mallah, 40 years old is a resident of village Khamoon Mallah in Union Council Bhugra Memon,District Badin. He is a fisherman by profession. People call him "Kulhirya" (Term Kulhirya is used for those fishermen who take nets on shoulders and catch fish in shallow waters; such fishermen are the most marginalized)

Recalling his past, "15 years ago we have more fish-catch. In those days fresh water was abundant; everywhere there was greenery of crops and rest of the family members were engaged in other activities than fishing such as agriculture for household consumption, rearing livestock, catching migratory birds, making mats and other household utility items from wild grasses. After 1996 the fresh water bodies started became saline due to shortage of water. Rains were not received in good quantity except in 1999 and 2003. Sana (prawns) went back to deep creeks and sea. Now I am not sure how to survive and to feed my children

#### *3.1.3.2 Small Businesses*

No small businesses of significance operate in the villages surveyed. The entire community is engaged in fishing.

#### *3.1.3.3 Migration*

Seasonal out-migration has increased in coastal fishing villages. Community members move out to other areas for labour purposes, while their families remain in the village. They return to their villages when the fishing season starts.

#### *3.1.3.4 Diseases*

The villages are surrounded by large expanses of seawater, which has increased solar radiation in the area, heating the shallow waters here. Furthermore, the absence of vegetative cover has added to the temperature rise. Given the lack of proper drainage facilities, this has created unhygienic conditions, giving rise to large bodies of contaminated water and provided breeding grounds for vector-borne diseases such as malaria and diarrhoea. Communities' report that the incidence of diarrhoea and malaria has increased during the summer.

#### *3.1.3.5 Women*

Women in these coastal areas now have to work much harder to make ends meet. Since the quality of drinking water has deteriorated considerably, women now have to fetch drinking water from farther away. Women often have to walk distances of up to 5 km, which takes them an average of 4 hours, just to fetch water, leaving them very little free time for other income-generating activities, such as needle work.

Now that the fish catch has reduced considerably and communities no longer practice supplementary agriculture, women have to clean and dry some of the fish caught for storage purpose to fulfil their own domestic requirements. This also takes up much of their time.

The entire community agreed that, 20 to 30 years ago, after managing the catch, finding drinking water, cooking food, tending to their homes, and caring for their children, women still had time for needlework. This no longer being the case, they have been deprived of an additional source of income stream that could be used in times of need.

One other reason that women cited for the reduced activity in this area was the non-availability of goods markets for their handiwork. The price that their work currently fetches is not commensurate with the effort that women put into preparing these items.

#### *3.1.3.6 Unsustainable Coping Mechanisms*

In order to improve their economic condition, fishermen in these areas have resorted to unsustainable practices that adversely affect fishing. These harmful practices are listed below:

- Communities have started using harmful nets to increase yield. Young fish are often caught in such nets, affecting the overall yield.
- In order to feed their families, fishermen have started fishing in the breeding season during which there is a government-imposed ban on fishing.
- Fishermen have increased the time they spend fishing: this has increased their costs, proving to be an unsustainable practice.

#### *3.1.3.7 Traditional Coping Mechanisms*

Badin has faced intense rainfall for many years, which has sometimes caused flooding in the areas. As a result, communities, especially those that practice agriculture, have devised prediction mechanisms for such events. Some traditional practices that were used to predict incoming sea storms and intense rainfall were the appearance of small bubbles in creek water, a bull let loose that then ran east, and seawater becoming cold. Flooding was predicted by the appearance of a small snake known as *loonddi*. Communities would rely on these indicators to prepare themselves for intense storms. Now, however, they find that such indicators do not always manifest themselves and leave the communities unable to predict and prepare for changes in the weather.

### 3.2 Flood-Prone Areas of Rajanpur

The district of Rajanpur is located in southern Punjab, and is bounded by the river Indus to the east.13 The villages selected for the purpose of the survey are located across two tehsils, Rajanpur and Rojhan. The villages are Basti Haiderabad in tehsil Rajanpur, and Ali Bagh and Qalander Baksh in tehsil Rojhan. The first two are located in the riverine belt, areas that are flooded by the Indus; Qalander Baksh is located in an area that is prone to hill torrents and flash floods from the Suleiman hill range.

The villages surveyed were of medium size, consisting of 70–80 households and a total population of 350–450. Most housing structures in the villages were *kachha* or huts, and had no access to electricity or natural gas. The communities use water from hand-pumps installed at the household level. There were very few latrines, and most people use traditional methods of sanitation. None of the surveyed villages had healthcare facilities, and people have to travel to other villages to reach the closest health centre. In some cases, they have to travel 25–30 km to reach a health facility. There are no secondary schools in the area, only a boys' primary school but no girls' school. The main source of income for communities is rain-fed agriculture and supplementary livestock management. Women also contribute to their household income by working in the fields. On the whole, the villages surveyed are very poor, with the average daily wage varying between Rs150 for unskilled labour, and Rs300 for skilled. Continuous flooding in the area has led to income uncertainty in both agriculture and livestock.

13 Govt. of Pakistan, District Census Report, Rajanpur 1998.

### 3.2.1 Physical Environment

#### *3.2.1.1 Floods*

Floods have inundated the plains along the banks of the Indus in this area for many years. Communities relate that repeated flooding has made the area's soil more fertile—a result of flooding caused by the river swelling. However floods caused by hill torrents from the west in the villages at the foot of the Suleiman hills deposit silt that is mostly sand-laden. The sand content hardens the soil when it dries, thus requiring more extensive tilling by farmers, the implements for which are not always available.

> We want to grow another crop in the (summer) season but are unable to do so because of the floods that come every year.
>
> *Rahim Buksh, 55 – District Rajanpur*

Communities have noticed that there has been no perceptible change in the incidence of floods: floods in Rajanpur have been an annual feature for more than 30 years. The government has constructed flood protection bunds to stop the inflow of floodwater into cropped areas. In addition, communities have developed their own coping mechanisms to deal with these devastating events. Individual farmers construct small bunds around their fields every year. Over the years, they modify them after mutual consultation, increasing their height. These bunds protect standing crops from damage by floodwater. In order to protect their grain rations and other valuables from harm, communities build high earthen platforms and move their rations there during floods. Farmers move their families and livestock temporarily to higher ground out of the reach of the floodwater. As soon as the water recedes, they return to their homes.

> When the floods come, we move to higher ground, storing our grains in a high place on our farms; we return to our homes when the water recedes.
>
> *Abdullah, 60 – District Rajanpur*

#### *3.2.1.2 Groundwater*

The groundwater table fluctuates with the seasons. In the winter, it falls far below 100 ft; during the rains and when the river floods, it rises to much higher levels.

Most houses in the villages surveyed have hand-pumps, and women no longer need to walk long distances to obtain drinking water. This is an improvement compared to 30 years ago, when women still needed to walk up to 3 miles to fetch drinking water.

#### *3.2.1.3 Temperature*

Communities have observed that, over the last 30 years, the temperature of the area has increased to the extent that there has been an overall perceptible increase in temperature all year round. Communities have noticed that during the winters they no longer need to wear sweaters, while in summers the intensity of the heat has increased. This is borne

out by the fact that communities need to use slightly less fuel wood during the winters for heating purposes (although there has not been a drastic decrease since Rajanpur was not previously known to have very cold winters). During the summer monsoon season, communities have noticed a slight cooling of the weather. Rising temperatures have shortened the crop-growing season by more than 20 days through later sowing and earlier harvesting (see agriculture section).

7-8 years before, we used to have six-months long winters and six-months long summers. Now the summers lasts for nine-months and winters for three-months, and in the winters we only require warm clothing during the night.

Muhammad Qasim, District Rajanpur

The summers are much hotter than before, the winters are also warmer.

*Ashiq Husain, 65.*

#### *3.2.1.4 Rainfall*

Rainfall patterns have become very erratic. People feel that they can no longer predict the rains as they were previously able to. A large number of rainfall events occur outside the monsoon season: these are intense isolated events that are capable of damaging standing crops.

### 3.2.2 Biological Environment

Villagers report that migratory birds such as herons, doves, and ducks were seen frequently in this area up to 20 years ago. Now, however, they are observed in significantly smaller numbers. Locally found species of quail, partridge, and wild pigeon are seen very rarely. Communities feel that this change is due to the onset of warmer weather and flooding. The area has seen an increase in human population as well as mounting pressure to hunt. Wildlife that was common to this area included wild boar, snakes, and jackals; the population of these animals has decreased to a noticeable extent.

In winters we used to have birds like herons, doves from Siberia, and people used to catch them and sell them in the market but now it we don't see any birds in winters

Noor Din, District Rajanpur

Shrubs and bushes in the area have decreased, along with a significant decrease in the number and distribution of previously abundant tree species, such as *kikar*, *tali*, *lai*, and *kanain*. Trees and shrubs have been cut because of the pressure of population, as well as the increase in cultivated area. Most wooded areas have been cleared for cultivation purposes.

Communities have observed that the number of butterflies has decreased over the last 30 years. Their direct explanation for this decline in abundance is the increased

application of pesticides. The appearance period for butterflies still remains February to March. There may be a perceptible shift, as there is in the sowing of wheat (discussed below), but as the time of appearance of butterflies is not directly linked to an economic benefit or loss, communities were not able to respond very clearly on the shift of time. The only change they noted was in abundance.

### 3.2.3 Socioeconomic Environment

#### *3.2.3.1 Agriculture*

Although communities in these flood-prone areas have developed coping mechanisms and adapted to the changes in daily life brought about by repeated yearly floods, they still are very marginalized. The floods come every year in the summer monsoon season, making it impossible for them to grow any cash crop in the *rabi* (winter) season. As a result, they grow wheat in the *kharif* (summer) season and have no option but to grow fodder and vegetables in the rabi season.

The main crop grown in the flood plains is wheat, which is grown in the kharif season. In areas to the west, communities have attempted to grow cotton in the rabi season, but had their crops destroyed due to flash floods and then been unable to till their lands again to prepare them for a rabi crop of cotton. Communities report that the yield of wheat has increased in the last 30 years: previously, they harvested as little as 10–15 *maunds* per acre *(one maund is equal to 40 kg),* whereas now their yield from most fields has more than doubled and ranges between 30 and 45 maunds per acre. However, this change is not due to more or less conducive climatic conditions but due largely to improved seed quality, more easily available and affordable fertilizer, mechanized agriculture, and cheaper pesticides. While these factors have combined to give better yields of wheat, the cost of tilling land and preparing it for crops has increased. In terms of the income generated, 30–45 maunds/acre is still a low yield. The typical yield from irrigated wheat in the same agro-ecological zone (semi-arid to arid plain) is close to 120 maunds/acre. The growing season, however, has become shorter. Crops are sown some 15 to 20 days later than before, and are harvested early—an effect of warming temperatures.

> This year the height of our cotton plant is only 1.5 ft and had been frequently exposed to disease as well.
>
> Maryum Bibi, District Rajanpur
>
> 5-6 years before we used to get 1200-1400 kg per hectare of wheat but now we only get 880-1020 kg per hectare, even though we are giving the same amount of fertilizer and seeds.
>
> Hameeda bibi, District Rajanpur

#### *3.2.3.2 Livestock*

In order to supplement their low agricultural incomes, communities would typically practice a significant level of supplementary livestock management. This is no longer the case. Thirty years ago, there were open grazing grounds where livestock could be let loose to graze and return home on their own; no supervision was required. In the following 10 years, these grazing areas grew smaller largely due to population pressure and increase in cultivated areas. Up to 20 years ago, livestock was still using these smaller grazing grounds but needed herding. At present, most areas have come under cultivation and there are no open grazing areas left. Since livestock needs to be stall fed, fodder needs to be grown in the rabi season after the wheat. Due to yearly flooding, not much fodder can be grown as it takes fields at least a month to become useable again. This reduced quantity of fodder has adversely affected the health of livestock, the quality of dairy products, and the price that products and animals fetch in the market.

