Drought Risk Assessment in the Province of Balochistan, Pakistan

Balochistan University of Information Technology, Engineering & Management Sciences (BUITEMS)
United Nations Development Programme (UNDP)

Table of contents

List of Tables

List of Figures

Executive summary

- Recurring drought is one of the major challenges faced by Balochistan province of Pakistan. Assessment of this natural calamity is crucial so that necessary precautionary measures may be taken to avoid colossal losses. This study aims to understand the current drought phenomenon in Balochistan and its impacts on agriculture, livelihood and water resources and to identify existing coping mechanisms adopted by rural households in the drought-affected areas.

- Many areas of the province are experiencing drought because since 2013 the rainfall has been hardly one fourth of the usual rainfall (usual rainfall is 200-250 mm). PDMA and UNDP identified the following districts affected by drought: 1) Dera Bugti, 2) Kohlu, 3) Loralai, 4) Zhob, 5) Qilla Saifullah, 6) Pishin, 7) Qilla Abdullah, 8) Noshki, 9) Kharan, 10) Awaran, 11) Mastung, 12) Kalat, 13) Khuzdar and 14) Lasbela.

- Among the affected districts, six districts including Pishin, Killa Saifullah, Loralai, Mastung, Noshki, and Lasbela were selected for this study. Primary and secondary data were collected and used for assessing the drought's impact. Participatory Rapid Appraisal (PRA) and Rapid Rural Appraisal (RRA) techniques were followed to collect the primary data. In total 385 households, 30 key informants, and 33 stakeholders were interviewed using semi-structured questionnaires.

- The available evidence shows that four types of drought, namely meteorological, agricultural, hydrological and socio-economic, exist in Balochistan with different intensities.

- A Standardized Precipitation Index (SPI) showed that out of the previous fifty years, twenty years experienced mild drought, seventeen near normal, three moderate and two years were extremely wet. SPI indicates that during the year 2014, moderate drought prevailed.

- Agricultural drought is defined by a reduction in crop area, a loss in crop yields, or both, as a result of deficient moisture contents during the crop-growing season.

- A Standardized Water level Index (SWI) was used to measure the intensity of hydrological drought. The SWI revealed the alarming situation of groundwater deficit in upland Balochistan due to several causes: mass installation of tubewells, inefficient irrigation systems, inappropriate cropping patterns and deficient precipitation. District Pishin and Loralai are experiencing extreme and Killa Saifullah severe hydrological drought conditions.

- The socio-economic impact of drought on incomes, nutrition and livelihood sources have been enormous.

- According to the survey results, about 60-70% of the population is projected to be at direct and indirect risk to drought in Balochistan.

- Some 50-60% of the population is affected by a moderate drought and is at risk in Pishin, Killa Abdullah, Mastung, Kalat, and Loralai districts. Loralai district is the worst-affected and the socio-economic impact of drought is evident in the form of livelihood loss, unemployment and forced migration.

- The degree of drought that affects the population of Killa Saifullah, Zhob, Sherani, Kohlu, Lasbela, Gawader and Kech districts was estimated to be 30-55%. Meanwhile, in Noshki, Chagai, Kharan, Quetta, Ziarat, Sibi, Nasirabad, Jaffarabad, Bolan, Dera Bugti, Musa Khal, Barkhan and Jhal Magsi districts 40-65% of the population are at risk due to different types and degrees of drought.

- The steepest average water table decline was reported by 2 to 5 meters in Killa Saifullah followed by Pishin, Mastung, Noshki, Lasbela and Loralai districts. The reasons for such an accelerated rate of decline were the meteorological drought prevailing over the last few years and massive pumping of groundwater.

- The increased competition for groundwater has resulted in a massive overdraft and drawdown of watertables, tubewells, *karezes* and springs, and failure is common in many areas of the province.

- The scarcity of irrigation water severely affected the most important fruit crop, apple, which is the main source of income in upland Balochistan. Due to drought, the reduction of apple production areas ranges from 20-40% in the different case study districts. Similarly, those of apricot, peach and plum are reported to have reduced by 2-38%.

- The highest reduction on fruit yields (15-25%) was reported in Killa Saifullah, Pishin and Mastung districts. Grape yields were affected the most in Mastung and Pishin districts. In Loralai district where the agriculture sector received a serious setback due to the previous drought, the yield of almond was reported to have reduced by 17%. In Lasbela district the yields of chikoo and banana were also reduced by 6% and 7% respectively.

- Among other cereal crops, irrigated wheat areas have been severely affected in Pishin, followed by Killa Saifulla, Mastung, and Noshki. Wheat, barley, maize, pulses and sorghum are the primary crops. Yield losses of almost 50-80% were reported during 2011-2015.

- Only occasionally could the rainfed/*khushkab/sailaba* cropping be practiced due to erratic and scanty rainfall during the winter and monsoon rainy seasons. The farmers of Pishin, Loralai, Mastung and Noshki districts reported that dryland cropping was hardly possible for many years due to untimely and insufficient rainfall.

- Average losses in livestock numbers due to the drought and subsequent effects were estimated at 37%. The district wise comparison reveals that Lasbella district was highest in terms of livestock losses, followed by Killa Saifullah, Noshki, Loralai, and Mastung. The losses in value of small animals (5-30%) were highest in Killa Saifullah district, whereas, those of large animals were greater in Nushki district.

- The greatest drought impact is observed among landless laborers and small marginal farmers. Due to production losses in agriculture and livestock, the incomes of farmers have also reduced. Therefore, vulnerable farmers were compelled to sell their valuable assets to meet the resource deficit.

- The recent drought has further worsened the already severe nutritional deficiency in Balochistan. Meat consumption has declined due to reduced purchasing power. Many people reported that they could barely afford meat once a week. The intake of fruits and nutritious food was minimal.

- The drought has differentially affected women and children the most. UNICEF reported that approximately 35% of child deaths are related to malnourishment and about 60% are related to poor water and sanitation conditions in Pakistan.

- In some areas, poor physical conditions also hinder children from going to school. Children work for their family, taking responsibility of livestock feeding, watering and grazing tasks.

- Reduction in cropping areas is the major coping strategy reluctantly adopted by farmers due to the water shortage. Changes in cropping patterns (change from high to low delta crops) and uprooting trees were strategies adopted by farmers especially in Pishin, Loralai and Mastung districts to combat drought risk.

- The lack of political will and financial support are significant constraints to dealing with the drought's impacts.

- The governmental agencies of Balochistan respond to drought in a reactive mode because of lack of an effective early warning system. The major institutions of the Government of Balochistan such as the Provincial Disaster Management Authority (PDMA), Department of Irrigation & Power and the Department of Agriculture, lack a well-coordinated drought policy. Monitoring and early warning systems, impact assessment procedures, risk management and drought preparedness, and a concrete emergency response plan do not exist in Balochistan.

- The formation of provincial committees is suggested in this study; this is expected to enable relevant stakeholders to effectively decide upon and implement necessary actions and initiatives. In order to deal with the increase in drought occurrence and its impacts, the Government of Balochistan should start working on the formulation and adoption of a provincial drought policy that provides a framework for proactive, risk-based management for dealing with drought events.

- Different regions of Balochistan are vulnerable to drought impacts during different seasons; as such, effective and reliable early warning seasonal forecasts are required to provide reliable risk-assessments.

- Steps must be taken to simplify access to climatic data, and to develop and maintain a database of natural resources. This would encourage the development of useful drought indices to better represent drought severity across the province.

- The Government of Balochistan needs to take steps for the enhancement of data communication by improving access to automatic data collection mechanisms and telecommunications.

- It is proposed that the Government of Balochistan takes steps for the diversification of income sources and livelihood systems that reduce vulnerability and hence risks, especially for the poor, and building capacity of smallholder farmers.

- It is proposed that the Government of Balochistan should run education and public awareness campaigns on water usage and planning. It would create public awareness about drought risk in Balochistan and help to educate people about efficient use of water for effective drought planning and preparedness, particularly the younger generations.

- Sustainable management of water resources is an important area of protection against drought impacts in Balochistan. The following five pillars of a plan for groundwater management in Balochistan are suggested: 1) Legal: Improved governance and effectiveness of institutions requires an increased focus on strengthening and enforcing groundwater laws; 2) Economic: Demand-side groundwater management should include a rationale for a pricing system for efficient water use and replacement of high delta crops with low delta crops, and groundwater markets with suitable institutional mechanisms to augment water supply; 3) Technological: Supply-side groundwater management options should include rainwater harvesting and surface-water use for increasing recharge, promoting conjunctive water use where possible, and the adoption of modern water-saving irrigation technologies and practice; 4) Social: Adoption by the community includes providing a sense of ownership to the regional groundwater resources and developing basin-wide groundwater users' associations; and 5) Institutional: Development of sustainable groundwater plans requiring the cooperation and coordination among different government agencies and key stakeholders.

- Immediate safety net measures are suggested such as supplying food aid and other non-food items to affected communities, providing supplementary livestock feeding (fodder, forage, hay distribution, water hauling, opening of strategic grazing areas, etc), and promoting emergency vaccination and de-worming.

- Short-term measures are suggested including the development of water use guidelines that consider the types and duration of drought; communication tools for climate-related information with specific advisories; local drought monitoring capacity and infrastructure; and support to most vulnerable groups such as women and children.

- The mid-term measures suggested include expanding efforts to promote rainwater harvesting and adopting alternative cultivars or crops that are more drought-resistant and/or heat-tolerant.

- And finally the long-term measures focus on improving groundwater management and governance; investigating business and farm diversification strategies (e.g. selecting drought-tolerant varieties, addressing deforestation and desertification that cause land degradation in drylands); and reinforcing legal, policy and institutional frameworks for drought risk mitigation and dryland development.

Chapter 1: Introduction

Drought is a recurring phenomenon affecting natural habitats, ecosystems, and many economic and social sectors that include agriculture, urban water supply and modern complex industries (Heim & Richard, 2002). The wide variety of sectors affected by drought, its diverse geographical and temporal distribution, and the demand placed on water supply in human-use systems makes it difficult to easily characterize drought (Heim & Richard, 2002). Drought often manifests itself as a creeping disaster, as the effects of drought often accumulate slowly over a prolonged period of time and may linger for years after the main event ceases.

Drought is a multivariate phenomenon characterized by its frequency and severity. The frequency and severity of drought have increased in Asian countries in recent years (Ganguli & Reddy, 2013). According to the Intergovernmental Panel on Climate Change (IPCC), the production of rice, maize and wheat has declined in many parts of Asia over the past decades due to the increasing water stress attributed to a combination of increasing temperatures, more frequent El Nino events and a reduction in rainfall (IPCC, 2013). Drought however does not always result in devastation unless it coincides with the crop-growing season, pointing to the need for drought characterization in relation to seasonal crop production (Ahmed et al., 2015).

There is growing concern about the increasing frequency and severity of drought in Pakistan (Ahmed et al., 2015). A significant increase in the frequency of heat waves, an indicator of forthcoming amplification and increasing severity of drought, has been reported (Zahid and Rasul, 2012). The province of Balochistan in southwestern Pakistan consists of a basic economy that relies on climate-sensitive sectors such as rain-fed and irrigated agriculture, livestock, and high dependence on and unsustainable exploitation of natural resources such as groundwater. Recently in 2013, very little rainfall ranging from 25 to 200 mm, associated with meteorological drought conditions prevailing in the province (NDMC, 2013), resulted in diminished availability of water resources and reduced response capacity of the ecosystem. Poor producers and consumers in developing countries such as Pakistan are severely affected by drought and extreme weather events (Pereira et al., 2002).

Due to its occasional and scanty rainfall (average around 200 mm), Balochistan is classified as an arid zone. The rural dwellers there mainly rely on agriculture and livestock for livelihoods. Their miseries increase when the occurrence of rain falls short of the average rainfall over an extended period of time and/or do not occur at the time when it is necessary for agriculture – such a situation is termed as drought in the literature. According to Pereira et al. (2002), "drought is defined as a natural but temporary, imbalance of water availability, consisting of a persistent lower than average precipitation" – an event of uncertain frequency, duration and severity, resulting in diminished water resources availability, and reduced carrying capacity of the ecosystem.

The drought situation in Balochistan is rapidly developing into one of the worst disasters in Pakistan. Upland Balochistan is the most heavily affected area of the province. Although the affected areas of Balochistan have always been prone to water shortages, rainfall measured over the last few years has reached a record low, with minimal or sometimes no rainfall. The abrupt decline in rainfall in most of the upland areas of the province has caused a complete drying up of the surface drinking water resources, and has decreased water output from springs and tubewells. This has caused the water table to drop in most of the valleys and low-lying areas. Drought-affected districts that are particularly identified include Dera Bugti, Kohlu, Loralai, Zhob, Qilla Saifullah, Pishin, Qilla Abdullah, Noshki, Kharan, Awaran, Mastung, Kalat, Khuzdar and Lasbela (UNDP, 2015); and Chagai, Lasbela, Kharan, Khuzdar, Kalat, Killa Saifullah, Loralai and Pishin (PDMA, 2012).

Recurring drought is thus one of the major challenges faced by Balochistan. Therefore drought assessment is crucial so that necessary precautionary measures can be taken to avoid the colossal losses that are being experienced. This research study is an effort to understand and estimate the nature and magnitude of the current drought situation in selected districts of Balochistan and suggest appropriate measures to combat this calamity. The specific objectives of this assessment are as follows:

1. To understand the drought phenomenon in Balochistan and its impact in the selected districts, focusing on agriculture, livelihoods and management of water resources, and to thereby identify existing coping mechanisms (formal and informal) at the field level.
2. To develop medium to long-term sustainable strategies and provide recommendations for adaptive governance on Disaster Risk Reduction (DRR) and Management (DRM).

Chapter 2: Overview of the study area

2.1 General overview of Balochistan

Balochistan is a southwestern province of Pakistan located between latitudes 25^0 and 32^0 N, and longitudes 61^0 and 71^0 E. The geographical area of Balochistan is around 347,190 square kilometres. The province consists of a plateau mostly comprised of hilly terrain. Balochistan has an annual rainfall of less than 250 mm on average and is thus a dry/arid region. Hence reliance on rainfall by Balochistan farmers for growing crops is low, which intensifies their search for a more reliable water source to secure irrigation to ensure high crop yields.

Balochistan is characterised by a diversified climate which ranges from semi- to hyper-arid. Temperature regimes vary widely within the province, from cool temperate to tropical, with cold winters and mild summers in the northern uplands. Owing to the wide agro-ecological diversity, the province has been divided into four agro-climatic zones, namely, uplands, coastal, plains and desert (PARC, 1980), and hence the province has the potential to cultivate a wide range of field crops, vegetables and horticulture. Agriculture is the dominant employment sector in the provincial economy; it contributes to 52% of the provincial GDP and employs approximately 67% of the labour force. Other sectors that contribute to the provincial GDP are services, construction and transport (33%), industry (10%) and minerals (5%) (Government of Balochistan, 2010).

The high altitude and arid environments of upland Balochistan provide ideal conditions for the production of good quality deciduous fruits (apples, plums, pears, apricots, peaches and pomegranates), which is significant at the national level. However, the cultivable area of the province was estimated in 2001-02 to be only around 6% of its geographical area, approximately 2.1 million hectares (Government of Balochistan, 1947-2010). Since the introduction of the tubewell, a revolution of a kind, the inclination has shifted from low value crops to high value horticultural commodities, due to the abundant, cheap and reliable water supply from tubewells.

The irrigated agriculture in the province is dependent both on surface and groundwater resources where about 47% of the cultivated area is irrigated, while the remaining 53% is under *sailaba*[1] and *khushkaba*[2] farming (Government of Balochistan, 2009-10). The main sources of surface irrigation are the IBIS's Khirther, Pat Feeder and Lasbela canals. Another important source of surface water is the floodwater that flows through streams. Around 30% of floodwater has been harvested for agriculture through *sailaba* diversions, storage dams and minor perennial irrigation schemes. Groundwater is available for irrigated agriculture through *karezes*, springs and tubewells.

The following section presents the overview of the study area, which includes six districts of Balochistan as shown in Figure 2.1. These districts are Pishin, Killa Saifullah, Loralai, Mastung, Noshki, and Lasbela.

---

[1] A cropping system irrigated by flows based on stream flow of flood water (generated from hill torrents).

[2] A cropping system irrigated by flows generated by incidental rainfalls or localized runoffs (generated from adjacent slopes or fields).

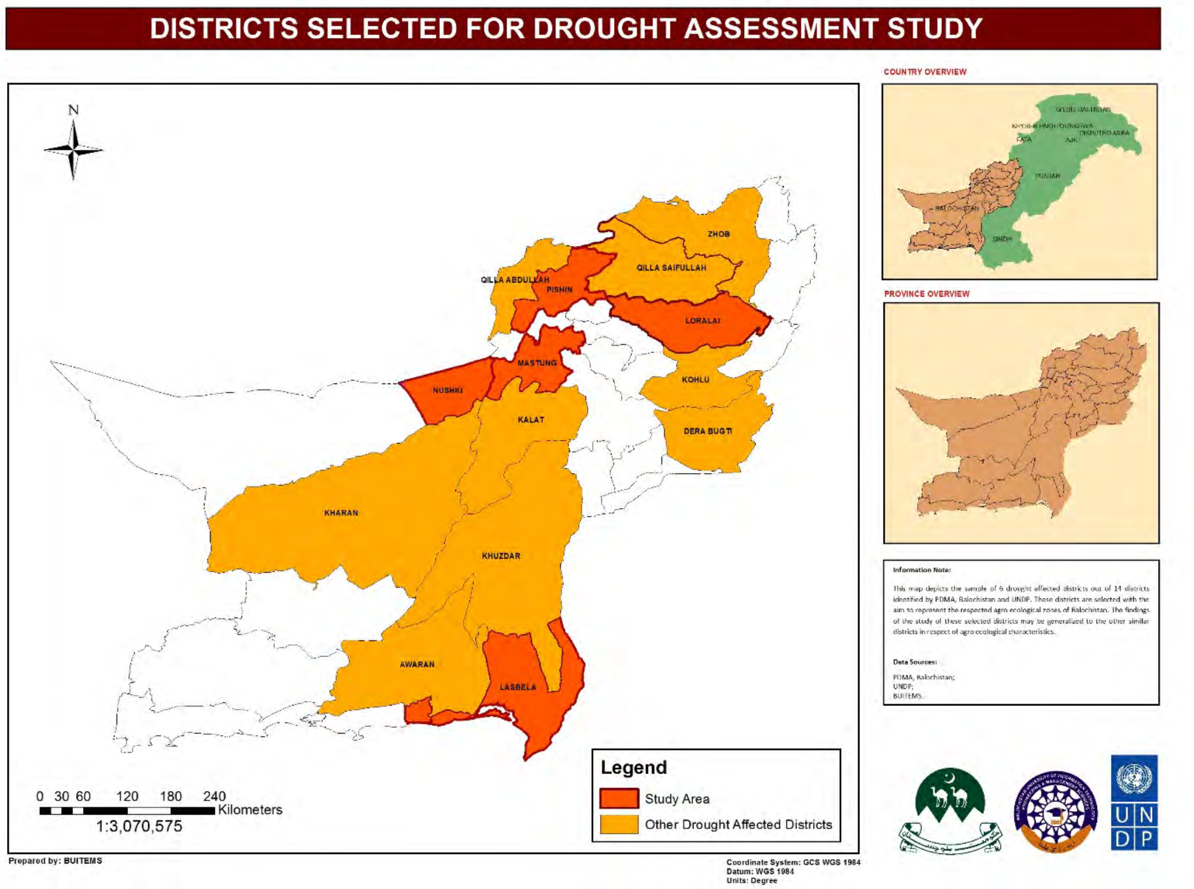

Figure 2.1: The study area

2.2 General overview of the case study districts

2.2.1 District Pishin[3]

The total geographical area of Pishin district is 5,000 square kilometers and it is situated between 66°46'01" to 67°49'19" degrees East Longitude and 30°44'02" to 31°14'02" degrees North Latitude. The climate of the district is pleasant in summer and very cold in winter.

District Pishin is administratively divided into four tehsils (tehsil is an administrative unit similar to a county) and 38 union councils. The district headquarter is “Pishin” town. It shares its boundaries with Quetta (the provincial capital) in the south, Killa Abdullah in the west, Killa Saifullah in the east and Afghanistan in the northeast. The district is inhabited by different tribal groups, mostly of Pashtun ethnicity. The major tribes in Pishin are Kakar, Tareen, Achakzai and Syed. Pashto is the dominant language in the district.

According to the 1998 census, the total population of the district is 367,183 with 196,330 males and 170,853 females. The annual growth rate is estimated at 3.40%. There are 54,048 housing units in the

[3] The contents of district profiles are taken from Government of Balochistan (2011) and IUCN (2011).

district of which some 6.8 persons live in a household on the average. Livelihoods of the people in Pishin are highly dependent on agriculture, livestock and government services. The main crops are wheat, barley, cumin, fodder, and vegetables in *Rabi* (around November - March) season and onion, potato, melons, vegetables, fodders, and tobacco. Fruits include almond, apple, apricot, grapes, peach, plum, pomegranate, cherry and pistachio. Livestock is also a major source of livelihood of the people in Pishin.

The health condition in the district is very poor. There is one doctor for every 8,740 persons. The most common diseases are respiratory infections, gastro and diarrhea. Other diseases are malaria, meningitis, fever and scabies.

Only 8% of children who are less than five years old are affected by malnutrition which indicates a reasonably good nutritional status. Only 5% of the families there use suitable iodized salt. The overall net primary school attendance ratio is 53% for boys and 47% for girls, but the secondary school attendance ratio of is only 19%. The literacy rate is 74% for males and 30% for females (IUCN, 2011).

2.2.2 District Killa Saifullah

The total geographical area of Saifullah district is 6,831 square kilometers and it is located between 67°17'37"- 69°22'54" East Longitude and 30°30'35"- 31°37'10" North Latitude and is administratively divided into 3 tehsils and 15 union councils. The district is located in northeastern Balochistan. The total mean rainfall is 279.1 mm in Killa Saifullah. Most of the precipitation occurs in the winter season as snowfall. Monsoon rainfall also occurs occasionally.

Pushtuns are the predominant group of inhabitants in the district and a smaller number of people belonging to other ethnic groups are also there.

According to the 1998 census, the total population of Killa Saifullah was 193,553 with 105,174 males and 88,379 females. The annual growth rate of the population is 1.58%. On average there are 7 persons in a household (Government of Balochistan, 2011).

The livelihood of the people of Killa Saifullah is highly dependent on agriculture and livestock. The main crops are wheat, barley, cumin, sunflower, fodder and vegetables in the *Rabi* season and also maize, mung bean, mash bean, onion, potato, melon, chili, vegetables, fodder, tobacco and cotton are cultivated. Fruits include almond, apple, apricot, grapes, peach, pear, pomegranate and cherry. A large proportion of the population is dependent on the livestock sector. Moreover, a significant part of the labor force is involved in agriculture.

87 infants in every 1,000 that are born die within a year. The most common diseases are respiratory infections, gastro and diarrhea. Other diseases are malaria, meningitis, fever and scabies. 23% of under-five children are affected by malnutrition. Only 38% of the children are breastfed whereas complete breastfeeding is reported merely in 27%. Polio vaccination roughly reaches to around half of the children aging up to 5 years. Only 5% of the total families in the district are reported to be using suitable iodized salt (IUCN, 2011).

The primary school net enrollment rate is about 29%, consisting of 37% for boys and 21% for girls. The net attendance ratio for secondary schools is just 12%. 63% of the population of 10 years or older have never attended any school, while this ratio in rural females is overwhelmingly about 91%. Only 5% of the females achieve primary or higher schooling level education. Among urban males, 83% attended and 72% completed primary schooling. The literacy rate in Killa Saifullah is 57% while it is 12% among females, and 37% among males (IUCN, 2011).

2.2.3 District Loralai

The total geographical area of the Loralai district is 8,155 square kilometers and it is located between 67°41'18"- 69°44'22" East Longitudes and 29°54'50"- 30°41'28" North Latitudes, administratively divided into three tehsils and 20 union councils. The district headquarter is “Loralai” town. It is in the northeast of Balochistan and shares its boundaries with Musakhel, Barkhan, Kohlu, Sibi, Ziarat, Killa Saifullah and Zhob districts.

The district comprises of heterogeneous tribes, though mostly Pashtuns. The climate of the district is semi-arid; however, it varies with the altitude at different locations in the district. The mean precipitation is 279 mm.

According to the 1998 census, the total population of the district was 297,555 with 158,168 males and 139,387 females. The annual growth rate is 1.40%. The average number of persons in a household is 7.4. The livelihoods of the people in Loralai are highly dependent on agriculture and livestock. Government services are also an important source of livelihood. The main crops are wheat, barley, cumin, fodder, chickpea (gram), peas, lentils and vegetables in the *Rabi* season. Sorghum, millet, maize, mung bean, mash bean, onion, potato, melon, chili, vegetables, fodder, coriander, garlic and cotton are *Kharif* (around April – October) crops. Fruits include almond, apple, apricot, grapes, peach, plum, pomegranate and cherry.

The health condition in the district is very poor. There is one doctor for every 5,247 persons. 87 infants in every 1,000 live births die within a year. The most common diseases are respiratory infections, gastro, fever and malaria. Other diseases are malaria, meningitis and scabies. 49% of the children under-five are affected by malnutrition. 92% of the children are breastfed, and complete breastfeeding is reported at 85%. Only 5.1% families use suitable iodized salt.

The primary net enrolment rate is about 22-25% for boys and 18% for girls. The net attendance ratio in secondary schools is just 15%. 63% of the population 10 years or older have never attended any school. The literacy rate in Loralai is 60% for males and 16% for females (IUCN, 2011).

2.2.4 District Lasbella

The total geographical area of Lasbella district is 15,153 square kilometers and is located between 65°12'11"-67°25'39" East longitudes and 24°53'2"-26°39'20" North latitudes, administratively divided into 5 tehsils and 22 union councils. It shares it boundaries with Sindh province in the east, Awaran and Gwadar districts in the west, Khuzdar district in the north and Arabian Sea in the south.

The district headquarter is Uthal. The district is mountainous in the east and has sandy lowlands in the center watered by the Porali and Kud Rivers.

The climate in the coastal areas is normal and wet and generally has a fine weather. The average rainfall is 36.3 mm per month and mean rainfall in the year is 254 mm. The raining season is generally the months of July and August.

According to the 1998 census, the total population of the district is 312,695 with 167,470 males and 145,225 females. The annual growth rate was 3.03% in 1998. Total housing units were 49,171. Main fuel used for cooking is wood (82%), straw/grass (4%) and animal dung (2%). The average household size slightly decreased from 6.5 persons in the 1981 census to 6.2 persons in 1998 census.

