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Drought Series. Paper 4

Analysis of Drought Coping Strategies in Baluchistan and Sindh Provinces of Pakistan

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IWMI International Water Management Institute

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Contents

Summary

This paper present the results of a comprehensive drought survey in Sindh and Baluchistan provinces of Pakistan, designed to understand the impacts of droughts on the livelihood systems and personal security of the population at the household and village level. It also reviews the role of government agencies and NGOs in providing relief to the drought-affected areas.

These two provinces were selected for this study, as they were usually perceived as the most drought-prone areas of Pakistan. During the recent drought of 1997–2001, these two provinces received less than 50% of their normal rainfall. The lower precipitation during this period resulted in reduced river flows and loss of precious human lives. Thousands of livestock heads also died due to the shortage of fodder crops. During 1999–2000 alone, 143 persons and 2.5 million livestock heads died due to the severe drought conditions. The drought of the year 2001 was the worst in the history of the country, which reduced the economic growth rate to 2.6 percent as compared to an average growth rate of over 6 percent. Furthermore, the drought reduced the country's ability to produce hydroelectricity, meaning that oil had to be purchased for this purpose. This fact alone caused an additional loss of nearly US$1.2 billion.

The field survey was conducted during the first half of 2004. Three different questionnaires for village level, household level and government agency/NGO level were developed for this study. The questions regarding perceptions on drought, their effects, coping strategies, causes of drought, role of NGOs and government agencies, in addition to basic information on the structure and characteristics of the villages, were included in the questionnaires. Interviews were held both at formal group or community level and at household level.

From each province, two districts that were "severely drought-hit" were selected, one from a rain-fed area and the other from an irrigated area. Ten villages were surveyed from each selected district. From each sample village, 15 respondents were interviewed. In total, about 300 respondents from the two provinces of Pakistan were interviewed for this study. All the agencies and department that were working for drought-relief and mitigation measures were interviewed as well.

Most of the people in the selected villages were mainly uneducated and their perceptions on drought relate to their environment and facts of everyday life. The perceptions of farmers on drought were different in the Sindh and Baluchistan provinces. In rain-fed areas of the Sindh province, people see a drought when "there is no water for agriculture," and/or there had been "no rainfall during the previous year or for more than one year." In rain-fed areas of Baluchistan they consider it a drought when tube wells do not pump groundwater. The general perception of the people was that the drought of 1997–2001 was not over as yet and difficult days might return.

The majority of the villagers in the selected villages were dependent on agriculture and some livestock-rearing. But due to persistent drought conditions during 1997–2001, the people are depending more on mixed occupations. There was a severe impact of drought on fodder crops and orchards. About 55% of the fodder crop and 60% of orchards were damaged due to this drought. On average, about 7 goats/sheep per household in Sindh and 16 per household in Baluchistan died during this drought. Almost the same numbers of goats/sheep were sold at three times lower than the normal prices for fear of their death. Nonavailability of water and feed for animals was reported as the major reason for these deaths.

The survey results indicate that the most impeding effect of drought was reduction in household incomes. From rain-fed areas of both provinces more than 9% of the people migrated to irrigated areas or nearby towns to find alternative income-generating off-farm activities to supplement their household incomes. Lack of drinking water for people and livestock was also reported as the major

reasons for the migration. This increased the burden on women as they were forced to do household income-generating activities in addition to their other duties.

Women and children in rain-fed areas have to walk about 2–8 km daily to fetch water from communal wells or hand pumps to meet their domestic needs. This caused great stress to the household women, especially when their male members were away from home in search of jobs.

About 60% household respondents living in drought-affected areas received some help from different NGOs (national and international). The help was mostly provided in rain-fed areas and consisted of flour, oil, pulses, sugar, tea, etc., given daily. The quantity and quality of the help provided were not sufficient for the average family, especially in the Sindh province. The efforts of NGOs and government agencies to provide relief measures were relatively better organized in the Baluchistan province than in the Sindh province. The respondents have serious concerns regarding distribution of relief items. Food items were mainly distributed in easily accessible areas whereas remote areas remained out of the reach of most NGOs and government agencies.

The respondents suggested that, to better cope with the drought in future, availability of potable drinking water should be given priority. Infrastructural development and extending small credit facilities to the drought-affected areas are also necessary to save people from the devastating effects of drought. Farmers should also be educated to adopt water-conservation strategies at both the household and field level. The respondents also felt the need to introduce more rainwater-harvesting techniques to store more and more rainwater. To strengthen anti-drought efforts, coordination between different NGOs and government agencies should be enhanced. Farmers' participation in drought-relief efforts should be increased to address their concerns.

Introuction

Drought is a normal, recurrent feature of climate. It occurs almost everywhere although its features vary from region to region. Defining drought is therefore difficult and remains the subject of severe debate in scientific literature. A definition depends on the regional features, the needs for which it is defined and the disciplinary perspectives. In Libya, a drought may be defined as an event occurring when annual rainfall is less than 180 mm. However, in Bali, a drought might be considered to occur after a period of only 6 days without rain. In the most general sense, drought originates from a deficiency of precipitation over an extended period of time, resulting in a water shortage for some activity, group or environmental sector. Whatever definition is adopted, a drought cannot be viewed solely in terms of climate (UN 2001) but should also be seen in social and economic contexts.

Drought refers to a condition of low rainfall over prolonged periods and denotes extreme scarcity of water resources. Drought is defined differently, and has different effects, in each of Pakistan's agro-ecological zones. As drought is a relative, rather than an absolute, condition it should be defined for each region. These specificities must be taken into account when analyzing the effects of drought, establishing drought-mitigation efforts and planning for drought in the future.

Although drought is essentially a climatically induced phenomenon its actual effects in a given eco-zone and the viability of responses to it will be mediated by ecological, social and infrastructural factors, as well as by the relevance, efficacy and timeliness of responses from governments, NGOs and the private sector. When drought begins with the lack of precipitation, the agriculture sector is usually the first to be affected because of its heavy dependence on stored soil water. Soil water can be rapidly depleted during extended dry periods. If precipitation deficiencies continue, then people dependent on other sources of water begin to feel the effects of the shortage. Those who rely on surface water (i.e., reservoirs and lakes) and subsurface water (i.e., groundwater), for example, are usually the last to be affected.

During 1997–2001, an exceptionally severe dry spell hit the regional countries like Pakistan, India, Afghanistan and some parts of Iran, affecting a population of about 60 million in these countries. The persistent drought that occurred in Pakistan during 1997–2001 has severely affected crop production and livestock in the country, with serious consequences for the food security and livelihood of a large segment of the population. This drought seriously affected the southern, southern-eastern, northwestern and western regions of the country, including some areas in the north. However, the severity was much higher in the provinces of Baluchistan and Sindh. According to the UN (2001), the drought in these provinces has been gradually progressing since 1997 but it became evident only in 2000 when things started turning worse. The initial reports mainly came from livestock owners who faced a situation where very little grass was left in the ranges and survival of the existing number of livestock became impossible. Later on, the effects of the drought became more pronounced and engulfed the human/livestock population, crops and water resources.

Vulnerability to drought exists in a continuum in Pakistan. The basic eco-agricultural distinction in terms of normal rainfall is between irrigated and rain-fed areas. A further distinction differentiates semiarid from arid areas, and desert areas from semiarid areas. All have suffered from the drought.

Drought is a conceptually and operationally complex phenomenon. In addition to the climatic factors, communities' histories of coping with reduced rainfall, people's settlement patterns and economies (e.g., degrees of resilience of agriculture, livestock and horticulture for subsistence) will affect their ability to respond to drought. The nature of the mechanisms they have adopted over

the years in response to drought is also important. People's access to power structures (political, governmental, community and household) will also affect their ability to respond.

During the drought of 1997–2001, government agencies and NGOs made their best efforts to reduce the impact of drought and to provide relief to communities. In addition to these efforts, people living in drought-prone areas continue their efforts to cope with drought conditions using their indigenous wisdom and means. In most parts of Sindh and Baluchistan provinces, drought is not a new phenomenon and, therefore, over time, local communities have developed strategies that can be used against drought as a shield. The recent drought (1997–2001) was the worst in the history of Pakistan and, therefore, preparations and management capacities of government agencies and NGOs to deal with the situation were fully exposed. A large number of people in drought-hit areas were unable to get relief assistance on time, which resulted in casualties and migration of people and livestock to other irrigated areas. This situation has resulted in an enormous amount of unrest in the civil society and embarrassment for the local governments.

This study planned to do a comprehensive situation analysis in the most drought-affected Sindh and Baluchistan provinces of Pakistan. Its primary focus was to learn about farmers' attitude and level of knowledge about the drought phenomenon, its effects on their socioeconomic conditions, coping strategies and the role of NGOs and government organizations in mitigation and relief measures. It was envisaged that this study will provide useful information about *"where we are"* and *"what more needs to be done"* to fight future droughts in a better way. The major objectives of the study were:

- To get first-hand information on farmers' perceptions regarding drought, its socioeconomic effects, coping strategies adopted by them and the role of different government agencies and NGOs in drought-mitigation efforts.

- To document lessons gained during the previous drought cycles.

- To review and analyze coping strategies at village and household levels adopted by various population groups and stakeholders in mitigating drought.

- To suggest technical, institutional and policy interventions for preparedness and management of future droughts.

Physiography and Social Profile of the Sindh and Baluchistan Provinces

Sindh Province

Sindh is the third largest province of Pakistan with an area of 140,935 km^2 (18% of the country total) and a population of 32 million (23% of the country total) out of which about half is living in rural areas. Administratively, Sindh is divided into 20 districts. The rural population is scattered in more than 10,000 villages across Sindh. There are about 60 houses in each village in rain-fed areas and more than 100 houses in irrigated areas. The scatter of villages is mainly based on the availability of water. The majority of the rural population comprises small subsistence farmers who make their living out of small agricultural fields. The average landholding varies from 1 hectare to 2 hectares with an average of 1.3 hectares. Holdings, each under 20 hectares, account for only 5% and those, each over 60 hectares, account only for 0.3%. The distribution of farm size in irrigated and rain-fed areas is given in table 1 (GOP 2000).

