THE SILENT CRISIS IN THE HIMALAYAN DESERTS

A Summary Report of a Pragya Study on—

Droughts & Desertification: Slow-Onset Disasters in the Himalayan Cold Deserts

By the Natural Resource Management and Research & Advocacy Teams at Pragya[1]

Though rarely recognized as major threats to human life and ecological stability, slow onset disasters account for 86.9% of human deaths caused due to natural hazards, with rapid-onset disasters like landslides (<0.1 %), earthquakes and tsunami (2.2 %) contributing much lower figures[2]. Famines caused by droughts have killed in very large numbers through starvation and thirst, disease, associated natural hazards, and even cannibalism. Periods of extreme aridity and areas affected by it are growing in the world today- a silent crisis that is being recognized in the attempt to bring out a new ten-year strategic plan for the UNCCD (UN Convention to Combat Desertification).

Drought is a recurrent feature of climate characterized by temporary water shortages relative to normal supply, over an extended period of time – a season, a year, or several years. The term is relative, since droughts differ in extent, duration, and intensity[3]. When rainfall is below normal for weeks, months or even years, it brings about a decline in the flow of rivers and streams and a drop in water levels in reservoirs and wells. If dry weather persists and water supply-related problems increase, the dry period can be called a 'drought'[4]. The World Meteorological Organization defines drought as the consequence of a natural reduction in the amount of precipitation over an extended period of time, usually a season or more in length, often associated with other climatic factors (viz. high temperatures, high winds and low relative humidity) that can aggravate the severity of the event[5].

Types of droughts[6]

Although there are several views on the definition of drought and whether it should be classified based on duration, intensity, region, or a combination of these parameters, the following classification is generally accepted:

1. **Meteorological drought**: According to the India Meteorological Department (IMD), meteorological drought occurs when the seasonal rainfall received over an area is less than 75% of its long-term average value. If the rainfall deficit is between 26-50%, the drought is classified as 'moderate', and 'severe' if the deficit exceeds 50%. Definitions of meteorological droughts are region specific since the atmospheric conditions that result in deficiencies of precipitation are highly variable from region to region.
2. **Agricultural drought:** Droughts of this nature occur when there is

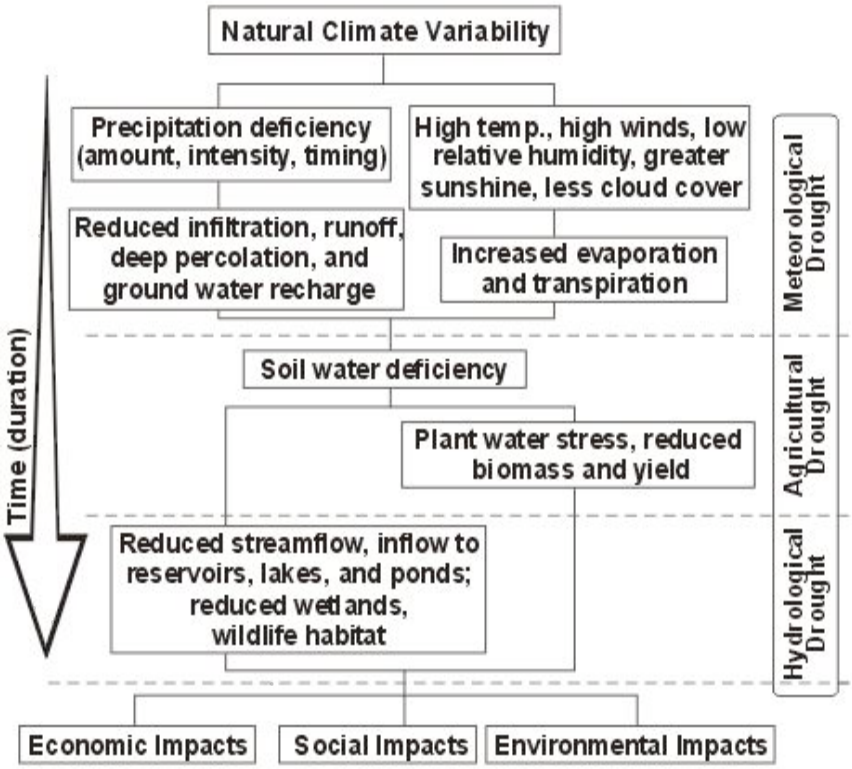


Fig. 1: Climate Impacts and Droughts
Source: 2006 National Drought Mitigation Center