Livelihoods of the people in Lasbella are highly dependent on agriculture and livestock. The main crops are wheat and barley in the *Rabi* season and sorghum, millet, maize, castor seed, mung bean, onion, melon, chili, coriander, sesame, guar seed, sugarcane and cotton in the *Kharif* season. The main fruits include banana, coconut, papaya and chickoo. Some 68% of the households own livestock and a large portion of the labor force are involved in the livestock sector.

The health condition in the district is very poor. There is one doctor for 4,474 persons. 88 infants in every 1,000 live births die within a year. The most common diseases are respiratory infections, gastro, and urinary tract infections. Other diseases are malaria, meningitis and scabies (IUCN, 2011).

Some 33% of the children under-five are affected by malnutrition. Only 28% of the children are breastfed. Polio vaccination roughly reaches half of the children of age up to five years. 28% families use suitable iodized salt (IUCN, 2011). Primary net attendance ratio of the children of school going age is about 65% for boys and 55% for girls. The net attendance ratio in secondary schools is just 31%. The literacy rate is only 40%, in males of age 10 or more and it is 53% for males and 26% for females (IUCN, 2011).

2.2.5 District Nushki

Total geographical area of the district is 5,797 square kilometers and is situated between 65°07'42"-66°18'45" East Longitudes and 29°01'51"-29°52'37" North Latitudes, administratively divided into one tehsil and 10 union councils.

The district headquarter is Nushki town. It is in the north of Balochistan and shares its boundaries with Quetta in the east, Chaghai in the west, Kharan and Kalat in the south and Afghanistan in the north. Eastern and southern parts of the district consist of hilly areas while the rest of the district area is plain land. The climate of District Nushki varies from extreme hot in summer to severe cold in winter. The rainfall is irregular and low.

According to the 1998 census, the total population of the district is 98,030 with 51,394 males and 46,636 females. The annual growth rate of the population in Nushki is 3.27%. There were 13,417 housing units in 1998 and on average 7.2 persons per household.

The livelihoods of people in Nushki are highly dependent on agriculture and livestock. The main crops are wheat and barley in the *Rabi* season and sorghum, maize, mung bean, mash bean, onion, potato, melons, chilies, vegetables and fodders in the *Kharif* season. The major fruits are grapes and pomegranate.

The health condition in the district is very poor. There is one doctor for 6,868 persons. 59 infants in every 1,000 live births die within a year. The most common diseases are respiratory infections, gastro and diarrhea. Other diseases are malaria, meningitis, scabies and fever.

About 80% of the children are breastfed. Some 19.3% families use suitable iodized salt. The primary net attendance ratio is about 38% for boys and 30% for girls. The net attendance ratio in secondary schools is just 21%. The literacy rate is 47-60% for males and 30% for females (IUCN, 2011).

2.2.6 District Mastung

The total geographical area of the district is 5,896 square kilometers and it lies between 66°11'34"-67°25'59" East Longitudes and 29°20'13"-30°15'8" North Latitudes, administratively divided into four tehsils and 13 union councils.

The climate is characterized by dry hot summers and mild to cool winters. Rainfall is scanty. During winter, snow falls in the valleys of Mastung and Dasht.

The total population of the district is 164,645 with 87,334 males and 77,311 females. The annual growth rate was 1.31%. There are 20,447 housing units in the district and 8 persons per household on average (IUCN, 2011).

The livelihoods of the people in Mastung are highly dependent on agriculture, livestock and government services. The main crops are wheat, barley, cumin, vegetables, fodder and sunflower in the *Rabi* season and mung bean, fruits, onion, potato, vegetables, melons, chilies, fodder, coriander and garlic in the *Kharif* season. Fruits include almond, apple, apricot, grapes, peach, plum, pear and pomegranate. A vast portion of the population is also dependent on the livestock sector.

The health condition in the district is very poor. There is one doctor for 6,637 persons. 88 infants in every 1,000 live births die within a year. The most common diseases are respiratory infections, gastro and diarrhea. Other diseases are malaria, meningitis, fever and scabies. 67% of the children under-five are affected by malnutrition while 97 % of the children are breastfed. Only 3.6% families use suitable iodized salt (IUCN, 2011).

The primary school net attendance ratio of the children of school-going age is about 35-42% for boys and 28% for girls. The net attendance ratio in secondary schools is just 20%. The literacy rate is 37%, in males of age 10 or more it is 56% while 21% for females (IUCN, 2011).

Chapter 3: Methodology

3.1 Assessment methods

The key principle in the assessment is to represent the four agro-climatic zones of Balochistan in the case study districts. According to the PARC (1980) classification, the province consists of four agro-climatic zones: uplands, coastal, plains and desert. Thus, the selected districts represent these four zones. The characteristics of these four zones are discussed below.

3.1.1 Uplands

Those areas that lie from 1500-2500 meters above sea level are uplands. These include Quetta, Pishin, Killa Abdulla, Killa Saifulla, Loralai, Muslim bagh, Zhob, Musa Khel, Kalat, Mastung, Toba Kakri, Toba Achakzai, Ziarat and Kan Mehtharzai, southern areas of Khuzdar, parts of Kharan, Wadh, Naal , Barkhan and Kholu.

The important *Rabi* crops of the uplands are wheat, barley, cumin, vegetables, fodder and sunflower. The major *Kharif* crops are mung bean, fruits, onion, potato, vegetables, melon, chili, fodder, coriander and garlic. Major fruits include apple, apricot, almond, grapes, peach, plum, pear and pomegranate.

3.1.2 Plains

The plain areas are very hot in summer with temperatures as high as 50°C. Winters are mild in the plains with the temperature never falling below the freezing point, with high summer temperatures and late summer monsoon rains. It includes the districts of Nasirabad, Jafarabad, Jalmagsi, Sibi, Bolan and Dera Bugti. The critical features of the climate are high temperatures and clear skies, which prevail for most of the year, and very low rainfall. Cultivation is possible when and where water is available. Rainfall during the summer season is associated with monsoons from the southeast, whilst winter precipitation is caused by western atmospheric currents, and occurs between November and February. Winter rainfall is relatively regular, widespread and uniform and contributes the most to groundwater recharge. Summer rainfall occurs generally from June to August, with showers of a short duration and high intensity; therefore it does not contribute much to groundwater recharge. Wheat, mustard, chickpeas, lentils, onion, tomato, rice, cotton, sorghum, fodder, squash, melon and vegetables are the most important crops.

3.1.3 Desert areas

Deserts here are around 700 meters above sea level and are part of a sub-tropical continental plateau with cold winters, very hot summers and very little precipitation. It includes the districts of Chagai, Kharan, and parts of district Panjgoor. The climate is dry and hot. Dust storms are experienced throughout the year. In summer, days are hot and nights are cool, while the winter is cold. The annual average rainfall in Kharan district is 100-150 mm, the average minimum temperature ranges from 2-4°C in January and the maximum temperature ranges from 40-45°C.

3.1.4 Coastal areas

These areas are characterized by moderate temperature and low rainfall. It includes the districts of Lasbella, Gawadar, Kech and part of Panjgoor. The important *Rabi* season crops are wheat and barley and *Kharif* season crops are sorghum, millet, maize, castor seed, mung bean, onion, melon, chili, coriander, sesame, guar seed, sugarcane and cotton. The main fruits include banana, coconut, papaya and chickoo.

3.2 Drought assessment survey

The following research design was used to conduct the household, key informant and stakeholder level surveys.

3.2.1 Selection of districts

The following procedures were used for the selection of case study districts:

- Desktop study on the representativeness of different agro-climatic zones of Balochistan.
- Consultation with PDMA (Provincial Disaster Management Authority) and UNDP (United Nations Development Programme).
- Severity of drought impacts and accessibility of the districts.
- According to PDMA & UNDP (2015), the following districts have been affected by a mild to moderate drought: 1) Dera Bugti, 2) Kohlu, 3) Loralai, 4) Zhob, 5) Qilla Saifullah, 6) Pishin, 7) Qilla Abdullah, 8) Noshki, 9) Kharan, 10) Awaran, 11) Mastung, 12) Kalat, 13) Khuzdar and 14) Lasbela. This list indicates that drought-affected districts exist in all the agro-climatic zones of Balochistan.

The selected districts were confirmed during the PASC (Provincial Assessment Steering Committee) meeting and were endorsed by PDMA.

3.2.2 Sampling method

A multi-stage sampling method was employed. In the first stage a sample of six districts (see Figure 3.1) including Pishin, Killa Saifullah, Loralai, Mastung, Nuashki and Lasbela out of 14 drought-affected districts – at least one from each agro-climatic zone – was selected.

In each district, drought-affected union councils were identified with the help of provincial authorities. For primary data collection, the survey teams received five days of intensive training led by senior and experienced staff from BUITEMS (Balochistan University of Information Technology, Engineering & Management Sciences), who had experience of conducting similar surveys in the province. For this purpose the samples were grouped into three strata: households, key informants and stakeholders.

At least 50 households from different UC and villages (see Appendix-A, Table 3.1) were selected. In addition, five distinct experts from key informants at the village level and a representative of each line department were interviewed in each district (see Table 3.1).

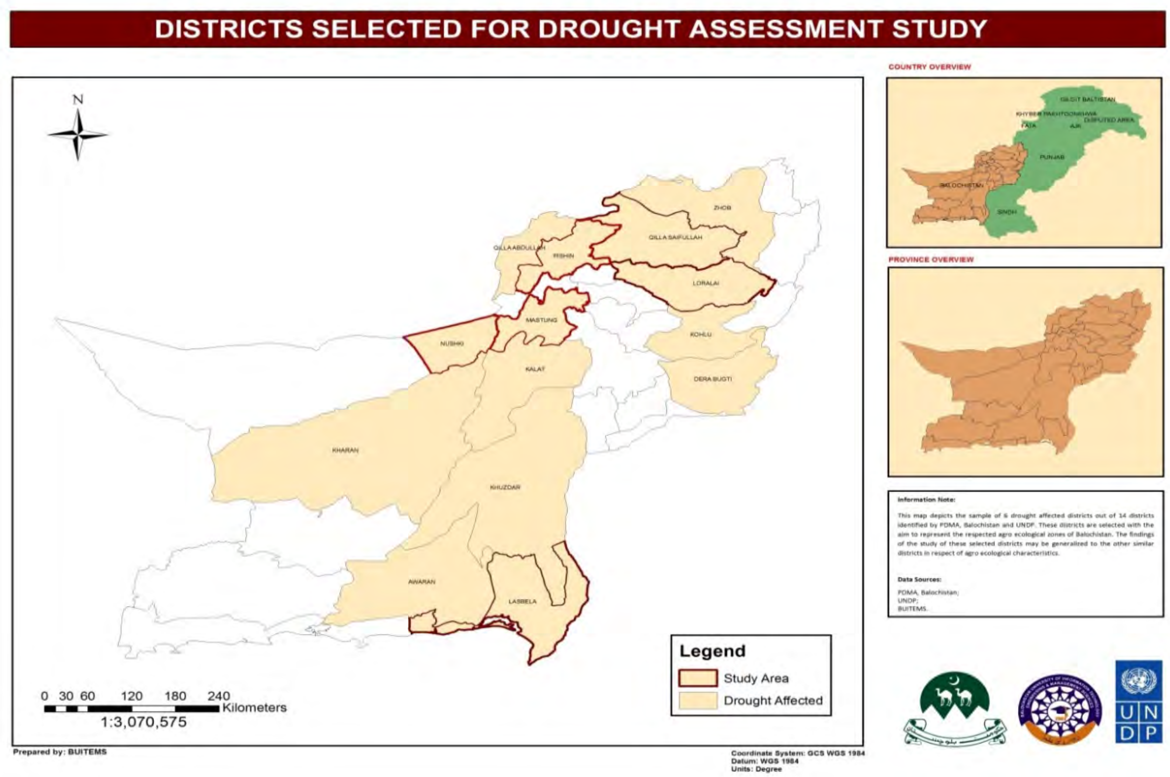

Figure 3.1: Case study districts of this study

3.2.3 Data collection

Participatory Rapid Appraisal (PRA) and Rapid Rural Appraisal (RRA) techniques were used to collect the primary data. Primary and secondary data sources were used to assess drought impacts in the study areas.

Primary data was obtained from interviews with local communities and related stakeholders, which is explained in more detail in this section.

Secondary data including various technical reports was reviewed to supplement the primary data. The reports were obtained from government offices as well as other international institutions and agencies. Some of the key documents are listed below:

- Website of Pakistan Bureau of Statistics (www.pbs.gov.pk).
- District Development Profiles (DDPs) of different districts (Government of Balochistan, 2011).
- Agriculture statistics of Balochistan (Government of Balochistan, 1947-2010).
- Integrated District Development Vision of Different Districts of Balochistan (IUCN, 2011).
- Multiple Indicator Cluster Survey, Balochistan (UNICEF, 2010).
- Website of PDMA Balochistan (www.pdma.gov.pk).

- Annual Report for Pakistan (UNICEF, 2011).
- Food Insecurity in Pakistan (SDPI et al., 2009).
- Website of the Integrated Food Security Phase Classification (IPC) Evidence and Standards for Better Food Security Decisions (http://www.ipcinfo.org/)
- National Nutrition Survey (Aga Khan University et al., 2011).

Table 3.1: District wise distribution of respondents (number)

Respondents	Pishin	Killa Saifullah	Loralai	Mastung	Noshki	Lasbela
Stakeholders	6	6	6	5	5	5
Key Informants	7	4	6	5	3	5
Households	50	58	57	50	50	57
Total	63	68	69	60	58	67

For household surveys, a semi-structured questionnaire was used (see Appendix D). The questionnaire was developed using key components from previous and recent studies carried out nationally and internationally and developed after consultations with UNDP-Pakistan. Before data collection, the questionnaires were pre-tested for validity and reliability. For the household surveys, teams of surveyors including two data enumerators and one supervisor were deployed in each district. The enumerators were briefed and trained prior to fieldwork and data collection.

The household survey consisted of 16 main questions, covering demographic and socio-economic information, social structure, land use and irrigation practice, crop patterns, livestock and respondents' experiences with drought. Semi-structured interviews were utilized as the main data collection tool, and in addition, transect walks were carried out in different villages of the study areas.

The transect walk technique provided a picture of the community's vulnerability and the resources available for drought risk assessment. This included observation of livelihoods and settlement patterns. Throughout this process, the existing community coping mechanism for drought risk management was observed; and this information was in turn verified by key community members.

To complement the information gathered from household surveys, the data collection process included interviews of staff of relevant authorities working on disaster management and other related institutions. Meanwhile, an interview checklist was designed for stakeholder surveys to collect the required information from key informant groups at each village level (see Appendix E).

Interviews of stakeholders were conducted using the pre-designed semi-structured interview questions (see Appendix F). Contacts with the relevant institutions were obtained through PDMA Balochistan during the first PASC meeting in May 2015. Based on these contacts, further contacts were gained through BUITEM's institutional network in the country.

At the province and district levels, interviews were conducted at the following institutions:

- Departments of Agriculture (extension, research and water management divisions), Livestock, Irrigation, Health, Social Welfare and Forest.
- At the district level, key administrative representatives (Additional Deputy Commissioner, Assistant Commissioner, Tehsildars, or Naib Tehsildars) were also interviewed. The meetings with district administration officials took place prior to data collection. During the meetings, the objective of the assessment was explained, emphasizing its focus of identifying future drought risk mitigation measures.

In addition, concerned officers of technical institutions were interviewed at the district-level in relation to the following sectors:

1. Agriculture;
2. Livestock;
3. Forestry;
4. Irrigation;
5. Social Welfare; and
6. Health.

3.2.4 Data analysis

The questionnaires were coded and numbered, and then the data was analyzed by computer software including Microsoft Excel and SPSS (Statistical Package for Social Sciences). The data was then scrutinized for missing values or outliers, and both the qualitative and quantitative data were analyzed by using descriptive statistics such as 'mean' and 'standard deviation'. Moreover, GIS (Geographical Information Systems) techniques were used for preparation of maps showing the drought intensity in each district.

3.2.5 Limitations of the study

The detail drought assessment was conducted in six selected districts. Although the aim of this assessment was to cover the whole province, due to the time and resources, the provincial drought mapping and assessment was done by extrapolating the data from the six districts.

The provincial analysis of drought is thus generalized, based on the similarity of the agro-climatic zones of all the districts in the province (for example, cropping patterns, altitude from sea level, etc). This is explained further in Section 4.2.7.

Although the purpose of the survey was explained in detail to respondents prior to the start of the interview, it was common to find exaggeration of drought-related losses and under-reporting of incomes; the interviewed participants may have perceived the survey team as a kind of drought compensation team. It was therefore necessary to verify such information with other respondents and district officials.

Chapter 4: Overview of drought in Balochistan

The drought situation in Balochistan is rapidly developing into one of the worst natural disasters in Pakistan. Upland Balochistan is the most heavily affected area of the province. Although the affected areas of Balochistan have always been prone to water shortages, rainfall in the last few years has reached a record low, with minimal or sometimes even no rainfall. The abrupt decline in rainfall in most of the upland areas of the province has caused a complete drying up of the surface drinking water resources, and has decreased water output from springs and tubewells.

Balochistan experienced a severe drought from 1997 to 2004, which affected its people in terms of loss of livelihood sources, that is, agriculture, livestock and related enterprises. This drought was termed as one of the worst in the history of Balochistan, judged from the fact that it was the major cause behind slowing the economic growth rate down to only 2.6% during that period. According to the figures released by the Ministry of Finance, the drought caused a loss of PKR 25 billion to the national exchequer in the year 2000-2002 (PDMA, 2015).

The drought affected many parts of Balochistan and caused a rise in food prices, resulting in widespread unavailability and unaffordability of food. Consequently, food consumption reduced, causing malnutrition and different diseases to the affected populations (PDMA, 2015). The agriculture and livestock sectors were also affected. Apple and other fruit orchards were devastated by almost 80%. The range lands providing food to large numbers of livestock dried and resulted in the mortality of thousands of animals of a monetary value of millions of rupees. Similarly, crops were also very adversely affected as thousands of acres of fruits trees dried and the irrigated and rain-fed agricultural areas turned into barren land. The losses to agriculture and livestock made thousands of people jobless, who were then compelled to migrate to urban areas in different parts of the country. Heavy cost was incurred by the government in providing relief supplies in the affected areas; 22 out of the 28 districts of the province sought water and food assistance.

According to Ahmad (2007), the obvious reason was scarcity of rainfall. However, there were other contributing factors including deforestation, depletion of grazing pastures and rangelands, environmental degradation and global warming.

Recurring drought is one of the major challenges faced by Balochistan. Many areas of the province are experiencing drought as rainfall since 2013 has hardly been a quarter of the usual amount. According to PDMA (2012) and UNDP (2015), the following districts have been affected by a mild to moderate drought: 1) Dera Bugti, 2) Kohlu, 3) Loralai, 4) Zhob, 5) Qilla Saifullah, 6) Pishin, 7) Qilla Abdullah, 8) Noshki, 9) Kharan, 10) Awaran, 11) Mastung, 12) Kalat, 13) Khuzdar and 14) Lasbela.

4.1 Historical drought events in Balochistan Province

Ahmed et al. (2015) conducted a study on the characterization of seasonal drought in Balochistan and found that early winter droughts were frequent in the north of Balochistan, where the return periods of moderate, severe, and extreme droughts were 7, 21 and 55 years respectively. The study also revealed that severe and extreme late winter droughts were more frequent in the upper north, with return periods of 16 and 35 years respectively. Early summer droughts occur more frequently in the east, returning every 8, 20, and 60 years. Late summer droughts occur in the northeast, with moderate, severe, and extreme droughts returning every 8, 22 and 65 years respectively (Ahmed et al., 2015). These seasonal droughts were found to be positively correlated with variations in the seasonal rainfall throughout the study area (Ahmed et al., 2015).

There is growing concern about the increasing frequency and severity of drought in Pakistan (Ahmed et al., 2015). A significant increase in the frequency of heat waves, an indicator of forthcoming drought, has been reported (Zahid and Rasul, 2012). Drought has been observed to occur every four out of ten years in Pakistan (Anjum et al., 2012). Balochistan is among the most drought-prone regions of Pakistan where severe drought events have been recorded in 1967-1969, 1971, 1973-1975, 1994, 1998-2002, and 2009-2015 (Ahmed et al., 2015).

The rural economy of Balochistan is highly dependent on agriculture, and is virtually at the mercy of seasonal rainfall. History shows that rural communities of Balochistan that had been devastated by drought faced great difficulties to return to normal once the drought period passed due to the dependence of their livelihoods on agriculture. The 1998-2004 drought reduced rain-fed crop yield by 60-80%, irrigated crop yield by 15-20%, and led to the deaths of approximately 2.0 million animals (FAO/WFP, 2000).

4.2 Identification of types of drought

Drought is defined as a lingering period of scarce precipitation that results in extensive damage to crops, further resulting in productivity loss (WMO, 2005). There are four major types of drought as reported by Wilhite and Glantz (1985): meteorological, agricultural, hydrological and socio-economic. In Balochistan, drought in all these four forms exists, with different intensities in different districts. Figure 4.1 below shows the interaction of various factors causing the different types of drought. In Table 4.2 the impacts of drought in the study areas are presented and categorized on the basis of intensity. The different drought types in Balochistan and their various causal factors are discussed in the following sections.

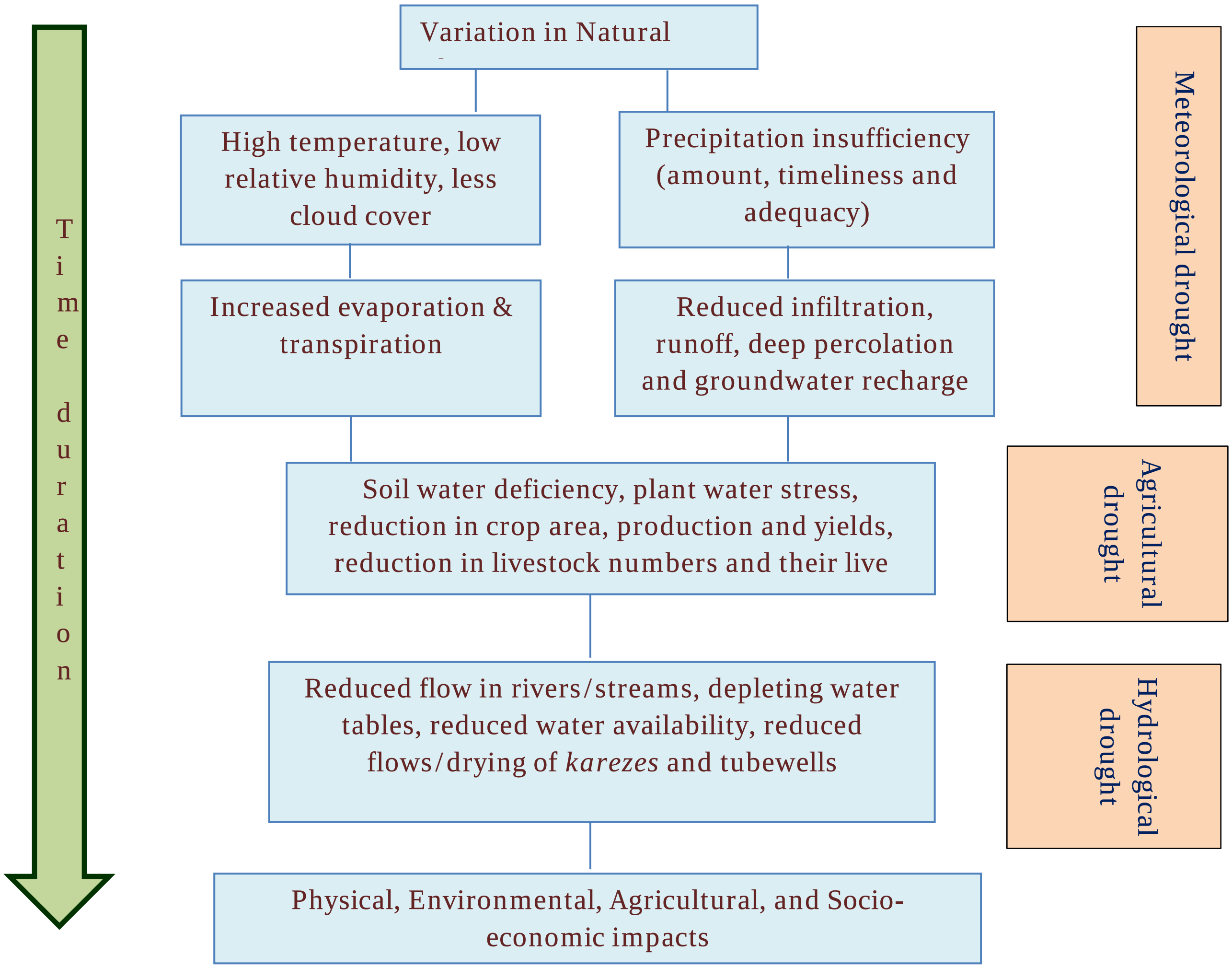

Figure 4.1: Linkages between different drought types and various physical, environmental, agricultural and socio-economic factors in Balochistan

4.2.1 Meteorological drought

Meteorological drought occurs when precipitation deficiency in terms of amount, intensity and timing causes reduction of water infiltration, runoff and deep percolation, and diminished groundwater recharge. Moreover, high temperature, strong wind, low relative humidity, greater sunshine and less or no cloud cover causes increased evaporation and transpiration (Tiwari et al., 2007; Wilhite & Glanz, 1985; WMO, 2005). Other conceptualizations may relate actual precipitation departures to average amounts on monthly, seasonal, or annual time scales (WMO, 2005). The definition of meteorological drought must be considered specific to a region, since atmospheric conditions vary from region to region (Wilhite & Glanz, 1985).

Meteorological drought is predicted by using the Standardized Precipitation Index (SPI). In 2009, the World Meteorological Organization (WMO) recommended the use of the Standardized Precipitation Index (SPI) (McKee et al., 1993) as the global standard hazard index to measure drought via the 'Lincoln Declaration on Drought Indices'. The SPI is computationally easy and enables transferability across temporal and spatial scales. The main obstacle in using the SPI is that it needs long-term rainfall data (at least 30 years of error-free data) to establish distribution parameters that capture the nature of meteorological drought in a given region. SPI is measured here only for Quetta meteorological station due to non-availability of data of Dalbandeen, Muslim Bagh, etc, stations in Balochistan. SPI can be calculated by the following expression:

$$SPI = \frac{Ri - Rm}{\sigma}$$

Where R_i is the annual rainfall and R_m is the long term seasonal mean rainfall and sigma is the standard deviation.