> Our livestock is getting sick more frequently, in the past they used to be sick in winters mostly, but now they are exposed to more sickness, and we are spending money to get them cured even when they are being fed the same amount of fodder as before
>
> Qasim, District Rajanpur

> Twenty years ago, we had more than 50 heads of livestock. We would simply let them graze in the open. Now we only have one or two heads of livestock, who remain hungry because there is just not enough fodder for them.
>
> Hameeda Bib, District Rajanpur

#### *3.2.3.3 Migration*

There is no permanent out-migration from the area. Communities move out temporarily at the time of flooding, leaving their grains and belongings on elevated platforms in their homes, and return when the floodwaters have receded.

#### *3.2.3.4 Women*

Southern Punjab has become more developed in recent times. Drinking water is now available in the villages, and wheat mills are powered by fuel. Women thus have more time for needlework, which fetches extra money for the household. In the flood-prone areas of southern Punjab, however, this activity is limited to the non-flood period, as when the floods come, women no longer have enough time to dedicate to this activity. Nonetheless, this has not had a significant impact on the overall income of the average household.

#### *3.2.3.5 Health*

Floods have caused the incidence of disease to increase. Most cases reported diarrhoea and gastrointestinal illnesses as a result of contaminated water and poor hygiene in times when the floodwater has taken longer to drain.

## 3.3 Arid Areas of Khuzdar

The drought-prone areas surveyed lie in district Khuzdar in the province of Balochistan. The villages selected were Bedrang, Gooni, and Alangi Karez in union council Sasool, tehsil Khuzdar. Sasool lies on hilly terrain east of the city of Khuzdar.

The villages surveyed are all small, consisting of about 25–30 families and a total population varying between 250 and 380. Most housing structures are kachha, and the villages do not have access to electricity or natural gas. Communities use water from wells or rainwater ponds and it takes on average 1.5 to 2 hours to reach the nearest water source; there is no tap water available. There are no latrines in the villages and all households use traditional methods of sanitation. None of the surveyed villages have healthcare facilities: the closest health centre is about 5 km away and is visited by a doctor two or three times a week. There are no secondary schools in the area. Most villages have a boys' primary school, but the surveyed villages had no girls' schools.

Communities' main source of income is barani agriculture and livestock. Women also produce embroidery, the income from which is used in times of need. In the event that crops fail due to the limited availability of rainwater, communities rely on their livestock. When insufficient rainfall also affects livestock, the men of the household migrate to other cities to earn a living. On the whole, the villages surveyed are very poor, with average daily wages varying between Rs150 for unskilled labour and Rs300 for skilled. Due to the uncertainty of the rains, income from both agriculture and livestock is very low and erratic.

### 3.3.1 Physical Environment

#### *3.3.1.1 Drought*

The soil of the area is dry and rocky/sandy with very little moisture content. Communities report that their villages are often subject to drought, including the drought of 1999–2004 and the drought in the 1960s. Short-term droughts occur when there are insufficient rains in a cropping season which affects standing crops, either destroying the crop altogether or affecting quality. Past long-term droughts mean that even the impact of short-term droughts is deeply felt. Communities do not have enough grain stored in the event that their crop is destroyed by a short-term drought. Furthermore, continuous drought has made the soil of the area even drier, as a result of which even the slightest variation in rainfall affects crops.

#### *3.3.1.2 Water Resources*

At present, the groundwater table lies between 80 and 90 feet; when it rains, the water table rises. In 1997/98, prior to the long drought of 1998–2006, the water table lay at 40 ft. In the 1980s and 1970s, groundwater could be found at 100 ft. Thirty years ago, the area also had springs which have since dried up due to persistent drought and irregular rainfall. The *karez* system of irrigation is not used in Khuzdar since the water shortage has never been as intense. Previously, livestock grazed freely on the plains where spring water was readily available.

> If we had large water storage ponds, it would solve the problem of water scarcity as we could store rainwater.
>
> *Jaan Bibi, 56.*

Now, however, there is no source of surface water in the area and people rely entirely on groundwater for their domestic and agricultural needs. Traditionally, communities would build rainwater harvest ponds and use the stored water for domestic and agriculture purposes. Due to prolonged drought conditions, they have not been able to sustain this practice, as there is never enough water to save and store. Although wells are now shared between two communities and water availability is more reliable, communities have to be very careful in managing this scarce and precious resource.

Communities use a combination of groundwater and rainwater to fulfil both domestic and agricultural requirements. Thirty years ago, all the agriculture they practiced was barani. Now, about 60% of agriculture is barani and the available water is supplemented by tube well irrigation. There is one deep bore in the Sasool area and its water is used to fulfill domestic and irrigation requirements.

#### *3.3.1.3 Temperature*

Communities have observed that temperatures have increased over the last 30 years such that there has been an overall perceptible increase in temperature all year round. Summers have become significantly hotter, and winters have become warmer. As a result, the cropping season for wheat has shifted forward and harvesting time now occurs earlier, indicating that the warm weather now lasts longer.

#### *3.3.1.4 Rainfall*

Rainfall in Khuzdar has always been sparse and erratic but people feel this is more true now than ever before. People feel they can no longer predict the rains. When the rains do occur, they are very intense and cause extensive soil erosion. Previously, the area experienced regular light rain. Now, however, the rains have become less regular and occur as intense downpours between very long rainless periods.

#### *3.3.1.5 Land Use*

Land use patterns have changed in this area over the last 30 years, with more and more rangeland having been brought under cultivation. Now, only about 15% of the land remains free for grazing purposes, compared with 95% 30 years ago. Decreased water resources have affected the quality and extent of grasses and shrubs.

### 3.3.2 Biological Environment

Forty years ago, there were many different bird species in the area. Villagers relate stories of how they used to go into the forest and hunt wild pigeons. At higher altitudes, *chakor* was quite common during the winters. During the summers, it would stay in the hills.

Wildlife common to this area was deer, which roamed the area freely at one time. The deer population has fallen drastically due to hunting, habitat depletion/deforestation, and population growth. Twenty to thirty years ago, many species of snake and lizard could be found in the area. This is no longer the case, but communities say they feel safer for it.

Previously, the hills surrounding Khuzdar were forested. Now, the hills are barren, with trees having been cut down for fuel wood. The area's greenery has also decreased significantly, with some previously abundant species having disappeared altogether.

### 3.3.3 Socioeconomic Environment

#### *3.3.3.1 Agriculture*

Droughts are a regular feature in this area. Water scarcity has had an intense effect on the communities here, and, accordingly, they have developed mechanisms to survive. Farmers in Khuzdar have always relied on rainwater and perennial river water for their irrigation needs. Originally, *khushkaaba* and *sailaaba* were the two modes of agriculture practiced here: khushkaaba agriculture involves tilling dry land and spraying the area with seeds as soon as the rains come. This is no longer possible as the rains have become even more scarce and unpredictable. In sailaaba agriculture, the farmer utilizes the overflow from perennial rivers to grow crops. Now that the only perennial river that existed in Sasool has completely dried up, this form of agriculture is no longer possible either. Now, farmers rely on groundwater irrigation for the limited agriculture they practice.

> We want to grow another crop in the (summer) season but are unable to do so because of the scarcity of water.
>
> *Farmer, Sasool.*

Due to the scarcity of water, communities only grow wheat as a cash crop once a year in the kharif season, and that too in synchronization with the rains. In the rabi season, they grow barley and pulses. Communities report that there is no regular pattern to their cultivation or yields. A good harvest is possible only if there are sufficient rains. In the event of a drought (a shorter, seasonal drought), there is no harvest. Their average yield is very low, and lies in the range of about 15–20 maunds per acre. As in the other areas studied the duration of the growing season has also decreased: crops are sown 15 to 20 days later and are reaped early—an effect of warming and increasing temperatures.

#### *3.3.3.2 Livestock*

Thirty years ago, there were open grazing grounds where livestock could be let loose to graze and return home on their own; no supervision was required. In the following 10 years, these grazing areas grew smaller largely due to population pressure. Up to 20 years ago, livestock was still using these smaller grazing grounds but needed herding. At present, most areas have come under cultivation and there are no open grazing areas left. Since livestock needs to be stall fed, fodder needs to be grown. Due to yearly droughts, not much fodder can be grown: this reduced quantity of fodder has adversely affected the health of livestock.

> Because of the scarcity of water and repeated droughts, our grazing lands have shrunk. Our animals no longer produce enough milk and are weak and unwell.
>
> *Mohammad Noor, 70.*

#### *3.3.3.3 Migration*

There is no permanent out-migration from the area as a result of droughts and water scarcity, although people do move out temporarily in search of alternative sources of income and, in some cases, to pursue higher education.

#### *3.3.3.4 Women*

The needs and requirements of the people of the area have increased: life has become tougher for the people of Khuzdar, including its women. Inflation has increased, and women need to work in the fields alongside their men to prepare the land for crops, an activity that was traditionally carried out by men. At the same time women still carry out their traditional responsibilities: fetching water, herding livestock, and tending their homes. Their workload has therefore increased. Due to the decrease in availability of water, women have to walk longer distances to fetch water. It now takes women longer to finish their household chores and fulfill the needs of their families. They have to stay out longer herding their livestock as grass resources have decreased and it takes animals longer to graze their fill. All this leaves women with very little time to indulge in additional income generating activities such as traditional needle work, tent making, and mat weaving (using local grass or *peesh*).

> We used to embroider clothes. Now, we are over-burdened with work. We have to walk long distances to fetch water, we have to tend our livestock, and do the housework. This leaves no time for handiwork.
>
> *Naz Bibi, 58.*

# 4 Correlation between Scientific and Community-Level Data on Climate Change

This study has drawn on the analysis of the IPCC's 4th assessment report (2007), which indicates that (i) temperatures have risen over the last 150 years, and (ii) rainfall intensity has increased while rainfall patterns have become more erratic. The frequency and incidence of extreme climatic events such as droughts, floods, and cyclones has increased. Sea levels continue to rise and seawater intrusion has increased in low-lying coastal areas.

The GCISC has looked at past climate data and established trends across various agro-ecological zones. In addition, it has used past data to model projections for future changes in temperature and precipitation. The GCISC's results show that temperatures have indeed warmed across Pakistan, with a sharper increase observed in the winters than in the summers. It is predicted that the occurrences and severity of floods and droughts in the South Asian region are expected to increase with the projected variability of monsoon and winter rains.

Through now and all the way to the 30-year period beginning with the 2080s, the GCISC has used this base data to generate future climate change projections through to the 2080s For all the areas under study, a warming pattern has been predicted with winters showing a greater increase above average temperatures than summers; rainfall patterns have been projected as erratic, but an overall increase in annual average rainfall is predicted, with a definite increase in summer precipitation, while the pattern of winter rainfall remains unclear.