Table 1. Distribution of farm size in Sindh.

Size of farm (ha)	Farms		Average size of farm (ha)
	Number	%	
<0.5	63,753	6	0.4
0.5–1.0	148,213	14	0.8
1.0–2.0	278,660	26	1.3
2.0–3.0	197,871	18	2.1
3.0–5.0	193,596	18	3.1
5.0–10.0	102,373	10	5.0
10.0–20.0	58,160	5	9.3
20.0–60.0	23,567	2.7	21.7
> 60.0	3,688	0.3	65.3

About 40% of the area in Sindh is arable and 5% is rangeland. Out of 14 million hectares of potential cultivable land, only 5.6 million hectares are presently cultivated. About 65% of this area is irrigated whereas the rest (35%) is rain-fed. Cotton, rice, wheat and sugarcane are the main crops produced in Sindh. Rice is the major crop in irrigated areas and wheat is the major crop in both irrigated and rain-fed areas. Cotton and sugarcane are next in importance. Table 2 gives the area, production and yield of major crops in Sindh (GOP 2001).

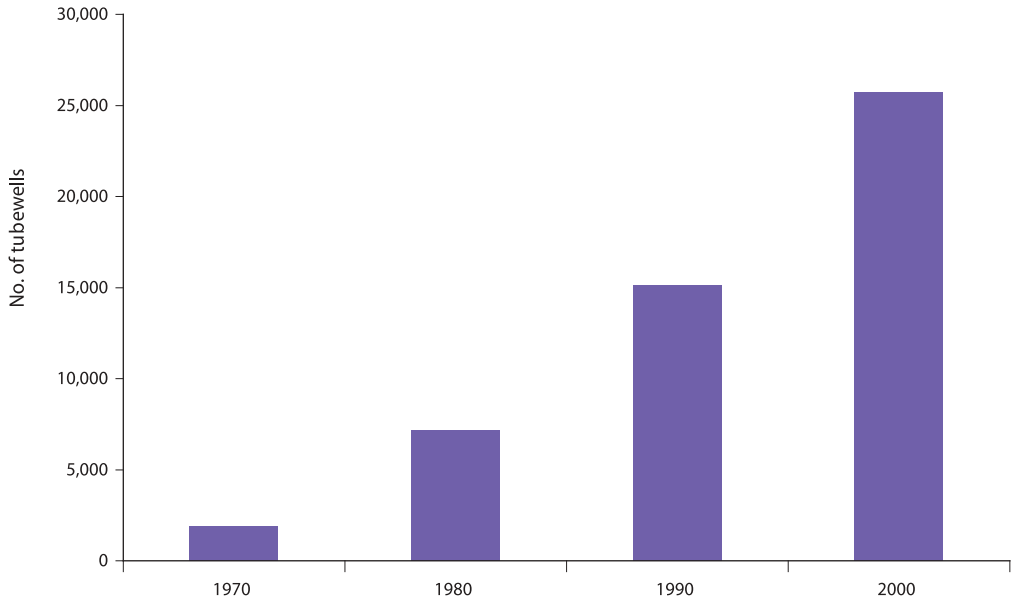
Table 2. The average area, production and yield of the major crops in Sindh.

Crops	Area ('000 ha)	Production ('000 tons)	Yield (kg/ha)
Wheat	1,123.7	2,675.1	2,381.0
Rice	704.1	1,930.3	2,741.5
Cotton*	630.2	2,134.1	1,727.0
Sugarcane	270.8	17,050.7	62,964.2

*Cotton ('000 bales).

Sindh has 14 publicly owned irrigation systems, which receive water from three barrages across the Indus river. In Sindh, about 94.8% of the area is irrigated with canal water and only 5.2% of the area is dependent on groundwater for irrigation. Farmer's dependence on groundwater has increased manyfold due to decreasing surface supplies over the past decade. Under normal wet years, people in Sindh are used to collecting runoff water from monsoonal rains in the village ponds for domestic and livestock consumption in rain-fed areas. In the areas where groundwater is of relatively good quality, farmers have installed shallow tube wells in large numbers to increase their access to groundwater. Figure 1 shows the historical development of the private tube wells in Sindh. Presently, there are more than 25,000 tube wells operating in Sindh which extract more than 12% of the total groundwater pumpage in Pakistan (Qureshi et al. 2003).

Figure 1. Growth in number of tube wells in the Sindh province.



The quality of groundwater in most parts of Sindh is only marginally fit for irrigation and it ranges from 5,000 to 15,000 ppm. With the increased overexploitation of groundwater, the water table depth in many parts of Sindh is falling by 0.5 to 1.0 meter annually and has affected the people having shallow tube wells. Currently, in many parts of the desert, groundwater is available at depths of 30 to 150 meters. As a result, it is not easily accessible to many living in these areas. Usually, people travel long distances to get potable drinking water from shallow wells. Camels and donkeys are usually used to lift groundwater.

The region of the Sindh province is a large desert with large annual variation in the rainfall. Rainfall in the monsoonal months (July to September) is the main source of water to support crop growth, rangeland, livestock and the human population. Rainfall ranges normally from 200 to 250 mm and it permits growing of millet as the main food crop and cluster beans as the main cash crop; it also supports the growth of seasonal and perennial grasses on the grazing lands providing feed resources to animals for the whole year. It also recharges the thin freshwater layer and provides

opportunities for collection of surface water flows in open ponds. If there is no rainfall during the monsoonal season, a drought situation may emerge, which normally results in acute shortage of food and fodder. Due to the continuous drought spell, range grasses may dry up completely causing a serious food shortage for livestock, which is a primary source of subsistence in this area.

Baluchistan Province

Baluchistan covers 44% of the total area of Pakistan and has a population of 6.6 million (only 5% of the country's total population). More than 85% of this population live in rural areas. Agriculture and livestock are the main economic activities in the rural areas. Due to traditional and historical practices in the arid climate of Baluchistan the rearing of small ruminants is dominant. Baluchistan contributes 46% sheep, 23% goats and 41% camels to the total animal population in Pakistan. The cultivated area of Baluchistan is 1.7 million hectares, out of which half is irrigated. An area of about 4.4 million hectares is culturable waste, 1.0 million hectares are forests and the other 21 million hectares are covered by rangelands (Nawaz 2000). The average landholding in irrigated areas is between 2 and 5 hectares whereas in rain-fed areas it varies from 2 to 10 hectares. The classification of farm sizes in irrigated and rain-fed areas of Baluchistan is given in table 3 (GOP 2000).

Table 3. Farm size distribution in Baluchistan.

Size of farm (ha)	Farms		Average size of
	Number	%	farm (ha)
<0.5	21,275	6	0.2
0.5–1.0	30,553	9	0.5
1.0–2.0	41,932	13	0.9
2.0–3.0	43,173	13	1.4
3.0–5.0	70,078	21	2.7
5.0–10.0	65,863	20	4.6
10.0–20.0	34,109	10	6.9
20.0–60.0	23,090	7	13.2
> 60.0	4,197	1	49.6

In Baluchistan, canal irrigation covers a very small area (only 3 out of 26 districts are canal irrigated) and the rest is irrigated through the control of floodwater, rain, karezes, springs and tube wells. Although irrigated crop production plays a dominant role in the agricultural economy of Baluchistan, dryland farming of the *sailaba* (flood water) and *khushkhaba* (rain-fed) types has been important for the livelihoods of the majority of the people. Both sailaba and khushkhaba systems are fully dependent on natural precipitation and therefore their performance keeps on changing with the rainfall patterns. The average area, production and yield of the major crops in Baluchistan are given in table 4.

Table 4. The average area, production and yield of the major crops in Baluchistan.

Crops	Area ('000 ha)	Production ('000 tons)	Yield (kg/ha)
Wheat	333.6	650.8	1920
Rice	116.5	340.6	2878
Cotton	40.4	61.9	1506
Sugarcane	0.675	35.5	51622

Agriculture, in 23 out of the total 26 districts, is done through control of floodwater, rain, karezes, springs and tube wells. Presently there are 800 karezes and more than 21,000 tube wells in the province. During 1998–2002 the drought greatly affected the density of the private tube wells. The growth of the number of private tube wells in Baluchistan is almost identical to that in Sindh (figure1).

The climate ranges from semiarid to hyperarid and temperature regimes vary widely from cool temperate to tropical. Cold winters and mild summers characterize the northern highland region. Most winters receive precipitation ranging from 250 to 350 mm. In the southwestern desert zone, the annual rainfall ranges from 50 to 125 mm and the region experiences the hottest summers, with the temperature rising occasionally above 50 °C. Annual evaporation rates are very high ranging from 3,200 mm to over 5,000 mm.

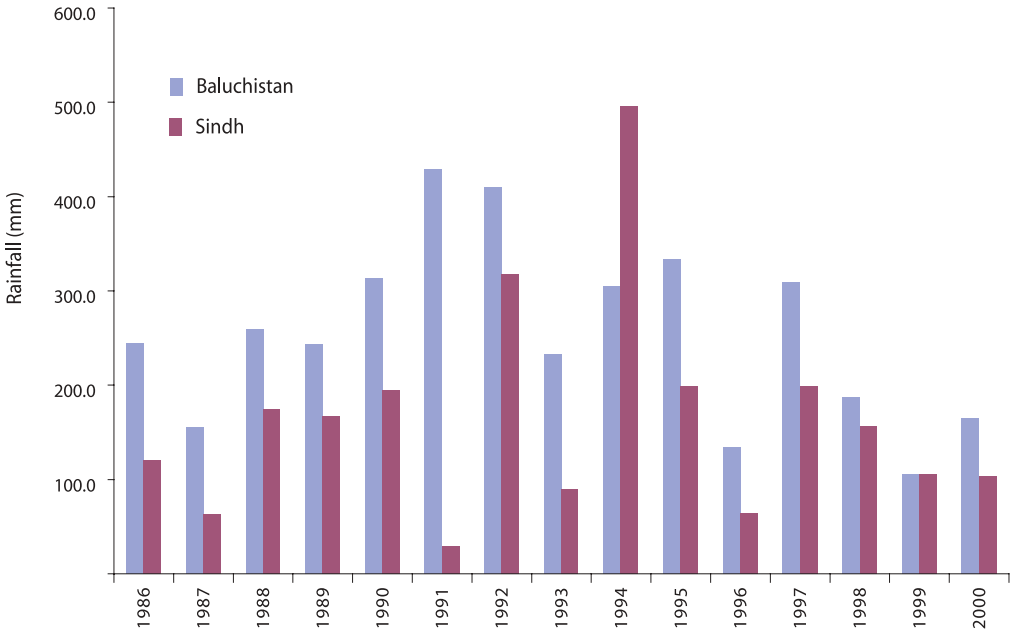
Although the province is a net importer of basic food staples such as wheat, traditional cereal production including wheat, rice, barley, sorghum and millet has remained important to its agricultural economy. The high altitude and the aridity in the atmosphere provide an ideal environment for the production of quality deciduous fruits in Baluchistan. The province's share of many deciduous fruits like apple, plum, pear, apricot, peach and pomegranate and non-deciduous fruits like date ranges from 35 to 85% in Pakistan's total production. The province has an exclusive monopoly in Pakistan for the production of quality grapes, almond and cumin.