Many districts of Balochistan have been experiencing meteorological drought in terms of amount, timeliness, and intensity of precipitation in recent years. The Bureau of Meteorology (2011 & 2013), reported that the lower half of Balochistan received very little rainfall during 2011 and 2013, ranging from 25 to 200 mm, leading most of the areas there towards a meteorological drought. Figure 4.2 shows a declining trend in precipitation over an extended period of time in Quetta, Balochistan. The SPI index was used to compute meteorological drought occurrence and intensity.

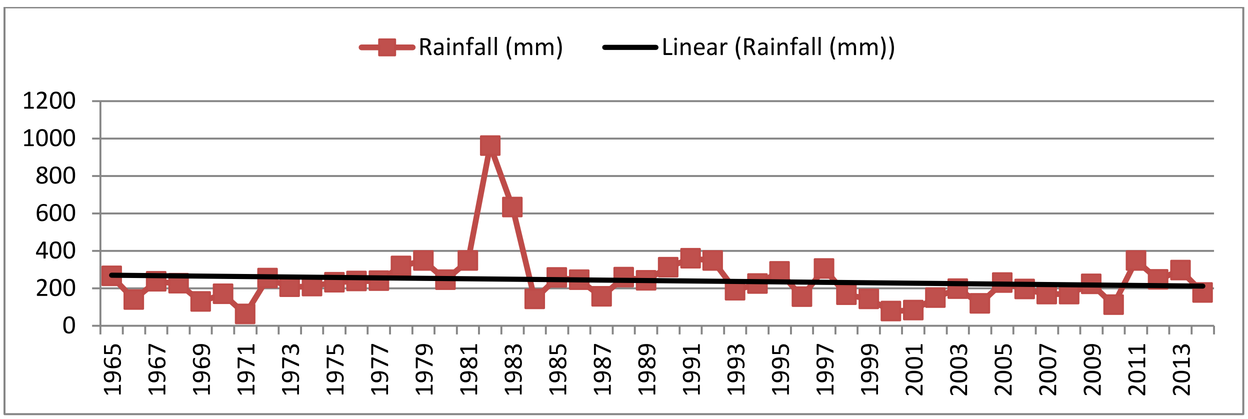

Figure 4.2: Rainfall over the period 1970 to 2013 (Source: Balochistan Agricultural Research Development Centre, Quetta, 1970-2013)

4.2.2 Standardized precipitation index (SPI), Quetta

SPI was calculated on the basis of annual rainfall data for Quetta city from the year 1965 to 2014 (Figure 4.3). The analysis showed that out of fifty years, twenty years experienced mild drought, seventeen near normal, three moderate and, in contrast, two years were extremely wet. The SPI indicates that during the year 2014, moderate drought prevailed.

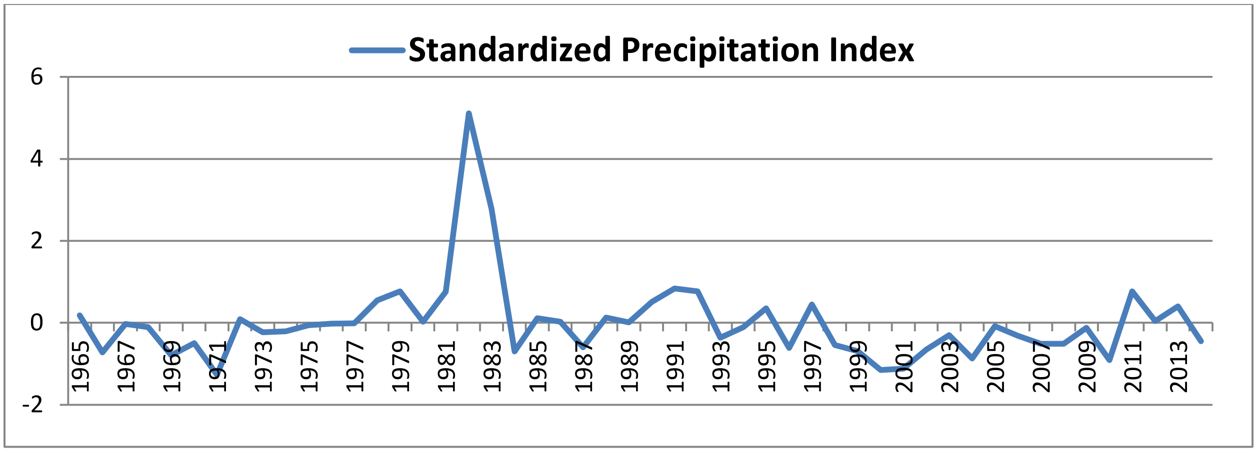

Figure 4.3: Standardized Precipitation Index for Quetta, 1965 – 2014.

SPI description

SPI< -2.0	Extremely dry
(-2.0<SPI<-1.5)	Severely dry
(-1.5 < SPI < -1.0)	Moderately dry
(-1.0 < SPI < 0.0)	Near normal
(1.0 < SPI < 1.5)	Moderately wet
(1.5 < SPI < 2.0)	Very wet
(2.0 < SPI)	Extremely wet

The continued deficit in precipitation and high temperature causes moisture stress on the crop root zone and leads to agricultural drought. Figure 4.4 shows the meteorological drought intensity in different districts, based on precipitation data, SPI index and information collected from the field during the surveys in 2015.

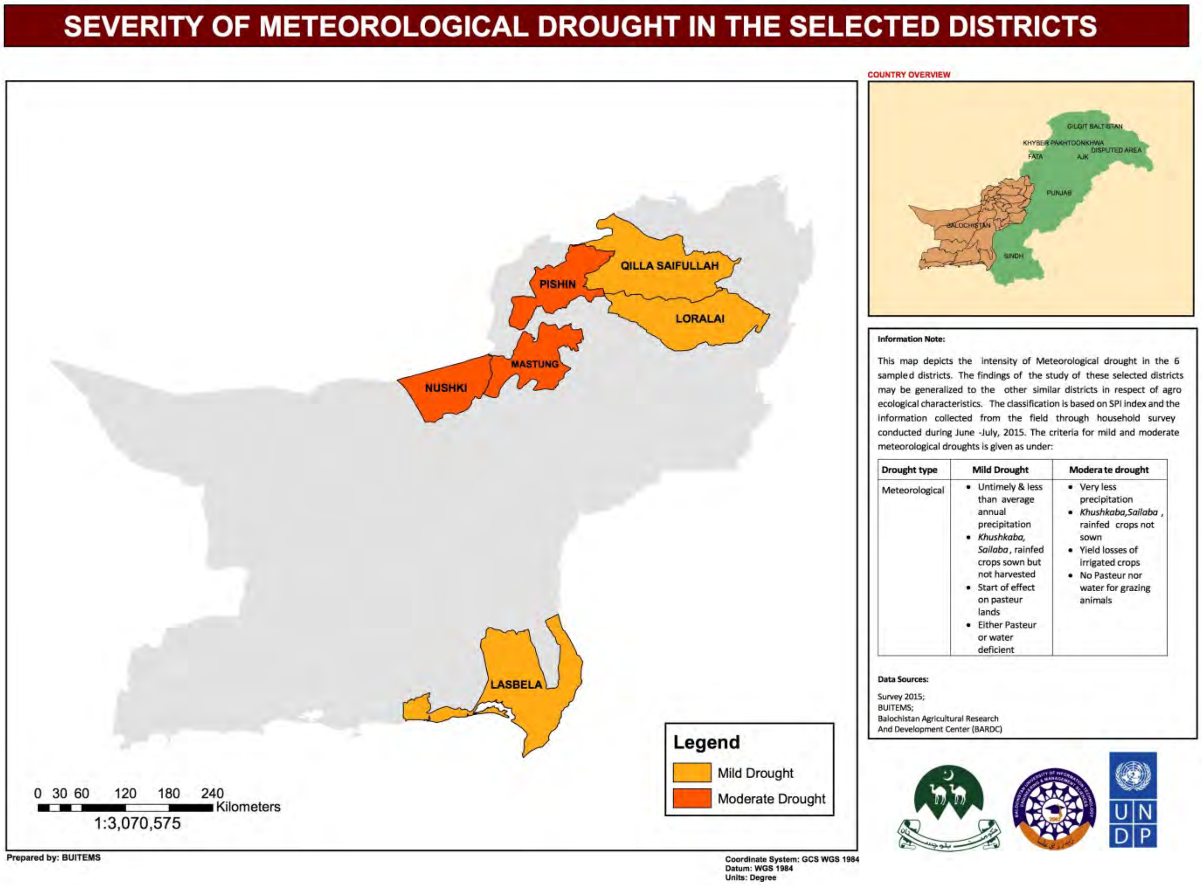

Figure 4.4: Severity of meteorological drought

4.2.3 Agricultural drought

Agricultural drought links various characteristics of meteorological (or hydrological) drought to agricultural impacts, focusing on precipitation shortages, differences between actual and potential evapotranspiration, soil water deficits, reduced groundwater or reservoir levels, and so forth. The existence of agricultural drought is evidenced by the fact that due to moisture stress a large agricultural area of the province could not be cultivated for the last many years. Jayanti & Husak (2013) reported that agricultural drought is defined by a reduction in crop area, a loss in crop yields, or both, as a result of insufficient moisture content during the crop-growing season. The untimely and scanty rainfall and lack of irrigation water from tubewells and *karezes* have caused a considerable decrease in the spatial distribution, production and yield of crops, fruits and vegetables in Balochistan. The rainfed/*sailaba/khushkaba* received the greatest setback (Survey, 2015). Moreover, livestock, particularly small ruminants, were adversely affected due to degradation of rangelands and pastures. The survey (2015) results (Table 4.2 & Section 4.3) show the effect of drought on agriculture, livestock, and water resources of the province. The continued water deficiency eventually led to hydrological drought.

Agricultural drought links various characteristics of meteorological (or hydrological) drought to agricultural impacts, focusing on precipitation shortages, differences between actual and potential evapotranspiration, soil water deficits, reduced groundwater or reservoir levels, and so forth (NDMC, 2013). Jayanthi and Husak (2013) predicted agricultural drought by assessing the reduction in crop yields or a loss of crop yield. For this study, the estimation of agricultural drought is based on the primary data collected from the field about the area cultivated, production and yield of major cereals, horticultural and rainfed/*khushkaba/sailaba* crops grown, livestock population and value over a 5-year period (2011 to 2015) in the case study districts of Balochistan (Figure 4.5).

Figure 4.5 shows the severity of agricultural drought in different districts of Balochistan. The analysis is based on crop areas, and yields data obtained from both primary and secondary sources.

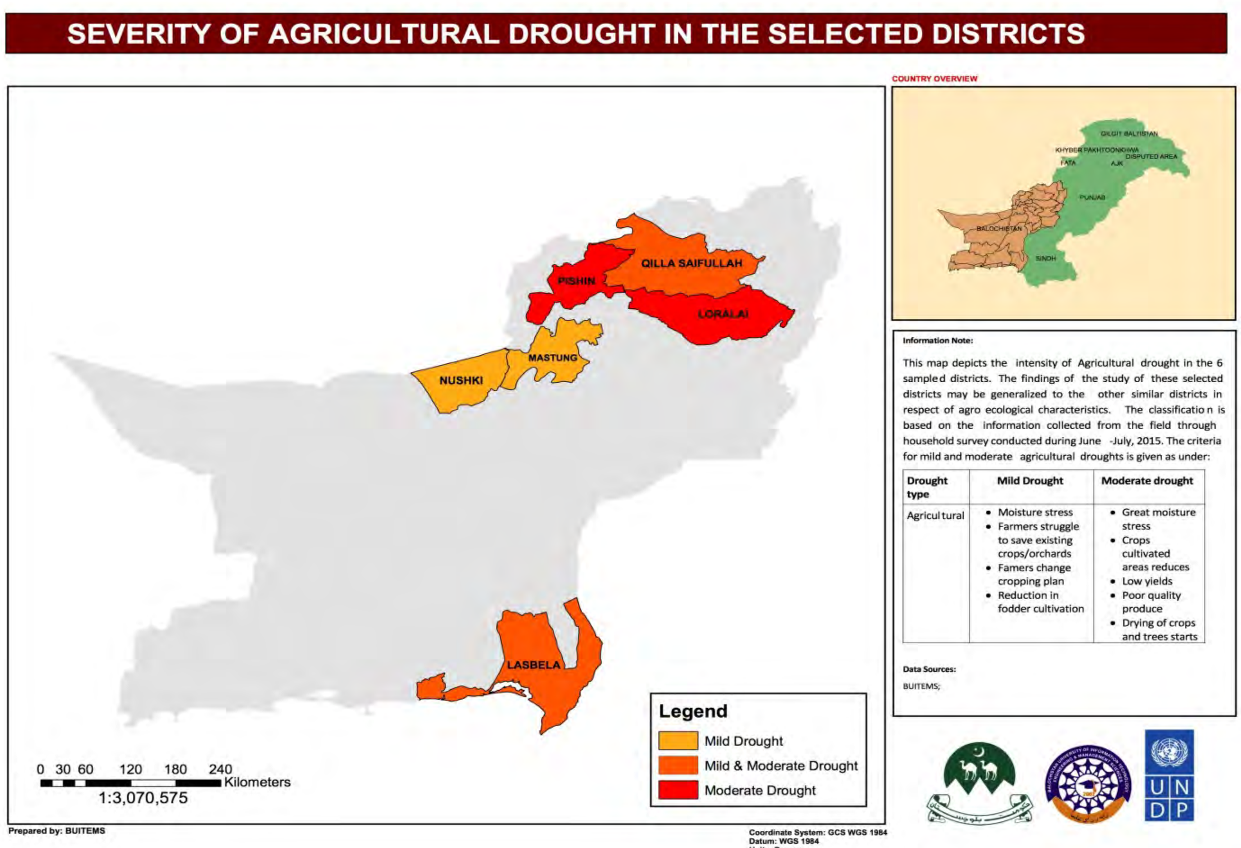

Figure 4.5: Severity of agricultural drought

4.2.4 Hydrological drought

Hydrological drought refers to deficiencies in surface and sub-surface water supplies. It is measured as stream flow, and as lake, reservoir, and groundwater levels. Hydrological drought is associated with the effects of periods of precipitation (including snowfall), shortfalls on surface or sub-surface water supply including stream flow, reservoir and lake levels, and groundwater (NDMC, 2013). The cumulative stream flow is used over overlapping periods of 3, 6, 9 and 12 months within each hydrological year to study the effects of hydrological drought (Nalbantis & Tsakiris, 2008). Because of unavailability of stream flow data for different basins, the stream flow could not be measured in this study. However, the basin wide data, and water table related information gathered from the field and various other sources was used to understand the deficit in groundwater basins in Balochistan (Appendix-B). The WMO (2005) reported that the frequency and severity of hydrological drought is often defined at a watershed or river basin scale. Moreover, the evidence from the surveyed areas with regard to water table depletion in different villages was used for evaluating the Standardized Water level Index (SWI). SWI is an index based on the probability of groundwater recharge deficit for any time scale (Jha, 2010). It is calculated by the following expression:

$$SWI = \frac{Wij - Wim}{\sigma}$$

where W_{ij} is the annual average water level for the i^{th} tubewell at j^{th} time period, while W_{im} is the long-term seasonal mean water table depth and sigma is the standard deviation. SWI is helpful for early warning of water shortage and hydrological drought. The long term water table data, that is, from 1980 to 2015, was used as found from through various sources (Khair & Culas, 2013; Irrigation Department, Balochistan; Survey Data, 2015). The water tables in the study area during 2010-11 and 2014-15 were compared to find the percentage and average decline in water levels over time, and hence, the effect of hydrological drought.

Although all droughts originate from a deficiency of precipitation, hydrologists are more concerned with how this deficiency plays out through the hydrologic system. Hydrological droughts are not necessarily synchronous with the occurrence of meteorological and agricultural drought.

Climate change and other factors such as changes in land use, land degradation, construction of dams and widespread installation of tubewells, all affect the hydrological characteristics of a basin. In Balochistan the mass installation of tubewells since the 1970s following the expansion of rural electrification (Figure, 4.6, Table 4.2) caused the over-exploitation of groundwater in many basins (Halcrow and Cameos , 2008; Ahmad, 2006). This resulted in the lowering of groundwater levels in the important basins of Balochistan and caused the near eradication of the historical *kareze* irrigation system (Khair et al. 2010). *Karezes* that used to be the major source of irrigation in Balochistan until the late 1960s are near to complete extinction due to rapidly declining water tables in the different basins of Balochistan.

Figure 4.7 shows the rise in tubewell irrigated areas and a decline in *kareze* irrigated areas over time. According to Halcrow and Cameos (2008), as a result of indiscriminate pumping of groundwater in Balochistan, groundwater of 10 out of 19 sub-basins is over-used and the basins are in deficit (Appendix-B). The Pishin Lora Basin (PLB), Nari Biver Basin (NRB), Zhob River Basin (ZRB) and Porali River Basin (PRB) are highly over-drawn as shown in Table 4.1.

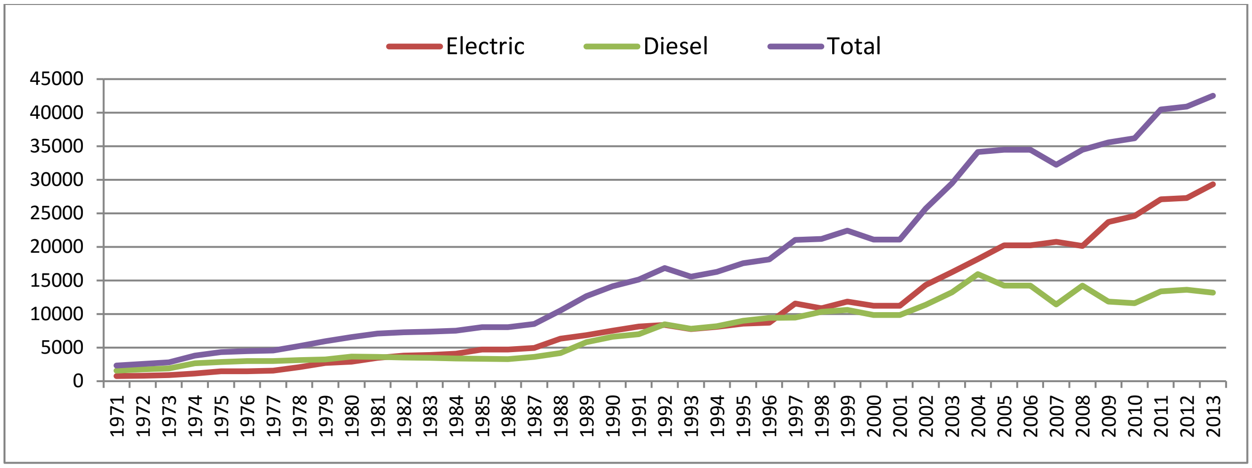

Figure 4.6: Growth of tubewells in Balochistan (Source: Government of Balochistan, 2013-2014)

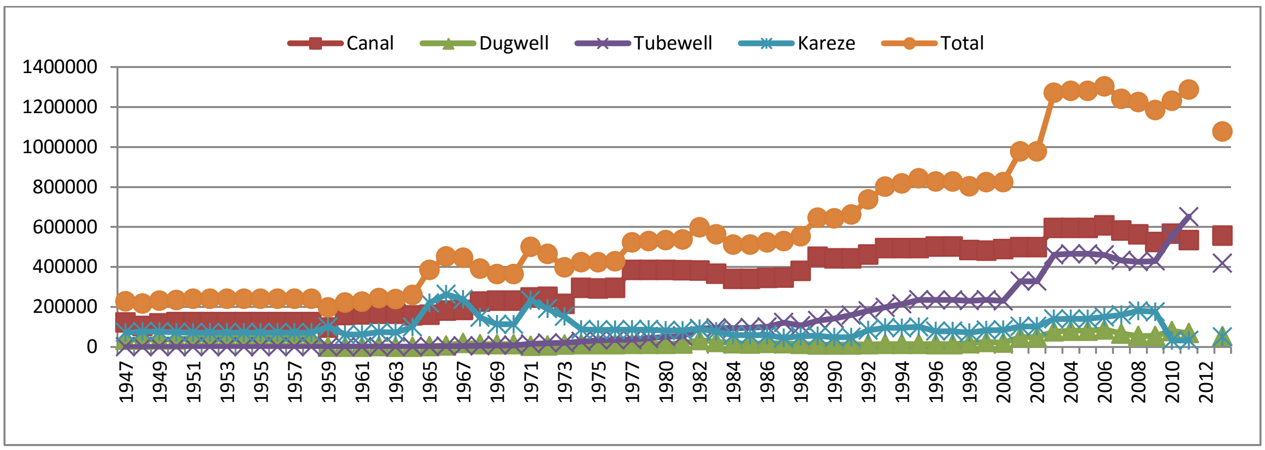

Figure 4.7: Contribution of different sources to irrigated areas in Balochistan (Source: Agriculture Statistics 2013-14)

Table 4.1: Groundwater balance of three major basins of Balochistan (m^3) (Source: Halcrow and Cameos, 2008)

Average year	Basin	Annual recharge	Current use	Surplus/Deficit
	PLB	0.17	0.566	-0.396
	ZRB	0.16	0.27	-0.11
	NRB	0.27	0.18	0.09
	PRB	0.140	0.146	-0.006
Dry year				
	PLB	110	566	-456
	ZRB	110	270	-160
	NRB	190	180	-10
	PRB	-	-	-

4.2.5 Standardized water level index (SWI)

Measurement of both groundwater and surface water levels are important indications of hydrological drought occurrence. Monitoring reservoir water levels and groundwater table through a closed well observation network is imperative for drought assessment.

SWI is helpful for early warning of water shortage and hydrological drought. The SWI index (Figure 4.8) revealed that there is an alarming situation of the groundwater deficit in upland Balochistan due to several reasons - mass installation of tubewells, inefficient irrigation systems, inappropriate agro-ecological cropping patterns and deficient precipitation. District Pishin and Loralai are experiencing extreme hydrological drought conditions and Killa Saifullah severe, respectively.

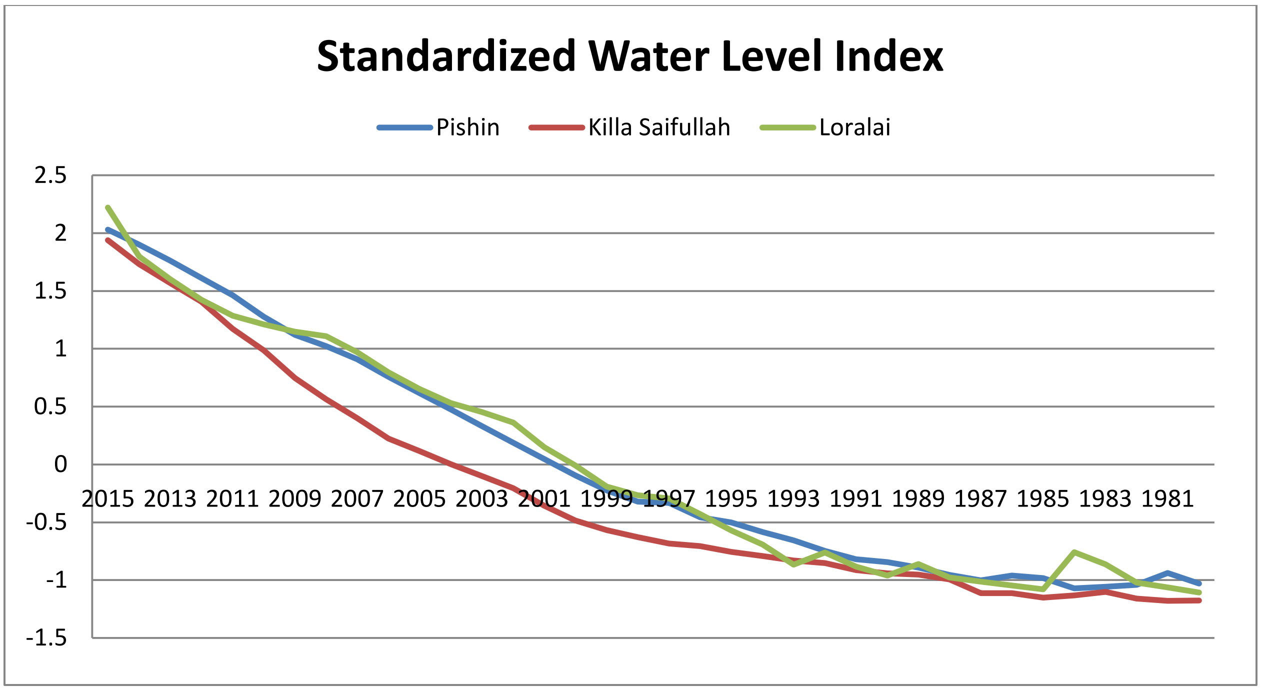

Figure 4.8: Standardized water level index

Drought classes	Criterion
Extreme Drought	SWI> 2.0
Severe Drought	SWI> 1.5
Moderate Drought	SWI>1.0
Mild Drought	SWI>0.0
No-Drought or normal	SWI<0.0

Note: +ve values of SWI correspond to drought while –ve indicates normal

The severity of hydrological drought in different districts of Balochistan is shown in Figure 4.8. It categorizes drought into mild and moderate based on the evidence obtained from the field and SWI results.