Community feedback was obtained from Badin, Rajanpur, and Khuzdar districts, and their perceptions of climate change and its impacts were recorded. Communities in the field have verified certain trends observed through modelling and data analysis. In all three areas, Badin, Rajanpur, and Khuzdar, both summers and winters are perceived to have become warmer in the last 30 years, with some cooling effects noticed during the monsoon season. Rainfall has tended to decrease, rather than increase thus far, and occur in more intense bursts. Communities have started to feel the impacts of climate change as it occurs.

## 4.1 Badin

Over the last 30 years or more, communities in the coastal areas of Badin have noticed an increase in the incidence of extreme climatic events: there have been more intense rains and two strong cyclones, whose intensity does not compare with the intensity of an earlier cyclone in the 1960s. The sea has intruded about 50 km inland, a phenomenon not entirely due to SLR but at least partially a consequence of global warming and climate change. Sea intrusion causes an increased volume of water on the continental shelf implies that there is a greater volume of shallow water that can be rapidly heated up as a result of high atmospheric temperatures. As a result, when a cyclone generated

in the Arabian Sea reaches such warm coastal waters, it gathers more speed before hitting the coast, causing greater devastation.

Fish and prawn catch in these areas has decreased, mainly because people caught mostly freshwater fish, which have been affected by seawater intrusion and increase in sea surges and cyclones (that bring seawater into land depressions far inland). Although some communities practice high sea fishing, not many fisher folk have access to or can afford larger, more powerful boats. Due to saltwater intrusion and the declining quality of groundwater, fishing communities cannot even switch to agricultural activities or supplementary livestock management. Hence it can be concluded that climate change, together with seawater intrusion, have further marginalized the lives of the already very poor fishing communities of coastal Badin. If appropriate measures are not taken to help these communities adapt to climate change, the areas in which they live will soon be completely inundated, and their source of livelihood left completely out of reach.

### 4.2 Rajanpur

In the flood-prone areas of Rajanpur, community feedback has shown that the flood frequency has remained the same: communities have faced floods nearly every year. The floods have been either from hill torrents in the west or the swelling of the river Indus east of Rajanpur. The swelling of the river in the belt of southern Punjab is mainly due to additions from hill torrents. Communities have noticed that the quantity of water brought down into rural areas has increased. Communities have had to construct their own bunds after mutual discussion, as the bunds that existed were not high enough. The bunds they make themselves have also become higher over the years.

Constant flooding has marginalized these communities: what they grow is not enough, and they cannot grow a second crop due to the yearly summer floods. Due to increasingly erratic, unpredictable rains, standing crops are also sometimes damaged. As a result of continuous heating, it is projected that wheat yields will eventually begin to decline in the future. At the moment, wheat yields are showing an increasing trend explained largely due to farm mechanization, increased use of fertilizers, better pest control, and irrigation.Supplementary livestock management is also unreliable, as rangelands have shrunk. Farmers now have to grow fodder, but due to continuous flooding there is not much time for the fodder crop to grow (as the land remains inundated for at least a month after the floods). This has caused a decline in livestock quality, dairy produce and hence has affected the income of these farmers.

### 4.3 Khuzdar

Drought is a regular feature in the arid areas of Khuzdar. Communities differentiate between long-term and short-term droughts. Short-term droughts occur when there are insufficient rains in a cropping season. This affects the standing crop, sometimes destroying it, sometimes affecting its quality. Long-term droughts increase the impact of shorter droughts as well. Communities have become marginalized by extended droughts: they do not have enough stored grain, and the land has become so parched that even the slightest decrease in rainfall seriously affects its productivity.

Communities have reported that droughts have become far more intense, water scarcity has become more acute, and the groundwater table is falling rapidly.

Rangelands are shrinking in size and the quality of grass is becoming poor: this has affected the health and condition of livestock. The produce from livestock is also becoming very poor in quality. Continuous low rainfall has marginalized these communities.

## 4.4 Conclusions

Thus it could be concluded that there is a complex interlocking ratchet of climate changes - partly likely induced by global greenhouse gas emissions but also partly by local factors e.g. more bodies of water reflecting heat, fewer trees etc - and climate changes due to both influences interact with poverty (and with population growth) leading to e.g. more hunting and the extension of cultivation and use of water, all of which is eroding the capacity of the environment to sustain development.

# 5. Recommended Adaptation Measures

Most communities and ecosystems are naturally resilient and able to adapt to natural disasters brought about for many reasons. However, this natural resilience can no longer be taken for granted as ecosystems have become degraded and no longer have the capacity to regenerate. Traditional adaptation measures used by communities depended largely on the resilience of their ecosystem. Now, however, continual change has slowly depleted many ecosystems of their ability to recover, making them vulnerable to extreme events that may also occur as a result of the changing climate.

## 5.1. Agriculture

- Use of more heat/drought-tolerant crop varieties in areas under water stress
- Use of more disease- and pest-tolerant crop varieties
- Use of salt-tolerant crop varieties for agriculture in coastal/saline areas
- *Rod-kohi* mode of irrigated agriculture in areas frequented by hill torrents and flash floods
- Introduce higher yielding crop varieties
- Improve flood management through mobilized communities (flood management village committees)
- Through technical assistance, establish floodwater earthen farm ponds (mini-dams) with community participation for agriculture and livestock purposes.

## 5.2. Water Resources Management

- Improved efficiency of irrigation system
- Rod-kohi mode of irrigation in areas frequented by hill torrents and flash floods
- Introduction of rainwater harvesting methods
- Check dams and rainwater-floodwater ponds constructed through community involvement
- Improve the use/storage of rainwater through covered piped irrigation channels for drought-prone areas
- Drip and sprinkler irrigation schemes for drought-prone/water stressed areas
- Control groundwater mining to maintain groundwater table.

## 5.3. Rangeland Management

- Breeding livestock for greater tolerance and productivity
- Increase stocks of fodder for drought and flood times to save livestock
- Improve pasture and grazing management, including improved grasslands and pastures
- Improve management of stocking rates and rotation of pastures
- Plant native grassland species
- Increase per hectare plant coverage.

### 5.4. Fisheries

- Breed fish tolerant to high water temperatures
- Fisheries' management capabilities to cope with impacts of climate change must be developed
- Assist communities in establishing deep-sea fishing practices on a community basis
- Introduce more shrimp farms in villages and assist in direct marketing.

### 5.5. Health and Hygiene

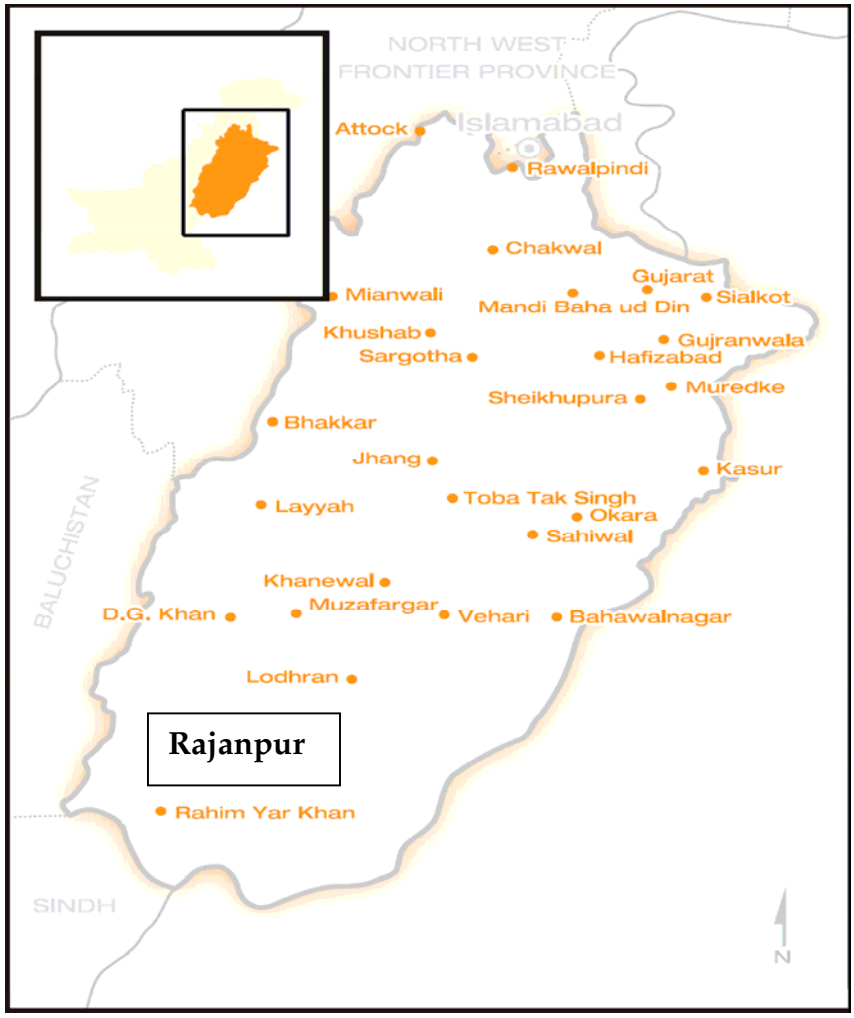
- Advocate better hygiene practices
- Educate communities concerning the spread of vector-borne diseases
- Through community involvement, establish wastewater treatment systems (on the Orangi Pilot Project model).

### 5.6. Disaster Risk Reduction

- Capacity building of the communities for future climatic changes
- Supporting communities to better adapt to climatic changes
- Ensuring risk reduction measures across all the above-mentioned sectors of agriculture, fisheries and health & hygiene.