Review of the Recent Drought Impacts in the Two Provinces

Pakistan is predominately arid with low rainfall and higher solar radiation over most parts of the country. The average annual rainfall in Baluchistan and Sindh provinces is about 160 mm as compared to 400 mm in the Punjab province and about 630 mm in the North-West Frontier Province (NWFP). Therefore, even a small negative deviation from the low mean rainfall creates additional water scarcity in the Baluchistan and Sindh provinces and makes them more vulnerable to drought.

Pakistan has a previous history of droughts but the frequency of droughts has increased in recent years. The drought phenomenon (dry year) has been observed to occur in 4 out of 10 years instead of 3 out of 10 years. Rainfall during 1997–2001 was exceptionally low, i.e., 50% of the normal. This was the longest dry spell in the country's 55-year history. During this period, the monsoonal rains have lowered only eastern parts of Baluchistan with limited and scattered rainfall whereas in large parts of the western and central areas there was no rainfall during this period. The Sindh province and rain-fed areas of Punjab suffered equally from shortage of water due to the 40% lower average rainfall. Figure 2 illustrates low rainfall in Sindh and Baluchistan provinces during 1996–2000.

Figure 2. Annual rainfall in Baluchistan and Sindh over the period 1986–2000.



Exceptional low rainfalls during 1997–2001 resulted in low river flows with the loss of both precious human lives and thousands of livestock heads, the latter due to shortage of fodder crops. The cumulative loss, during these 4 years was estimated at 43% of the country's livestock population. According to the UN (2001) estimates, during 1999–2000 alone, 143 human beings and 2.5 million livestock died due to severe drought conditions. During this drought period, Sindh had to face a loss of Pak. Rs33 billion (about US$600 million) due to drought and water shortage. An area of about 22,000 km^2 was reported to be affected in Sindh with a population of 1.0 million. The loss of livestock due to the drought was about 40% in Baluchistan and 60% in Sindh.

The drought of 2001 was one of the worst in the history of the country and this can be judged from the fact that it was the major cause for last year's low economic growth rate of 2.6%. Agricultural growth suffered a severe setback during 2000–2001 due to the unprecedented drought situation and shortage of irrigation water, causing a decline of 2.5 percent as against an impressive growth of 6.1 percent the previous year (PWG 2004). This drought caused a loss of Rs25 billion (about US$450 million) to the national exchequer in 2000–2001 (UN 2001). Heavy direct losses due to animal mortality, production losses and distress sales of animals have been widely reported. If the productivity levels can be restored to levels similar to the rest of the region, then Pakistan should be able to resolve medium- to long-term food-security concerns.

During 1997–2001, rain-fed areas of Sindh were badly affected due to the drought. This was the major drought after 1987. In most parts of Sindh, there was no or little rain for 4–5 years, which completely eliminated rain-fed crop production and livestock sustaining on rangeland vegetation, the two primary means of subsistence in these areas. According to official figures (GOP 2001; Bhatti 2003) 1.3 million people and 2,664 villages in the arid zone of Tharparkar, Umerkot and Dadu districts have been affected by the wave of drought (1998–2002). In 2,664 "calamity hit" villages, 1.3 million human beings and 5 million cattle heads have been affected.

UN (2001) described that "Baluchistan province was adversely affected by the drought of 2000 and low rains in 2001 had significantly worsened the situation. The winter rains in 2001 were down by 60 to 73% as compared to 1995. According to the provincial authorities, during 2001, 1.911 million people had been affected and of the 9.31 million affected livestock 1.76 million had perished. A total of 0.798 million hectares of cultivable land also remained uncultivated due to lack of water. Generally, the economic and human conditions in Baluchistan present a dismal picture of underdevelopment. The reasons for this state of affairs are many, ranging from the limited socioeconomic opportunities, lack of education, poor infrastructure (particularly road networks), limited cultivable land, scarcity of water and irrigation schemes, limited access to health services and a lack of industry.

In addition to deficiency of rains, there are two other reasons responsible for the present drought, which are the rise in temperature and extraction of groundwater. Due to high evaporation values, the lakes and the normal wells have dried up causing serious deficiency of water. The groundwater from the surface down to 50 meters is used by plants and trees and, therefore, vegetation in these areas has vanished and even the survival of huge trees is at risk (Shakir 2001).

Methodology for Field Investigations

Data Collection Methods

This study was aimed at assessing the spread and severity of drought and measures taken by various government and nongovernmental agencies to alleviate the misery of the affected population. The affected people themselves are the best judges of the needs of the communities, households and individuals and the necessity of alleviation measures. This study was designed to do a comprehensive field survey to understand people's perceptions about awareness of drought, coping strategies adopted at household level and the role of various government agencies and NGOs in mitigating the drought effects in these areas.

The appraisal team consists of one field investigator with two local persons. Team members were conversant with the local culture and sensitivities and had experience and understanding of the issues and impact of drought and drought-relief measures in the area. Field data were collected through a variety of research methods including:

- Structured Focus Group Discussions with vulnerable groups conducted by moderators who took care to ensure that particular individuals do not dominate the same.
- A structured household-assessment schedule and in-depth interviews of elderly persons to learn about traditional coping mechanisms to deal with drought conditions in the past.
- A field diary to record detailed notes on the current drought and past drought-relief programs in the field.

Study Locations

Selection of villages was the first key task after finalizing the methodology for field investigation. From each of the two provinces, two districts were selected. One district was from rain-fed areas and other from irrigated area. The criteria used for village selection were:

- Population (mid-size village).
- Accessibility (a well-connected and relatively less-well connected village in the districts selected).

Meetings were held with NGOs conducting relief measures in the affected area, to understand their perceptions and insights gained from experience on relief works and their impacts on the village population. In order to arrive at a shortlist of villages based on predefined criteria (population and accessibility) NGOs were consulted in each district for the drought survey in the villages. Using the above criteria and based on discussions with NGOs, the following villages were short-listed for field investigation (table 5). Overall, the survey was conducted in 20 selected villages in Sindh and Baluchistan provinces and 300 households were interviewed, apart from structured interactions with other stakeholders. Figure 3 shows the drought-hit areas of two provinces together with the villages selected for the field survey.

Table 5. Sample villages in which fieldwork was conducted.

Province	District	Villages	Type
Sindh	Dadu	Goth Baro Sharif	Rain-fed
		Goth Khan Muhammad Palari	Rain-fed
		Goth Haibat Khan Khusu	Rain-fed
		Goth Haji Allah Bachayo Khaskali	Rain-fed
		Goth Dad Khan Palari	Rain-fed
	Hyderabad	Goth Fazal Baghul	Irrigated
		Goth Jam Samoon	Irrigated
		Mooza KhaskaliIrrigated	
		Goth Raise Dural Khan Khusu	Irrigated
		Goth Allah Dino Noomrio	Irrigated
Baluchistan	Chaghi	Killi Malik Noor Baksh	Irrigated
		Killi Safar KhanIrrigated	
		Killi Daud KhanIrrigated	
	Pishin	Killi Yousaf Katch	Irrigated
		Killi Ameer Khan	Irrigated
	Chaghi	Killi BulghaniRain-fed	
		Killi Malik Haji Ghous Baksh	Rain-fed
		Landi Mamoo Zai	Rain-fed
		Killi Niam BailaRain-fed	
		Killi Garri PirjanRain-fed	

Broad Areas of Investigation at Village Level

These included the resource base, socio-demographic profile, economic activities, occupational structure and indebtedness, migration pattern and forms of migration, social-support system, health status, public-relief interventions and activities of NGOs, people's perception on drought- relief measures and traditional coping mechanisms to cope with drought situations. Our endeavor was also to understand the way in which drought-relief assistance provided so far is influencing the coping mechanisms of the people.

The impact of drought on ownership of assets, alternative livelihood, formation of self-help groups and their role in people's empowerment, water conservation and harvesting practices, landownership patterns and implications on access to water and communal lands and other common-property resources, etc., was also examined.

Village Characteristics

The differences between the villages in terms of drought impacts are influenced by the extent of man-made safeguards in each village/region (e.g., number of wells, accessibility and closeness to towns, etc.), which better help adapt to scarcities. Tables 6 and 7 summarize basic characteristics of the selected villages.

Figure 3. Drought-affected areas of Sindh and Baluchistan showing the villages selected for the field survey.

Table 6. Characteristics of villages of the Baluchistan province.

Village	No. of houses	Population	Access	Facilities	Impact of drought	Reason
Baluchistan (rain-fed areas)						
Killi Garri Pirjan	30	330	Less accessible	Primary school; dispensary	Moderately affected	NGO presence; relief measures
Killi Niam Baila	80	700	Accessible	Primary school	Moderately affected	No relief measures
Landi Mamoo Zai	65	600	Less accessible	Primary school; dispensary	Severely affected	NGO presence; relief measures
Killi Malik Haji Ghous Baksh	280	1600	Accessible	Middle school; dispensary	Severely affected	NGO
Killi Bulghani	300	3000	Accessible	Middle school; dispensary	Moderately affected	NGO presence; relief measures
Baluchistan (irrigated areas)						
Killi Daud Khan	40	450	Accessible	Middle school	Severely affected	NGO presence; relief measures
Killi Ameer Khan	70	850	Accessible	Primary school (Boys & Girls)	Moderately affected	NGO presence; relief measures
Killi Yousaf Kutch	70	1100	Accessible	Middle school; dispensary	Severely affected	NGO presence; relief measures
Killi Safar Khan	25	300	Less accessible	Primary school	Severely affected	NGO presence; relief measures
Killi Malik Noor Baksh	95	700	Accessible	Primary school	Moderately affected	NGO presence; relief measures

Table 7. Characteristics of villages of the Sindh province.