[1] Pragya is an organization working towards sustainable development of the high altitude Himalayan region (www.pragya.org). NRM and RA team members: Sejuti Basu, Anushree Bhattacharjee, Medhavi Sharma, Nabila Aziz Siddiqui, Chandni Singh
[2] Wisner,B., Blaikie, P., Cannon, T., Davis, I., 2003. At Risk Second Edition: Natural hazards, people's vulnerability and disasters.
[3] Ameziane T., Iglesias, A., Ed. Drought Management Guidelines, European Commission
[4] National Drought Mitigation Centre University of Nebraska-Lincoln, USA (http://drought.unl.edu/)
[5] World Meteorological Organization, No. 869, 1997
[6] Drought in India: Challenges & Initiatives, 2001-2008. Report by Poorest Areas Civil Society (PACS) Programme

insufficient soil moisture to meet the needs of a particular crop at a particular point in time. Deficit rainfall over cropped areas during their growth cycle can destroy crops or lead to poor crop yields. Agricultural drought is typically witnessed after a meteorological drought, but before a hydrological drought.

3. **Hydrological drought:** This results from a deficiency in surface and sub-surface water supply. It is measured as stream flows and also as lake, reservoir and groundwater levels. It can be defined as a period during which the stream flows are inadequate to supply established use of water under a given water management system. A hydrological drought year can be defined as one in which the aggregate run off is less than the long-term average runoff. Most of the criteria developed for hydrological drought are specific to individual streams or river basins.

EXACERBATING CONDITIONS

As against the general belief, drought events are not always due to monsoon failures. Often, the interplay of departure from normal precipitation patterns and anthropogenic influences (overexploitation of land and water resources) result in the culmination of the process of desertification into a drought event. The conditions that contribute to the occurrence of droughts are:

Climate Change

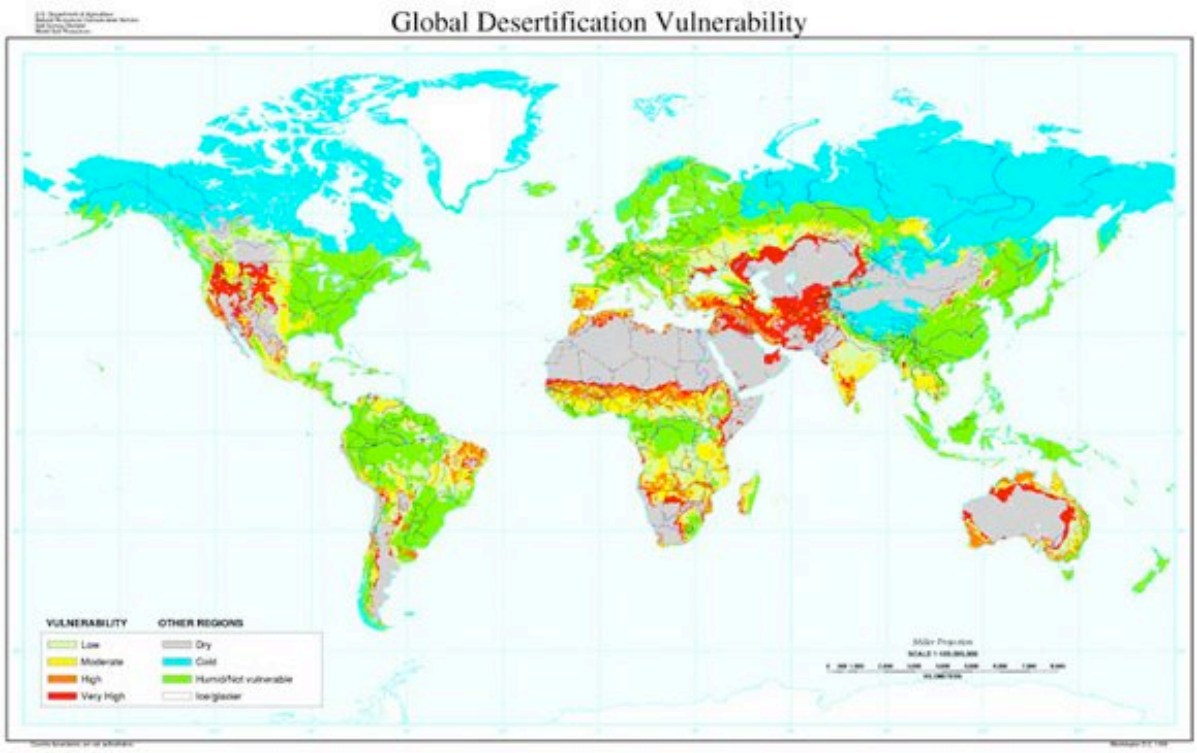
Evidence base of global climate change and associated increase in natural hazards has been growing with well-documented trends of increase in average air and sea surface temperatures, retreat of glaciers, rising sea levels and associated environmental threats. According to Centre for Research on the Epidemiology of Disasters (CRED), 68% of deaths, and 89% of all economic losses from 2000 to 2007 resulted from climate change induced natural disasters. *Climate change modifies the patterns of extreme weather events making the hazards more intense, more frequent, less predictable, longer lasting, especially in areas characterized by high human vulnerability.*