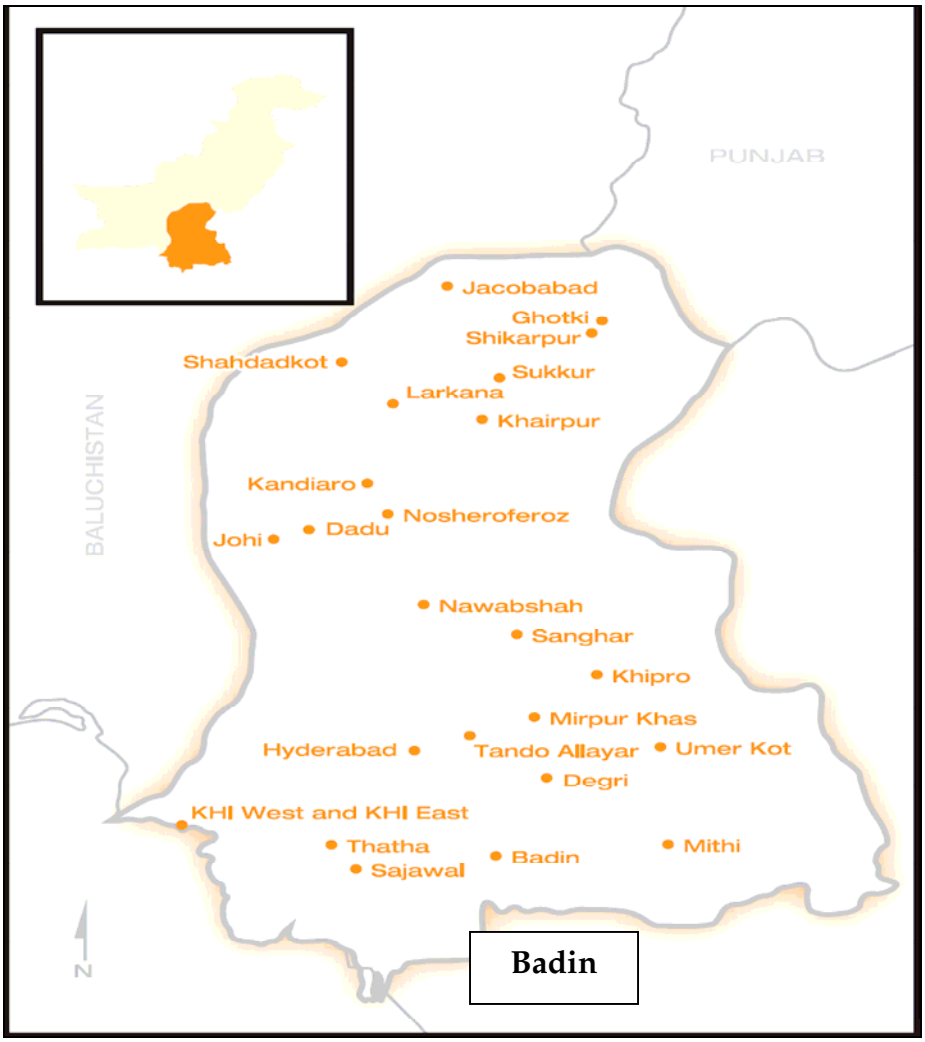
# Annexure

# Annex 1: Maps




1.1. Map of Punjab (Showing location of District Rajanpur)


1.2. Map of Balochistan Province (Showing District Khuzdar)




1.3. Map of Sindh Province (Showing District Badin)

# Annex 2: Detailed Profiles of Selected Districts

#### *4.4.1.1 Pakistan: General Profile*

Geographically, Pakistan is unique in that it stretches from the Himalayan mountains in the north to the Arabian sea in the south, with a range of physiographic features in between, including marine and coastal ecosystems, deserts, river-fed plains, and hill ranges. Due to this longitudinal variability, climatic conditions across the country are also diverse. Large parts of the country are arid to semi-arid, with some hyper-arid areas in the southern parts of Sindh, Punjab, and Balochistan, and a humid belt along the sub-montane region of the Himalayas. Even the slightest shifts in temperature and precipitation patterns can lead to drastic changes in the fragile ecosystems supported by these areas. Associated with this geographic variability is a rich natural resource base and biodiversity. This includes species such as markhor, snow leopard, and brown bear in the north and urial, chinkara, blind Indus dolphin, houbara bustard, vulture, crocodile, and Indian ass in the south. Due to climate change, certain plant species have disappeared in various ecosystems, in turn leading to habitat depletion for marginalized species, along with over-population by humans.

#### *4.4.1.2 Badin*

##### 4.4.1.2.1 Physical Features

Badin lies in an alluvial plain with a uniform landscape with no hills or rivers. The eastern part of the district is connected with the sand dunes of Tharparkar. The district lies 50 m above sea level. Before the 1999 cyclone, the sea was 50 km away from Badin city and there existed a network of creeks and swamps. However, now the sea has reached the villages of union council Bhugra Memon, which is only 35 km away from the main city.

The district is part of the lower Indus plain formed by the alluvial deposits of the Indus River. The southern part of the district lies close to the Indus delta and is lower than sea level. Soils in the district are characterized as clayey and sandy, with a significant presence of natural salts, making them fertile and appropriate for growing rice and sugarcane in the upper reaches of the district.[14]

Although no rivers flow through Badin, there are surface water bodies, primarily canals emanating from the irrigation system of Sindh and fresh and brackish water lakes, locally called *dhands*. Irrigation is supported by water coming from the Sukkur and Kotri barrages. The canal network comprises the Gooni, Phulaili, Akram Wah, and Nasir canals. Despite the proximity of the irrigation network in Badin, there is insufficient water to irrigate fertile areas. Of the total command area of 0.603 million ha, only about 40% of the area is cropped. The lakes traditionally served as sources of freshwater for drinking purposes and were also fishing grounds and an important source of freshwater

[14] Govt of Pakistan, District Census Report, Badin 1998.

fisheries. Now, however, most of these lakes have become dumping sites for effluents from sugar factories in the area. This has greatly reduced the fish catch and supply of freshwater for local communities.[15]

Groundwater in Badin can be found at very shallow depths: in winter, it can be found at a depth of 240 cm, while in summer it rises further and can be found at 150 cm. The quality of available groundwater has deteriorated considerably over the last 20 years, and water from wells is often brackish. Due to poor drainage, there is frequent flooding by canal and salt water from the irrigation and drainage systems flowing into the area.

The climate of Badin is moderate, and is tempered by the sea breeze, which blows for eight months of the year from March to October, making the hot weather comparatively cool. The average monthly rainfall is 125 mm; during the monsoon period, the sky remains cloudy with very little precipitation. The climate in summer is generally moist and humid. The cold weather in Badin starts from the beginning of November when a sudden change from the moist sea breeze to the dry and cold northeast wind brings about (as a natural consequence) an immediate fall in temperature. The maximum temperature in the hot weather does not usually exceed 40°C, while the minimum reading in winter does not fall below 8°C. The autumn starts in September and lasts for about six weeks.

Certain irrigation features in Badin affect resident communities, especially those settled along the coast. The left bank outfall drain (LBOD) passes through the district along with other ancillary drains. The LBOD is supposed to drain saline ground and surface water and storm runoff from 1.27 million acres of land in the three districts of Nawabshah, Sanghar, and Mirpur Khas to help avoid water logging and salinity. The LBOD collects excess irrigation water, saline seepage, pumped saline groundwater, and rainfall runoff. At its terminus near the coastal zone, the LBOD discharges its flow into two drains, the Kadhan Pateji outfall drain and the Dhoro Puran outfall drain. These flow into two natural, shallow lakes that form part of the wetlands of the Rann of Kutch.[16]

The LBOD has, however, become an environmental threat for coastal communities in the area. Industrial and domestic wastewater from districts upstream is now also discharged into the LBOD, with the result that it has become a potent wastewater body. Following a major flood and the cyclone of 1999, the Chlori weir of the LBOD was severely damaged, causing this wastewater to spread into the neighbouring area. This has continued to happen as no repairs were made to the weir. In addition, the low-lying areas of Badin have retained this waste stream from the LBOD and its ancillary drains, since the LBOD is designed to prevent the discharge of effluents against the gravity flow,[17] i.e., the wastewater is not discharged into the sea.

#### 4.4.1.2.2 Hazard History

15 IUCN and District Govt. Sindh, District Vision Badin, IUCN 2006.
16 LHDP Monsoon Contingency Plan,District Badin 2009
17 IUCN Sindh State of the Environment and development, IUCN 2004.

Badin is prone to a number of natural disasters. Over the past 50 years, it has been struck repeatedly by cyclones, floods, storm surges, and heavy rains. These coastal areas are inhabited by poor fishing communities who rely heavily on freshwater fishing as their sole source of income. When such disasters occur, the lives and livelihoods of these coastal communities are most affected.

Of the major natural disasters that have occurred in Badin, the most frequent are cyclones, heavy rainfall, sea intrusion, floods, and, in some areas, drought. Of these, floods, cyclones, and heavy monsoon rains have caused immense and widespread devastation, in particular to coastal fishing villages. Coastal areas are more vulnerable than other rural areas: 215,080 acres of land are affected with 370,000 individuals living in a danger zone, while 294 *dehs* are directly affected by all prevailing disasters. Villages that are in close proximity to the Arabian Sea and LBOD have been the most frequent subjects of recurring disasters. According to the District Disaster Risk Management Plan for Badin, in tehsil Badin, union council Bhugra Memon is identified as one of the most vulnerable to disasters. Of these "hazards," the highest priority is assigned to cyclones, followed by floods, the LBOD and sea intrusion, while heavy rainfall is classified as medium priority. Cyclones have hit the Badin coastline in 1964, 1999, and 2007; floods have occurred here in 1976, 1988, 2003, and 2006. Heavy rainfall has often occurred in between.[18]

#### *4.4.1.3 Rajanpur*

##### 4.4.1.3.1 Physical Features

The lower hills of the Suleiman range extend into Rajanpur district in the de-excluded area to the west of the district. The Pachadh area at the base of the hills is inhabited by Baloch pastoralists. The more settled areas are agricultural villages that depend on water brought down by hill torrents. The riverine plains are adjacent to the Indus River and are irrigated by river flood waters, while the area between the plains and the hills is an intermediate zone where well irrigation is used.

The Suleiman range consists of a series of ridges of varying heights that run parallel to each other in a north-south direction. The higher altitudes are located in Balochistan and the lower hills in the Rajanpur and Dera Ghazi Khan districts of Punjab. The highest peaks are nearly 3,000 m above sea level. These continuous parallel ridges are broken by approximately 270 hill torrents that flow down from the Suleiman range in the monsoon season. The torrent passages thus formed serve as routes to Balochistan, and the surrounding communities live close to them. The hill torrents also transport materials that form fertile soils in the high altitude plains.

The Suleiman range forms an important feature of Rajanpur district as the hills are an extensive source of hill torrents. The barren hillsides allow rapid water flow to the plains without absorption by the soils of the area, causing flash floods in the foothills and at the base of the hills, affecting the communities residing there. Further upstream, the water

18 UNFAO, WFP Badin Hazard, Livelihood and Vulnerability Baseline and Contingency Plan 2009

from these hill torrents combines with the already welled Indus River during the monsoon season, and causes additional flooding in the riverine tract of Rajanpur. Tehsils Jampur, Rojhan, and Rajanpur in the plains are particularly affected 19.

The main sources of surface water are the perennial Indus River, that forms the western boundary of the district, and the rainwater hill torrents that flood the area during the summer Monsoon, and whenever there are erratic rains. The communities in the foothills have traditionally bunded the water of the hill torrents. However, the increasing volume of water in recent years has made this difficult. Communities will require alternative methods to make use of this water.

Groundwater is usually found between 30 and 35 feet below the surface and is accessed using hand-pumps. However, groundwater in the foothills is saline due to years of salt and sand transported by the hill torrents in the Suleiman range. The water table rises moving west towards the Indus River, and the groundwater becomes drinkable.

The climate of the district is very hot with temperatures reaching 45°C in June. The annual mean maximum temperature is 32.6°C, while the annual mean minimum temperature is about 18°C. Rainfall is low except in the Monsoon season. The annual mean precipitation is 187 mm, with a high in July-August.

Population estimates for 2008 (based on the 1998 census19) indicate that the total population of the district is approximately 1.53 million, of which about 57% is rural. Physically, the district is a narrow 20 to 40 mile wide strip of land between the Indus River to the east and the Suleiman range to the west. It is spread over an area of 8,565 sq. km and covers tehsils Jampur, Rajanpur, and Rojhan, and a 1,260 sq. km de-excluded tribal area (which is counted as a union council). The district contains 44 union councils including the tribal area.

About 441,000 ha of district Rajanpur constitutes farmed land. The district has a canal network irrigating about 295,000 ha (through Dajal Branch, Link No III and Kadra canal and their tributaries). Tube wells irrigate another 90,000 hectares. The remaining 64,100 ha are rain-fed. Major crops grown in the irrigated area include wheat, cotton, sugarcane, and sunflower, and in the rain-fed areas include wheat, sorghum, and millet. Rajanpur district also has some forest area.