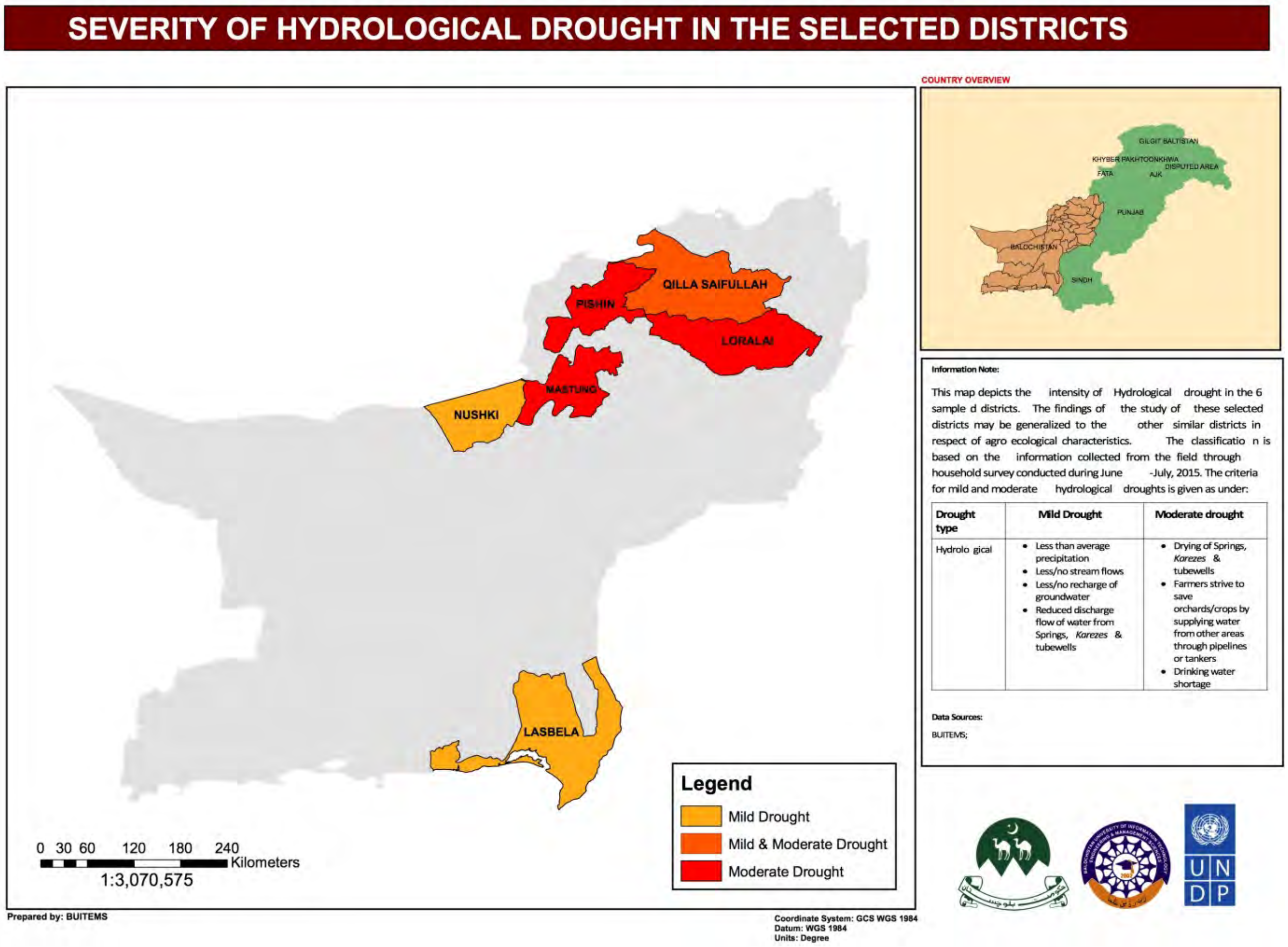

Figure 4.9: Severity of hydrological drought

4.2.6 Socio-economic drought

Socio-economic drought associates the supply and demand of some economic good with elements of meteorological, hydrological and agricultural drought (Wilhite & Glantz, 1985). It differs from the aforementioned types of drought because its occurrence depends on the time and spatial processes of supply and demand to identify or classify drought. Socio-economic drought occurs when the demand for an economic good exceeds supply as a result of a weather-related shortfall in water supply. The socio-economic impact of drought has been enormous with severe impact on incomes, nutrition, livelihood sources, etc.

The socio-economic impact of drought in the drought-affected areas of Balochistan is substantial in terms of loss of livelihood sources, resulting in rural-urban migration (Table 4.2, Section 4.3.2 for results of survey, 2015).

Socio-economic definitions of drought associate the supply and demand of some economic good with elements of meteorological, hydrological and agricultural drought. Primary data was collected on income losses, monthly food intake, and gender and child well-being at the household level during the drought. The severity of socio-economic drought is presented in Figure 4.11.

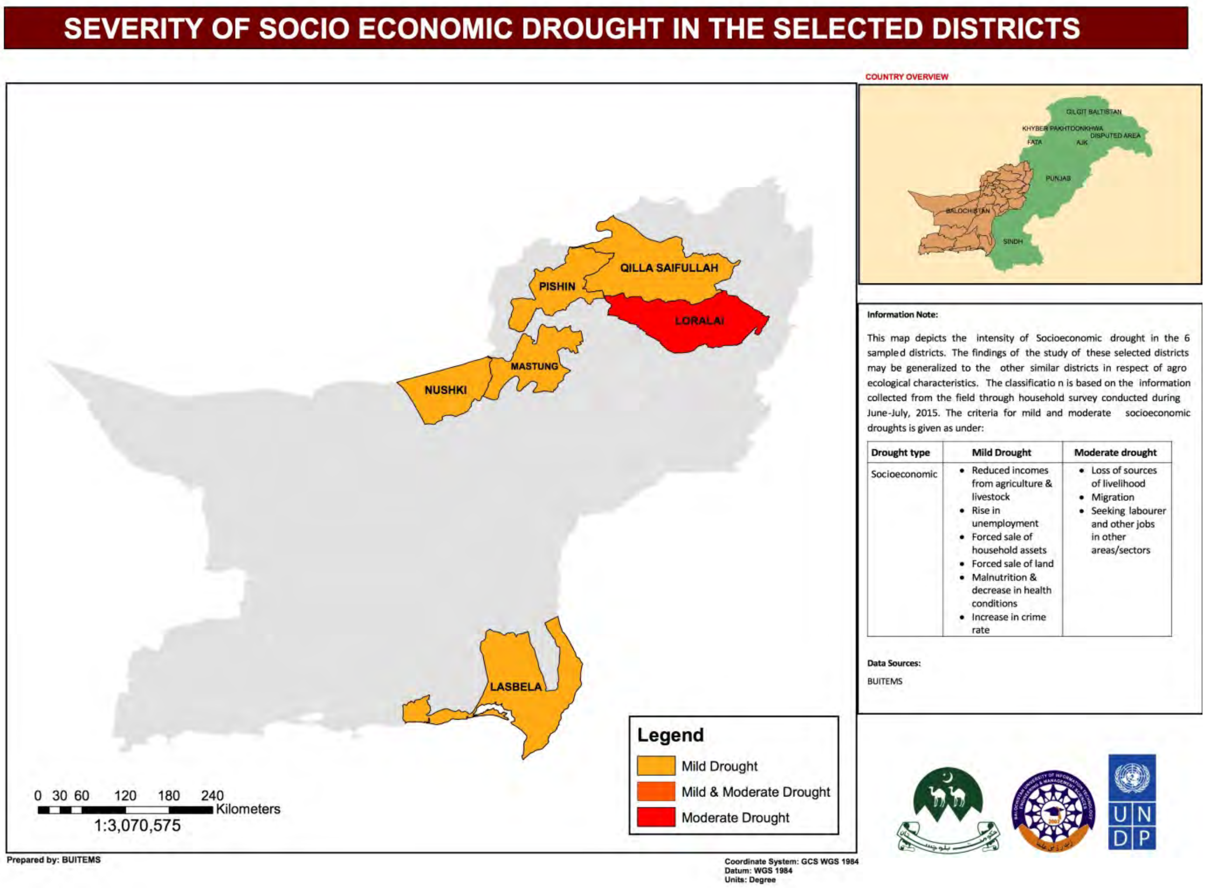

Figure 4.10: Severity of socio-economic drought

4.2.7 Provincial analysis of drought

The results of the study based on six districts are generalized to the remaining districts of the province (Figure 4.11). The rationale for the generalizability of the results of the six case study districts on the remaining drought-affected districts of Balochistan is as follows:

1. The agro-ecological similarity (cropping patterns, altitude) of districts (please refer to chapter 2 and section 3.1.1 - 3.1.4 for details)
2. Dependence on groundwater for irrigation purposes (please refer to chapter 2, and sections 3.1.1 - to 3.1.4 for details)
3. Dependence on agriculture and livestock as major sources of livelihood (please refer to chapter 2, and section 3.1.1 through to 3.1.4 for details)
4. In addition to the above three criteria, a sample of six districts is adequately representative of all the drought-affected districts of the province. The basic objective of such sampling is to minimize the gap between the values obtained from the sample and those prevailing in the wider population to economize cost, time and other resources; the sample can provide a fairly accurate reflection of the population that is being studied. Therefore, for the present study, at least one district was selected in each affected agro-ecological zone.

Table: 4.2: Drought types and their intensity scale based on evidence from the field (Source: Survey 2015; drought categorization according to Union Councils)

Drought type	**Mild drought**	**Moderate drought**
Meteorological	• Untimely and less than average annual precipitation • *Khushkaba, sailaba*, rainfed crops sown, but not harvested • Start of effect on pasture land • Either pasture or water deficient	• Very little precipitation • *Khushkaba,sailaba*, rainfed crops not sown • Yield losses of irrigated crops • No pasture or water for grazing animals
Agricultural	• Moisture stress • Farmers struggle to save existing crops/orchards • Farmers change cropping plan • Reduction in fodder cultivation	• Great moisture stress • Areas for crop cultivation reduces • Low yields • Poor quality produce • Drying of crops and trees begins
Hydrological	• Less than average precipitation • Less/no stream flows • Less/no recharge of groundwater • Reduced discharge flow of water from springs, *karezes* and tubewells	• Drying of springs, *karezes* and tubewells • Farmers strive to save orchards/crops by supplying water from other areas through pipelines or tankers • Drinking water shortage
Socio-economic	• Reduced incomes from agriculture and livestock • Unemployment • Forced sale of household assets • Forced sale of land • Malnutrition and decrease in health conditions • Increase in crime rate	• Loss of sources of livelihood • Migration • Seeking laborer and other jobs in other areas/sectors

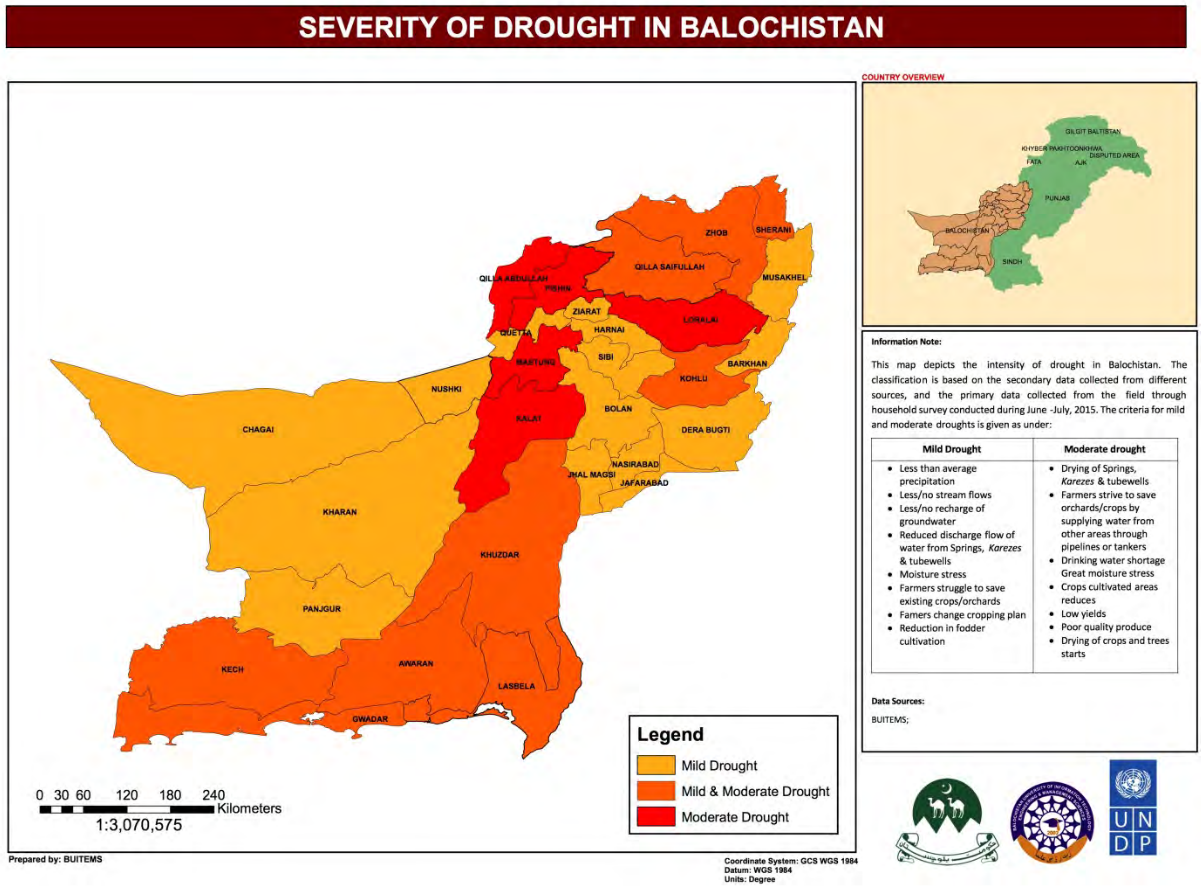

Figure 4.11: Severity of drought in Balochistan based on the sample results

4.2.8 Population at risk from drought

According to the survey results, the projected rise of population at risk to drought, directly or indirectly, is around 60-70 % in Balochistan (Figure 4.11). Some 50-60% of the population is affected by a moderate drought and are at risk in Pishin, Killa Abdullah, Mastung, Kalat and Loralai districts. Among other districts, Loralai district is the worst affected and the socio-economic impact of drought can be observed in the form of loss of sources of livelihood, unemployment, migration, etc. The degree of drought effect in Killa Saifullah, Zhob, Sherani, Kohlu, Lasbela, Gawader and Kech districts is 30-55% as shown in Figure 4.11. The districts of Noshki, Chagai, Kharan, Quetta, Ziarat, Sibi, Nasirabad, Jaffarabad, Bolan, Dera Bugti, Musa Khal, Barkhan and Jhal Magsi are at drought risk by 40-65% due to different types of drought that exist in varying degrees.

4.3 Vulnerability context: drought impact and respondents' perceptions

Drought vulnerability is a complex concept that includes both biophysical and socio-economic drivers of drought impact that influence coping capacity. The term vulnerability is used here to convey the characteristics of a system or social group that make it susceptible to suffering the consequences of drought. Vulnerability in the context of disasters can be defined as the prevailing or consequential characteristics of an element at risk, which reduces the ability to mitigate, prepare for, respond to or recover from the negative impacts of a hazardous event.

Balochistan is climatically arid to semi-arid, frequently in the grip of meteorological drought, which results in the other types of drought. The impacts of drought include food insecurity, destruction of critical ecological habitats and consequent loss of biodiversity, socio-economic instability and poverty, and conflicts over the use of diminishing natural resources. Moreover, drought also brings a multitude of other adverse effects such as mortality of people and livestock due to famine in extreme drought events, rise in diseases, deterioration of nutritional status, reduction in drinking and irrigation water resources, decline in the ground water tables, social disruption due to migration, increased rates of inflation and desertification.

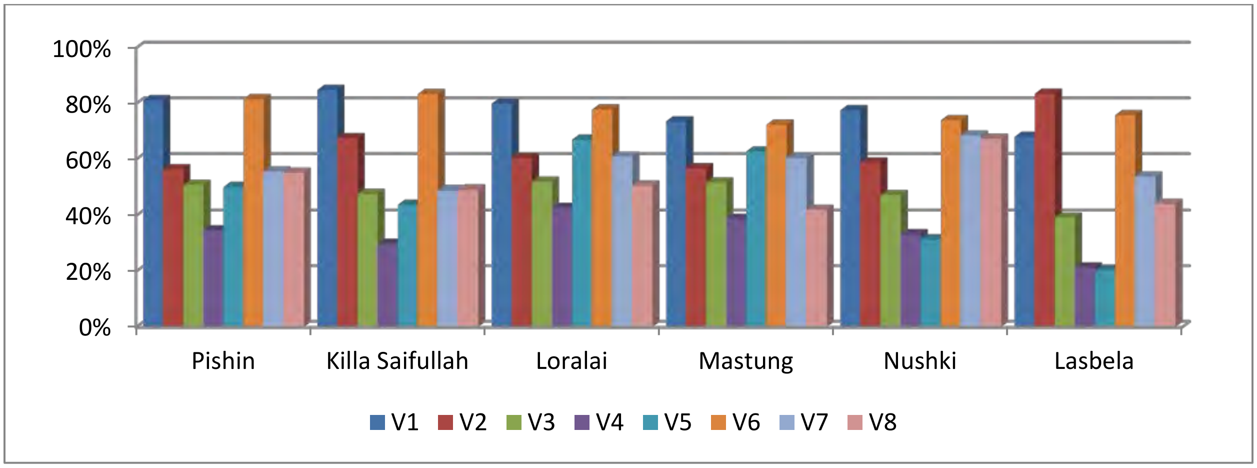

Figure 4.12: Respondents' perception about drought impacts (%) (Source: Survey, 2015)

V1	Decline in crop yields/food insecurity
V2	Livestock losses
V3	Forced sale of household assets
V4	Forced sale of land
V5	Increase in crime rate
V6	Depletion of water for agricultural use
V7	Depletion of water for human use (drinking, cleaning and cooking)
V8	Decline in health due to malnutrition or lack of safe drinking water and spread of diseases

Figure 4.12 shows the households' perception about their vulnerability to drought impacts. Among other factors, the decline in crop yields/food insecurity (V1) and depletion of water for agriculture use (V6) got the highest percentage responses (minimum variation) from all districts, suggesting the commonality of these two factors among all districts. Similarly, livestock losses (V2) and depletion of water for drinking purposes (V7) received around 60% response, indicating the severity of impact of drought on such elements. Livestock losses (V2) received the highest response from the respondents of Lasbela, indicating the highest impact of drought on livestock there. Forced sale of household assets (V3) and decline in health due to malnutrition or lack of safe drinking water and spread of diseases also received a fair amount of response, around 50%. In Noshki district, the water quality was brackish in the Inam Bostan area, which is why the lack of good quality drinking water due to salinity

intrusion (V8) was marked higher than other districts because of the context-specific nature of the problem. Zanginawar Lake was reported to be the cause of salinity intrusion into groundwater in Inam Bostan area of Noshki. The increase in crime rate (V4) was recorded highest in Mastung and Loralai districts compared to the other districts. Forced sale of land (V4) was recorded lowest due to loss of land value after groundwater depletion.

Migration and population growth have also contributed to the vulnerabilities of the rural population in the case study areas. Migration of people was reported in some of the areas (union council/villages) of Balochistan affected by severe drought, such as Lahore, Shabozai and Poonga union councils of Loralai district, Manzari and Khudu Khanzi union councils of Pishin and Kan union council of Qilla Saifullah district.

The effect of population growth on natural resources was evident in many areas of the province, which is exerting pressure on the natural resource base and diminishing its bearing capacity. This should be considered as a very important issue, keeping in view the capacity of the existing cultivated land and groundwater in the province.

The following sections present the physical, agricultural and socio-economic impacts of drought.

4.3.1 Physical impacts of drought

When the rivers, lakes, ponds and reservoirs tend to dry up, wells and tubewells reduce discharge flows or are rendered unserviceable due to lowering of water tables (Wilhite & Glantz, 1985). The main effect can be seen on groundwater which is used as the main source of irrigation in 30 out of 32 districts in Balochistan. The increased reliance on groundwater caused its over-exploitation and as a result the water tables have started declining at a rate of two to five metres annually, mainly due to the government policy of groundwater sector development, improvements in technology and subsidised electricity (Khair & Culas, 2013). The higher profit motive from growing high value fruits and vegetables has also resulted in the installation of a large number of tubewells by individual farmers. Additionally, the low average rainfall also contributed to less recharge of the groundwater. All the above factors in turn caused tremendous pressure on groundwater resources and have aggravated the groundwater situation, mostly due to the high water requirements for fruit and vegetable cultivation.

4.3.1.1 Drought impact on water resources

Figure 4.13 shows the declining water tables over time in different districts of Balochistan due to the effect of drought, and intensive and indiscriminate pumping of groundwater in all the districts. The declining water tables lead to an increase in extraction costs, reducing the flow of existing tubewells and in worst cases causing the failure of dugwells and tubewells. The decline in the water table tends to accelerate with: (i) A reduction in the quantity of rainfall; while the subsidized electricity tariff policy continued; (ii) More groundwater development projects, giving people more opportunity to use groundwater; and (iii) An increase in the total irrigated area due to the development of irrigated areas, hence causing more pressure on the groundwater supply (Khair & Culas, 2013). The average depth to the water table is deepest in Mastung and lowest in Lasbela district.

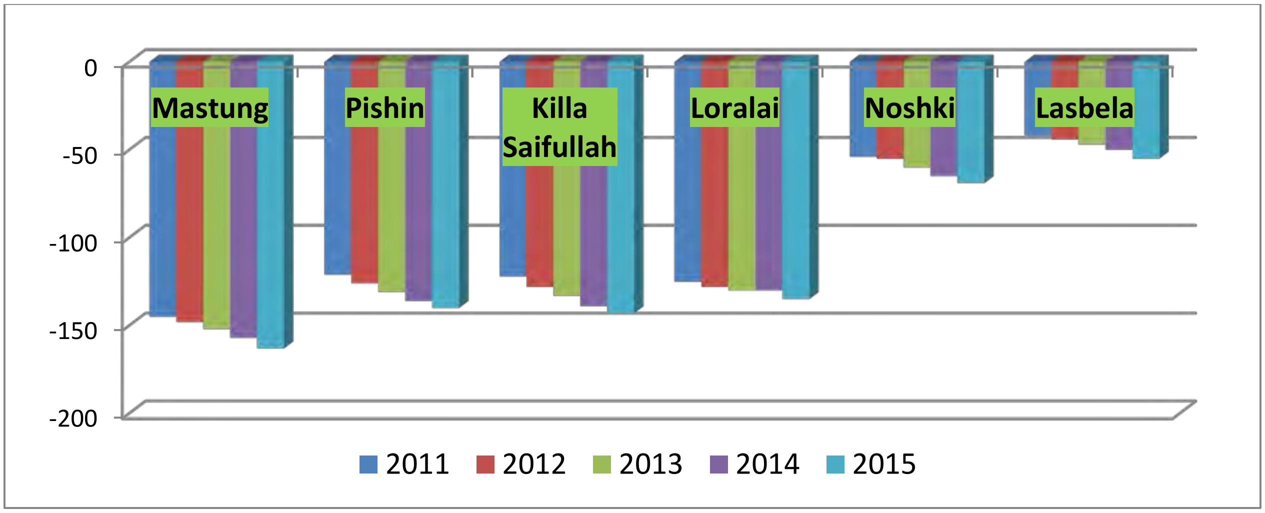

Figure 4.13: Declining watertables over time (meters) (Source: Survey, 2015)

4.3.1.2 Average decline in water tables (meters per year)

Figure 4.14 depicts the average water table decline since 2011. The highest average water table decline was reported in Killa Saifullah followed by Pishin, Mastung, Noshki, Lasbela and Loralai districts. The reasons for such accelerated rate of decline were the meteorological drought prevailing over the last few years and massive pumping of groundwater.

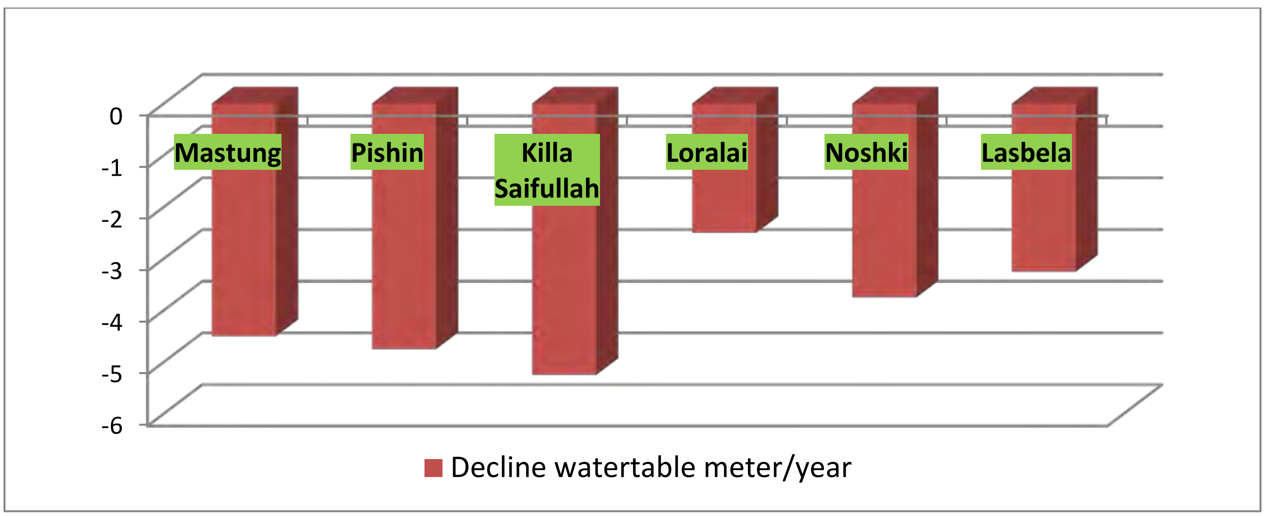

Figure 4.14: Average decline in watertable per year (meters) (Source: Survey, 2015)

The highest dependency on groundwater is in the upland districts (Mastung, Pishin, Killa Saifullah and Loralai) due to the lack of alternative sources of water for irrigation. In Lasbela district due to drying of the Hub dam, the fall in water tables has accelerated. In Noshki the dryness of *Zanginawar* Lake has caused brackish water intrusion into groundwater in Kharina village and the dryland farming could not be practiced for the last three to four years. In Loralai area, the drought effect was worst, but the comparatively less average water table decline meant that in the few affected Union Councils (Ponga, Chena Alizai, and in some villages of Lahore union council) shallow dugwells or tubewells with a discharge flow of 0. 5 to 1 inch could be used mainly for drinking water supply.

The severity of the issue of declining water tables is also reported in literature and is described as 'water mining'. Ahmad (2006) reported that in upland Balochistan the overall water table decline from 15-30 meters to 60-200 meters in a period of around 30 years is a clear example of water mining. The inefficient irrigation methods, drought, uncontrolled installation of tubewells in large numbers, indiscriminate pumping of water and highly subsidized electricity are the main reasons for this (Ahmad, 2006). The drawdown of groundwater was accelerated by the drought during 1998-2004, which caused a large number of groundwater sources like *karezes*, springs and tubewells to become dry.

4.3.1.3 Increasing failure of tubewells, karezes and springs

The increased competition for groundwater has resulted in a massive overdraft and drawdown of watertables, tubewells, *Karezes* and springs; failure is common in many areas, such as Kan Mehtarzai in Killa Saifullah, Manzari, Tora Shah, Malikyar, Huramzai, Khanzai area in Pishin. In Loralai area, the Ponga, Shabozai, Cheena Alizai, and Lahore union councils have become completely devoid of water for irrigation purposes. Moreover, in these areas, the existing running Karezes and tubewells have only half of their discharge flow left. In these areas, farmers have made massive investments in planting fruit orchards on their land with tubewell irrigation. After the drying up of tubewells in some aquifers, the farmers are losing their source of irrigation and hence their main source of livelihood. These farmers are struggling to save their orchards in the following ways: (i) Wealthy farmers are installing tubewells in downstream areas on their own or in other areas, and bringing the water through long pipelines; (ii) Resource poor and small farmers are purchasing water from nearby tubewell owners to save their orchards, not being able to afford long pipelines; and (iii) In the case of unavailability of these two options, the water-scarce farmers are bringing water to save their orchards by using tractor-mounted water tanks, while hoping for better climatic conditions in the future.