Village	No. of houses	Population	Access	Facilities	Impact of drought	Reason
Sindh (irrigated areas)						
Goth Fazal Baghul	50	4,000	Accessible	Primary school	Severely affected	No relief measures
Goth Jam Samoon	100	938	Accessible	Primary school	Moderately affected	No relief measures
Goth Mosa Khaskali	50	700	Less accessible	Primary school	Moderately affected	No relief measures
Goth Raise Dural Khan Khusu	300	2,400	Accessible	Primary school (Boys and Girls)	Moderately affected	No relief measures
Goth Allah Dino Noomrio	30	300	Accessible	Primary school	Moderately affected	No relief measures
Sindh (rain-fed areas)						
Goth Dad Palari	50	450	Not accessible	No school	Severely affected	No relief measures
Goth Allah Bachayo Khaskali	80	1,300	Less accessible	Primary school	Moderately affected	NGO presence; relief measures
Goth Baro Sharif	125	800	Less accessible	Primary school	Severely affected	No relief measures
Goth Khan Muhammad Palari	25	275	Not accessible	Primary school	Severely affected	No relief measures
Goth Haibat Khan Khusu	25	200	Accessible	No school	Severely affected	No relief measures

Household Characteristics

In each village, 15 households were selected for in-depth analysis of the impact of drought on them and their coping strategies. Salient characteristics of the households are briefly described below.

Average *family size* of the respondents varies from 4 to 8 depending upon the area (table 8). The variation in family size in rain-fed and irrigated areas of Sindh is almost negligible whereas in Baluchistan there is a marked difference in family sizes between rain-fed and irrigated areas.

Table 8. Family sizes of the sample households in Sindh and Baluchistan.

Size of family	Baluchistan		Sindh	
	Rain-fed	Irrigated	Rain-fed	Irrigated
Male	4	7	6	6
Female	5	8	5	5

Household respondents normally have mixed activities in the *occupation* list. In Baluchistan, they are involved in agriculture, some family members go to the nearby town for jobs and they have also some goats/sheep and cows. In the Sindh province, the respondents mainly depended on agriculture and when they did not have enough water for agriculture, they turned to mixed activities (table 9).

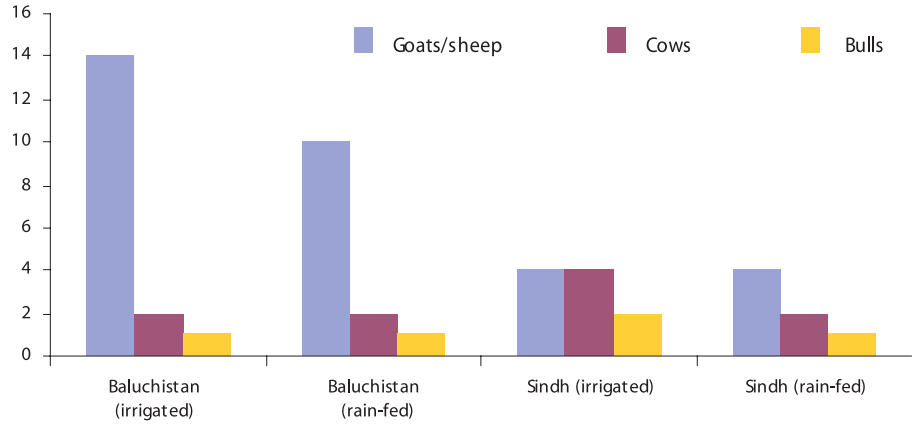
Table 9. Occupation of the household respondents.

Occupation	Percentage of respondents			
	Baluchistan		Sindh	
	Irrigated	Rain-fed	Irrigated	Rain-fed
Agriculture	12.7	6.7	44.6	46.7
Livestock and animal husbandry	3.6	15.0	3.1	1.7
Nonagricultural activities	3.6	13.3	30.8	21.6
Mixed activities*	80.0	65.0	21.5	30.0

*"Mixed activities" means the respondents having the occupation of agriculture, livestock and animal husbandry and nonagricultural activities.

Animal ownership refers here to how many livestock is owned by a household. The average number of goats/sheep owned by an average respondent household was 12 in Baluchistan and 4 in Sindh. It was also found that more than 90% respondents own goats/sheep in Sindh and Baluchistan areas because this ensures their subsistence security under different conditions. The second most-needed animal is the "cow." The frequency distribution of ownership of goats/sheep and cattle for rain-fed and irrigated areas of Sindh and Baluchistan are shown in figure 4.

Figure 4. Frequency distribution of animal ownership in Sindh and Baluchistan.



Results of the Field Survey in Sindh

General Perception on Drought at Household Level

In Sindh, more than 20% respondents believe that they are facing a drought condition if there is no rainfall for more than one year. In irrigated areas of Sindh, farmers mainly depend on canals and groundwater for irrigation. Therefore, shortage of water in streams and reservoirs for agriculture and shortage of fodder for animals are considered as important indicators for defining drought. However, people living in rain-fed areas have different perceptions about drought. Shortage of drinking water for human beings and animals was ranked second in importance after considering rainfall. Rain-fed streams used to be the main water source. However, due to the persistent drought (1997–2000) conditions and inadequate rain in 2000, these streams had dried up. Without rain, the livelihood of the local people rests on the usage of groundwater, which is brackish and not fit for drinking purposes. The survey results indicate that, in most areas, access to groundwater is available to only 15% of the households. Bringing safe drinking water from distant areas is entirely the responsibility of women in the Sindh culture. Therefore, women have to walk 3–8 km daily to fetch drinking water for their families.

In irrigated areas of Sindh, the shortage of canal water greatly increased the demand of groundwater in order to fulfill the crop water requirements. This shortage of canal water during drought years greatly impacted on groundwater development. The density of private tube wells per 1,000 hectares in Sindh increased to 5 during 2002 as compared to 3 in 1995.

A drought should not be viewed as merely a physical phenomenon or natural event. Its impacts on society result from the interplay between a natural event (less precipitation than expected resulting from natural climatic variability) and the demand people place on water supply. Human beings often exacerbate the impacts of drought. When people were asked in these rain-fed and irrigated areas about the present drought situation, about 60% respondents in rain-fed areas indicated that drought is "not over yet." In irrigated areas, about 60% respondents think that drought has retreated marginally due to recent rainfall and the improved canal water supplies. However, people in rain-fed areas consider drought as a more frequent phenomenon, which recurs usually after every 2–3 years.

Vulnerability to Drought and Personal Security

The survey results indicate that the agriculture sector (crops, vegetables, orchards) was the most vulnerable to drought conditions. There were no crops in rain-fed areas during 1998–2002. This situation forced the local people to migrate to nearby towns and cities to look for off-farm employment opportunities to supplement their house income. Drought has affected all population classes in drought-affected areas. However, the impact of the drought situation on women is worst due to their sociocultural and economic positioning within the family and the community. Women's work load has increased manyfold due to loss of male employment in the agriculture sector with their migration to other cities in search of work. About 27% respondents think that men are the most vulnerable to drought in rain-fed and irrigated areas of Sindh. Being the head of the family, he has the responsibility for all socioeconomic and financial matters. In case of his unemployment,

the whole family is affected. The workload of women increased as they started doing additional household income-generation activities such as handicraft and embroidery.

Economically, the people are highly deprived. High mortality rate and reduction in the weight of livestock have significantly reduced the income of the people in the drought-affected areas. In some parts of Sindh, where no vegetation exists, people are also using wheat as fodder to preserve their only asset and means of livelihood. The survey results show that in rain-fed areas of Sindh, most of the households have an income in the range of Pak. Rs[1] 2,000–Pak.Rs4,000, whereas, in irrigated areas the range of income is above Pak.Rs4,000. The prices of food commodities have gone up in the last few years, while income of the affected population has gone down. This has reduced their purchasing power and, hence, their calorie intake, especially in rain-fed areas. Consumption of meat, milk products, edible oil and pulses had gone down. This, coupled with the consumption of contaminated water, has exacerbated the health problems.

The health status of people and animals has been badly affected by the drought. People reported increasing incidence of diarrhea among children, skin diseases in human beings and in animals, eye infection, fever, gastro, stomach pain and vomiting. People frequently mentioned tuberculosis as a health problem due to the drought. Due to reduced cash income, people are not consulting doctors or purchasing medicine. According to local doctors, there was an increase of illnesses related to water and malnutrition.

Waterborne diseases are common in the area because of both poor sanitation and almost total lack of awareness about hygiene. It is observed during the survey that in rain-fed areas no health facility of any type is available within the village. However, the villages in irrigated areas have access to the healthcare units. During the survey, it was observed that the general health status in the affected areas of Sindh is related to the poor living conditions, unhygienic storage of water, lack of proper sanitation, inadequate diet and limited access to health facilities.

In rain-fed and irrigated areas of the Sindh province, the quality of water has gone worse. At many places, people and animals were seen drinking water from the same open ponds. This was causing health problems particularly among children and old people. In some villages, water was collected in ponds and people were forced to buy it.

The water problem will worsen if there is no rainfall in the near future. The water table has already gone deep and will further go down due to excessive pumping. This situation is forcing people to migrate to canal areas. Lack of fodder and grazing opportunities in rangelands has increased the migration of cattle. It was found from the survey results that, in rain-fed areas, more than 9% of the people migrated to other areas and there are about 34% of the households one or two of whose family members are outside the village in search of other income sources.

The trend of migration due to drought in irrigated areas is almost negligible. Increased labor force in irrigated areas has resulted in low wage rates and problems in procuring work are increasing. Due to recession, the on-farm and off-farm employment opportunities are shrinking and unemployed people are being involved in unhealthy activities.