The district's extensive road network includes the Indus highway and various link roads connecting the highway to towns and villages.

According to the Pakistan Participatory Poverty Assessment (PPPA) - Punjab Province Report – 2003,[20] 80% to 90% of the population was characterized as "poor" or "very poor." Southern Punjab is relatively poor compared to upper Punjab.

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19 UNFAO, WFP Rajanpur Hazard, Livelihood and Vulnerability Baseline and Contingency Plan 2009.

20 Source: Between hope and poverty , Pakistan Participatory Poverty Assessment, Planning and Development Report, August 2003.

#### 4.4.1.3.2 Hazard History

The districts located along the banks of the Indus in the plains of Southern Punjab have a history of regular riverine flooding during the Monsoon season. In addition, extensive deforestation over the last 50 years in the Suleiman range (in neighbouring Balochistan) has intensified hill torrents, resulting in flash floods in the foothills in Rajanpur. The hill torrents have also added to the water of the Indus, contributing to a further swelling the river between the Chashma and Taunsa barrages, as well as downstream of Taunsa, intensifying riverine flooding. Riverine flooding has been assigned a high priority by the District Disaster Risk Management Plan for Rajanpur. The hazard history of Rajanpur district constitutes a series of regular floods due to hill torrents, and about five yearly high floods due to extreme riverine swelling.19

Years of high flash floods include 1977, 1983, 1985, 1994, 2003, 2004, 2005, and 2007. Riverine flood years include 1973, 1977, 1983, 1988, 1992, 2004, 2005, and 2006. These events affected the entire rural areas of the district, but sometimes just the majority of the western areas have been affected.

### *4.4.1.4 Khuzdar*

#### 4.4.1.4.1 Physical Features

Khuzdar district is bounded by the districts of Jhal Magsi and Larkana, Sindh to the east. The districts Kalat and Kharan lie on the north and northwest side. Khuzdar district borders Avaran and Lasbela districts to the south, and district Dadu, Sindh to the southeast. The total area of Khuzdar district is 43,261 sq. km and is about 1,600 meters above the sea level.[21]

The general topography of the district is mountainous, consisting of numerous ridges and valleys of varying widths. The hills are formed of sandstone and shale. Notable ranges in the north of the district include the Harboi and Central Brahvi ranges that run north to south. An important range in the east close to Jhalwan is the Moola hills. The Khudo, Pab, and Chapar are important ranges in the south that run from the northwest to the southeast. The Kirthar hills form the eastern boundary of the district, and run in a north-south direction, while the Garr hills form the western boundary. The surveyed areas lie in the hills of union council Sasool.

The soil of the area is fertile and suitable for growing crops, but a scarcity of water and prolonged drought conditions do not allow this. The types of soils found in Khuzdar include “mutt” or muddy, “rikpoad” or clay, “yally” or stony, “shoor” or mud-rock, “karkat” or hard, and “rage” or wetland. Similar to clay, mutt is the most fertile, composed of silt washed down from the hills, or through soil erosion. Considered the next best, Karkat is harder and cracks upon drying. Both mutt and karkat are suitable for all crops and are found in the surveyed area, Sasool, although they are also found in other places across Khuzdar, namely Baghbana, Nal, Gresha, Wadh, Waheer, Darakhalo,

21 Govt. of Pakistan, District Census Report, Khuzdar 1998.

and Tootak. However, the unavailability of water has been a limiting factor in utilizing these fertile soils.

The Nal and Porali are the main rivers in the district. Hill torrents flow down the hills when there are rains, but this is rare as the area is drought prone. Most of the *nullahs,* locally known as "nadis" remain dry, and people often build their homes in the dry beds. The Malooki *nullah,* which is a dry bed, lies close to the surveyed villages.

The climate of Khuzdar is characterized by warm summers and mild winters. However, the northern areas of the district become very cold in the winters, with snow on the higher peaks in the Zehri area. There is a great variation between day and night temperatures. The southern areas become warm during summer, but the climate of Khuzdar on the whole remains moderate. June is the hottest month with a mean maximum temperature of 38°C and a mean minimum temperature of 25°C. January is the coldest month with mean maximum and minimum temperatures of 17°C and 3°C respectively. The winter winds, locally called "Goorich" blow north to south, while summer winds known as "Nambi" blow from the south, indicating approaching rains.

Annual rainfall (mostly in the summer) exceeds 250 mm thus categorizing the district as semi-arid. The rainfall record is irregular, but the average rainfall of the district is sufficient for the growth of vegetation for livestock grazing. In addition, the steep topography causes rainwater to flow away as torrents without seeping into the soil and causing soil erosion.

#### 4.4.1.4.2 Biological Environment

Wild olives are found on the higher slopes of Khuzdar, and tamarisk and dwarf palm in the valleys. Some varieties of acacia, parpuk or loiro, and the guggul tree are also found. Hawe, gorkha, and kashum are the principal fodder grasses. State forests and game sanctuaries cover 118,533 hectares, which is 2.7% of the total geographical area of Khuzdar district. The forest areas include Zeddi, Chari, Shasar, Sasool, and Kheradori.

The district contains four wildlife sanctuaries at Chorani, Dhura, Kacher, and Shahshan. The exact boundaries of the sanctuaries could not be obtained, but the proposed irrigation site does not lie close to the sanctuaries. Endangered species of wildlife in Khuzdar district include the Balochistan black bear, urial, houbara bustard, caracal, Sindh Ibex, and chukor. Common species in the area include the red fox, grey partridge, and seesee partridge. No wildlife species were observed in the surveyed area.

#### 4.4.1.4.3 Hazard History

Being arid to hyper arid, Khuzdar district has been denuded of vegetation and become increasingly prone to droughts and in some areas, flash flooding. The past 50 years have seen the district faced with medium to intense droughts due to scarce surface water, scarce and rapidly depleting groundwater, and a high evapotranspiration rate. The areas along the banks of the *nullahs* in central Khuzdar experience flooding, while the areas of Sasool and the remaining district are prone to droughts.

The District Disaster Risk Management Plan for Khuzdar has assigned the highest priority to droughts, followed by floods.

Khuzdar district's economy depends on agriculture and livestock, and the scarcity of water has therefore had major repercussions on the lives and livelihoods of the communities. The district has had a history of natural disasters: a severe drought in 1965 was followed by medium seasonal droughts that cause temporary damage to crops. This was followed by destructive floods lasting from 1995 to 2004 that damaged the agriculture and livestock industries22.

#### *4.4.1.5 Climate Change Research in Pakistan*

Climate change (CC) research in Pakistan is being conducted at various institutes and organizations, but the only institutions that are comprehensively addressing the issue are the Global Change Impact Study Centre (GCISC) and the Pakistan Meteorological Department (PMD). The GCISC has played a leading role, as its team of physicists and climatologists have been collaborating with various international research organizations to work towards obtaining a realistic picture of CC in Pakistan. The GCISC was established in 2002 under the Planning Commission, Govt. of Pakistan. The Centre keeps track of current and future CC trends, conducts CC research and modelling for local conditions, and analyzes the impacts of CC on environmental receptors.

Global circulation models (GCMs) are mathematical representations of the large-scale physical processes of the Earth-atmosphere-ocean system that provide a complete and internally consistent view of future climate change. These models are used by the IPCC to predict global climate change under different scenarios. They provide information on a global level, typically on a scale of 300km x 300km. The GCISC however, has developed regional climate models (RCMs) that predict climatic conditions on a much finer scale of 50km x 50km. These models employ base data for at least the past 30 years to make reasonably accurate predictions for the future. The GCISC has made some basic calculations for future climate trends in Pakistan by dividing it at latitude at 30N (courtesy GCISC) into two regions, north and south Pakistan, and have made predictions for temperature and precipitation changes for different scenarios and over different time periods (see Figure 1).

The GCISC has divided the geographic spread of Pakistan into six major agro-ecological climatic regions to study past patterns and reasonably determine future trends for the country (see Figure 2). Temperature and precipitation have been recorded for each of these regions annually from 1951 to 2000, as well as for different periods such as the Monsoon season (summer: Jun. to Sept.), Winter (Dec. to Mar), Apr - May; and Oct-Nov.

22 District Govt. Khuzdar and OGB Khuzdar Draft District Disaster Risk Management Plan, 2008.

**Figure 1: Pakistan Divided by Latitude**

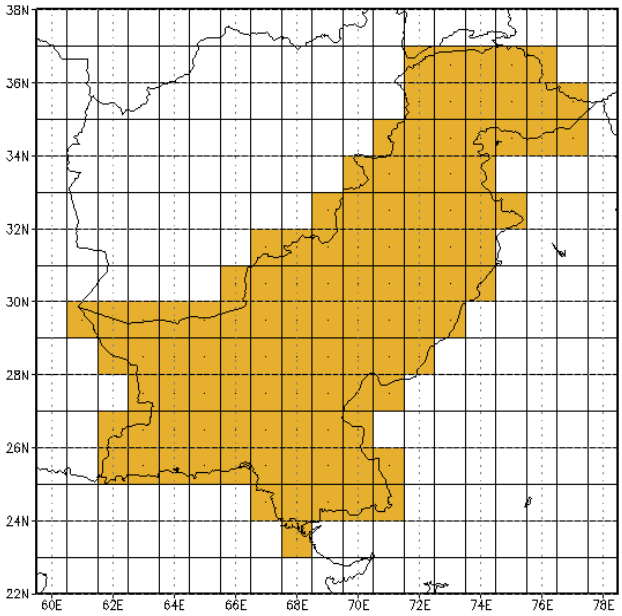
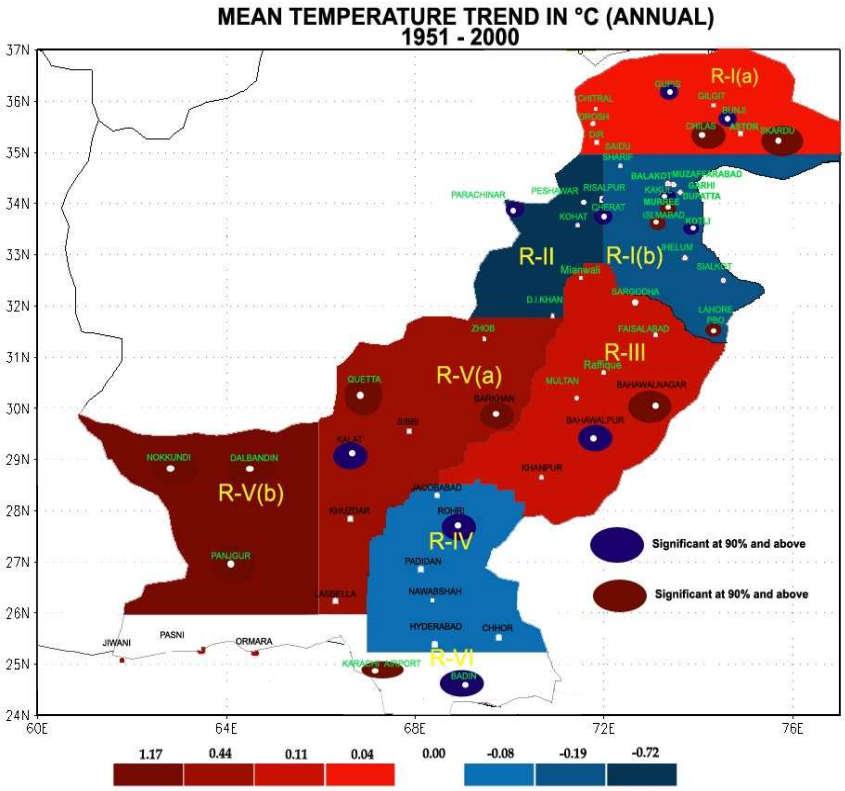



**Figure 2: Mean Annual Temperatures in Pakistan**




Based on GCISC's modelling, predictions have been made for various scenarios in the future (2080's). See the following boxes.