Groundwater extraction started in Balochistan back in the 1960s when electric and diesel powered motor pumps was introduced. Soon, the *kareze* / spring irrigation systems became the source of only about half of the total groundwater. With the passage of time, tubewell installation expanded, accompanied by 'Green Revolution' technologies, which exerted huge pressure on groundwater resources. By the early 1990s, groundwater sources became overdrawn.

Thus, the closure of spring / *karez* irrigation ensued. At present, less than 10% of *karezes* are functional, with less than half of their natural flow. In addition, drying up of tubewells has become a common phenomenon and water scarcity for drinking and irrigation is a crucial issue in many parts of Balochistan.

4.3.2 Economic impacts with reference to the agriculture sector

Agriculture in Balochistan still depends largely on precipitation. The effects of drought include the shortfall in cultivated areas and drop in agricultural productivity. Historically, severe shortage of food-grains had been experienced in the province during previous droughts and the province had to resort to importing food-grains to save the poor people and livestock from hunger and starvation. The shortfall in agricultural production may be the direct impact of meteorological droughts, but the consequent hydrological and agricultural droughts have a long range and far-reaching impact on agriculture. This impact may continue to play out in the form of changes in the cropping patterns and destitution of cattle and other livestock assets.

4.3.2.1 Drought impacts on fruit production

Agricultural drought is estimated by a reduction in crops (area or yield, or both) due to deficient moisture conditions during the crop-growing season (Jayanthi & Husak, 2013). Drought over the past three years has significantly affected both the arable and pastoral sectors in Balochistan. The scarcity of irrigation water severely affected the most important fruit crop, apple, which is the main source of income in upland Balochistan (Figure 4.15). The apple crop area has been reducing significantly in the uplands of Balochistan (Government of Balochistan, 2013-2014). Even in Kan Mehtarzai, which is one of the best apple-producing areas, apple orchards are undergoing a decline due to continuous drought and depleting watertables. About a third of the orchard areas have dried up, a third under great stress, while the remaining one third is alive due to spring water (Figure 4.16 & 4.17). Kan Mehtarzai has now become a timber market for the sale of wood from uprooted dead trees. The continued stress also affects the fruit quality, especially apple, which is very sensitive to water stress and thus highly requiring irrigation (Naor, 2006 and Girona et al., 2010). As shown in Figure 4.15, the reduction of apple areas ranges from 20-40% in different districts. Similarly, the apricot, peach and plum are reported to be reduced by 2-38%. Grape cultivation is reported to have been increased because farmers prefer it to apple, peach, plum, etc, due to its comparatively low water requirement and better yields. Some farmers in Pishin reported that they have left their apple and other fruit trees to dry up and were concentrating mainly on saving grapes from desiccation.

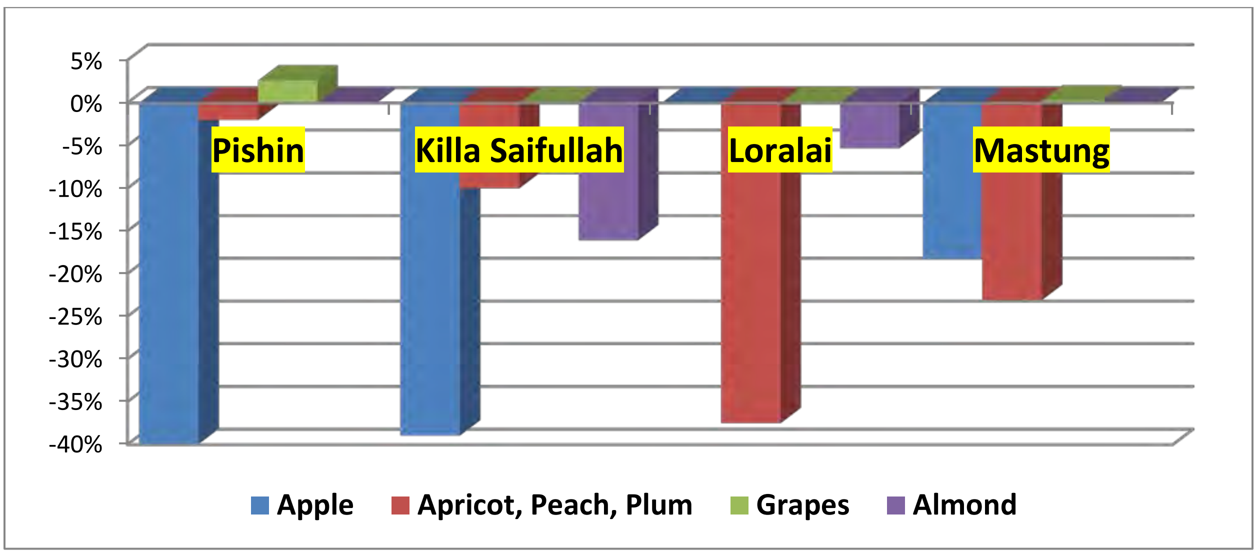

Figure 4.15: Drought impact on fruit areas (%) (Source: Survey 2015)

Figure 4.16: Drying fruit trees due to water stress

Figure 4.17: Dried orchards

4.3.2.2 Drought impact on orchard yields

Irrigation is a major horticultural activity and availability of water for it is crucial for the survival of apple orchards in arid and semi-arid zones. The crop yield, fruit size, fruit quality, storability and long-term productivity are highly dependent on the availability of irrigation water throughout most of the growing season. Figure 2.1 indicates the percentage decline in average yields of major fruits due to water stress amid drought in upland Balochistan. The hydrological drought created by excessive exploitation of groundwater has placed extreme stress on groundwater resources, leading to greater human misery. The decline in this vital resource is serious - it has contributed to unemployment and consequently poverty in rural areas. Furthermore, farmers were considering selling off their valuable assets such as generators, tractors and motor cars to preserve their orchards. Leaf burning in apple and grape orchards was observed due to the effects caused by drought. Plants suffering from heat stress close down basic growth functions, being unable to draw up sufficient water into their leaves, a form of drought stress.

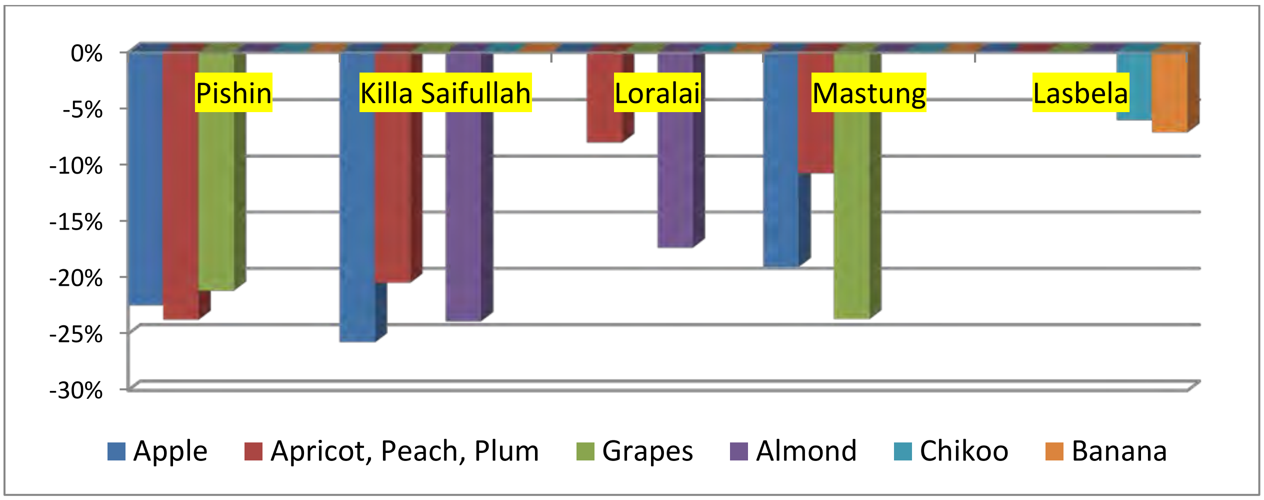

Figure 4.18: Drought impact on the yields of major fruits (Sources: Survey, 2015)

As shown in Figure 4.18, the highest reduction in fruits yields was reported in Killa Saifullah, Pishin and Mastung districts. Grape yields were affected the most in Mastung and Pishin districts. In district Loralai where the agriculture sector received serious setback due to the previous drought, the yield of almond was reported to have reduced by 17%. In Lasbela district the yields of chikoo and banana were reduced by 6% and 7% respectively.

4.3.2.3 Drought impact on crops and vegetable cultivated area

Among other irrigated cereal crops, wheat areas have been severely affected in Pishin, followed by Killa Saifulla, Mastung, Noshki and respectively (Figure 4.19).

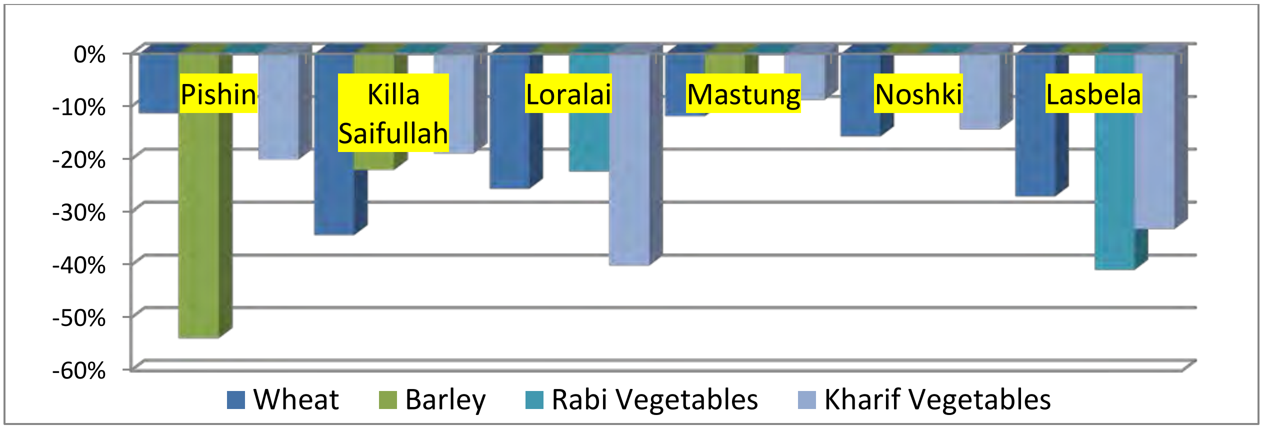

Figure 4.19: Drought impact on crop and vegetable cultivated areas (Source: Survey, 2015)

The reason reported by farmers was the deficient water supply due to drought and unreliable electricity supply for irrigation. In such circumstances, the drought coping strategies of the farmers tended to devote the available irrigation water to the fruit trees in order to ensure survival of orchards. Accordingly, irrigated crop and vegetable areas reduced significantly due to the scarcity of irrigation water (Figure 4.19).

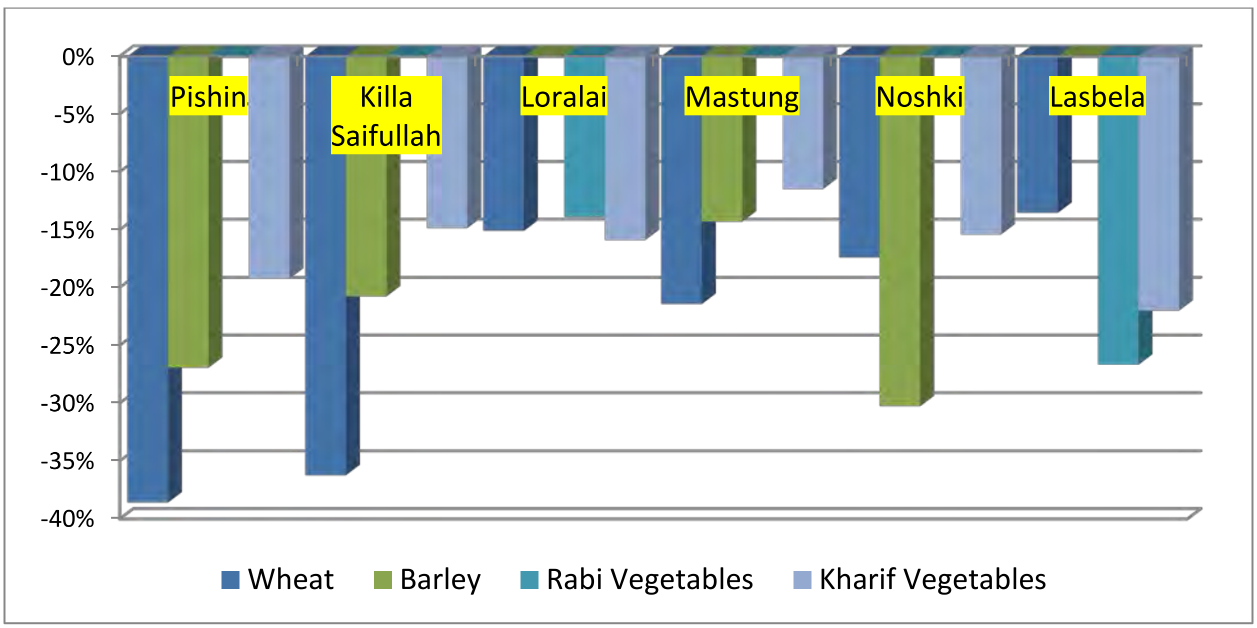

Figure 4.20: Drought impact on the yields of major crops and vegetables (Source: Survey, 2015)

4.3.2.4 Drought impact on the yields of major crops and vegetables

The subsistence farmers of Balochistan focus on growing just enough to feed their families. Wheat, barley, maize, pulses and sorghum are the primary crops. Almost 50-80% yield losses were reported during the 5-year period from 2011 to 2014 as shown in Figure 4.20. The low yield of principal cereal crops is also one of the reasons for increasing rural poverty. Moreover, the declining agricultural production - caused by low precipitation, reliance on rainfed agriculture and unfavorable weather conditions- is one of the principal causes of poverty in rural areas.

4.3.2.5 Drought impact on rainfed/khushkaba/sailaba crops

During the surveys, it was reported that the rainfed/*khushkaba/sailaba* cropping could be practiced rarely due to erratic and scanty rainfall during the winter and monsoon rainy seasons (Figure 4.21 & 4.22). The farmers of Pishin, Loralai, Mastung and Noshki districts reported that this type of cropping has not been possible for many years due to untimely and insufficient rainfall. They also reported that most of the time they could not harvest the sown crop due to its failure from lack of moisture. In the most affected districts, land was prepared, but could not be cultivated eventually because of delayed rainfall. In the union councils of Inaam Bostan and Daak of district Noski (Figure 4.21, 4.22 & 4.23), the farmers could not sow the rainfed/*sailaba/khushkaba* crops for the last four years.

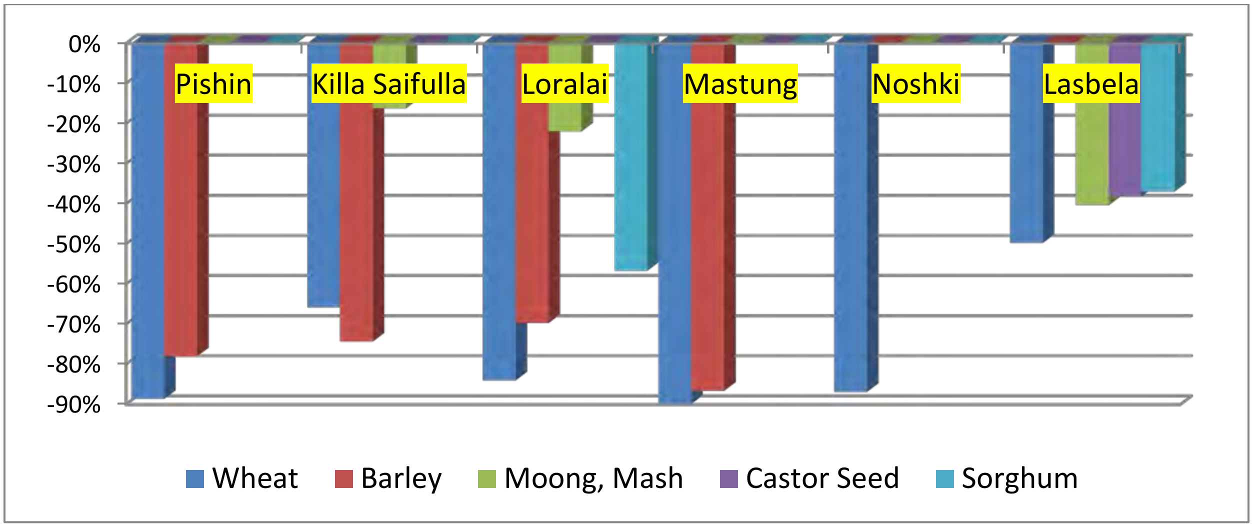

Figure 4.21: Drought's impact on the yields of rainfed/*khushkaba/sailaba* crops (Source: Survey: 2015)

Figure 4.22: A view of Zanginawar Lake that has dried up 4-5 years ago

Figure 4.23: The area in Lasbela that could not be cultivated because of shortage of water supply from Hub Dam

4.3.2.6 Drought impact on livestock

The recent drought has caused the degradation of green cover and pasture land/ grazing areas for livestock, and decline in availability of water for livestock. This causes the animals to become weaker and results in losses in animal products. Loss of body weight in animals causes reduced immunity and makes them susceptible to parasite attack by lung worm, Congo Virus, ticks, etc. Moreover, the weakness also causes a reduced pregnancy rate and makes them more prone to disease. Migration of animals was also reported due to transfer of contagious parasitic diseases.

The 2015 survey results showed that the average losses in small animals such as goat and sheep were high compared to larger animals such as cattle. Along with mortality, low market price, disease attack, increase in production cost (due to shortage of feed, fodder and water) were common problems due to the prevailing severe drought conditions. Among the case study districts some of the areas in Killa Saifullah, Nushki and Lasbella were severely affected by the recent drought. In Killa Saifullah district, the most affected union councils in terms of livestock losses are Badini, Sheran Jogezai and Toblai.

According to the secondary data and observations of the survey team, the most affected areas in Pishin district were Murghafekaryazai, Bashore, Ajrum Shadizai and Kass Hassanzai. Whereas, in Mastung district, the most affected union council was Kadkocha. The empirical evidence regarding livestock losses is shown in Figures 4.24 and 4.25.

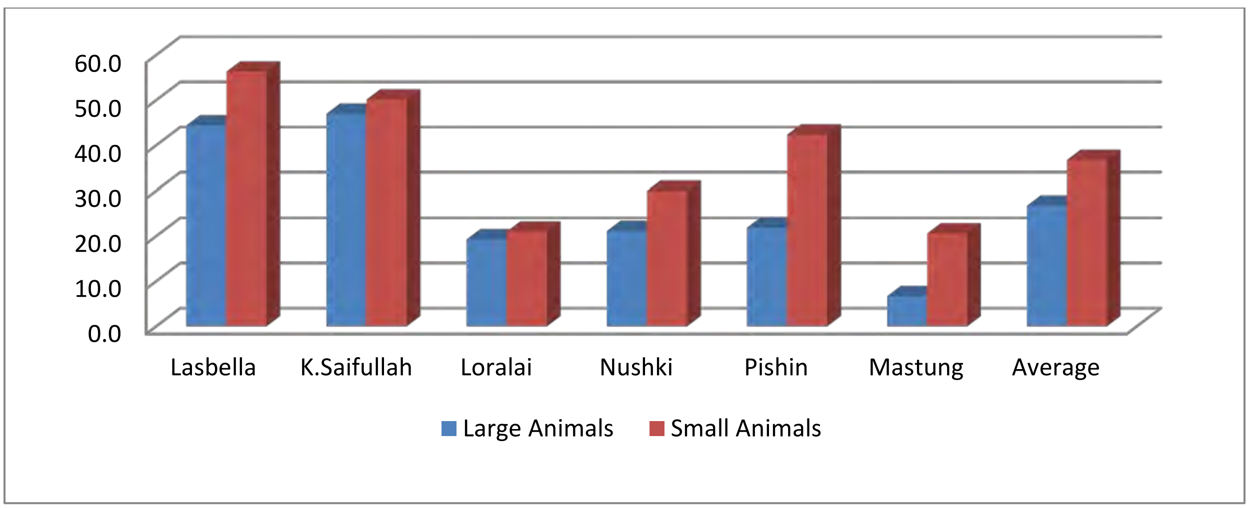

Figure 4.24: Impact of drought on livestock population (%) (Source: Survey, 2015)

Figure 4.24 shows that the losses are greater in small animals (goat and sheep). The average loss due to drought and subsequent effects were about 37%. The district wise comparison reveals that Lasbella district was highest in terms of livestock losses, followed by Killa Saifullah, Noshki, Loralai, and Mastung. The fatalities to large animals (bullock, cow, camel and donkey) are also greater in Killa Saifullah and Lasbela districts.

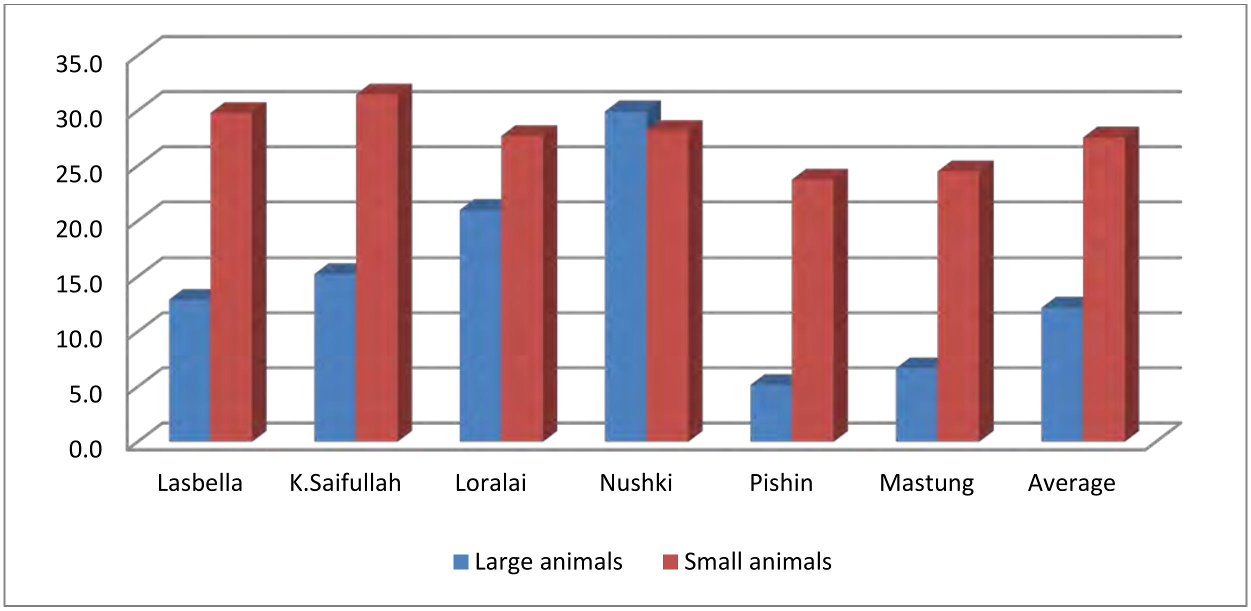

Figure: 4.25: Loss in livestock value (%) (Source: Survey: 2015)

The rural community of Balochistan mainly depends upon livestock that commonly include sheep and goat, which are badly affected by the ongoing drought. Figure 4.25 shows that the average value losses in these small animals are greater than large animals. The value loss was incurred because of low market price of animals mainly due to weight loss, increased cost of rearing and high cost of medicines. The value loss of small animals were the highest in Killa Saifullah district, whereas, the loss for large animals were greater in Nushki district.

4.3.3 Socio-economic impact of drought

The greatest impact of a drought is often on the socio-economically weaker sections of society. These include landless laborers and small-scale marginal farmers. Such people live in a hand-to-mouth economy and do not have enough asset stock to sustain them in the event of a drought. Whatever little stock they have, it is quickly exhausted and they are compelled to undertake distress sale or mortgage their belongings to wealthy landlords. Thus, whereas a drought situation brings miseries and sufferings for poor people, affluent people take undue advantage of the situation and exploit the poor. Often the poor become poorer and the rich become richer in a drought situation. A series of bad harvests plunges the small and marginal farmers in a vicious circle of poverty, eventually making them landless and penniless.

Local moneylenders charge high interest rates and the consequent inability of poor farmers to repay the loan compels them to forfeit their mortgaged property. In extreme cases, some farmers even commit suicide. Cases of suicide by farmers have been reported from time to time.

4.3.3.1 Income losses

The recent drought has affected the agriculture and livestock sectors and hence the incomes of the overwhelming majority of rural households. The 2015 survey results show that production of fruit orchards has decreased by 10%-25%, and the area and yield of cereal crops has reduced by 10%-40%. Consequently due to production losses, the incomes of farmers have reduced by almost the same proportion. Therefore, the helpless farmers are compelled to sell their valuable assets to meet the resources deficit. The status of incomes from rainfed/*khushkaba*/*salaiba* cropping is also not satisfactory and even worse than irrigated agriculture because most of the rain-dependent areas could not be sown due to untimely and insufficient rainfall in many districts of the province. The production of rainfed crops has declined by around 30% to 90% as reported by farmers. As a consequence, the economic conditions of small farmers and peasants have become miserable.

The livelihood source of a significant number of rural people is livestock. Losses in the livestock sector have plunged due to the recent drought – people sell their animals at a time when they are needed the most. Due to pasture degradation, lack of water and disease occurrence, the people dependent on this sector are very vulnerable and are in an uncertain situation. The survey results show that the livestock population of large animals has reduced from 3%-40% in different areas, the small ruminants' population has reduced by 20%-50% due to high mortality rate, incidence of diseases, high cost of rearing, low market prices due to weight loss and shortage of water. Because of these reasons, the market value of large animals has decreased by 5%-28%, while that of small animals by 20%-30%. It can be concluded that drought has worsened the economic conditions of farmers and disrupted their socio-economic equilibrium.