[1]US$1.00 = Pak. Rs58.00.

Impact of Drought on Agriculture

In rain-fed areas, rainwater is the major source of irrigation. The other source of irrigation is "spate irrigation," also known as *rod-kohi* or flood irrigation. This kind of irrigation relies on the floods of the hill torrents. Wherever possible, the runoff is harnessed for irrigation by weirs or temporary diversion structures. Farmers divert the spate flow into their fields by constructing breachable earth bunds (called *gandas*) across the rivers, or by constructing stone/gravel spurs leading towards the center of the river. Captured water flows from field to field and when the soil profile is saturated, the lower bund is breached to release water into another field.

Due to low rainfall, these irrigation systems are almost abandoned in many areas. As a result, rain-fed crop areas have reduced by 60 to 80% with productivity going down by almost 50% due to moisture stress in Sindh. Millet, sorghum and castor beans are the main traditional summer rain-fed crops while barley and mustard are grown during winter. In addition to producing grains for human consumption or sale, these crops have been the primary source of stalks/crop residues for livestock feeding. The survey results showed that 70% farmers cultivated the fodder for their livestock and about 45% fodder crop of each farmer was damaged due to no, or insufficient, rainfall. In irrigated areas of Sindh, there is an overall shortage of 30 to 40% in the water flows of the Indus basin canals further multiplying the negative effects of drought. Reduced supply of canal water has resulted in a substantial reduction in areas under most major crops, especially orchards (mango and banana) and their per hectare yields. According to the survey results, about 40% orchards of mango and banana were damaged. Now the farmers are turning towards low-deltaic water crops and orchards. But the marketing of these new crops is not properly established, which is upsetting the farmer's income. Table 10 shows the impact of drought on various crops in the Sindh province.

Table 10. Impact of drought on the major crops per household in Sindh.

Name of crop*	% of farmers who grow the crop		Average area sown (ha)		Average area damaged (ha)	
	Rain-fed	Irrigated	Rain-fed	Irrigated	Rain-fed	Irrigated
Wheat	9.1	99.0	1.0	2.5	0.1	0.0
Cotton	4.5	90.0	0.6	1.6	0.2	0.0
Fodder	70.9	35.0	1.8	0.9	1.0	0.0
Vegetable	6.8	35.0	1.9	0.7	0.6	0.0
Orchards	na	6.2	0.0	2.5	0.0	1.5

*The wheat, cotton and vegetable crops are grown in rain-fed areas mostly by those farmers who have access to groundwater.

Impact of Drought on Livestock

Livestock has been a major asset base for the inhabitants of arid zones. Lack of drinking water and vegetation in the areas has badly affected the health of animals. Milk production of animals has declined, which has implications for the nutritional status and income level of the households in this area. Due to fodder unavailability, especially in rain-fed areas, and its high price, some people reported that they had moved their livestock to safer areas but there is a pressure on them to maintain them from a distance.

The impact of drought on the livestock sector can be discussed by dividing the drought period into three phases. In phase one, drought brings about a fall in available forage throughout the area. Drought conditions in this phase are sufficiently harsh and widespread and livestock cannot move beyond the drought-affected area. During this stage, the number of livestock starts falling mainly through sale. The survey results indicate that about 96% households kept rearing of goats/sheep and that each household in rain-fed areas sells about 6 goats/sheep. As drought hits harder, bringing about failure of grain crops (mainly wheat) and deterioration of animal conditions, grain prices rise while livestock prices fall. Farmers have to sell their sheep and goats for less than half the normal price. These relative price movements impose strong economical pressure on livestock communities to sell more animals to raise cash for food and fodder.

In phase two, the number of livestock falls mainly due to mortality while shortage of grain continues to keep food prices high. However, food prices may come down if the government intervenes and delivers food aid in substantial quantities. In phase three, after a significant amount of rainfall, weak animals die due to hypothermia and outbreak of diseases whereas fodder production starts to recover. The survey results also indicate that every house lost (died or slaughtered) about 7 goats/sheep. When the farmers were asked about the causality of the animals/livestock, they ranked the mortality and unavailability of water and food for animals as the highest. The details of the reason are ranked below:

1. Mortality due to hunger (34%)
2. Nonavailability/high cost of feed (31.9%)
3. Bad water quality/nonavailability of water (28.3%)
4. Nonavailability of medicine (5.8%)

While prices of animals during this phase shoot up, poor pastoral people find it difficult to rebuild their herds. It was also found from the survey that there are hardly any veterinary services available in the area. Details of animal losses in rain-fed areas of Sindh are given in table 11.

Table 11. Loss of livestock per household due to drought in rain-fed areas of Sindh.

Livestock type	% of households having livestock	Present ownership	Died/ slaughtered during 1997–2001	Sold during 1997–2001	Average price (Rs)	
					Actual price	Normal price
Goats/sheep	95.8	4	7	6	690	2,100
Cows	31.3	2	0	2	7,143	10,900
Buffaloes	16.7	1	0	1	9,000	11,000
Bulls	8.3	1	0	2	11,000	15,000

On the other hand, there was no loss of animals in irrigated areas. In irrigated areas, the groundwater for irrigation purposes came out as the most reliable and effective source against drought situations as compared to rain-fed areas where a limited number of people had access to groundwater. There was no such shortage of fodder or vegetation in irrigated areas as it was in rain-fed areas.

Coping Strategies at Household Level

Major sources of livelihood in the arid zones of Sindh are livestock, rain-fed agriculture and wage labor. In normal years, main crops are sown immediately after the rainfall, followed by harvesting, stocking, marketing and feeding animals in grazing lands for the rest of year. The seasonal calendar provides an opportunity for the people to secure their subsistence for the whole year and it determines their economic security and social credibility. In dry seasons, from 15 to 20% of the human population migrate to irrigated lands along with their animals to work as farm laborers. They work in irrigated areas from November to June (for sugarcane and wheat harvest and picking of cotton). Sale of livestock has increasingly become a source of cash to meet their requirements of medicine, education and other social obligations (marriages and funerals). It was also reported that villagers have started cutting trees and selling them for cash. This will have serious consequences on the environment.

The drought has severely affected the main sources of livelihood of the desert people and eroded their purchasing power. Farm operation-related jobs have reduced by adding to unemployment. Horticultural production in irrigated areas has been providing jobs to thousands of people engaged in orchard management, fruit picking, grading, packing and transportation. These jobs are now available in much reduced numbers. They are surviving on the donations received from the government and philanthropists, selling their livestock at throwaway prices and relying on loans at exorbitant interest rates (more than 50% per annum). Moneylenders, landlords and middlemen also exploit them. About 60% respondents reported that they got credit for their daily living purpose during drought periods in rain-fed areas of the Sindh province. About 32% respondents indicated that they got credit when they were in need and only 17% found that the credit provided was according to their need. Government agencies and NGOs did not provide any credit facility in rain-fed and irrigated areas of Sindh.

Traditionally, women earn some income by making *ban* (string made of husk from wheat and rice used for knitting local beds) and through embroidery/handicrafts. Women are spending a lot more time on these activities now to make up for the lost income due to the nonfarming situation. Ban making is considered a woman's job, but now many women reported that their men are also making it, as they do not have anything else to do. One kilogram of ban can be sold in the market for Rs10–15. It was observed that men, women and children all work to make bans and this seems to be the main source of cash income for the family at the moment. The drought has adversely affected women's income-generating activities. The sale of their products has decreased due to the low purchasing power of the people in general. The middlemen are also exploiting their weak bargaining position by offering lower prices for their products. The household income is almost entirely spent on buying essential food items and they are barely left with the money to buy raw material for their handicrafts.

During normal years, the diet includes wheat and/or millet, vegetables, tea, pulses and milk products (*lassi*[2]/butter). In the Sindh province, a large number of Hindus reside in the desert areas and therefore meat is not used there. Muslims also tend to avoid sacrificing animals in the areas where they live in proximity with the Hindus. The drought has led to a change in the dietary pattern and the food intake of the majority of the affected population in Sindh and Baluchistan. It is now

[2]"Lassi" is the local traditional drink made from by mixing water (50%) and yogurt (50%). Salts and/or sugar may be added in order to improve the taste.

limited to wheat/sorghum (*roti*[3]), which is usually taken with onion and chili. Resources permitting, they also consume broken rice (low quality), potatoes and pulses. Traditionally, the families eat together, including women and children. Reduction in the intake of "lassi," other milk products and locally produced vegetables has contributed to the low nutritional intake of the population. The variety of the traditional diets has disappeared. Essential food items are available from the local village shops and nearby towns but they are expensive and most of the population cannot afford to procure them in the required quantities.

Drought is not a new thing for the pastoral people of the arid lands. In the past, they maintained their livestock during drought periods by migrating from one area to another without many restrictions. They had historical links with the farmers of the irrigated lands. The cultivated areas along the herders' migratory routes provided crop residues to the livestock of the migrating pastoral people and, in the process, the agricultural lands too benefited from the manure. This was the first traditional option available to them. During the drought periods the pastoral communities got some relief by engaging themselves in harvesting and thrashing of wheat crop, because these operations were manual and required extra manpower. This crucially important option of transferring grazing pressure from areas of deficit to those of surplus unfortunately does not exist in extreme drought years (especially 2000–2001) due to shortage of water in the irrigated areas.

Slaughtering/sale of livestock was the second option. This option greatly reduced the number of livestock, especially of goats/sheep per household. The goats or sheep were the major source of income. In irrigated areas, there was pressure for the transfer of these animals and shortage of grazing lands but no major casualty of livestock was reported in this regard.

Transportation of feed and availability of water for livestock constituted the only option for reducing mortality. Hence, necessary measures are required for feeding livestock in the drought-hit areas. There are various options for providing feed to animals. For example, provision of credit according to herd size so that the farmer can buy feed himself; subsidized transportation and distribution of livestock feed; and establishment of animal feeding centers to which fodder can be brought in.