**Box 5: Temperature Projections for 2080s for North –South Pakistan**

| Region | Summer | Winter |
|---|---|---|
| Northern Pakistan | 4.56 ±0.28oC | 4.72±0.24oC |
| Southern Pakistan | 3.90 ±0.26oC | 4.33 ±0.18oC |

**Temp. Increase in Northern and Southern Pakistan are higher in winter than in summer 1.

**Box 6: Modeled Past Trends for ΔT and Rainfall for Badin**

| Region VI-Coastal Belt | Annual | Monsoon (Jun-Sept) | Winter (Dec-Mar) | Apr-May | Oct-Nov |
|---|---|---|---|---|---|
| Temperature | | | | | |
| (ºC) | 0.00 | -0.18 | 0.05 | 0.03 | 0.3 |
| Precipitation | | | | | |
| % Change | -41.0 | -67.0 | 0.00 | - | - |

**Box 7: Temperature and Precipitation Predictions for Badin 2080s**

| Badin | Annual | Summer | Winter |
|---|---|---|---|
| Temperature (increase) | 3.98ºC | 3.33 ºC | 4.36 ºC |
| Precipitation % change | 5.11 | 0.05 | 11.64 |

**Box 8: Modeled Past Trends for ΔT and Rainfall for Rajanpur**

| Region III-Central and Southern Punjab | Annual | Monsoon (Jun-Sept) | Winter (Dec-Mar) | Apr-May | Oct-Nov |
|---|---|---|---|---|---|
| Temperature | | | | | |
| (ºC) | 0.11 | -0.25 | 0.03 | 0.83 | 0.31 |
| Precipitation | | | | | |
| % Change | 31.5 | 28.5 | 49.5 | - | - |

**Box 9: Temperature and Precipitation Predictions for Rajanpur 2080s**

| Rajanpur | Annual | Summer | Winter |
|---|---|---|---|
| Temperature (increase) | 5.0ºC | 5.17 ºC | 4.97 ºC |
| Precipitation % Change | 2.14 | 0.45 | -1.48 |

**Box 10: Modeled Past Trends for ΔT and Rainfall for Khuzdar**

| Region V(a)-Balochistan plateau East | Annual | Monsoon (Jun-Sept) | Winter (Dec-Mar) | Apr-May | Oct-Nov |
|---|---|---|---|---|---|
| Temperature | | | | | |
| (ºC) | 0.11 | 0.46 | 0.63 | 0.79 | 0.5 |
| Precipitation | | | | | |
| % Change | 59.5 | 58 | 57 | - | - |

**Box11: Temperature and Precipitation Predictions for Khuzdar for 2080s**

| Khuzdar | Annual | Summer | Winter |
|---|---|---|---|
| Temperature (increase) | 5.04ºC | 1.82 ºC | 4.76 ºC |
| Precipitation % change | 13.62 | 7.64 | -39.44 |

**Box12: Temperature and Precipitation Predictions for Khuzdar for 2080s**

| Khuzdar | Annual | Summer | Winter |
|---|---|---|---|
| Temperature (increase) | 5.04ºC | 1.82 ºC | 4.76 ºC |
| Precipitation % change | 13.62 | 7.64 | -39.44 |

# Annex 3: Survey Forms

## Coastal Zone-District Badin

| **1. General Information** | | | |
|---|---|---|---|
| **1.1. Date of interview** (day / month / year) | | | **1.2. Time of interview** |
| **1.3. Name of village** | | | **1.4. Name of data collector** (first name / last name) |
| **1.5. Name of respondent** (first name / last name) | Gender | Age | **1.6. Key position(s) held by respondent** (if any) (e.g. village head / *numberda* / *tehsildaar* / *subedar* / district member) |
| | | | |

| **2. Household Information** | |
|---|---|
| **2.1 Number of members in the household** (specify gender) | **2.2 Family system**<br>☐ Joint ☐ Single |
| **2.3 Legal ownership of assets**<br>☐ House ☐ Agricultural land (kanal)<br>☐ Fishing ☐ Shop<br>☐ Other (specify)<br>Specify land use (e.g. agriculture, agro forestry, pastoral) | **2.4 Occupation / means of livelihood**<br>State all sources of income for household (e.g. farmer, fishing, artisan)<br>At present:<br>Ten years ago (if different from above, state reason):<br>Twenty Years ago<br>Thirty years ago |

| **3. Information on Climate Change and its Impact- Biological/Agriculture** | | |
|---|---|---|
| **3.1 If occupation is agriculture / farming, which crops are grown?** (specify any change in diversity) | Commercial use | Domestic use |
| At present (e.g. rice, cotton, chillies, sugarcane, cotton crops wheat and barley) | | |

| | | |
|---|---|---|
| Ten years ago (if different from above, state reason) | | |
| Twenty Years ago | | |
| Thirty Years ago | | |

**3.2 Any land use changes observed, has land become unusable, if yes, why, discuss changes.**

***3.3*** **Changes in fishing season, type of catch, discuss if needed.**

| **Main catch 1 (prawn/fish/shrimp, name??)** | | **Main catch 2 (prawn/fish/shrimp, name??)** | |
|---|---|---|---|
| At present | | At present | |
| Ten years ago | | Ten years ago | |
| Twenty yrs ago | | Twenty yrs ago | |
| Thirty yrs ago | | Thirty yrs ago | |

**3.4 Changes in spawning time, discuss if needed**

| | | | |
|---|---|---|---|
| | | **Crop 2** | |

| | | | |
|---|---|---|---|
| At present | | At present | |
| Ten years ago | | Ten years ago | |
| Twenty yrs ago | | Twenty yrs ago | |
| Thirty yrs ago | | Thirty yrs ago | |

**3.5 Coping mechanism practiced by communities during this ban time (i.e. spawning time)**

| **3.6 Changes in time of appearance of pests** | | **3.7 Changes in appearance time of butterflies** | |
|---|---|---|---|
| At present | | At present | |
| Ten years ago | | Ten years ago | |
| Twenty yrs ago | | Twenty yrs ago | |
| Thirty yrs ago | | Thirty yrs ago | |

| | |
|---|---|
| **3.8** | **Change in status or distribution of any plant species (like mangroves, any other that are depleting or increasing in the area)** |
| | If yes, state which species, and explain<br>☐ Yes ☐ No |

**3.9 Fish/prawn-Annual yield** (maunds/kg)

At present:

Ten years ago (if different from above, state reason):

Twenty yrs ago

Thirty yrs ago

**3.10 diseases / pests or any other reason for decline in catch**

At present:

Ten years ago

Twenty yrs ago

Thirty yrs ago

**3.11 Livestock / poultry owned by household**

| Type (e.g. cow,goat,shee buffalo) | Number | | | |
|---|---|---|---|---|
| | Now | 10 yrs ago | 20 yrs ago | 30 yrs ago |
| | | | | |

**3.12 Has there been any change in the quantity and quality of milk / meat obtained from livestock?** If yes, state reason.

**3.13 Has there been any change in the quality and quantity of resources** (grass) **at grazing sites?**

If yes, state reason.

☐ Yes ☐ No

**3.14 Has there been any change in the location and duration of stay at grazing sites during the past thirty years?**

☐ Yes ☐ No

| **If yes, state:** | Duration of stay | Travel time |
|---|---|---|
| At present | | |
| Ten years ago | | |
| Twenty yrs ago | | |
| Thirty yrs ago | | |

**3.15 When do trees blossom/flower? Have any perceptible changes been noticed by elders**

Last year:

10 years ago:

20 yrs ago

30 yrs ago

**3.16 How are forest resources used?**(e fuelwood,construction)

At present:

Ten years ago:

20 yrs ago

30 yrs ago

**3.17 Has there been any change in forest cover?** If yes, state how and provide reason for change.

☐ Yes ☐ No

**3.18 Any discussion pertaining to mangroves, uses, cover (density, distribution) cause for change?**

**3.19 Energy usage for:**

| | Fuel used (firewood, gas, kerosene) | Now | 10 yrs ago | 20 yrs ago |
|---|---|---|---|---|
| Cooking | | | | |
| Heating | | | | |
| Lighting | | | | |

**3.20 Are the Summers getting warmer? If yes explain how** (previous cooling practices not enough, any new practices)

☐ Yes ☐ No

**3.21 Are the Summers getting cooler? If yes explain how** (previous cooling practices re more than sufficient)

**3.22** ☐ Yes ☐ No

**3.23 Are the winters getting warmer? If yes, explain how.** (e.g. lessened use of sweaters/blankets use, fuelwood use ecreased, construction style changes)

☐ Yes ☐ No

**3.24 Are the winters getting cooler? If yes, explain how.** (e.g. use of sweaters/blankets use, fuelwood use, construction style changes)

☐ Yes ☐ No

**3.25 Has there been any change in the incident of extreme climatic events?**

☐ Yes ☐ No

If yes, specify change / type of event that occurred:

**3.26 Is there a change in the frequency of extreme climatic events? State nature of event**

No of events in past 5 yrs (03-08)

No of events in (03-90)

No of events in (90-80)

No of events in the 70's

| **3.27 Fuelwood consumption** | **3.28 Rainfall pattern** |
|---|---|
| last year: | last year: |
| Ten years ago: | Ten years ago: |
| Twenty yrs ago | Twenty yrs ago |
| Thirty yrs ago | Thirty yrs ago |
| **3.29 Any change in sea level, for coastal villages** | **3.30 Sea water intrusion noticed in creeks** |
| This year: | This year (if different from below, state reason): |
| Ten years ago: | Ten years ago: |
| Twenty yrs ago | Twenty yrs ago |
| Thirty yrs ago | Thirty yrs ago |

**3.31 In the community's perception, is there any link between sealevel intrusion/rise and drop/increase in catch?**

**c**

**3.32 Has there been any change in water table (ground water)? If yes, how much?**

| **3.33 Source of water for:** | Present | Ten yrs ago | Twenty yrs ago | Thirty yrs ago |
|---|---|---|---|---|
| Agriculture | | | | |
| Domestic | | | | |
| Livestock | | | | |
| Other | | | | |

**3.34 Have there been any changes in the availability of water for domestic use? If yes how?**

**3.35 What adjustments have you made to adapt to the changes in water availability over the past 30 yrs?**

Agriculture:

House use:

Other (specify):

**3.36 Can you relate any traditional practice that were handed down to you from your forefathers to deal with change in water availability?**

**3.37 Have there been any changes in the quality of water over the past 30 yrs? If yes what?**

**3.38 What have you done to cope with this change? New mechanisms or old**

**3.39 Has any increase in diseases(human) been noticed in recent years? Who is the most vulnerable,** If yes, state and emphasize reason in their opinion.