4.3.3.2 Nutritional losses

In Balochistan, some 48% of the population is poor and rural poverty is 51% (PBS, 2003). 63% of households there are food-insecure. Of the 20 most affected districts in Pakistan in terms of food insecurity, 10 are in Balochistan. No district of Balochistan is recognized as food-secure (SDPI et al., 2009).

In Balochistan the food insecurity phase classification at district level was done by World Food Programme (WFP) during 2014 (Appendix-C). The districts of Killa Saifullah, Loralai, and Pishin were classified as moderately food-insecure (minimally adequate food consumption, but are unable to afford some essential non-food expenditures). District Lasbela and Mastung were classified as highly food-insecure (highly stressed and critical lack of food access with high and unusual malnutrition). District Noshki (Chagai) was classified as severely food-insecure (needed immediate response due to severe lack of food access).

The recent drought has further worsened the already severe conditions of Balochistan in terms of nutrition. People are often dependent solely on agriculture and livestock for livelihoods. Crop production and livestock yields are at an all-time low. Typically, nutritional items in Balochistan are wheat, yoghurt, meat, vegetables and fruits (FAO/WFP, 2000). Previously people there would use meat and milk from their own livestock, fruits from their own orchards and vegetables from their own land. In some areas, people used to slaughter rams in winter. But the use of such energy-giving products has reduced now. Throughout the drought, they had been eating just wheat or rice and often only one daily meal (FAO/WFP, 2000). But our survey experience reveals that the people consume wheat and pulses frequently during drought. Meat consumption has however declined due to reduced affordability. Many people reported that they could barely afford meat once a week. Fruit consumption was minimal and cultural events, such as marriages, had become modest and simple food was catered during these events. People complained that their miserable conditions were due to drought.

4.3.3.3 Gender-related impact of drought

Women contribute to agriculture and related work - livestock feeding, poultry caring, harvesting, weeding of crops, etc. (FAO, 2005). However, they are socially not accepted as farmers or paid laborers despite working alongside men, and their ownership of houses or agricultural land is also disallowed. Many women are involved in home-based income-generating activities such as embroidery and tailoring (IUCN, 2011).

Women and children are those most severely affected by the drought in Balochistan. Around 35% of child deaths in Pakistan are related to malnourishment and around 60% related to water-borne diseases and poor sanitation (UNICEF 2011). The impact of the food insufficiency during disasters is acute on women and children are particularly helpless; Balochistan has the highest infant and maternal death rates in South Asia. Around 130 out of every 1,000 children who are born die in the province (PDMA, undated).

The group in society most affected by drought is women. Violence against women rises during disasters (PDMA, undated). In most rural areas, women are generally responsible for collecting water for daily household needs, often carrying it from long distances. When there is a drought, their miseries increase because they have to bring water from even more distant places. Hence they experience more physical exertion, mental stress and become more susceptible to diseases. The low quality of water in many areas also causes water-borne diseases such as cholera, diarrhea and hepatitis, especially affecting women and children.

The Gender Reform Action Plan approved by the Provincial Cabinet in July 2004, is a milestone towards gender equality. The objective of the plan is greater involvement of women in social, political and economic activities. Foreign-funded NGOs (non-governmental organizations) and the Benazir Income Support Program are also trying to reduce gender inequalities. District Social Welfare departments have also established some women's groups for training in income-generating activities.

Education for women is essential in many ways, and should be made compulsory. An educated woman is more informed about better nutrition and health choices for herself and her children, and can also have a greater decision-making role in the home to implement those choices. Higher education for women creates opportunity for better incomes.

4.3.3.4 Child education

In some areas, physical conditions such as poor infrastructure and long distances act as a hindrance for children to go to school. Children also work for the family and undertake tasks such as livestock feeding and grazing, and watering crops, as shown in Figure 4.26 of a photograph taken in Kharina village of Noshki district.

Figure 4.26: Children feeding animals in Noshki

4.3.3.5 Recreation opportunities

Previous recreational activities such as picnics and excursions has reduced or been discontinued because of the decline of incomes brought about by the drought. Moreover, recreational facilities are not widely available in the province and are particularly lacking in rural areas. Due to falling incomes, people are unable to send their children to school; instead, in many families, it was observed that children were either fetching water, feeding or grazing livestock (Figure 4.26).

4.3.3.6 Community perception on the causes of drought impact

The sampled households' responses about the causes of drought impacts are shown in Figure 4.27. Poor groundwater governance (V2), poor water resource management (V4) and community's lack of awareness of drought mitigation methods (V6) were ranked in consensus by the farmers of all the case study districts. Environmental degradation (VI), climate change (V3) and detrimental cultural practices (V5) were ranked with more than 40% response rate.

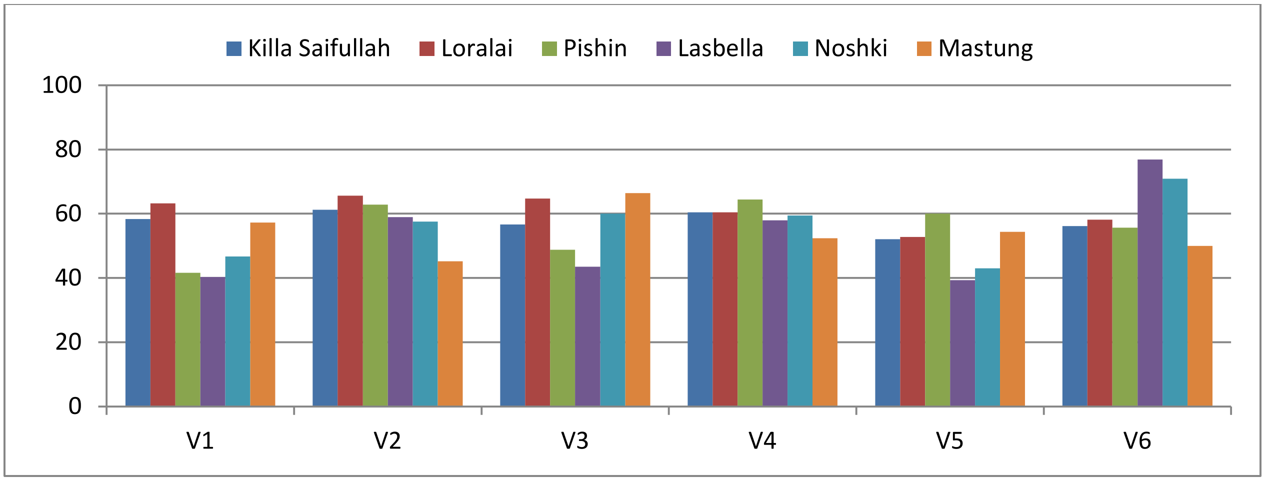

Figure 4.27: Causes of drought impacts (%) (Source: Survey, 2015)

V1 Environmental degradation

V2 Poor groundwater governance

V3 Climate change

V4 Poor water resource management

V5 Detrimental cultural practices (e.g. overgrazing)

V6 Community's lack of awareness of drought mitigation methods

4.4 Farmers' coping strategies

Figures 4.28 & 4.29 present farmers' coping strategies and their rate of adoption of these strategies in the case study districts. Reduction in cropping area is the major strategy adopted by farmers, usually reluctantly, due to the water shortage.

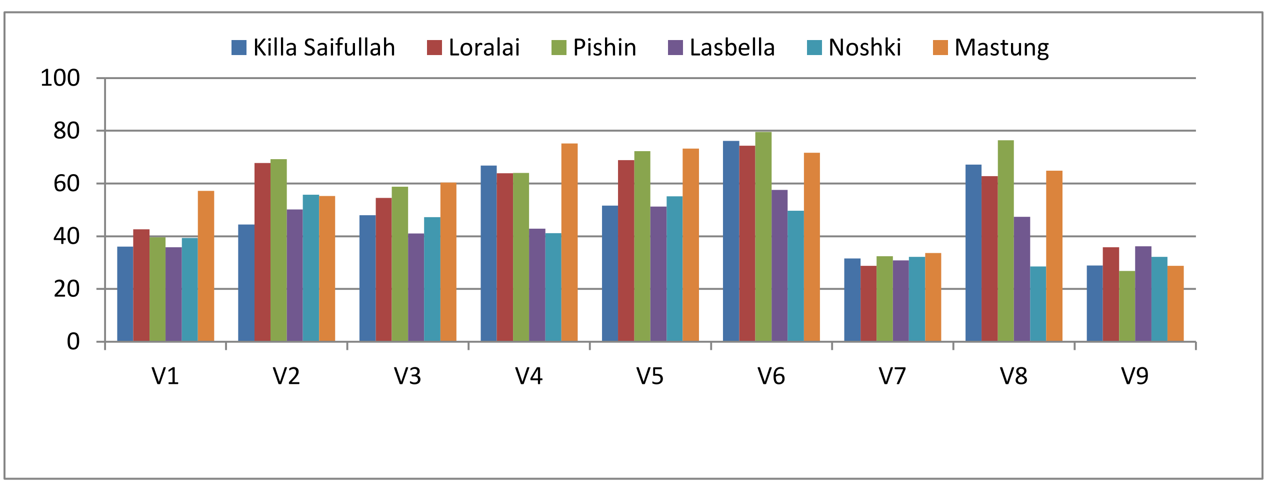

Figure 4.28: Existing coping strategies at farm level (%) **(**Source: Survey, 2015)

(Continued from previous page)

V1 Diversion from flood irrigation to controlled irrigation method
V2 Cropping pattern changes (from high delta to low delta crops)
V3 Installation of delivery pipes to supply water to orchards/crops
V4 Changes in irrigation intervals
V5 Changes in timing of irrigating crops
V6 Reduction in cropping areas
V7 Utilization of high efficiency irrigation systems (i.e. bubbler, sprinkler, or drip)
V8 Uprooted fruit trees
V9 Mulching

Figure 4.29: Irrigating fruit trees in narrow strips: a strategy for coping with drought stress

Changes in cropping patterns (from high delta crops to low delta crops) (V2) and uprooting fruit trees (V8) were the strategies adopted by farmers especially in Pishin, Loralai and Pishin districts. The response rate to other strategies is also given in Figure 4.28. Use of thermal energy tubewells was reported in Loralai and Pishin districts to meet the problem of energy shortages. In some areas the emphasis was on saving vineyards which are considered drought-resistant as compared to other deciduous fruits grown in the uplands (Figure 4.29). Farmers were also observed working on increasing irrigation efficiency by using pipes to irrigate crops and trees, narrowing down the trees basins and avoiding irrigation during daytime.

Figure 4.30: Vineyards considered a drought-resistant crop and preferred to apple - a coping strategy

4.5 Challenges in addressing drought impacts

It is important to understand the obstacles to addressing drought impacts. Figure 4.31 shows the farmers' responses on the various barriers to addressing the impacts of drought. In all the districts, lack of political will (V2) and lack of funding (V3) were considered as significant factors that hinder addressing drought impacts. This implies that there is no proper mechanism in place to monitor drought regularly, possibly due to lack of political will and/or lack of funding. The vulnerable communities are not given a helping hand to cope with the drought miseries. Lack of technical capacity at the local level is also a major barrier in all the districts as reported by interview respondents. Experts that could undertake research and understand the phenomenon are either lacking or not working in these areas. There is also a lack of sensitization of local communities towards reducing drought impact, as reported by the respondents.

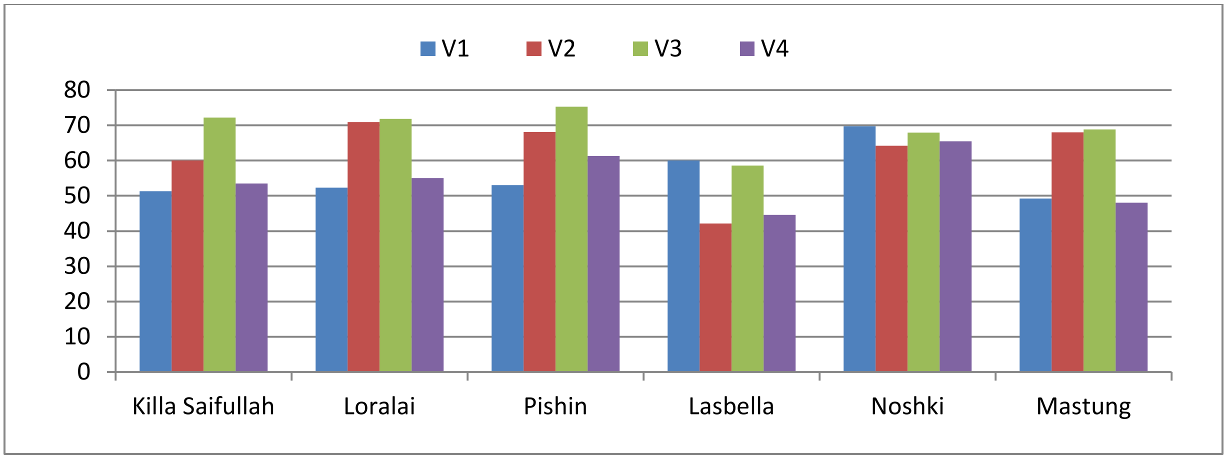

Figure 4.31: Challenges to addressing the drought impacts (%) (Source: Survey, 2015)

V1 Lack of technical capacity at the local level

V2 Lack of political will

V3 Lack of funding

V4 Lack of local awareness

4.6 Review of institutional structure and drought response mechanism of the government

According to the IPCC (2013) report, nations need to have a national drought policy that is well-coordinated. This policy must consist of monitoring, early warning systems, impact assessment procedures, risk management and drought preparedness planning, and finally, a concrete emergency response plan.

Ideally, interventions should first act to prevent resource loss at the community level, in particular by raising community awareness and clearing the confusion associated with the definition of drought. Because of the fact that different people have different perceptions of drought, its onset is often unnoticed and its impacts are not detected on time. As a result, reaction to drought is usually late, resulting in greater losses and hardships, and making the cost of emergency response and recovery even higher. This situation can be avoided only through well-planned monitoring of drought according to clear and well-defined criteria applied by trained personnel. Drought monitoring would also serve as the basis for response to which it would be closely linked. Both monitoring and response should be coordinated by a single agency (Balochistan PDMA), under the supervision of a higher authority.

The institutions of the government of Balochistan respond to droughts in a reactive mode because of the lack of an adequate early warning system. The major relevant institutions of the Government of Balochistan such as PDMA, Department of Irrigation & Power and the Department of Agriculture lack a well-coordinated drought policy. Monitoring and early warning systems, impact assessment procedures, risk management, drought preparedness and a concrete emergency response plan do not exist in Balochistan.

So far, the provincial government of Balochistan has usually reacted to drought by providing assistance on an ad-hoc basis, and the assistance activities have often been fragmented between several institutions, with limited or no coordination. To overcome these limitations, a new vision is needed with a policy that focuses on prior preparedness, with a close linkage between regular development programs and drought mitigation. The policy must also address response to drought in a manner that promotes sustainable development and management of natural resources.

4.6.1 Key institutional issues and efforts

It is necessary to establish an integrated national policy that focuses on the key sectors, and should link the different levels of government, local authorities and communities, and promote appropriate coordination in drought management mechanisms, namely, targeted support, institutional capacity building, integrated water resource management, systemic planning and sustainable development of agriculture and livelihood systems.

Drought management should be based on an integrated, comprehensive, systemic, pluralistic, participative and network-oriented strategy, recognizing and embracing all stakeholders, beneficiaries and clients. In fact, this process needs to recognize the several interrelated causes of drought as a complex phenomenon, comprising of different forms of drought – meteorological, hydrological, agricultural and socio-economic.

Drought management programs cannot be effective unless rural communities have a voice in the planning and implementation of schemes (Abarquez & Murshed, 2004). If all stakeholders are involved in drought management plans, it would transform vulnerability into strength, hazards into productive resources and would improve local capacities, and as a result, vulnerability to drought reduced. Education can focus on increasing knowledge of people for drought prevention, and empower them to participate in the operational phases of drought management.

A critical component of a national drought policy and plan must be an integrated national climate monitoring system to continuously track climatic conditions and thereby forecast water availability. Some components of such a system are already in place on the national level, they need to be upscaled. This monitoring system would provide the basis for the early detection of drought and other extreme climatic events, enabling planners, natural resource managers, and others to make more informed and timely decisions. The lessons learned from previous drought response attempts in Balochistan and elsewhere in Pakistan, need to be documented, evaluated and shared with all levels of government through post-drought audits.

4.7 Existing drought mitigation strategies in Balochistan

4.7.1 Sectoral adaptation strategy

The institutions of the government of Balochistan generally respond to drought in a reactive mode. Lack of funding resources is one of the main obstacles to properly involve various line departments in the districts where the study was conducted. Despite this situation, some adaptation strategies have been implemented and are discussed in this section.

4.7.1.1 Livestock

The Department of Livestock and Veterinary maintains regular check-ups of animals as reported in the case study districts. Daily veterinary clinics are open to the public for regular health check of animals and the department provides medication for injured and sick livestock at the district headquarter level. The relevant stakeholders at the district level reported shortage of funds as a key obstacle to extend the facility more widely to all the livestock owners.

4.7.1.2 Agriculture and water management

The Department of Agriculture has been providing technical assistance and advice to farmers on improved agricultural practices such as pesticide application, better agronomic practices and low-delta crops such as grapes, olive, pistachio and almond. Failure in the agriculture system is mostly triggered by the inadequacy of water, which is essential for the survival of crops. Dwarf varieties of apple and some commercial grape varieties, appropriate for drought-prone areas, were also disseminated in a few areas under the RAHA programme of UNDP.

Pakistan Agriculture Cold Chain Development (PACCD) has constructed cold storages (mega and mini) for major fruits in the province in order to minimize post-harvest loss of fruits. PACCD also helps farmers with the use of improved packaging material such as plastic and paper, and cotton fabric baskets for picking and packing fruits.

4.7.1.3 Water management

The water management section of the Department of Agriculture is spending a considerable amount of funds under the Public Sector Development Programme (PSDP) on construction of water tanks, water courses and provision of delivery pipes to minimize water losses in the province. In the past, a national programme for improvement of water courses and promoting high efficiency irrigation systems was also implemented for the same purpose.

The Department of Irrigation & Power is working on the development and construction of check-and-delay action dams, perennial and flood irrigation schemes, and rehabilitation of natural resources (*karezes* and springs) in the province. The provincial government of Balochistan with the help of the World Bank has implemented the Balochistan Small Scale Irrigation Project (BSSIP) to improve the management of scarce water resources in the Pishin Lora Basin (PLB).

The United Nations System in Pakistan has also initiated measures to gauge the impact of drought in the affected areas from reports of rural communities. UNDP is working on construction of water channels in farms, tanks for drinking water, delivery pipes and paving roads under the RAHA programme in a few areas of Loralai, Killa Saifullah and Pishin districts. The Food and Agriculture Organization (FAO) is working on construction of water tanks, water channels and pipelines in Loralai, Killa Saifullah, Mastung and Pishin districts.

Non-Governmental Organizations (NGOs) such as the Taraqi Foundation, Balochistan Rural Support Programme (BRSP) and WESS (Water, Environment & Sanitation Society) are working on construction of check dams and rehabilitation of *karezes* in Loralai, Killa Saifullah, Mastung and Pishin districts.

4.7.2 Community coping mechanisms and enhancement of disaster resilience

Two types of drought coping mechanisms have been well investigated (Zamani et al., 2006). First are agricultural adjustments, most commonly the sale of livestock, early sowing of seeds, no sowing, livestock diversification, plant protection, storing of crop residue, purchase of forage, investment in shallow or deep tubewells, and cultivating more water-efficient crops (Keenan & Krannig 1997; MacDonnel et al. 1995; Mortimor & Adams 2001).

Second are economic adjustments, where risks to food security are frequently anticipated and carefully planned for. Economic coping strategies relate to asset management. During non-crisis years, two sorts of assets are acquired: (1) Savings and self-insurance through accumulation of small stock and jewelry, which can be liquidated in times of crisis; and (2) Investment in assets that play a key role in production and income generation, such as oxen and land, which can be more risky and less liquid.

To improve farmers' resilience and to enable farmers and governments to better combat future droughts, various farm as well as provincial level adaptation strategies amongst the farmers with the help of government officials should be promoted. The strategies may include: (1) To develop, introduce and implement water harvesting practices at the community level through community participation; (2) To reduce wastage of irrigation water by changing irrigation practices; and (3) To introduce drought-resistant varieties of crops to increase resilience against drought. The farmers' resilience can also be created and improved over the long-term by strengthening the government's capacity to respond. Diversifying livelihoods, switching to more drought-resistant livestock species and breeds, and improving rangeland management can also contribute to resilience.

Television, radio, newspapers and cell phones should be used as tools to disseminate weather information to the community about the current and predicted state of the drought and also drought adaptation practices. In addition to the governmental drought relief measures, community-based effective planning, implementation and management should be undertaken to overcome the failure of relief measures.

4.8 Challenges in drought risk management

One of the main challenges in drought risk management in Balochistan is the lack of political will. Some of the disincentives for drought risk management are the inherent complexity of drought as a multifaceted phenomenon that stretches beyond an understanding of meteorological conditions alone and its gradual, elusive effects, the seriousness of which takes a while to become apparent. The non-structural side of drought can also create a political vacuum in which suitable interventions lose their power in comparison to other political priorities.

Even when benefits of a risk management approach seem clear, and economically and morally sound, calls for action are irrelevant if they are not in step with political needs and desires.

Balochistan faces many challenges related to development and implementation of drought risk management strategies. Factors contributing to these challenges include a lack of:

- Technical capacity at the local level;
- Technical capacity at the national/provincial level;
- Reliable data (statistics) to assess the long-term socio-economic effects of drought;
- Documentation of the impacts of drought using standardized methodologies in order to identify those sectors most affected and to devise and implement mitigation measures in a systematic manner directed at reducing those impacts;
- Understanding of the diverse impacts of drought on agriculture;
- Improved policies related to national and provincial drought risk management;
- Drought early warning systems, consisting of monitoring, prediction, and well-developed information dissemination structures and mechanisms;
- A comprehensive long-term national drought strategy with coordination and cooperation at local, national, and regional levels, and even across the border
- Political will at the national/provincial level;
- Funding;
- Local awareness;
- Other (misplaced) priorities.

Chapter 5: Policy recommendations for drought risk management in Balochistan

Taking into consideration the complex and multi-sectoral nature of drought, this chapter provides comprehensive policy recommendations on drought risk management and mitigation in Balochistan. The recommendations provided herein are based on extensive consultations with various actors in Balochistan, including technical departments at both provincial and district levels. The voices of drought-affected and at-risk communities are also taken into consideration to accommodate their needs in mitigating the impacts of droughts.

The recommendations in this document for drought risk management and mitigation consist mainly of policy-related recommendations and sectoral-based actionable measures. At the end of this chapter, a framework for drought risk management and mitigation in Balochistan is proposed, highlighting the importance of an integrated approach to drought risk management. The recommendations provided here are designed to be synergized with the UNDP recommendations under the framework of Sustainable Land Management Programme (SLMP) to Combat Desertification in Pakistan, being implemented from 2015-2020. In addition, the recommendations complement the broader framework of the Balochistan Integrated Water Resources Management and Development Project, a World Bank initiative started in June 2015.

The World Bank's initiative has three major components, as below:

1. Setting up the Integrated Water Resource Management initiative, including community mobilization and training, institutional strengthening and data management;
2. Implementation of sub-projects, including irrigation and potable water supply as well as flood and erosion risk reduction measures; and
3. River Basin Management Plan.

UNDP's SLMP initiative places emphasis on addressing the specific barriers to land management for combatting desertification, including the following issues[4]:

1. The lack of policy for land use and land management;
2. Weak institutional capacity and system gaps for proper planning and monitoring of SLM initiatives;
3. Lack of well-documented knowledge of land management practices and technologies for rehabilitation of degraded lands;
4. Low awareness of farming communities (lack of sufficient information and knowledge) regarding sustainable land management;
5. The existing land tenure system in all its forms acts as a barrier for any kind of investment by tenants for improving land, soil quality and farm capacity;

[4] A complete list of long-term solutions and barriers to SLMP in Pakistan is presented in the SLMP Project document.

6. Mainstreaming the process of Sustainable Land Management (SLM) at the federal level is slow, therefore, the provincial governments are not yet on board; and
7. The lack of government funds for sustainable land management/improvement related projects.

Integrated with those two broader initiatives in integrated water management (World Bank) and SLM (UNDP) with a focus on combatting desertification in the arid and semi-arid districts, this study proposes a framework for drought risk management and mitigation in Pakistan, highlighting the importance of an integrated approach to drought risk management. The findings and recommendations are derived from consultations with various stakeholders in Balochistan, combined with findings from interviews with local communities. The set of recommendations have been presented and verified during the PASC meetings at the provincial level in May and July 2015.

5.1 Institutionalization of drought risk management and mitigation policy

The existing situation of drought in Balochistan, which requires multi-sectoral intervention, demonstrates the urgency of institutionalizing disaster risk management. This section discusses the mechanism for institutionalization of drought risk management and presents the steps for it.

5.1.1 Mainstreaming drought risk management to support improved governance system

There is a need for adopting an approach that emphasizes drought risk reduction in all sectors, given the escalating impacts of drought in a number of sectors and current and projected trends for the increased frequency, severity and duration of drought events associated with a changing climate. The governance system in drought risk management must provide comprehensive action-oriented policy guidance based on a holistic understanding of the effects of drought with regard to human vulnerability.

Given the severity of drought, that is, drought becoming a persisting everyday phenomenon, drought risk management must be integrated and mainstreamed at all levels of governance. The agenda of drought risk management must be integrated into the long-term planning of each sector of the government so that it is reflected as a national and local priority. In practice, mainstreaming drought risk management is demonstrated by the inclusion of drought risk mitigation in the short and long-term plans of various sectors of the government, especially in the provincial and district level plans.

The process of mainstreaming drought risk management in all government sectors will cut across the other recommendations presented in the next sections. Specifically, sectoral mainstreaming of drought risk management will be discussed in Section 5.2.

5.1.2 Formulation of a provincial drought policy

The important stage of institutionalization, which reflects the mainstreaming process at the policy level, is the formulation and adoption of a provincial drought policy. The policy should provide a framework for proactive risk-based management for reducing the impacts of drought with multi-sectoral involvement of government bodies. The drought policy should also include organizational frameworks and operational arrangements, which are set up prior to the onset of drought and maintained between drought episodes by the government and/or other entities. This approach represents an attempt to create greater institutional capacity focused on improved coordination and collaboration within and between different levels of government and with stakeholders in the plethora of private organizations with a vested interest in drought management including community-based organizations, district natural resource management agencies, utility companies, agribusiness corporations and farm organizations. Focusing on land management, the SLMP initiative also emphasizes an integrated and cross-sectoral approach to sustainable land management, an initiative which may contribute to an integrated relationship between various land uses in the landscape that sustains and restores critical ecosystem services. This approach must be based on a bottom-up, participatory process that will require capacities and awareness of SLM approaches and practices to be raised at all levels.