Destocking may be more appropriate in the present conditions. For destocking, animals can be sold while still in good shape, either for meat or to those who have better access to fodder. Where animals are already in poor conditions some value can be obtained by selling them at the price of hide. If the government develops large mechanical slaughterhouses and cold storage facilities then a large number of animals can be taken off from the rangelands relatively quickly thus minimizing losses occurring due to the death and/or declining weight of animals. Receipts from such commercial sales can be banked for subsequent reinvestment when drought conditions ease. Such practices have been quite successful in Zimbabwe, Botswana and Kenya.

The agriculture sector is most severely affected by drought in both rain-fed and irrigated areas of Sindh. In rain-fed areas, the crop failed completely. However, those farmers who have access to groundwater (they have dug-wells), deepened their bore and improved their bore design in order to get some supply of groundwater. A few people also got loans in order to install dug-wells.

In irrigated areas, the food availability was not a major issue. However, the major impact of drought was on the agriculture sector. In irrigated areas of Sindh, the major source of irrigation is canal water but due to shortage of water in the canal, the people started to install tube well for irrigation purposes. About 32% villagers reported that they installed tube wells to fulfill their crop

[3]This means "bread."

water requirements during the last 5 years. Due to canal water shortage and costly tube-well water, the area irrigated has also reduced. Accessibility to groundwater proved sufficient to some extent but due to bad water quality and saltwater intrusion into the fresh aquifer the severity of the water problem increased. Around 28% of the population of the Sindh province has access to fresh groundwater suitable for irrigation, i.e., the water has less than 1,000 mg/l TDS. Close to the edges of the irrigated lands, fresh groundwater can be found at 20–25 m depth (GWP 2000). Large areas in the province are underlain with groundwater of poor quality. Indiscriminate pumping has resulted in contamination of the aquifer at many places where the salinity of tube-well water has increased. All these issues have forced the farmers to change their cropping pattern from high-deltaic crops to low-deltaic crops. The farmers in these areas have been advised to switch to cotton instead of rice, sugarcane, and mango and banana orchards due to an acute water shortage. The farmers also cope with drought by irrigating less area due to the high cost of tube-well water. About 60% respondents in irrigated areas indicated that the area irrigated has reduced to about 10–20%.

Results of the Field Survey in Baluchistan

General Perceptions of Drought at Household Level

Drying up of streams and reservoirs and inability of the tube well to pump groundwater due to falling groundwater tables are equally important perceptions of farmers for the incidence of drought in irrigated areas. However, this is not the case in rain-fed areas as groundwater tables are usually deep and not accessible to farmers. Therefore, fluctuations in groundwater tables in rain-fed areas have no direct and immediate impact on the life of farmers. The prolonged dryness of the area is considered harmful for the environment and human health.

Next in importance is the nonavailability of drinking water for humans and livestock. However, this indicator is taken more seriously in rain-fed areas as compared to irrigated areas (about 19% in rain-fed areas as compared to only 10% in irrigated areas). In Baluchistan, the access to drinking water is a major problem. People have to wait long hours to collect water from wells. Indicators such as sickness of livestock, fodder shortage and less water availability for agriculture are also considered more serious in rain-fed areas than in irrigated areas. Any deficiencies in the rainfall in irrigated areas are supplemented by the groundwater whereas in rain-fed areas the effect of reduced rainfall becomes apparent immediately. In irrigated areas of Baluchistan, falling groundwater tables due to lack of recharge are considered as the major impact of drought.

Most of the households think that drought conditions are not completely over as yet and their sufferings might continue for some more time. The frequency of drought in irrigated areas is reported to be 5–10 years whereas in rain-fed areas, drought is considered as a more recurrent phenomenon which can repeat itself every 2–3 years.

Vulnerability to Drought and Personal Security

The last four years of continuous drought (1997–2001) have taken a heavy toll on the Baluchistan economy and have increased the vulnerability and hardship for many predominantly rural communities. There have been widespread damages to biological potential of land, extinction of livestock and problems for human life due to the nonavailability of water.

The overall impact of impending drought and ensuing reduction in water supplies is a fall in household incomes. The survey results indicate that men and children are most vulnerable to drought. Man is the head of the family and has the responsibility for all financial matters. When employment opportunities for male members of the family are reduced, the whole family starts suffering. About 55% respondents in irrigated areas and 73% in rain-fed areas consider it a desperate situation for the whole family, especially for the women and children.

The impact of drought on women is worst after men due to their sociocultural and economic positioning in the family and community. Women and children in most parts of Baluchistan play a central, albeit indirect, role in home economics, although their work remains concealed under veils and, therefore, they have equally been affected from water scarcities. Lack of food, poor nutrition and poor sanitation typically result in decreased resistance to diseases. Due to out-migration of male members of the family for income supplementation, livelihood burden on women is increased. They are involving themselves in household income-generation activities such as embroidery and handicrafts. The need to carry water, wherever it is from, has increased women's labor. On average,

a woman must carry more than 200 liters of water every day, after a long wait at the communal/ private water sources (due to low yields). This has increased the workload of women by manyfold and they are working hard to sell their traditional skills to meet the demand of cash for their family.

Impact of Drought on Agriculture

Families with crop production and livestock as the mainstay of their source of livelihood reported significant reduction in crop yields and loss of livestock. Table 12 gives details of loss in crop failure due to drought in both irrigated and rain-fed areas.

Table 12. Impact of drought on the major crops per household in Baluchistan.

Name of crop	% of farmers who grow crops		Average area sown (ha)		Average area damaged (ha)	
	Rain-fed	Irrigated	Rain-fed	Irrigated	Rain-fed	Irrigated
Wheat	38.2	16.7	5.6	2.5	4.8	0.0
Cotton	1.8	1.7	0.4	8.1	0.2	3.2
Fodder	2.8	4.9	2.2	2.0	1.4	0.6
Vegetable	25.4	7.0	1.7	1.6	1.3	0.6
Orchards*	32.0	0.0	0.0	2.8	0.0	2.1

*Mostly apple orchards.

The farmers in rain-fed and irrigated areas of Baluchistan mainly depend on the "karez"[4] system of irrigation. This system depends completely on rainfall occurrence during the year. Although Baluchistan is mainly an arid region and only 5–6% of the land area is arable, the alluvial soils supplied with karez water are capable of producing crop yields equivalent to those in canal-irrigated areas in other parts of Pakistan. Due to 4 years of continuous drought, most of the karezes dried up because there was no, or less, precipitation. Due to water shortage, the apple orchards were mostly affected in irrigated areas. The survey results indicate that about 75% of the area of each farmer who cultivated apple orchards was damaged due the drought during 1997–2001. In rain-fed areas, almost all the crops were affected due to less precipitation.

The reduced crop yields and farm incomes forced the male members of the family to migrate to nearby cities for labor jobs. Households, whose primary source of income is employment and agricultural income is only supplementary have, to some extent, been resilient to drought-related economic stress, which points to the importance of income diversification and employment creation in the nonagriculture sector for the rural poor. More than 30% respondents blame less or no rainfall as the major reason for their migration. Nonavailability of water for agriculture is ranked second in the priority list for migration. No employment opportunities and lack of pasture for livestock are the two next important reasons for migration to other places.

[4]The ancient "karez" system comprised a series of wells and linked underground channels that use gravity to bring groundwater to the surface, usually far away from the source

Impact of Drought on Livestock

Lack of food and grazing opportunities in the rangelands has resulted in the migration of cattle. High mortality rate and reduction in the weight of livestock have significantly reduced the income of the people in the drought-affected areas. More than 80% respondents reported that high costs and nonavailability of feed, water and clinical facilities are the major reasons for the death of their livestock. During the drought of 1997–2001, livestock was sold almost at one quarter of their original price due to sickness and loss of weight of the livestock. Details of the loss of livestock in rain-fed areas of Baluchistan during the drought period of 1998–2002 are given in table 13.

Table 13. Loss of livestock due to drought in rain-fed areas of Baluchistan.

Livestock type	Households with livestock (%)	Present ownership	Died during 1997–2001	Sold during 1997–2001	Average price (Rs)
Goats/Sheep	93.3	10	16	16	612
Cows	30.0	2	0	2	8,000
Buffaloes	0.8	1	0	1	9,500
Bulls	2.3	1	0	0	000

In irrigated areas, no loss of cattle was reported. The karez system and groundwater for irrigation resulted as the most effective source against drought situations as compared to rain-fed areas where a limited number of people had access to groundwater. There was no such shortage of fodder or vegetation in irrigated areas as in rain-fed areas.

Coping Strategies at the Household Level

Households have responded to the drought variously, and attempted to marshal financial resources, in different ways, according to their financial and social abilities. Due to reduced agricultural activity, on-farm jobs, such as fruit picking, harvesting, packing and transportation are not available any more. Therefore, most of the people are surviving on relief donations from the private sector and NGOs.

In irrigated areas, reduction in cropped area, changing cropping patterns (high-deltaic apple crop was replaced by pomegranates), sale of livestock and their products and doing casual labor were common coping strategies under drought conditions. Sale of safe assets such as jewelry, watches and domestic items and productive assets such as land, livestock, farm machinery and sewing machines were seen as frequent phenomena during the 4 years of severe drought. Under extreme drought conditions, migration to other places was also considered as an option for more than 10% of the respondents. The survey results indicate that, in Baluchistan, selling of livestock and their products is the most reliable drought-coping strategy, as more than 30% of the people practice it. More than 20% people limit their irrigated area and change cropping patterns to compensate for drought conditions. This ultimately reduces the crop production and threatens the food security. As a result, more than 15% people choose to do off-farm jobs in nearby cities and towns to supplement their household income to buy other necessities of life.

In rain-fed areas, use of stored grains, farm ponds to store rainwater, sale of livestock and their products, seasonal migration of humans and livestock and change in eating habits are the

most common methods adopted to live with drought conditions. Sale of livestock and their products is even a stronger phenomenon in rain-fed areas as more than 36% people use it as a shield against drought. About 16% of the respondents consider it safe to migrate together with the livestock to their relatives living in irrigated areas during the drought period and come back after the situation has improved. During the drought period, people also change their eating habits, e.g., eating twice a day instead of thrice a day. Their main food was also reduced to bread and yogurt shake (locally called *lasi*). This causes serious malnutrition problems, especially for women and children.