☐ Yes ☐ No

| Time | Summer (e.g. diarrhoea) | Winter (e.g. pneumonia, TB, cough) |
|---|---|---|
| At present | | |
| Ten years ago | | |
| Twenty yrs ago | | |

**3.40 Have you noticed any usual pattern in the climate?** (e.g. unusual rainfall, change in wind pattern)

**3.41 Has there been any change in intensity of the climate?**

| | |
|---|---|
| ☐ Yes ☐ No<br>If yes, specify change:<br><br>What do you think has caused the change(s)? | ☐ Yes ☐ No<br>If yes, specify change: |

**3.42 Have you noticed any change in the bird species in the region?** (e.g. migratory birds, crow, wild pigeon, partridge) If y explain.

☐ Yes ☐ No

**3.43 Have you noticed any change in mammals / reptiles / amphibian species in the region**? (e.g.fox, owl, deer).

☐ Yes ☐ No **If yes, state:**

| | |
|---|---|
| Current status (seen less, not seen at all, seen only in winters etc. – specify name of species): | Reason for observed change in status |
| Migratory pattern/corridors of species (specify name species):<br>From:<br>To: | Reason for observed change in migratory pattern |
| Future predictions (change in number/location of species): | |

**3.44 Fishing practices**

| | |
|---|---|
| Location for fishing now | Local fishing practices / tools |
| Location for fishing Ten yrs ago | Location for fishing Twenty yrs ago |
| Location for fishing Thirty yrs ago | Future Fishing scenario |

**3.45 How has the change in climate affected agriculture?**

**3.46 How has the change in climate affected business?**

**3.47 How has the change in climate affected livestock?**

**3.48 How do you think the change in climate has affected or will affect:**

Migratory pattern of local human population
Gender roles: Women, men, children, elderly
Changes in livelihood patterns
Social impact (education, health, hygiene etc)

**3.49 Are women still practicing traditional handiwork/needle work, or has this tradition stopped, or is decreasing due to less availability of time, discuss why. Are women more involved in fetching water, coping with other climate induced changes?? Discuss clearly**

**3.50 What do you think is being done, can be done or needs to be done to deal with the changing natural conditions?**

(e.g. afforestation, plantation, education, local action body, awareness, migration, storage, diversification, communal pooling, trade, seed variety/price, human/animals medicine, less polluting machines) State current efforts (communal transformation/external support)

**3.51 What steps have you taken to adapt to changing natural conditions?**

Agriculture

Fisheries

Social infrastructure

# Hyper Arid Areas- District Khuzdar

| **4. General Information** | | | |
|---|---|---|---|
| **1.7. Date of interview** (day / month / year) | | | **1.8. Time of interview** |
| **1.9. Name of village** | | | **1.10. Name of data collector** (first name / last name) |
| **1.11. Name of respondent** (first name / last name) | Gender | Age | **1.12. Key position(s) held by respondent** (if any) (e.g. village head / *numberda* / *tehsildaar* / *subedar* / district member) |
| | | | |

| **5. Household Information** | |
|---|---|
| **2.5 Number of members in the household** (specify gender) | **2.6 Family system**<br>☐ Joint ☐ Single |
| **2.7 Legal ownership of assets**<br>☐ House ☐ Agricultural land (kanal)<br>☐ Livestock ☐ Shop<br>☐ Other (specify)<br>Specify land use (e.g. agriculture, pastoral) | **2.8 Occupation / means of livelihood**<br>State all sources of income for household (e.g. farmer, artisan)<br>At present:<br>Ten years ago (if different from above, state reason):<br>Twenty Years ago<br>Thirty years ago |

| **6. Information on Climate Change and its Impact- Biological/Agriculture** | | |
|---|---|---|
| **3.52 If occupation is agriculture / farming, which crops are grown?** (specify any change in diversity) | Commercial use | Domestic use |
| At present (e.g. wheat, barley, chillies, fodder) | | |
| Ten years ago (if different from above, state reason) | | |

| |
|---|
| Twenty Years ago |
| Thirty Years ago |

**3.53 Any land use changes observed, has land become unusable, if yes, why, discuss changes.**

***3.54*** **Any changes in agriculture season observed? Did you need to change the type of crop grown, if yes why, discuss.**

| **Main crop 1 (name?)** | | **Main crop 2 (name?)** | |
|---|---|---|---|
| At present | | At present | |
| Ten years ago | | Ten years ago | |
| Twenty yrs ago | | Twenty yrs ago | |
| Thirty yrs ago | | Thirty yrs ago | |

**3.55 Changes in sowing time to become early or late. Discuss clearly what the community/person has observed.**

| **Crop 1** | | **Crop 2** | |
|---|---|---|---|

| | | | |
|---|---|---|---|
| At present | | At present | |
| Ten years ago | | Ten years ago | |
| Twenty yrs ago | | Twenty yrs ago | |
| Thirty yrs ago | | Thirty yrs ago | |

**3.56 Coping mechanism practiced by communities during this change in sowing time**

| **3.57 Changes in time of appearance of pests** | | **3.58 Changes in appearance time of butterflies** | |
|---|---|---|---|
| At present | | At present | |
| Ten years ago | | Ten years ago | |
| Twenty yrs ago | | Twenty yrs ago | |
| Thirty yrs ago | | Thirty yrs ago | |

| | |
|---|---|
| **3.59** | **Change in status or distribution of any plant species (like local bushes, trees, shrubs are they decreasing or increasing in the area)** |
| | If yes, state which species, and explain<br>☐ Yes ☐ No |

**3.60 Crop 1-Annual yield** (maunds/kg)

At present:

Ten years ago (if different from above, state reason):

Twenty yrs ago

Thirty yrs ago

**3.61 Crop 2-Annual yield** (maunds/kg)

At present:

Ten years ago

Twenty yrs ago

Thirty yrs ago

**3.62 diseases / pests or any other reason for decline in Yield from crops**

At present:

Ten years ago

Twenty yrs ago

Thirty yrs ago

**3.63**

**3.64 Livestock / poultry owned by household**

| Type (e.g. cow,goat,shee buffalo) | Number | | | |
|---|---|---|---|---|
| | Now | 10 yrs ago | 20 yrs ago | 30 yrs ago |
| | | | | |

**3.65 Has there been any change in the quantity and quality of milk / meat obtained from livestock?** If yes, state reason.

**3.66 Income from Livestock**

At present:

Ten years ago

Twenty yrs ago

Thirty yrs ago

**3.67 Has there been any change in the quality and quantity of resources** (grass) **at grazing sites?**

If yes, state reason.

☐ Yes ☐ No

**3.68 Has there been any change in the grazing area? Area reduced?**

If yes, state reason.

☐ Yes ☐ No

Extent of grazing grounds:

At present:

Ten years ago

Twenty yrs ago

Thirty yrs ago

| **3.69 Has there been any change in the location and duration of stay at grazing sites during the past thirty years?** ☐ Yes ☐ No | **If yes, state:** | Duration of stay | Travel time |
|---|---|---|---|
| | At present | | |
| | Ten years ago | | |
| | Twenty yrs ago | | |
| | Thirty yrs ago | | |

**3.70 When do trees/plants blossom/flower? Have any perceptible changes been noticed by elders**

Last year:

10 years ago:

20 yrs ago

30 yrs ago

**3.71 How are forest resources used?**(e fuelwood,construction)

At present:

Ten years ago:

20 yrs ago

30 yrs ago

**3.72 Has there been any change in forest cover?** If yes, state how and provide reason for change.

☐ Yes ☐ No

**3.73 Any discussion in relation to the cause for change? What is the reason for this change in grazing area in the opinion of the communities?**

**3.74 Energy usage for:**

| | Fuel used (firewood, gas, kerosene) | Now | 10 yrs ago | 20 yrs ago |
|---|---|---|---|---|
| Cooking | | | | |
| Heating | | | | |
| Lighting | | | | |

**3.75 Are the Summers getting warmer? If yes explain how** (previous cooling practices not enough, any new practices)

☐ Yes ☐ No

**3.76 Are the Summers getting cooler? If yes explain how** (previous cooling practices re more than sufficient)

**3.77** ☐ Yes ☐ No

**3.78 Are the winters getting warmer? If yes, explain how.** (e.g. lessened use of sweaters/blankets use, fuelwood use ecreased, construction style changes)

☐ Yes ☐ No

**3.79 Are the winters getting cooler? If yes, explain how.** (e.g. use of sweaters/blankets use, fuelwood use, construction style changes)

☐ Yes ☐ No

**3.80 Has there been any change in the incidence drought?**

☐ Yes ☐ No

If yes, specify change / type of event that occurred are they much sooner now:

When was the last drought (ask community elder)

When was the drought before that (20 years ago or ten years ago or sooner???) please explain, discuss clearly with community to get a clear answer.

**3.81 Is there a change in the frequency of drought**

Drought in the past 5 yrs (03-08)

Drought (03-1990)

Drought in (1990-1980)

Drought in the 70's

**3.82 Fuelwood consumption**

last year:

Ten years ago:

Twenty yrs ago

Thirty yrs ago

**3.83 Rainfall pattern**

last year:

Ten years ago:

Twenty yrs ago

Thirty yrs ago

**3.84 In the community's perception, is there any link between increased drought and state of livestock?**

**3.85 In the community's perception, is there any link between increased drought and agricultural yield?**

**3.86 Has there been any change in water table (ground water)? If yes, how much?**

| **3.87 Ground water table** | Present | Ten Years ago | 20 yrs ago | 30 yrs ago |
|---|---|---|---|---|
| | | | | |

| **3.88 Source of water for:** | Present | Ten yrs ago | Twenty yrs ago | Thirty yrs ago |
|---|---|---|---|---|
| Agriculture | | | | |

| | | | | |
|---|---|---|---|---|
| Domestic | | | | |
| Livestock | | | | |
| Other | | | | |

**3.89 Have there been any changes in the availability of water for domestic use? If yes how?**

**3.90 What adjustments have you made to adapt to the changes in water availability over the past 30 yrs?**

Agriculture:

House use:

Other (specify):

**3.91 Can you relate any traditional practice that were handed down to you from your forefathers to deal with change in water availability?**

**3.92 Have there been any changes in the quality of water over the past 30 yrs? If yes what?**

**3.93 What have you done to cope with this change? New mechanisms or old**

**3.94 Distance travelled by community to reach drinking water source?**

| Present | 10 yrs ago | 20 yrs ago | 30 yrs ago |
|---|---|---|---|
| | | | |

**3.95 Has any increase in diseases(human) been noticed in recent years? Who is the most vulnerable,** If yes, state and emphasize reason in their opinion.

☐ Yes ☐ No

| Time | Summer (e.g. diarrhoea) | Winter (e.g. pneumonia, TB, cough) |
|---|---|---|
| At present | | |
| Ten years ago | | |
| Twenty yrs ago | | |

**3.96 Have you noticed any usual pattern in the climate?** (e.g. unusual rainfall, change in wind pattern)

☐ Yes ☐ No

If yes, specify change:

What do you think has caused the change(s)?

**3.97 Has there been any change in intensity of the climate?**

☐ Yes ☐ No

If yes, specify change:

**3.98 Have you noticed any change in the bird species in the region?** (e.g. migratory birds, crow, wild pigeon, partridge) If y explain.