Drought policy options should be taken into account in four principal areas: (1) Risk prediction and early warning, including vulnerability analysis, impact assessment and risk communication; (2) Mitigation and preparedness, including the application of effective and affordable practices; (3) Awareness and education, including a well-informed public and a participatory process; and (4) Policy governance, including political commitment and responsibilities (UNISDR, 2009).

This type of policy would provide a platform in which a paradigm-shift from reactive crisis management to a more comprehensive, proactive and prospective policy environment. Without a coordinated provincial drought policy that takes into consideration the above mentioned four components, the provincial government departments and agencies will continue to respond to drought impacts in a reactive and crisis management mode.

The policy, however, should not neglect the inclusion of policy options for emergency response and relief. In all cases, when severe drought occurs, governments and other organizations must provide some form of emergency relief to those sectors and communities most affected. This relief and response endeavor would also help to fulfill the goals and objectives of the national drought policy in pursuit of securing the sustainability of the natural resource base.

The proposed governance system for drought risk management in Balochistan may establish and maintain specific units in the Department of Irrigation & Power, Department of Agriculture and Cooperatives, Public Health Engineering Department, Balochistan Water and Sanitation Authority (WASA), Local Government Department, Environmental Protection Agency (EPA), and coordinated by the Provincial Disaster Management Authority (PDMA). These institutions should form a committee or task force, which is discussed in more detail in the following section.

From a water policy analysis in Balochistan (Gondal, undated), there are three main groups that need to be involved in the drought committee:

1. *Climatologists and others* who monitor how much water is available now and in the foreseeable future (monitoring committee);
2. *Natural resource managers* and others who determine how lack of water is affecting various interests - agriculture, recreation, municipal supplies, etc (risk assessment committee);

3. *High-level decision makers,* often elected and appointed officials, who have the authority to act on information they receive about water availability and a drought's effects (drought task force).

5.1.3 Establishment of a provincial drought committee and drought task force

The main mechanism of cooperation should occur and operate through the establishment of a provincial committee for drought risk management formed from representatives of various provincial government departments and agencies, who would function as members of a task force. The formation of a provincial committee would enable relevant stakeholders to effectively decide upon and implement actions. The Integrated Water Management Initiative of the World Bank (2015) also highlights the importance of establishing a task force for river basin management plans, which consists of representatives from various departments namely Forestry, Irrigation, Agriculture, Health, Public Works, and Transportation and Communications. The SLMP initiative of UNDP also emphasizes a multi-sectoral working group to address inappropriate land use as part of integrated land use planning in the broader context of land management.

The drought committee or task force would have two major purposes: (1) Supervision and coordination of development of the plan, including provision of policy recommendations; and (2) After the plan is developed and during times of drought when the plan is activated, the task force would coordinate actions, and implement mitigation and response programs.

The committee and the task force should reflect the multidimensional impacts of drought through multidisciplinary engagement. It should include representatives of government agencies and other technical institutions (such as universities).

Specifically, the provincial drought committee would be responsible for:

- Establishment of proactive mitigation and planning measures, risk management, public outreach, and resource stewardship;
- Greater collaboration to enhance the provincial observation networks and information delivery systems to improve public understanding of, and preparedness for, drought;
- Incorporation of comprehensive governmental and private insurance and financial strategies into drought preparedness plans; and,
- Coordination of drought programs and response efforts in an effective, efficient and user-friendly manner.

In a more action-oriented plan, the drought committee and task force would have the following responsibilities that:

- Collect and analyze drought-related information in a timely and systematic manner;
- Establish criteria for declaring drought emergencies and triggering various mitigation and response activities;
- Provide an organizational structure and delivery system that assures information flow between and within different levels of government;

- Define the duties and responsibilities of all agencies with respect to drought risk management;
- Provide a mechanism to ensure timely and accurate assessment of drought impacts on agriculture, industry, municipalities, wildlife, health, tourism and recreation, and other areas; and,
- Keep the public informed of current conditions and response actions by providing accurate, timely information to media in print and electronic form (via TV, radio and the Internet).

The committee should also conduct periodic reviews of the provincial drought policy and propose changes of implementation methods, if necessary. Regularly updating the existing policy should be part of the task of the provincial drought committee.

The committee should also function as a task force in various sectors relating to drought risk management, including, but not limited to, water management and conservation.

5.2 Establishment of drought forecast and early warning mechanisms

One of the major challenges for drought monitoring is the integration of hydrological, meteorological, agricultural and socio-economic information.

Pakistan Meteorological Department has established a data-collection mechanism for developing an effective early-warning system by ascertaining drought conditions. Although meteorological data is important, it only represents a part of a comprehensive monitoring system. Other physical indicators (such as groundwater and stream flow) must also be developed and monitored to reflect the impacts of drought on agriculture, households, industry, energy production and water use. The Integrated Water Management Initiative of the World Bank (2015) also emphasizes the establishment of a water management and information system, which is part of the effort in setting up an Integrated Water Resources and Management (IWRM) system.

The challenge now is how to translate that technical information to the operational level. Sectoral recommendations on drought risk mitigation given in the next section represent an effort to provide a platform on which to mitigate drought with various prongs of intervention.

Ideally, an early warning system should incorporate technology such as soil-moisture sensors, automated weather stations and GIS/remote sensing, as well as advanced modeling for climate forecasting. In practical terms, the proposed establishment of a provincial committee on drought, consisting of technical agencies of different governmental departments, should have strategies for translating drought information into mitigation plans and actions.

5.2.1 Enhancement of data communication for drought risk management

The existing system of drought monitoring and its effectiveness regarding the various sectors is one of the issues that need to be addressed in the first place. In order to have a well-established early warning system, several steps must be taken to simplify access to climatic data, and to develop and maintain a databank or database of natural resources. This would support the development of useful drought indexes to better represent drought severity across the province.

UNESCO highly recommends the development, establishment and institutionalization of a National Drought Information System (NADIS) to facilitate and represent a scientific and officially authorized information depository comprising a central database and environmental information management system(s), as well as rules and defined mandates for monitoring, early warning (preparedness) and drought management (action planning) for all sectors. Drought policy should include a strategy for access to information related to drought and water management.

The provincial government needs to take steps to enhance data communication by improving access to automatic data collection mechanisms and telecommunications. Automated meteorological and gauging stations (ATMOS) such as Telemetric Water Resources Observation Network (TeWaRON) could be installed in all basins of Balochistan, which will reduce visits to stations, alert staff to equipment malfunctions, and facilitate data-sharing. Moreover, communicating data through data-sharing networks would improve real-time data visualization and reduce the burden of metadata management. TeWaRON and NADIS should be coordinated under PDMA on a provincial level, serving the provincial and local governmental responsibilities at the same time and also providing remotely accessible official data repositories and administrative support functions.

5.2.2 Integration of drought and water resources management

It is strongly recommended that drought risk management be integrated into water resources planning and groundwater management and conservation. This is because the occurrence of drought (and floods) is related to precipitation, surface water and groundwater levels and supply. Thus information about water use and demand, natural resources, and hydrological and cultural practices relate to drought risk management as well.

Furthermore, it would be a good idea to develop a model for integrating drought and water resources management and planning by using the available climatic and water resources databases. The computer model, which would be used as a planning tool, must have a component to incorporate socio-economic-environmental knowledge and norms to highlight differential vulnerabilities. Understanding and assessing vulnerabilities are crucial to drought early warning and could help inform how to assess and monitor drought.

Sustainable management of water resources is an important area of protection against drought in Balochistan. In this relation, five pillars of groundwater management in Balochistan are recommended (adapted from Mushtaq et al., 2014).

1. ***Legal***: Strengthening and enforcing groundwater laws (as specified in the above drought policy section), including establishing clear and tradable property rights for water; better quantification of groundwater yield followed by appropriate groundwater licensing and enforcement to prevent over-extraction of groundwater; establishing appropriate systems for resource monitoring on a regular basis at the basin and sub-basin levels. This would require further work on updating the Balochistan Groundwater Rights Administration Ordinance established in 1978. One of the key recommendations of the major water management projects in Balochistan also highlights the

important process of enforcing the existing groundwater rights. This includes ADB's (Asian Development Bank) Balochistan Resource Management Program (2005), as well as the World Bank initiative of 2015, mentioned above, which focuses on basin-level water management and planning.

2. ***Economic***: Demand-side groundwater management should include a rational pricing system for efficient water use; and groundwater markets with suitable institutional mechanisms to augment water supply.
3. ***Technological***: Supply-side groundwater management options should include rainwater harvesting and surface-water use for increasing recharge; promoting conjunctive water use where possible; replacement of high delta crops with low delta crops; and the adoption of modern water-saving irrigation technologies and practice.
4. ***Social***: For adoption by the community it is necessary to provide a sense of ownership to the regional groundwater resources and developing basin-wide groundwater users' associations with responsibilities to conserve, protect, develop and manage groundwater resources to increase community welfare.
5. ***Institutional***: Development of sustainable groundwater plans will require the cooperation and coordination of a number of government agencies and key stakeholder groups; and rigorous collaboration between various departments.

These recommended measures are in line with the major donors' priority on water management in Balochistan, for example the World Bank. The measures were also highlighted in the recommendation of ADB's Balochistan Resource Management Programme in 2005.

5.3 Public awareness on drought risk management and mitigation

Implementing education and public awareness campaigns on water usage and planning is another outreach program that can be recommended. The program would create public awareness about drought in Balochistan and educate about the efficient use of water for effective drought planning and preparedness, particularly for the younger generations.

Coordinated education campaigns should target all levels of the community on the importance of water conservation and tap the knowledge of community elders. Information extension and awareness activities should reinforce an understanding of drought recurrence and possible future amplification because of climate change. Sustainable natural resource management should be promoted as being complementary to and an essential part of institutionalized drought mitigation.

Activities relating to drought awareness should also include evaluation of the impacts of awareness campaigns, design of awareness programs tailored to drought conditions at the provincial level, and a concentrated effort to unite all the departments and agencies of the Government of Balochistan.

The drought policy should also include regulation on efficient use of water at all times. Permanent 'Water Saving Rules' can be recommended to ensure efficient and fair use of water resources. A set of regulations can be established on residential and commercial uses, including regulation on how to efficiently use water for daily needs (such as, when to water the garden, and issue of permits on car wash businesses, a growing enterprise in Balochistan). In the long run, when the system is well-established, penalties can be applied. Similar water policies have been established in advanced countries such as Australia (Bureau of Meteorology, 2015). However, for a developing country such as Pakistan, given the limitations on enforcement of regulations, such policies would need to be initiated at a basic level and then improved incrementally over time.

5.4 Sectoral and cross-scale recommendations on drought risk management and mitigation

Specific sectoral recommendations have been partly presented when discussing the study findings in Chapter 4. The umbrella of sectoral interventions is rooted in the wide concept of risk-informed development. The establishment of policy should also present sectoral interventions in greater detail. Some of the prime sectoral recommendations are presented below. The findings were obtained from consultations with various stakeholders, as well as during the PASC meetings.

The sectoral recommendations presented here point to the necessity of securing access to food and livelihood. Some of the interventions are actually development-focused measures, which might foster sustainability of the community living in drought-stricken areas. In addition to proper water management and irrigation, many of the interventions would depend on applied research on forestry and agriculture, and research-and-development of drought-resistant agricultural and other products, which can be beneficial for livelihood and livestock related activities.

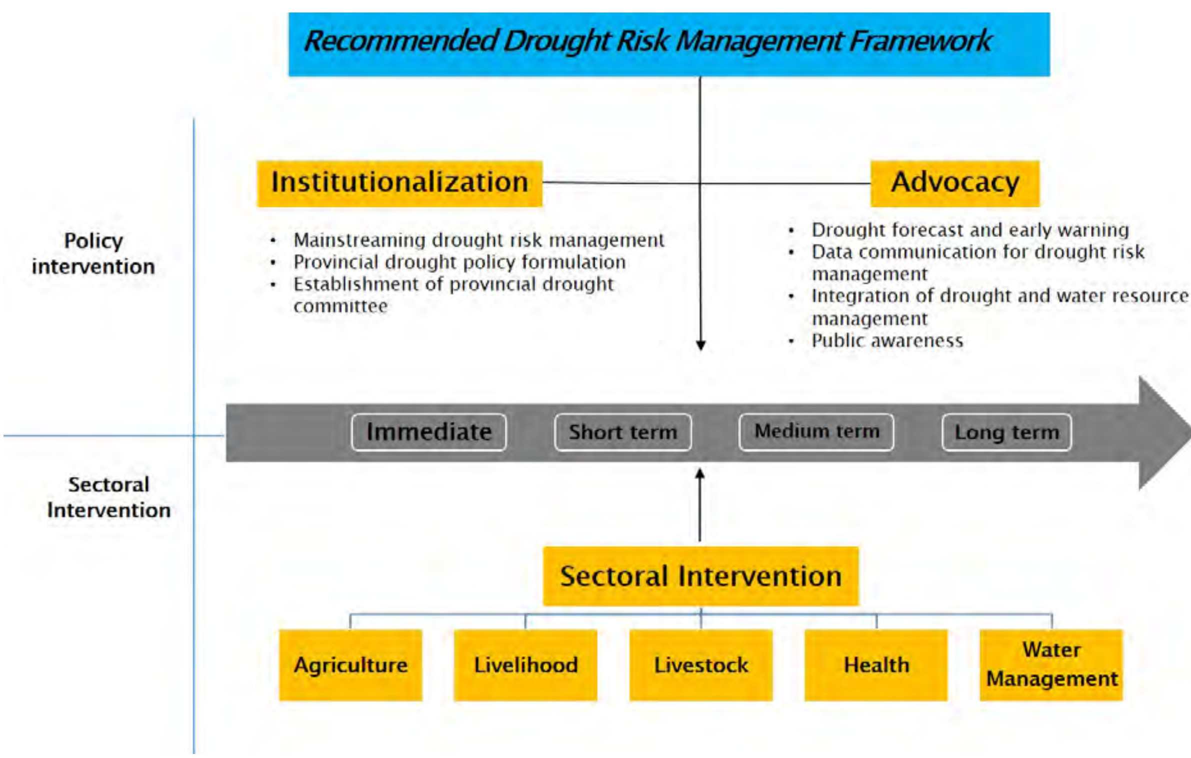

Figure 5.1: Recommended drought risk management framework for Balochistan

To date, however, a common response to drought has focused mainly on offering relief to the affected population. The provision of relief is essential to reduce the secondary incidences of hunger and starvation. However, relief-focused response to drought has shortcomings because of its slow delivery process and limited coverage due to budgetary constraints. Most importantly, a 'firefighting approach' that underlies the provision of drought relief, that is responding only when the problem becomes critical, has proven ineffective in facilitating long-term drought-proofing, despite the large amounts of money spent in drought years.

It is important that provision of relief be complemented by a long-term strategy of investment in soil and water conservation and use; policy support; infrastructure development to promote crop and income diversification in drought-prone areas; and encouragement of community participation in managing and developing local water resources. Figure 5.1 and Table 5.1 illustrate how a drought policy is cross-cutting and multi-scalar in terms of its timeframe.

Table 5.1: Sectoral elements of the recommended drought risk management policy according to timeframe

	Immediate	Short term	Medium term	Long term
Cross cutting	▪ Establishing a local coordinating body to ensure emergency response based upon priorities	▪ Increasing communication of climate-related information with specific advisories ▪ Increasing local drought monitoring capacity and infrastructure ▪ Establishing food subsidy programs for drought-affected individuals ▪ Providing support to the most vulnerable groups, such as women and children	▪ Promoting rainwater harvesting ▪ Establishing a system for sharing of experience and capacity development for vulnerable groups in their adaptation measures/responses ▪ Strengthening market access and rural infrastructure	▪ Addressing deforestation and desertification (land degradation in drylands) ▪ Reviewing the effectiveness of mid-term measures and strengthening capacities as needed ▪ Reinforcing legal, policy and institutional frameworks for drought risk mitigation and drylands development
Agriculture	▪ Seed distribution and stockpiling cereals ▪ Low-interest agriculture loans and emergency assistance programs ▪ Pest prevention in the drought context ▪ Change in cropping patterns focusing on low delta crops / low water requirements	▪ Promoting short duration crops	▪ Introducing improved soil management techniques that decrease soil erosion and increase water-holding capacity of soil ▪ Adopting alternative cultivars or crops that are more drought-resistant and/or heat-tolerant ▪ Selecting drought-tolerant, quick maturing crops	▪ Addressing deforestation and desertification (land degradation in drylands) ▪ Improving on-farm water management practices for agricultural production

Livestock	▪ Providing supplementary livestock feeding (e.g. fodder, forage, hay distribution, water hauling, opening of strategic grazing areas) ▪ Promoting emergency vaccination and de-worming ▪ Growing water-resistant bushes for livestock ▪ Medicine supply for livestock	▪ De-worming and vaccination	▪ Livestock monitoring and inventory maintenance	▪ Systematic grazing / strategic grazing areas ▪ Identification of common diseases and development of disease prevention strategies
Livelihood	▪ Supplying food aid and other necessities to affected communities	▪ Supplying food aid and other non-food support to affected communities	▪ Seed distribution and stockpiling cereals to support agricultural livelihoods ▪ Low-interest agriculture loans and related livelihood assistance programs	▪ Investigating business and farm diversification strategies (e.g., drought-tolerant varieties, market access and rural infrastructure development)
Water management and resources	▪ Facilitating borehole rehabilitation and water- trucking ▪ Providing water access to affected communities ▪ Water-efficient technologies ▪ Rehabilitation of *karezes* and natural springs	▪ Developing water use guidelines based on the type and duration of drought	▪ Improving water management practices for household and agricultural use	▪ Improving groundwater management and governance ▪ Establishment of water conservation policy ▪ Improving groundwater management and governance ▪ Supply side management (e.g. dam, delay action dam). ▪ Demand side management (introduction of high efficiency irrigation system, on-farm water management)

Chapter 6: Conclusion

Drought in Balochistan, characterised by a diversified environment ranging from semi-arid to hyper-arid, is a multi-variate phenomenon with a number of contributing factors. Upland Balochistan is the most heavily affected area of the province. Drought has been a recurring phenomenon in the province since the 1960s and about 60-70% of the population face direct or indirect risk to drought. The main factors behind drought risk are increased human pressure on land and the absence of adequate water management. The lack of rainfall associated with climate change has also contributed extensively to the current drought situation. Recently, rainfall has been recorded as one fourth of the usual rate of 200-250 mm, resulting in diminished water availability and reduced resilience of the ecosystem. In addition, a significant increase in the frequency of heatwaves, an indicator of forthcoming increase in drought, has been reported in Balochistan in the last five years. The abrupt decline in rainfall in most of the upland areas of the province has caused a complete drying up of surface drinking water resources and has decreased water output from springs and tubewells. This has caused the water table to drop in most of the upland valleys.

The study selected six case study districts representing the four agro-climatic zones of Balochistan - uplands, coastal, plains and desert. These districts are Killa Saifullah, Lasbella, Loralai, Mastung, Nushki, Pishin.

The study reveals that different types of drought are likely to prevail in Balochistan. Meteorological drought, which is caused by less than average precipitation, triggers other types of drought, including agricultural drought, hydrological drought, and socio-economic drought. Through a generic analysis, the study further reveals that the case study districts Loralai, Mashtung and Pishin experience moderate drought, while other the two districts (Nushki and Lasbella) experience mild and moderate drought. Mild drought is characterized by less than average annual precipitation, whereas moderate drought is characterized by significantly less precipitation resulting in yield losses of irrigated crops.

The impacts of drought have led to a chain of incidences. Findings from interviews with various governmental line departments in the province, validated by interviews in local communities, reveal that the drought has impacted food insecurity, which is primarily caused by the decline in crop yields, livestock losses and depletion of water for agricultural and daily use. Malnutrition and decline in health quality has also been reported, resulting from the lack of access to safe drinking water. The incidence of drought has also contributed to an increase in crime rate and forced sale of land and household assets.

The study provides several recommendations to strengthen institutionalization, and advocacy and sectoral strategies, for immediate, short-term, medium-term and long-term interventions for drought risk management.

Mainstreaming drought risk management in all relevant sectors is recommended for comprehensive drought risk management policy and practice in the province. Formulation of a provincial drought policy is an important avenue for this important process, which should include: (1) Early warning based on risk and vulnerability analyses, impact assessment and risk communication; (2) Mitigation and preparedness, including the application of effective and affordable practices; (3) Awareness and education, including a well-informed public and a participatory process; and (4) Policy governance, including political commitment and responsibilities.

The establishment of a drought committee and task force and strengthening the existing provincial institutional structure is considered important for implementing proactive drought mitigation and planning measures, and managing greater collaboration between the various relevant sectors to ensure proper implementation of the recommended drought risk management measures presented in this report.

References

Abarquez, I. and Murshed, Z. (2004). *Field Practitioners' Handbook: Community-based Disaster Risk Management*. Bangkok, Asian Disaster Preparedness Center and United Nations Economic and Social Commission for Asia and Pacific (UNESCAP).

Aga Khan University, Pakistan Medical Research Council (PMRC), Government of Pakistan (2011) National Nutritional Survey. Islamabad, UNICEF (United Nations International Children's Emergency Fund).

Ahmad, S. (2005). Drought in Balochistan. Water for Balochistan Policy Briefings, 3(4). TA-4560 (PAK) Project for sup.Ahmad, S. (2007). *Persistent Drought of Balochistan and Impacts on Water Availability and Agriculture*. Water for Balochistan: Policy Briefings, 3(6).

Ahmad, S. (2006) "Issues Restricting Capping of Tubewell Subsidy and Strategy for Introducing the Smart Subsidy in Balochistan" in *Water for Balochistan Policy Briefings*, vol. 2, no. 1, under the project for supporting implementation of IWRM policy in Balochistan, Government of Balochistan, Asian Development Bank and and Royal Government of the Netherlands.

Ahmead, K., Shahid, S., Sobri, H. and Wang, X. (2015) *Characterization of Seasonal Droughts in Balochistan*. Heidelberg (Germany), Springer-Verlag Berlin Heiderberg 2015.

Anjum, S.A., Saleem, M.F., Cheema, M.A., Bilal, M.F., Khaliq, T. (2012) "An Assessment to Vulnerability, Extent, Characteristics and Severity of Drought Hazard in Pakistan". *Pakistan Journal of Science*, vol. 64, no. 2, p. 85.

Bureau of Meteorology (Government of Australia) (2015) "Water Restrictions". Available from: http://www.bom.gov.au/water/restrictions/?waterRestriction=7053 (accessed: 7 November, 2015)

FAO (2005) *Rural Women and and Food Security in Asia and the Pacific*. Bangkok, FAO (Food and Agriculture Organization of the United Nations) Regional Office.

FAO/WFP (2000) *Special Report of FAO/WFP Crop and Food Supply Assessment Mission to the Baluchistan Province of Pakistan*. Rome, FAO (Food and Agriculture Organization of the United Nations) and Islamabad, World Food Programme.

Ganguly, P. and Reddy, M..J. (2014) "Evaluation of Trends and Multivariate Frequency Analysis of Droughts in Three Meteorological Subdivisions of Western India. *International Journal of Climatology*, vol. 34, no. 3, pp. 911–928.

Girona, J., Behboudian, M.H., Mata, M., Del Campo, J., and Marsal, J. (2010) "Exploring Six Reduced Irrigation Options under Water Shortage for 'Golden Smoothee' Apple: Responses of Yield Components over Three Years. *Agricultural Water Management*, no. 98, pp. 370–375.

Government of Balochistan (2010) *White Paper on Budget 2010-11*. Quetta, Department of Finance.

Government of Balochistan, (2011). *District Development Profiles (DDPs) of Ddifferent Ddistricts*. Quetta, Planning and Development Department.

Government of Balochistan. (1947-2010). *Agriculture Statistics of Balochistan*. Quetta, Department of Agriculture Extension, Balochistan, Pakistan.

Government of Balochistan. (2013-2014). *Agriculture Statistics of Balochistan*. Quetta, Department of Agriculture Extension, Balochistan, Pakistan.

Halcrow and Cameos (2008). *Supporting Public Resource Management in Balochsitan: Identification of Recharge Potential Zones in Three Over-drawn Basins (PLB, Nari, and Zhob)* (report). Islamabad, Halcrow Pakistan (Pvt) and Cameos Consultants.

Heim, J.R., and Richard, R. (2002) "A Review of 20th Century Drought Indices Used in the United States". *Bulletin of the American Meteorological Society*, vol. 83, no. 8, pp. 1149-1165.

IPCC (2013) Climate Change 2013: The Physical Science Basis. Contribution of Working Group I to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change [Stocker, T.F., D. Qin, G.-K. Plattner, M. Tignor, S.K. Allen, J. Boschung, A. Nauels, Y. Xia, V. Bex and P.M. Midgley (eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA.

IUCN (2011) *Integrated District Development Vision of Different Districts of Balochistan*. Karachi, IUCN (International Union for Conservation of Nature and Natural Resources).

Jayanthi, H. and Husak, G. (2013) "A Probabilistic Approach to Assess Agricultural Drought Risk" in UNISDR (2013) *Global Assessment Report on Disaster Risk Reduction*. Geneva, UNISDR (United Nations Office for Disaster Risk Reduction).

Keenan S.P. and Krannig, R.S. (1997) "The Social Context of Perceived Drought Vulnerability". *Rural Sociology*, vol. 62, no.1, pp. 69–88.

Khair, S.M. and Culas, R.J. (2013) "Rationalizing Water Management Policies: Tubewell Development and Resource Use Sustainability in Balochistan Region of Pakistan". *International Journal of Water*, vol. 7, no. 4, pp. 294-317.

MacDonnel, L.J., Getches, D.H., Hugenberg, W.C. (1995) "The Law of the Colorado River: Coping with Sustained Drought". *Water Resources Bulletin*, vol. 31, no. 5, pp. 825–836.

McKee, T. B., Doesken, N. J., and Kleist, J. (1993) "The Relationship of Drought Frequency and Duration of Time Scales", paper presented in the *Eighth Conference on Applied Climatology, American Meteorological Society*, Jan17-23, 1993, Anaheim CA, pp.179-186.

Mortimor, M.J. & Adams, W.M. (2001) "Farmer Adaptation, Change and Crisis in the Sahel". *Global Environmental Change*, no. 11, pp. 49–57.

Mushtaq, S. and Reardon-Smith, K. and Stone, R. and Khair, S.M. (2013) *A Blueprint for Sustainable Groundwater Management in Balochistan, Pakistan*. In: Free flow: Reaching Water Security through Cooperation. Paris, UNESCO, pp. 222-224.