Labor in nearby towns and agricultural fields (having access to groundwater) is also a well-established way to cope with drought in rain-fed areas. Women earn some income by making hand-made embroidery and handicraft items. Women spend a lot more time on these activities now to make up for the lost income due to the nonfarming situation. This is usually considered a woman's job, but now many women reported that their men are also taking part, as they do not have anything else to do. These off-farm income-generation activities have been adversely affected by drought. The sale of their products has decreased due to low purchasing power of the people in general. The middlemen are also exploiting their weak bargaining position by offering lower prices for their products. The household income is almost entirely spent on buying essential food items and they are barely left with the money to buy raw material for their handicrafts.

Food security at the household level is under considerable stress in Baluchistan. People are managing by changing their eating habits and reducing caloric intake that, in turn, has affected the overall nutritional status of the population (especially on livestock) and their health. Nutritional levels of poor men, women and children are inadequate in normal times: drought reduces the availability of food and compromises its quality. Maternal and infant mortality and morbidity rates rise, as do stunting and wastage. The effects of diseases, which are not otherwise life-threatening, are intensified by malnutrition.

In most of the urban and rural areas of Baluchistan, shallow wells are used to get water for drinking and agricultural purposes. As the water table continues to fall by around 0.5 to 3 m each month depending on the place, the poorer families are unable to dig their wells deeper and thus are forced to get water from communal wells. Many of these communal wells are already dried up and people (often women and children) are forced to walk miles to meet their daily water demands. More than 80% of the respondents from irrigated areas believe that their coping strategies failed due to decline in groundwater tables. However, this percentage was only 25 for rain-fed areas as the dependence on groundwater in these areas is relatively low. In rain-fed areas, lack of labor and other off-farm opportunities and drying of shallow dug-wells were considered as the major reasons for the failure of coping strategies. Most of the respondents (80% in irrigated areas and 40% in rain-fed areas) were of the view that only international NGOs came to their rescue from drought conditions.

More than 70% respondents in irrigated areas and about 48% in rain-fed areas of Baluchistan were of the view that NGOs helped them in developing these coping strategies. However, more than 80% respondents believe that these coping strategies were only partially successful in solving their problems.

Role of NGOs/Government Agencies in Providing Relief Measures in Sindh and Baluchistan Provinces

There were mainly three sectors in drought areas that needed the relief measures, i.e., humans, livestock and agriculture. Very little attention was given to the agriculture and livestock sector both in rain-fed and irrigated areas of Sindh and Baluchistan provinces by the national and international NGOs and at provincial and federal government levels.

In the Sindh province, drought-relief operations of the government were planned, coordinated and monitored by the Relief Commission. The Steering Committee of the Drought Emergency Relief Assistance (DERA) chaired by the Additional Chief Secretary provided overall guidelines and played a supervisory role. The drought situation in arid zones of the province was continually monitored and areas requiring emergency assistance were periodically notified. Though relief work was begun in Sindh, it has not reached most outlying villages. The population of many villages has lodged protests for being neglected by the authorities. According to the Sindh Relief Commissioner, 4,613 victims of drought have received free food. Medical teams have visited 347 villages and vaccinated 1,554,600 heads of cattle.

In the Baluchistan province, a Relief Commission was also established to coordinate relief efforts. Pakistan Army set up a Drought Crisis Control Center in the Log Area essentially to provide logistical support to the Commissioner's relief operations. Later the Provincial Government set up a Drought Emergency Relief Assistance (DERA) program to coordinate relief efforts and plan on longer-term mitigation strategies. The Government of Baluchistan has allocated about US$22 million for relief assistance programs over the past five years (Yousaf et al. 2002).

The data gathered from the planning division of the Government of Baluchistan revealed that the government had spent about US$1.0 million in extending and improving 100 karezes in Baluchistan over the last 5 years. The government has also recently built a number of water-storage ponds in different parts of Baluchistan with the help of local communities. These storage tanks are connected to the karez system. In Baluchistan, the government is also working on a comprehensive plan for the reconstruction and rehabilitation of karezes supplemented by the installation of hand pumps. A number of water-supply and sanitation schemes are also underway. Despite these concerted efforts from the governments, respondents were of the view that more needs to be done in order to reduce the damage in future.

The survey results indicate that people from irrigated areas could not get any relief assistance from provincial or federal governments during the drought years of 1997–2001. However, the people in rain-fed areas of Sindh and Baluchistan indicated that they received some help from local NGOs. About 60% of the households received help from different NGOs (national and international) working in the drought areas, in the form of flour, oil, sugar, tea and pulses. Most of the respondents were not happy with the quantity distributed per family, which was far lower than the actual required quantity for minimum survival of many families. Table 14 gives the details of the average quantity provided by the NGOs and required by a household in Sindh and Baluchistan provinces.

Table 14. Quantities of daily-consumed items provided by NGOs as a relief measure.

Items	Sindh province		Baluchistan province	
	Quantity provided (kg/house/month)	Quantity required (kg/house/month)	Quantity provided (kg/house/month)	Quantity required (kg/house/month)
Flour	5–10	110–126	65–130	118–150
Oil	0.5–2	8–10	4–13	10–12
Sugar	1–2	3–15	na	na
Rice	2–5	5–12	12	10
Tea	0.25	1–2	na	na
Pulses	2–5	3–10	27–35	5–11

More than 80% of the respondents in irrigated areas and 40% in rain-fed areas were of the view that only international NGOs came for their rescue during drought conditions. Some villages of Sindh also got help to install hand pumps. The people of rain-fed areas of Sindh indicated that these hand pumps were installed without any technical consideration, which resulted in pumping saline water. The people and the animals were using that water for drinking in conditions of extreme water shortage. During the survey, people indicated that they got help only once during 4 years of drought whereas in irrigated areas no help was provided to the villagers. Some NGOs (Oxfam, an international NGO) constructed farm ponds for water storage while agricultural departments provided drought-resistant seeds of different crops and cereals. About 70% respondents in irrigated areas and 48% in rain-fed areas of Baluchistan appreciated the role of NGOs in developing coping-strategies for drought. However, more than 80% believe that these coping strategies were only partially successful in solving their problems and there is a need to do more in this regard.

Most of the government agencies and NGOs provided relief assistance to the areas, which were relatively more accessible. Inaccessible areas, which usually do not have community-based organizations, were ignored by the government and NGOs in their relief-assistance programs. NGOs provided relief material 3–4 times in the area although distributed quantities were not according to the requirements of most households.

The respondents were also greatly concerned about unfair distribution of relief items. Relief items were given to notable persons of the area for further distribution and they did not do justice with the distribution. Another complaint was that needs of women were ignored both in assessment and relief distribution. The families headed by women were left out from the distribution process as relief items were given only to men. It was learnt during the survey that distribution strategies of most NGOs were not well organized and coordinated. At places it created more chaos than support. However, the civil administration, with the help of the army, was able to reach the remote areas. Therefore, there is a need for strong linkages between national agencies and NGOs for long-term planning of drought-forecasting and -mitigation strategies.

Most of the NGOs provided relief measures for drought with the permission of local governments but they have no mechanism for future forecasting and planning of anti-drought activities. Mostly NGOs complained about the shortage of funds, which restricted them from providing less-than-required relief measures. In Baluchistan, the position of NGOs was relatively better than in the Sindh province. In Baluchistan, NGOs were able to provide engineering structures (water ponds) for storing water for drinking and other domestic purposes.

During the drought years, the canal-water supplies were almost negligible and farmers were totally dependent on groundwater for domestic as well as agricultural needs. However, the government did not provide any relaxation in the *abiana* (water tax) and farmers have to pay the same *abiana* for the drought years.

Government agencies and NGOs did not provide any credit facilities to the drought-affected people of irrigated and rain-fed areas. About 60% respondents were able to get credit facilities in rain-fed areas through local agents and their relatives. The interest rate on credit was very high, i.e., 2.5–10% per month. As a result, this facility remained out of the reach of many deserving farmers. As regards the reliability of the credit facilities, about 32% respondents got the credit at the time of need and only 17% could get it according to their need.

Recommendations for Developing an Integrated Framework of Action for Drought Mitigation

Drought requires an integrated response. Although expertise is necessarily discipline-specific, focusing on health, agriculture, technologies, poverty alleviation, etc., it must be brought into a common framework. Nurturing community support and mobilizing the community's organizational, financial and human resources for integrated management of existing water and other natural resources must form the core of any drought-mitigation strategy. The survey results indicate that the agriculture sector is the most vulnerable to drought. Less-than-normal rainfall reduced the flow of rivers and natural streams that, in turn, affected crop production in irrigated as well as rain-fed areas. This has devastating consequences on the food security of humans and livestock in Sindh and Baluchistan provinces. The rain-fed areas of Sindh and Baluchistan are mainly irrigated by traditional irrigation systems such as karez, and spate irrigation (locally called *sailaba* [flood water] and *khushkhaba* [rain-fed]). During the 4 years of continuous drought, these traditional systems were exhausted, which threatens the sustainability of agriculture in both Sindh and Baluchistan provinces.

In order to sustain agricultural production in these provinces and to cope with the future droughts, rehabilitation of these traditional irrigation systems should be given priority. For this purpose, the government should take the lead as most of the farmers are poor and cannot afford to rehabilitate these systems themselves. Moreover, farmers in Baluchistan are still using old indigenous methods for the construction and rehabilitation of karezes. Due to declining groundwater tables, these methods are no more effective and, as a result, more than 60% of karezes are not functional. Therefore, the government should make a comprehensive plan (with the participation of local communities) to provide the necessary modern technologies and skilled manpower for the rehabilitation of these irrigation systems. This will be a significant contribution for restoring water supply to communities once rainfall returns to normal because, for communities, karez means "life" and "survival."

During this study, lack of drinking water for humans and livestock also emerged as the biggest issue for the drought-prone areas especially in rain-fed areas. Lack of drinking water was the reason for most health problems, especially for women and children. Although some NGOs and government agencies have installed a few communal wells and hand pumps in Baluchistan and Sindh provinces, their coverage is restricted to a small proportion of the population. In remote areas of Sindh and Baluchistan, women and children still have to walk 3–8 kilometers daily to fetch water from communal wells to meet their domestic demands. This has increased the workload of the women and children by manyfold. Most of the respondents suggested that the availability of drinking water for humans and livestock should be given top priority in drought-relief efforts.