☐ Yes ☐ No

**3.99 Have you noticed any change in common mammals / reptiles / amphibian species in the region**? (fox, lizards etc).

☐ Yes ☐ No **If yes, state:**

| Current status (seen less, not seen at all, seen only in winters etc. – specify name of species): | Reason for observed change in status |
|---|---|
| Migratory pattern/corridors of species (specify name species):<br>From:<br>To: | Reason for observed change in migratory pattern |

Future predictions (change in number/location of species):

**3.100 How has the change in climate affected business?**

**3.101 How has the change in climate affected livestock?**

**3.102 How do you think the change in climate has affected or will affect:**

Migratory pattern of local human population
Gender roles: Women, men, children, elderly
Changes in livelihood patterns
Social impact (education, health, hygiene etc)

**3.103 Are women still practicing traditional handiwork/needle work, or has this tradition stopped, or is decreasing due to less availability of time, discuss why. Are women more involved in fetching water, coping with other climate induced changes?? Discuss clearly**

**3.104 What do you think is being done, can be done or needs to be done to deal with the changing natural conditions?**

(e.g. afforestation, plantation, education, local action body, awareness, migration, storage, diversification, communal pooling, trade, seed variety/price, human/animals medicine, less polluting machines) State current efforts (communal transformation/external support)

**3.105 What steps have you taken to adapt to changing natural conditions?**

Agriculture

Social infrastructure

# Flood Prone Areas- District Rajanpur

| **7. General Information** | | | |
|---|---|---|---|
| **1.13. Date of interview** (day / month / year) | | | **1.14. Time of interview** |
| **1.15. Name of village** | | | **1.16. Name of data collector** (first name / last name) |
| **1.17. Name of respondent** (first name / last name) | Gender | Age | **1.18. Key position(s) held by respondent** (if any) (e.g. village head / *numberda* / *tehsildaar* / *subedar* / district member) |
| | | | |

| **8. Household Information** | |
|---|---|
| **2.9 Number of members in the household** (specify gender) | **2.10 Family system**<br>☐ Joint ☐ Single |
| **2.11 Legal ownership of assets**<br>☐ House ☐ Agricultural land (kanal)<br>☐ Livestock ☐ Shop<br>☐ Other (specify)<br>Specify land use (e.g. agriculture, pastoral) | **2.12 Occupation / means of livelihood**<br>State all sources of income for household (e.g. farmer, artisan)<br>At present:<br>Ten years ago (if different from above, state reason):<br>Twenty Years ago<br>Thirty years ago |

| **9. Information on Climate Change and its Impact- Biological/Agriculture** | | |
|---|---|---|
| **3.106 If occupation is agriculture / farming, which crops are grown?** (specify any change in diversity) | Commercial use | Domestic use |
| At present (e.g. wheat, barley, chillies, fodder) | | |
| Ten years ago (if different from above, state reason) | | |

| |
|---|
| Twenty Years ago |
| Thirty Years ago |

**3.107 Any land use changes observed, has land become unusable, if yes, why, discuss changes.**

***3.108*** **Any changes in agriculture season observed? Did you need to change the type of crop grown, if yes why, discuss.**

| **Main crop 1 (name?)** | | **Main crop 2 (name?)** | |
|---|---|---|---|
| At present | | At present | |
| Ten years ago | | Ten years ago | |
| Twenty yrs ago | | Twenty yrs ago | |
| Thirty yrs ago | | Thirty yrs ago | |

**3.109 Changes in sowing time to become early or late. Discuss clearly what the community/person has observed.**

| **Crop 1** | | **Crop 2** | |
|---|---|---|---|

| | | | |
|---|---|---|---|
| At present | | At present | |
| Ten years ago | | Ten years ago | |
| Twenty yrs ago | | Twenty yrs ago | |
| Thirty yrs ago | | Thirty yrs ago | |

**3.110 Coping mechanism practiced by communities to deal with floods**

| **3.111 Changes in time of appearance of pests** | | **3.112 Changes in appearance time of butterflies** | |
|---|---|---|---|
| At present | | At present | |
| Ten years ago | | Ten years ago | |
| Twenty yrs ago | | Twenty yrs ago | |
| Thirty yrs ago | | Thirty yrs ago | |

| | |
|---|---|
| **3.113** | **Change in status or distribution of any plant species (like local bushes, trees, shrubs are they decreasing or increasing in the area)** |
| | If yes, state which species, and explain<br>☐ Yes ☐ No |

**3.114 Crop 1-Annual yield** (maunds/kg)

At present:

Ten years ago (if different from above, state reason):

Twenty yrs ago

Thirty yrs ago

**3.115 Crop 2-Annual yield** (maunds/kg)

At present:

Ten years ago

Twenty yrs ago

Thirty yrs ago

**3.116 diseases / pests or any other reason for decline in Yield from crops**

At present:

Ten years ago

Twenty yrs ago

Thirty yrs ago

**3.117**

**3.118 Livestock / poultry owned by household**

| Type (e.g. cow,goat,shee buffalo) | Number | | | |
|---|---|---|---|---|
| | Now | 10 yrs ago | 20 yrs ago | 30 yrs ago |
| | | | | |

**3.119 Has there been any change in the quantity and quality of milk / meat obtained from livestock?** If yes, state reason.

**3.120 Income from Livestock**

At present:

Ten years ago

Twenty yrs ago

Thirty yrs ago

**3.121 Has there been any change in the quality and quantity of resources** (grass) **at grazing sites?**

If yes, state reason.

☐ Yes ☐ No

**3.122 Has there been any change in the grazing area? Area reduced?**

If yes, state reason.

☐ Yes ☐ No

Extent of grazing grounds:

At present:

Ten years ago

Twenty yrs ago

Thirty yrs ago

**3.123 Has there been any change in the location and duration of stay at grazing sites during the past thirty years?**

☐ Yes ☐ No

| **If yes, state:** | Duration of stay | Travel time |
|---|---|---|
| At present | | |
| Ten years ago | | |
| Twenty yrs ago | | |
| Thirty yrs ago | | |

**3.124 When do trees/plants blossom/flower? Have any perceptible changes been noticed by elders**

Last year:

10 years ago:

20 yrs ago

30 yrs ago

**3.125 How are forest resources used?**(e fuelwood,construction)

At present:

Ten years ago:

20 yrs ago

30 yrs ago

**3.126 Has there been any change in forest cover?** If yes, state how and provide reason for change.

☐ Yes ☐ No

**3.127 Any discussion in relation to the cause for change? What is the reason for this change in grazing area in the opinion of the communities?**

**3.128 Energy usage for:**

| | Fuel used (firewood, gas, kerosene) | Now | 10 yrs ago | 20 yrs ago |
|---|---|---|---|---|
| Cooking | | | | |
| Heating | | | | |
| Lighting | | | | |

**3.129 Are the Summers getting warmer? If yes explain how** (previous cooling practices not enough, any new practices)

☐ Yes ☐ No

**3.130 Are the Summers getting cooler? If yes explain how** (previous cooling practices re more than sufficient)

**3.131** ☐ Yes ☐ No

**3.132 Are the winters getting warmer? If yes, explain how.** (e.g. lessened use of sweaters/blankets use, fuelwood use ecreased, construction style changes)

☐ Yes ☐ No

**3.133 Are the winters getting cooler? If yes, explain how.** (e.g. use of sweaters/blankets use, fuelwood use, construction style changes)

☐ Yes ☐ No

**3.134 Has there been any change in the incidence floods?**

☐ Yes ☐ No

If yes, specify change / type of event that occurred are they much sooner now:

When was the last flood (ask community elder)

When was the flood before that (20 years ago or ten years ago or sooner???) please explain, discuss clearly with community to get a clear answer.

**3.135 Is there a change in the frequency of floods**

Floods in the past 5 yrs (03-08)

Floods (03-1990)

Floods in (1990-1980)

Floods in the 1970's

| **3.136 Fuelwood consumption** | **3.137 Rainfall pattern** |
|---|---|
| last year: | last year: |
| Ten years ago: | Ten years ago: |
| Twenty yrs ago | Twenty yrs ago |
| Thirty yrs ago | Thirty yrs ago |

**3.138 In the community's perception, is there any link between increased floods and agricultural land quality?**

**3.139 In the community's perception, is there any link between increased incidence of floods and agricultural yield?**

**3.140 Has there been any change in water table (ground water)? If yes, how much?**

| **3.141 Ground water table** | Present | Ten Years ago | 20 yrs ago | 30 yrs ago |
|---|---|---|---|---|
| | | | | |

| **3.142 Source of water for:** | Present | Ten yrs ago | Twenty yrs ago | Thirty yrs ago |
|---|---|---|---|---|

| | | | | |
|---|---|---|---|---|
| Agriculture | | | | |
| Domestic | | | | |
| Livestock | | | | |
| Other | | | | |

**3.143 Have there been any changes in the availability of water for domestic use? If yes how?**

**3.144 What adjustments have you made to adapt to the changes brought about by floods over the past 30 yrs?**

Agriculture:

House use:

Other (specify):

**3.145 Can you relate any traditional practice that were handed down to you from your forefathers to deal with the turmoil caused by floods?**

**3.146 Have there been any changes in the quality of water over the past 30 yrs? If yes what?**

**3.147 What have you done to cope with this change? New mechanisms or old**

**3.148 Distance travelled by community to reach drinking water source?**

| Present | 10 yrs ago | 20 yrs ago | 30 yrs ago |
|---|---|---|---|
| | | | |

**3.149 Has any increase in diseases(human) been noticed in recent years? Who is the most vulnerable,** If yes, state and emphasize reason in their opinion.

☐ Yes ☐ No

| Time | Summer (e.g. diarrhoea) | Winter (e.g. pneumonia, TB, cough) |
|---|---|---|
| At present | | |
| Ten years ago | | |
| Twenty yrs ago | | |

**3.150 Have you noticed any usual pattern in the climate?** (e.g. unusual rainfall, change in wind pattern)

☐ Yes ☐ No

If yes, specify change:

**3.151 Has there been any change in intensity of the climate?**

☐ Yes ☐ No

If yes, specify change:

| What do you think has caused the change(s)? | |
|---|---|

**3.152 Have you noticed any change in the bird species in the region?** (e.g. migratory birds, crow, wild pigeon, partridge) If y explain.

☐ Yes ☐ No

**3.153 Have you noticed any change in common mammals / reptiles / amphibian species in the region**? (fox, lizards etc).

☐ Yes ☐ No **If yes, state:**

| Current status (seen less, not seen at all, seen only in winters etc. – specify name of species): | Reason for observed change in status |
|---|---|
| Migratory pattern/corridors of species (specify name species):<br>From:<br>To: | Reason for observed change in migratory pattern |

Future predictions (change in number/location of species):

**3.154 How has the change in climate affected business?**

**3.155 How has the increase in the incidence of floods affected livestock?**

**3.156 How do you think the increase in incidence of floods has affected or will affect:**

Migratory pattern of local human population
Gender roles: Women, men, children, elderly
Changes in livelihood patterns
Social impact (education, health, hygiene etc)

**3.157 Are women still practicing traditional handiwork/needle work, or has this tradition stopped, or is decreasing due to less availability of time, discuss why. Are women more involved in fetching water, coping with other flood induced changes?? Discuss clearly**

**3.158 What do you think is being done, can be done or needs to be done to deal with the changing natural conditions?**

(e.g. afforestation, plantation, education, local action body, awareness, migration, storage, diversification, communal pooling, trade, seed variety/price, human/animals medicine, less polluting machines) State current efforts (communal transformation/external support)

**3.159 What steps have you taken to adapt to changing natural conditions?**

Agriculture

Social infrastructure

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