Minor shifts in climate pattern can significantly increase the disaster risk for vulnerable communities across the world. Historical analysis of drought prone areas carried out by the World Bank reveal that the intensity and duration of these events are likely to increase as a result of climate change. The drought risk hotspots of the world are located in Sub-Saharan Africa, South and South-East Asia. *The drought risk hotspots also coincide with the areas facing high-risk of climate-related conflict.* In South Asia, particularly Iran, Afghanistan, Pakistan, parts of India are also deemed most vulnerable to droughts and desertification, which are also identified as among the regions with high overall human vulnerability (Humanitarian Implications of Climate Change – Mapping emerging trends and risk hotspots, CARE International & Maplecroft, 2008).

Desertification

The UNCCD defines desertification as "land degradation in the arid, semi-arid and dry sub-humid areas resulting from various factors, including climatic variations and human activities". It is imperative to note that the people who are most vulnerable to the threat of desertification include many of the world's poorest, most marginalized, and politically weak citizens (Climate and land Degradation, WMO No. 989).

A rapid overview of the land use patterns across the world suggest that the dry lands account for >40% of potentially productive surface of the earth and are inhabited by approximately 40% of the world's total population. Asia has the largest area under dry lands, and is considered amongst the most affected in the world - both in terms of extent of coverage and at risk population due to desertification. China and India together have the largest number of population living in the dry lands and affected by land problems of desertification.



Source: National Resources Conservation Service, USDA

Fig. 2: Global map of desertification vulnerability

Factors that cause desertification mainly include overgrazing, over exploitation of water resources, deforestation and global climate change. Land degradation, resulting from the above factors, lead to desertification. While this phenomenon has a large spatial impact and cannot be quantified in terms of its enormous socio-economic and environmental impacts, desertification often culminates into droughts, which are events of water scarcity due to climatic factors. In the context of climate change, drought events are now increasing because change in precipitation patterns has a direct relationship with increasing the number and severity of a drought event. The relationship between desertification, drought events and climate change can be theoretically depicted as follows.

Droughts occur frequently in the areas affected by desertification, and are generally a feature of their natural climate. The relations between desertification and drought on the one hand, and human influence on the other, are complex. Occasional droughts … and long-term droughts covering wide areas are both caused or aggravated by the influence of man on the environment … Human influence can also hasten desertification and aggravate the negative consequences on man. But the degradation of land due to desertification has a serious compounding effect on drought, and thereby reduces the chances of the local people to cope with difficult periods. (http://www.fao.org/sd/EPdirect/EPan0005.htm).