Lack of drinking water supply was reported, also, as the major reason for migration of humans and livestock to irrigated areas. From this angle alone, it is seen that there is a strong need to develop strategies for improving drinking water supply for the long term. In many areas, relatively well-off people have installed tube wells and electric motors to extract groundwater from deeper depths and dug-wells. They see this as a solution for improved water supply. Therefore, the government should collaborate with NGOs and local communities to increase communal wells and hand pumps to improve drinking water supply to a large section of the poorer population in the drought-prone areas of Sindh and Baluchistan.

Improvement of water supply would entail the construction of deep tube wells and water reservoirs, overhead water tanks, rehabilitation and extension of canals and water distributaries, supply of hundreds of water tankers and repair of existing water reservoirs and water-evaporation plants along the coastal areas. The affected people must be consulted before plans to avert drought are formulated and implemented. All such plans must be made public.

Farmers in Sindh and Baluchistan are not making good use of available water resources. They have the tendency to overirrigate due to ignorance of actual crop-water requirements. Therefore, there is a need to educate them to enhance the benefits of available water supplies, and to optimize water use efficiency once rainfall resumes. Most of the farmers in Baluchistan still use karez water to flood their fields. Farmers should be encouraged to use more water-efficient irrigation methods such as pressurized irrigation systems. Experiments on vegetable crops in Baluchistan have shown that drip irrigation has 2.4 times higher water use efficiency over furrow irrigation (Halcrow 2001).

Farmers should be encouraged to use water harvesting including more water-storage structures both small and large. This should begin with the collection and storage of every drop of rainwater in household cisterns, wells and check dams. There is a need to give more attention to the water-harvesting techniques such as *bandat* (embankment system), diversion of ephemeral streams and spate irrigation. In many areas, farmers do not have enough expertise to get maximum benefits from these systems. For these areas, the government should set up special extension centers to extend technical assistance to the local farmers for improving rainwater-harvesting structures.

Recharging of aquifers with rainwater is a very useful water conservation strategy. In Pakistan, large numbers of delay-action dams have been constructed to accelerate the artificial recharge to the aquifer. The technique consists of constructing dams across streams to store floodwater for recharging aquifers. Unfortunately, many of these dams are not performing optimally due to faults in their designs. Most of them are highly susceptible to siltation. Therefore, this approach needs to be looked into in more detail in order to improve their usefulness. During the survey, people were keen to get support from government agencies and NGOs to improve the design of their rainwater-harvesting and artificial recharge structures. They were especially interested in gaining access to machinery for construction and rehabilitation of these structures as manpower is becoming scarce due to migration of male members to nearby towns in search of jobs to supplement their incomes.

Farmers should be trained in the use of modern water-saving techniques and drought-resistant crop varieties. Farmers should grow crops that do not require large amounts of water and hold the soil in place; this would be appropriate for subsistence cropping and marketing. Some of the work done in rain-fed areas of Pakistan, for example zero tillage technologies, and elsewhere in South Asia, for example, micro-irrigation technologies, could be usefully extrapolated for this purpose. Some local institutes such as PARC and agricultural departments have developed low-cast pressurized irrigation systems and water-resistant crop varieties. The farmers of Sindh and Baluchistan demanded that their access should be increased to more remote areas and that training programs for farmers should be initiated. Agriculture and extension departments should introduce more water-tolerant crops suitable for drought-prone areas and set up their nurseries in the local areas so that farmers can get proper seed and training for growing their crops. These activities should be initiated in drought-prone areas without waiting for disasters.

Water conservation, i.e., maximizing water usage and reducing water losses, must be the key to a stable and sustainable effort to ensure that the effects of future droughts are less devastating. The conservation of every resource utilized for subsistence and cash cropping must be encouraged through public-awareness campaigns and through enlightened policies that reward efforts to conserve

water and impose negative sanctions on those who waste it. Most of the respondents were concerned about inequitable distribution of water resources. This was particularly true for groundwater exploitation as rich farmers can afford to install deep tube wells to meet their water demands. Poor farmers are then forced to buy this tube-well water at very high rates, which every one cannot afford. As a result, they are deprived of their share of water not only from these tube wells but also from the karez systems as they go dry due to overexploitation of groundwater. Therefore, necessary steps should be taken for the revision and enforcement of water laws. Communities should be directly involved in the campaign of artificially recharging aquifers, conjunctive use of surface water and groundwater resources and adoption of water-conserving irrigation methods.

Despite heavy risks of droughts, no emergency plans are available for monitoring, regulation, management and mitigation of drought. Drought is not a type of disaster, which occurs overnight but rather a slow onset phenomenon. Therefore, instead of taking a retroactive approach and providing emergency relief, the government must adopt proactive strategies to address the problem and its solution on a long-term basis. There should be a comprehensive need assessment of different sections of society and the quantity of existing resources. These data should be used to prepare projections for different sections of society by keeping in view environmental impact and sustainability of all interventions. Water and health constitute the first priority in the area, followed by employment generation through food for work projects. The supply of food items on subsidized rates is essential. The Department of Public Health Engineering must work on the basis of a war footing to provide water to affected people.

The study results indicate that people of drought-hit areas found it very difficult to get credit facilities to buy essential items to reduce their misery. Government agencies failed to help farmers in this regard and farmers were forced to take loans from local rich people at very high interest rates. Therefore, there is a need to establish a permanent public bank for the development of drought-prone areas in Pakistan. This bank should extend advisory and financial services to the people not only during the drought period but also in other years. People should be able to get credit at reasonable interest rates to produce and store food and other necessary items as preparedness for future droughts. Micro-credit activities extended by some NGOs (e.g., NRSP) in many parts of Punjab and Sindh have proved very successful in household income-generation activities. The success rate of these schemes has been very high, which shows that people are responsible and they do want to help themselves.

Another lesson learned from this study was that many relief workers could not reach the affected people due to lack of accessibility in infrastructure. In order to reduce damages for future droughts, the government should immediately start a crash program for building roads, supplying electricity and developing transport means in the remote drought-prone areas of Sindh and Baluchistan. This should be considered as a drought-preparedness activity.

All of these potential actions will require a skillful integration of social, scientific and technological research and action. Governmental commitment (i.e., "political will," the commitment of resources, and good governance) is also critical. Part of a long-term, integrated response, i.e., "management" in the widest and best sense, should include analysis of successful efforts to integrate social, economic, scientific and scholarly research in other parts of South Asia as well as in Pakistan itself.

It seems inevitable that the effects of water shortages will increase in the foreseeable future, because of the effects of at least 20 years of overextraction for subsistence crops, livestock and industry, coupled with increased demand to meet human needs. The need for an integrated response

requires that local, provincial, federal and regional policies are integrated with, or at least congruent with, each other. The government must take a lead in putting in place the coordination mechanism providing effective oversight. Unfortunately, a national-level integrated institutional mechanism is not operational in the country to coordinate drought-related programs and to integrate them with ongoing federal and provincial drought programs and the efforts of civil society, NGOs, etc. Unless such a mechanism is developed, the country will continue to rely on emergency relief after droughts. There is a need to develop a National Drought Policy Commission. The commission should outline a course of action, which includes a preparedness initiative to help reduce the damages and cost of droughts. Federal- and provincial-level partnerships should be developed to ensure that federal drought programs are better-coordinated and integrated with provincial and nonfederal programs.

Appropriate institutional arrangements should be made for proper coordination of different ministries and line agencies involved in the management of water resources. The roles and responsibilities of these organizations should be clearly defined to avoid overlapping and to ensure effective management of water resources at all levels. A drought-management plan is essential for the government to ensure that appropriate institutional and legal structures are in place prior to the onset of drought conditions and that the necessary actions are well-thought-out.

Literature Cited

Bhatti, A. 2003. *Investigating the political economy of drought in Pakistan.* http://drought.iucnp.org/may-28.htm

GOP (Government of Pakistan). 2000. *Pakistan 2000, Agricultural census*. http://www.statpak.gov.pk/depts/aco/publications/agricultural_census2000/table01h.pdf

GOP. 2001. *Pakistan statistical yearbook 2001*. Pakistan: Federal Bureau of Statistics, Statistics Division.

Halcrow. 2001. Pakistan national water sector profile. Report submitted to Asian Development Bank under Water Resources Strategy Study-ADB TA 3030 Pak.

Nawaz, K. 2000. *Community participation and water management in Baluchistan, Pakistan. Proceeding of the workshop " New approaches to Water Management in Central Asia" held in Aleppo, Syria, November 6–11.* http://www.unu.edu/env/Land/Aleppo/06%20-%20Nawaz.doc

PWG (Pakistan Water Gateway). 2004. *Strategy to avert drought*. http://www.waterinfo.net.pk/artsad.htm

Qureshi, A. S.; Mujeeb, A. 2003. Impact of utilization factor on the estimation of groundwater pumpage of private tube wells in Punjab, Pakistan. *Pakistan Journal of Water Resources* 7 (1): 17–27. January–June. Pakistan Council of Research in Water Resources (PCRWR). ISSN: 1021–5409.

Qureshi, A. S.; Shah, T.; Mujeeb, A. 2003. *The groundwater economy of Pakistan.* Working Paper No. 64. Lahore, Pakistan: International Water Management Institute. http://iwmi.org.pk/iwmi/WP%2064%20final-With%20C%20&%20B%20Page.pdf

Shakir, S.H. 2001. *Natural hazards monitoring in Pakistan*. Paper presented in the seminar on "Natural Hazards Monitoring." January 7. http://www.unescap.org/enrd/space/RWDM_China/Word/HazardsMonitoring_PAKISTAN.doc

UN (United Nations). 2001. *Special report FAO/WFP crop and food supply assessment*. United Nations in Pakistan. http://www.un.org.pk/crop-food-asses.htm

Yousaf, M. C.; Sadaqat, H. H.; Faris, R. H. 2002. *FAO/WFP crop and food assessment for drought affected areas in Baluchistan and Sindh (2002).* http://www.un.org.pk/undp/crisis_p/report-drought-assessment-22.doc

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