Nalbantis, I., and Tsakiris, G. (2009). "Assessment of Hydrological Drought Revisited". *Water Resources Management*, vol. 23, no. 35, pp. 881-897.

Naor, A. (2006). "Irrigation Scheduling and Evaluation of Tree Water Status in Deciduous Orchards". *Horticultural Reviews*, no. 32, pp. 111-166.

NDMC (2013) *Climate of Pakistan*. Islamabad, National Drought Monitoring Centre (NDMC).

PARC (1980). *Agro-ecological Regions of Pakistan*. Islamabad, PARC (Pakistan Agricultural Research Council), Islamabad, 1980.

PBS (2003) Household Integrated Economic Survey. Islamabad, PBS (Pakistan Bureau of Statistics).

PDMA (Provincial Disaster Management Authority) (2012) "Droughts in Balochistan". Available from: http://www.pdma.gob.pk/?p=54 (accessed: 7 November, 2015).

PDMA (Provincial Disaster Management Authority) (undated) "Situation Analysis: Balochistan – Incorporating Gender in Disaster Risk Management". Available from: http://www.pdma.gob.pk/wp-content/publication/Situation%20Analysis-Geneder%20and%20Child%20Protection%20Cell.pdf (accessed: 7 November, 2015).

Pereira, L.S., Corderly, I. and Lacovides, L. (2009) *Coping with Water Scarcity: Addressing the Challenges*. New York, Springer Science & Business Media.

SDPI, World Food Programme and Swiss Agency for Development and Cooperation (2009*). Food Insecurity in Pakistan*. Islamabad, SDPI (Sustainable Development Policy Institute).

Survey (2015) *Drought Assessment Survey in Balochistan*. Quetta, BUITEMS (Balochistan University of Information Technology, Engineering & Management Sciences) and Islamabad, UNDP (United Nations Development Programme).

Tiwari K.N., D.K., Paul and Gontia, N.K. (2007). "Characterization of Meteorological Drought". *Hydrology Journal*, vol. 30, no. 1-2, pp. 15-27.

UNDP (2015) *Request for Proposals (RFP): Drought Risk Assessment in Selected Districts of Balochistan*. Islamabad, UNDP (United Nations Development Programme).

UNICEF (2011) *Annual Report for Pakistan, 2011*. Islamabad, UNICEF (United Nations International Children's Emergency Fund).

UNISDR (2009) *Drought Risk Reduction Framework and Actions*. Geneva, UNISDR (United Nations International Strategy for Disaster Risk Reduction).

Wilhite, D.A., and Glantz, M.H. (1985) "Understanding the Drought Phenomenon: The Role of Definitions". *Water International*, vol. 10, no. 3, pp. 111–120.

WMO (2005) *Drought Assessment and Forecasting*. Geneva, WMO (World Meteorological Organization).

Zahid, M. and Rasul, G. (2012) "Changing Trends of Thermal Extremes in Pakistan". *Climatic Change*, no. 113, pp. 883-896.

Zamani G.H., Gorgievski-Duijvesteijn, M.J. and Zarafshani, K. (2006). "Coping with Drought: Towards a Multilevel Understanding Based on Conservation of Resources Theory". *Human Ecology*, no. 34, pp. 677–692.

Appendix A: Distribution of sampled households on the basis of union council (UC)

District	Union Councils	Frequency	District	Union Councils	Frequency
Pishin	Malikyar, Sheikhalzi	13	**Killa Saifullah**	Kan	9
	Tora Shah, Kamalzi	12		Sori Kan	12
	Sar Khanzi	16		Kanchoghi	4
	Kass	9		Tubli	15
	i. Total	**50**		Sharan Jogezi	10
Loralai	Dargi, Lahore	15		**ii. Total**	**50**
	Poonga, China Alizi	21	**Noshki**	Daak	17
	Toratana	13		Inaam Bostan	18
	Shabozi	8		Ahmed Wall	17
	iii. Total	**57**		**iv. Total**	**50**
Mastung	Khad Kucha	14	**Lasbela**	Kanraj	18
	Sor Ghaz	15		Kahnwari	19
	Mastung 1	21		Dureji, Lakhra	11
	v. Total	**50**		Sakran, Pania Loharani	9
				vi. Total	**57**
vii. Sub Total (i+iii+v)		**157**	**viii. Sub Total (ii+iv+vi)**		**157**
Grand Total (vii+viii)				**314**	

Appendix B: Groundwater balance in an average year (billion m^3)

Basin	Average Recharge	People	Livestock	Agriculture	Total	Balance
Dasht River Basin	0.100	0.013	0.012	0.069	0.094	0.006
Gaj River Basin	0.070	0.001	0.001	0.070	0.072	-0.002
Gawadar - Ormara	0.040	0.004	0.003	0.017	0.025	0.015
Hamun-e-Lora	0.040	0.001	0.001	0.139	0.141	-0.101
Hamun-e-Mashkel	0.300	0.008	0.007	0.012	0.027	0.273
Hingol River Basin	0.200	0.005	0.007	0.156	0.168	0.032
Hub River Basin	0.080	0.001	0.001	0.086	0.088	-0.008
Kachhi Plain	0.180	0.017	0.012	0.140	0.169	0.011
Kadanai River Basin	0.030	0.000	0.005	0.110	0.115	-0.085
Kaha Basin	0.190	0.000	0.004	0.315	0.319	-0.129
Kand River Basin	0.010	0.000	0.000	0.018	0.019	-0.009
Kunder River Basin	0.050	0.000	0.000	0.048	0.048	0.002
Mula River Basin	0.120	0.002	0.001	0.126	0.129	-0.009
Nari River Basin	0.270	0.006	0.004	0.171	0.180	0.090
Pishin Lora Basin	0.170	0.024	0.029	0.513	0.566	-0.396
Porali River Basin	0.140	0.002	0.003	0.142	0.146	-0.006
Rakhshan River Basin	0.050	0.003	0.003	0.075	0.081	-0.031
Zhob River Basin	0.160	0.002	0.001	0.267	0.270	-0.110
Balochistan	**2.210**	**0.091**	**0.094**	**2.474**	**2.659**	**-0.459**

Source: Halcrow and Cameos, 2008

Appendix C: Phased food security classification of districts in Balochistan province

IPC Phase		General Description	District
1	**Generally Food Secure (Minimal Food Insecure)**	More than four in five households (HHs) are able to meet essential food and non-food needs without engaging in typical, unsustainable strategies to access food and income, including any reliance on humanitarian assistance. *(Usually adequate and stable food access)*	Quetta
2	**Moderately/ Borderline Food Insecure (or Stressed)**	Even with any humanitarian assistance at least one in five HHs in the area have the following or worse: Minimally adequate food consumption, but are unable to afford some essential non-food expenditures with engaging in irreversible coping strategies. *(Borderline adequate food access with recurrent high risk (due to probable hazard events and high vulnerability) of sliding into Phases 3, 4 or 5)*	Killa Saifullah, Loralai, Barkhan, Zhob, Ziarat, Pishin, Sibi, Nasirabad, Jaffarabad, Sohbatpur, Kech, Killa Abduallah,
3	**Highly Food Insecure requiring immediate attention (Crisis)**	Even with any humanitarian assistance at least one in five HHs in the area have the following or worse: Food consumption gaps with high or above usual acute malnutrition. Or are marginally able to meet minimum food needs only with accelerated depletion of livelihood assets that will lead to future food consumption gaps. *(Highly stressed and critical lack of food access with high and above usual malnutrition and accelerated depletion of livelihood assets that, if continued, will slide the population into Phases 4 or 5 and/or likely result in chronic poverty)*	Sherani, Musakhel, Harnai, kohlu, Lehri, Kacchi, Kalat, Jhal Magsi, Nushki, Washuk, Khuzdar, Panjgur, Lasbella, Gawadar, Mantung
4	**Severely Food Insecure requiring immediate response (Emergency)**	Even with any humanitarian assistance at least one in five HHs in the area have the following or worse: Large food consumption gaps resulting in very high acute malnutrition and excess mortality. Or extreme loss of livelihood assets that will lead to food consumption gaps in the short term. *(Severe lack of food access with excess mortality, very high and increasing malnutrition, and irreversible livelihood asset stripping)*	Chaghai, Dera Bugti, Awaran, Kharan,
5	**Famine or Catastrophe (Large Scale Immediate Humanitarian response)**	Even with any humanitarian assistance at least one in five HHs in the area have an extreme lack of food and other basic needs where starvation, death and destitution are evident. (Evidence for all three criteria of food consumption, wasting, and CDR is required to classify Famine) *(Extreme social upheaval with complete lack of food access and/or other basic needs where mass starvation, death, and displacement are evident)*	None

Source: World Food Programme (2015)

Appendix D: Household survey drought risk assessment baseline information in Balochistan

Enumerator's Name ________________________________

District ____________________ Tehsil _______________________ Village ___________________

Altitude of the area from sea level____________________ Latitude of study area______________

Longitude of study area_____________________________ GPS ID________________________

Household head's name ________Gender ______Male/Female

Age (years)__________ Education (schooling years)___________

1. Occupation of household head

Occupation type	Yes	No
Agriculture (Irrigated annuals- crops, vegetables etc)		
Agriculture (Irrigated perennials- orchards)		
Dryland (Rainfed/Khuskawa, Sailaba (crops)		
Dryland (Livestock)		
Dairy farming		
Other (specify):		

2. Demographic and socio-economic information of other household family members

Family members	Relationship with household head	Gender (M/F)	Age (Years)	Education (Schooling years)	Occupation	Estimated Income
1						
2						
3						
4						
5						
6						
7						
8						
9						
10						
Total						

3. Social involvement of family members

Over the past 12 months have you or your family members been involved with any groups which could fall into the following categories:

Type of group	**Involvement (yes/no)**
Crop based cooperative	
Dairy cooperative	
Water user cooperative/association	
Cultural group	
Political group or movement	
Water management group	
Local schools	
Sporting group	
Landcare or Waterwatch group	
Social group	
Other (specify)	

4. Land use & Irrigation sources

Plot #	Area (acre)	Type of land 1. Irrigated 2. Rainfed	Source of irrigation 1. Tubewell 2. *Kareze* 3. Spring 4. Other	Cultivated by 1. Owner 2. Owner cum tenant 3. Tenant 4. Other
1				
2				
3				
4				
5				

5. Crop patterns and changes over time (acres)

	2013		2015	
	Area	Yield (kg)	Area	Yield (kg)
Apple				
Apricot				
Peach				
Plum				
Grapes				
Almond				
Pomegranate				
Banana				
Chickoo				
Other				
** ***Rabi* crops**				
Wheat				
Barley				
Lentil				
Maize				
Vegetables				
Other				
*Fallow land other than current fallow				
*** ***Kharif*** crops				
Maize				
Vegetables				
Melon				
Cotton				
Pulses				
Other				
* Fallow land other than current fallow				

* *All land which is used for cultivation, but temporarily not cultivated for a period of not less than 1 year and not more than 5 years*

** ***Rabi*** is a cropping season that begins in October-December and ends in April-May

*****Kharif*** is a cropping season that begins in April-June and harvesting during October-December

5.1 Specify the reasons for any changes in the cropping pattern

6. Rainfed/*Sailaba*/*Khushkaba* cropping over time (acres)

	2013		2014		2015	
Crop	Sown	Harvested	Sown	Harvested	Sown	Harvested
Wheat						
Barley						
Cumin						
Mong						
Mash						
Other						

6.1 Reasons for change in area under rainfed/sailaba/khushkaba crop cultivation

____

____

____

____

____

7. Livestock & poultry inventory (before and after drought)

Livestock	Number in 2013	Number in 2015	Purchased last year	Sold last year	Approximate Value (Rs)	Cost items	Rs/Year
Bullock/Ox						Fodder	
Cow						Straw	
Buffalo						Supplementary feed	
Camel						Wheat/Barley Grain	
Sheep/Goat						Medicine	
Horse						Labor	
Donkey						Shelter	
Poultry						Other	
Other							

8. Estimated gross family income (Rs/year)

S. No	Enterprise/Activities	Income (males)	Income (females)	Total Income
		A-Farm Income		
1	Income from irrigated agriculture			
2	Income from non-irrigated agriculture			
3	Income from livestock			
4	Any other (specify)			
		B-Off-farm Income		
1	Shop keeping			
2	Daily wages earning			
3	Other (specify)			
	Gross income (A+B) (Rs)			

8.1 Have you been affected by drought in terms of income losses **Yes/No**

If yes, then specify sector wise as follows:

Agricultural losses (Yes/No)____________________ _If yes, specify the losses in Rs or volume

____

____

Livestock losses (Yes/No)_______________________If yes, specify the losses in Rs or volume

____

____

Off farm income sources (Yes/No)________________If yes, specify the losses in Rs or volume

____

____

Any other Losses (Yes/No)______________________If yes, specify the losses in Rs or volume

____

____

____

9. Nutrition intake and estimated food expenditures (Rs/month)

Item	Expenditure	Item	Expenditure
Wheat flour		Milk	
Rice		Medicines	
Vegetables		Clothes	
Meat (beef/mutton/chicken/fish)		Education	
Pulses		Transportation	
Oil/Ghee		Utility bills	
Sugar/Gur		Savings	
Tea		Other	

9.1 Did the drought affect the monthly intake of any of the above mentioned food items **Yes/No**

If yes, then specify

____

____

____

____

10. Water resources and management

10.1 Tubewell Owners' Perceptions on the Groundwater Situation

Item	Unit	Response
First tubewell installed since	Yrs	Experience of tubewell
Type of tubewell		Diesel/electric/solar
Tubewell operation duration	Hours	Jan……Feb. …….March……… April…May…. June…………..… July …….Aug.….Sept………….. Oct. ………Nov..…….Dec………..
Power supply (average)	Hours	Summer season………………… Winter season…………………..
Watertable depth when you installed tubewell	Meter	
Since then average decline in watertable…………….per year.	Meter	
Reasons for rapid decline in watertable during the last few years.	Var.	1. Extensive pumping of groundwater 2. Subsidized electricity 3. Over irrigation 4. Inefficient irrigation techniques 5. Mass installation of tubewells in nearby area 6. Other (specify)
No of tubewells in 1000^2 meter area When you first installed TW	Meter	
Now the number of TW/1000^2	No.	
Have the TW installation norms[a] been followed here?	Var.	1. Yes and 0 otherwise
How many of yours tubewells have dried since your first TW?	No.	
Success rate in tubewell installation	Ratio[a]	[a]Ratio = Successful/Total installed
Effect of newly installed TW in nearby area on discharge flow of your TW.	Var.	1. No effect 2. Minor 3. Major
If yes, magnitude of effect as percentage change in flow of TW	%	
If your tubewells have dried, then from where are you getting water now?	Var.	1. Fellow farmers 2. Friends/relatives 3. Purchase water 4. None
History of depth of water table	Meter	<u>Year Watertable</u> 2015 ……… 2014 ……… 2013 ……… 2012 ……… 2011 ………

[a] Tubewell Installation Norm is a rule that is meant to monitor inter-tubewell distance and allow new tubewell installation at a certain distance from an already working tubewell.

11. Water scarcity and climate change

- Are you aware of the climate change issue?

  a. Yes b. No

- What is the source of information on climate change issues?

  a. Radio b. T.V. c. Newspaper d. NGOs

  e. Government departments (PDMA, Metrological Department, etc) f. Fellow farmers

  g. Other

- Do you see any type of climate change effect on your fields?

  a. Yes b. No

- Is the climate change issue responsible for water scarcity in your area?

  a. Yes b. No

- Is climate change a man-made problem?

  a. Yes b. No

- What are the key impacts of climate change in your area?

  a. Change in cropping pattern b. Discontinuation of agriculture

  c. Seasonal agriculture d. Use of water saving technologies

  e. Other

12. Water scarcity coping strategies at the farm level

Strategies	Effectiveness on water saving				
	Very Low	***Low***	***Moderate***	***High***	***Very High***
Diversion from flood irrigation to controlled irrigation method					
Cropping pattern changes (from high delta to low delta crops)					
Installation of delivery pipes to supply water to orchards/crops					
Changes in irrigation intervals					
Changes in timing of irrigating the crops					
Reduction in crop areas					
Utilization of high efficiency irrigation system (i.e. bubbler, sprinkler or drip)					
Uprooted trees (fruit name)					
Mulching					
Other (specify)					

13. Vulnerability context

Indicate the significance of the following drought impacts in your life

Description	Very low	Low	Medium	High	Very high
Decline in crop yields/food insecurity					
Livestock losses					
Forced sale of household assets					
Forced sale of land					
Increase in crime rate					
Depletion in water for agricultural use					
Depletion in water for human use (drinking, cleaning and cooking)					
Decline in health (through malnutrition or lack of safe drinking water and spread of diseases)					
Other					

14. To what degree do the policy frameworks and plans of organizations/government/other agencies support drought risk management?

Description	No	Occasionally	Often	Completely
Do they emphasize prevention of drought measures?				
Are they taking measures to deal with new drought risk?				
Are they supportive of long-term investment to overcome deep-rooted problems?				
Is the participation of the public and NGOs encouraging to combat drought?				

15. To what degree is drought and other hazards related awareness and knowledge shared?

- Never
- Rarely
- Often
- All the time

16. What are the main causes of drought in your area?

	Least important	Somewhat important	Very important	Most important
• Environmental degradation				
• Poor groundwater governance				
• Climate change				
• Poor water resource management				
• Detrimental cultural practices (e.g. overgrazing)				
• Lack of access by communities to information on how to reduce drought impacts				
• Other				

17. What are the barriers to addressing drought impacts in your area?

	Least important	Some important	Very important	Most important
Lack of technical capacity at the local level				
Lack of political will				
Lack of funding				
Lack of local awareness				
Other priorities				
Other				

18. What has been the most effective approach to manage drought, and could it be replicated in a different context? How?

1.
2.
3.
4.

Appendix E: Key informants survey questionnaire

Enumerator's Name ______________________ ____________________Date_________________
District ____________________ Tehsil _______________________ Village ___________________
K.I. 1 Name ______________ Gender [_________] 1. Male 2. Female Occupation____________
K.I. 2 Name ______________ Gender [_________] 1. Male 2. Female Occupation____________
K.I. 3 Name ______________ Gender [_________] 1. Male 2. Female Occupation____________
K.I. 4 Name ______________ Gender [_________] 1. Male 2. Female Occupation____________
K.I. 5 Name ______________Gender [_________] 1. Male 2. Female Occupation____________
K.I. 6 Name ______________Gender [_________] 1. Male 2. Female Occupation____________
K.I. 7 Name ______________ Gender [_________] 1. Male 2. Female Occupation____________

Village Profile

Facility	Yes/No	Distance (Km)	Facility	Yes/No	Distance (Km)
Metal Road			Water Supply Scheme		
Basic Health Unit			Post Office		
Veterinary Center			Implements Repair		
Agr. Extension Office			Input Dealer(s)		
School (Boys) primary/middle/high			Output Market		
School (girls) primary/middle/high			OFWM office		
Commercial Bank			Agri .Research Station		
Transport			Soil Fertility Lab		
Electricity			NGOs		
Pesticide Dealer			Other		

Major Occupations of the people in the village (please click the right √ option/s)

Agriculture: (crops / orchards / or both)
Livestock: (Small ruminant / dairy farming / or both)
Other: (specify)
1.____ 2.____
3.____ 4.____
5.____ 6.____
7.____ 8.____

Have the enterprises of the livelihoods changed due to the drought? (Yes No)
If yes, then what are the alternate sources of livelihood?

1.____ 2.____
3.____ 4.____

Major crops and source of irrigation of the respondents in the village

Serial No	Major crops/orchards	Type of land 1. Irrigated 2. Rainfed	Source of irrigation 1. Tubewell 2. *Kareze* 3. Spring 4. Other	Cultivated by 1. Owner 2. Owner cum tenant 3. Tenant
1				
2				
3				
4				
5				

What are the common disasters that you experience in your village

____

____

Can you list the big disasters in the last 10 years?

____

____

Causes of these disasters

____

____

Are the people are affected by the drought? 1. Yes 2. No

If yes then identify the losses and what measure take to overcome the losses?

Losses	**Measures taken to cover the losses**
1.	
2.	
3.	
4.	
5.	

Please indicate the significance of the following drought impacts in your life

Impact	Very low	Low	Medium	High	Very high
Decline in crop yields/food insecurity					
Orchard dried					
Livestock losses					
Forced sale of household assets					
Forced sale of land					
Increase in crime					
Depletion in water for agricultural use					
Depletion in water for human use (drinking, cleaning and cooking)					
Decline in health (through malnutrition or lack of safe drinking water and epidemic diseases)					

To what degree is drought awareness and knowledge shared?

- Never
- Rarely
- Often
- All the time

How do disasters usually affect the livelihoods of the respondents in the village?

____

____

____

Climate change and water scarcity

I. Are you aware of the climate change issue?

a. Yes b. No

II. What is the source of information on climate change issues?

a. Radio b. T.V. c. Newspaper d. NGOs

e. Government departments (PDMA, Metrological Department, etc) f. Fellow farmers

g. Other

III. Do you see any type of climate effect on your field?

a. Yes b. No

IV. Is climate change responsible for water scarcity?

a. Yes b. No

V. Is climate change a man-made problem?

a. Yes b. No

VI. What are the key impacts of climate change?

a. Crop choices b. Crop types c. Crop diversification

d. Discontinuation of agriculture e. Seasonal agriculture

f. Water use g. Water allocation h. Water saving technologies

Perceptions on Groundwater Situation

S #	Item	Unit	Response	Explanation
1	Reasons for decline in water table	Var.		1. Extensive pumping of groundwater 2. Subsidized electricity 3. Over irrigation 4. Inefficient irrigation techniques 5. Mass installation of tubewells in nearby area
2	No of tubewells in 1000^2 meters area in 2005	Meter		
3	Now (2015) the number of TW/1000^2 in the village	No.		
4	Have the TW installation norms[a] been followed here?	Var.		1. Yes 0. Otherwise
5	Success rate	Ratio		Ratio = Successful/Total installed
6	History of depth of water table	Meter		Year Water table Year Water table 2015 ……… 2009 ……… 2014 ……… 2008 ……… 2013 ……… 2007 ……… 2012 ……… 2006 ……… 2011 ……… 2005 ……… 2010 ………
7	Effect of newly installed TW in nearby area on discharge flow of your TW.	Var.		1. No effect 2. Minor 3. Major
8	If yes, magnitude of effect as percentage change in flow of TW	%		

[a] Tubewell Installation Norm is a rule that is meant to monitor inter-tubewell distance and allow new tubewell installation at a certain distance from an already working tubewell

How many Karezes and springs are functional in your village? (Number) ________________________

How many *Karez*/springs existed in the village? (Numbers) *Karez* _________ Spring___________

Recall the years passed____________________________

To you, what are the reasons for abolishment of kareze/spring system?

1.

2.

3.

4.

Do you think that the karezes and springs can be rehabilitated? Yes/No

If yes, how?____

If no, why? ____

Water scarcity coping strategies

Strategies	**Effectiveness on water saving**				
	Very Low	***Low***	***Moderate***	***High***	***Very High***
Diversion from flood irrigation to controlled irrigation method					
Cropping pattern changes (from high delta to low delta crops)					
Installation of delivery pipes to supply water to orchards/crops					
Changes in irrigation intervals					
Changes in timing of irrigating the crops					
Reduction in crop areas					
Utilization of high efficiency irrigation system (i.e. bubbler, sprinkler or drip)					
Uprooted trees (fruit name)					
Mulching					
Other (specify)					

Is there any CBO prevailing in the village? 1. Yes 2. No

If yes then specify organization's name____

What sort of benefits does the organization provide in relation to drought?

____

____

Are there any social / community groups in your area? 1. Yes 2. No

Type of group	***Involvement (yes/no)***
Crop-based cooperative	
Dairy cooperative	
Water-user cooperative/association	
Religious group	
Political group or movement	
Water management group	
Local schools	
Sporting group	
Land care or Water watch group	
Social group	
Other (specify)	

What coping strategies should be adopted by government/agencies to overcome the drought problem?

1.____

2.____

3.____

4.____

Appendix F: Stakeholders survey questionnaire

Enumerator's Name ________________________________ District ___________________________

Tehsil __________________________________ Gender [______] 1. Male 2. Female

Organization's Name_______________________________ Designation______________________

Service Experience_______________________________

What are the common disasters in your Town/city?

____

What are the causes of those disasters?

____

____

Why does drought become a phenomenon?

____

____

What are the causes of the phenomenon?

____

____

Which particular UCs or villages of the administrative unit are being affected the most?

____

____

How has the drought been affecting the area?

____

____

Identify the sector wise losses as per following table:

Sector	Extent of losses	Any measures taken to control these losses by the government/NGOs, etc
Agriculture		
Livestock		
General health (mal nutrition and epidemic/other diseases)		
Degradation of pasture land		
Other		

An estimation of drought effects on the agriculture sector

Indicators	Affected by drought (%)
Reduction in crop yields/productivity	
Orchard (destroyed) dried	
Rainfed/khushkaba/sailaba farming	
Unemployment	
Other	

An estimation of drought effects on the livestock sector

Indicators	Affected by drought (%)
Livestock mortality	
Excess of diseases (specify)	
Feed insecurity	
Rangeland degradation	
Abnormal migration	
Forced sale livestock at minimal prices	
Other	

What are the vulnerability factors and their susceptibility as identified by the government?

Factors	Least susceptible	More susceptible	Most susceptible
Rainfall variability			
Drought intensity			
Source of water for irrigation dries up			
Increases default on loans in rural areas			
Pasture degradation			
Forced sale of livestock at minimum prices			
Other			

Have there been any changes occurring in people's livelihood sources due to the drought? (Yes/No)

If yes, then what are the alternate sources of livelihood after drought?

1.________________________________ 2.________________________________

3.________________________________ 4.________________________________

Have community members in the respective areas been informed about the drought phenomenon? 1. Yes 2. No

Do you have a specific strategy on drought risk management? 1. Yes 2. No

Have you informed other related department in the area of your responsibility about this phenomenon? 1. Yes 2. No

If yes, then specify

____

____

Water scarcity coping strategies

Strategies	Effectiveness on water saving				
	Very Low	Low	Moderate	High	Very High
Diversion from flood irrigation to controlled irrigation method					
Cropping pattern changes (from high delta to low delta crops)					
Installation of delivery pipes to supply water to orchards/crops					
Changes in irrigation intervals					
Changes in timing of irrigating the crops					
Reduction in crop areas					
Utilization of high efficiency irrigation system (i.e. bubbler, sprinkler or drip)					
Uprooted trees (fruit name)					
Mulching					
Other (specify)					