Key Principles & Trends

- Desertification is increasing due to impacts of climate change.
- Desertification has adverse impacts on the ecological balance and pushes the ecological system nearer a collapse threshold.
- Desertification increases resource stress and reduces the adaptive capacity of communities.
- Periods of extreme aridity are natural and recurrent; when severe they become drought events. Climate change however, and its impact of climatic vicissitude, is increasing the frequency and intensity of such periods of aridity.
- Desertification and its impact of pushing the socio-ecological system nearer the collapse threshold, is resulting in a greater number of periods of aridity converting into drought events.

What is of grave concern is that desertification as a phenomenon is difficult to map and predict. Also, with impacts showing long after the initial onset, mitigation measures are mostly reactive in approach and thus do not adequately address the vulnerability of affected communities. It is also crucial to recognize that desertification is as much an environmental problem as it is a developmental one. It affects ecological systems by degradation of

land and water resources and loss of biodiversity. It also impacts local populations by directly affecting their food availability, livelihood sources and health.

DROUGHTS AND DESERTIFICATION AS SLOW-ONSET DISASTERS

Droughts and desertification are different from other natural hazards in the nature of their onset, and may be defined as a "*cumulative departure from normal or expected precipitation*" which may build up over several years or in one season. Droughts and desertification differ from other natural hazards in several important ways. They are a slow-onset, creeping phenomenon that makes it difficult to determine the onset and end of the event. The duration may range from months to years and no single indicator or index can precisely identify the onset and severity of the event. The impacts are generally non-structural and difficult to quantify. The spatial extent is usually much greater than for other natural hazards, making assessment and response actions difficult. Also, due to their potentially long duration, the core area or epicenter often changes over time, reinforcing the need for continuous monitoring of climate and water supply indicators. The impacts are cumulative and the effects magnify when events continue from one season or year to the next.

Slow onset events like droughts and desertification are defined by the characteristic unpredictability of their exact time of start and end. Predicting their onset, duration, severity and possible socio-economic and environmental impacts with reasonable accuracy is difficult and as a result, such events usually do not attract humanitarian or political aid. However, the fact that the impacts of such events take time to surface should by no means undermine their catastrophic nature. The slow initiation and undefined end of a drought makes it difficult to select the opportunity to take defensive or remedial action. Being a slow onset phenomenon, desertification and its periodic culmination into drought events often do not get adequate policy and research interventions. The lack of a precise and universally accepted definition of droughts, large spatial extent of such events and challenges in quantifying the exact impacts compound the problem further[7]. In the face of such factors, drought management as a discipline becomes an important field of study.

CLIMATE CHANGE ASSOCIATED ENVIRONMENTAL TRENDS IN COLD DESERTS

High dependence on natural resources under the high growth scenario shifts a system to a state of non-equilibrium, as projected in the future for India. According to UN projections, India might experience severe water stress by the year 2025, and is likely to cross the benchmark of water scarcity (defined as per capita annual water availability <1000 cu. m.) by 2050 (UNDP, 2007). Land degradation due to natural or human induced disruptions is a major concern in India both in terms of per capita availability of arable land and per capita availability of natural resources such as forests. Hence, the country faces a great challenge to meet the food, fuel and fodder requirements in the coming decades. The Himalayan communities in the cold desert region form one of the most vulnerable group in the country in this context as climate change shrinks their already limited natural resource base that sustains their life and the traditional indigenous livelihoods.

In the cold deserts precipitation is in the form of snow and it is the water from this snowmelt that sustains agriculture, and hence life in these areas. The prime source of water for the people living in the cold deserts has been the water from the glacial melts. Secondary sources in the form of natural springs are also used to access water, mainly for domestic use, but the contribution of such sources is relatively less. Climate change has affected the water regime in cold deserts in the following manner:

1. It has led to a **skewed precipitation pattern**. These regions are experiencing lower snowfall in winters leading to a consequent scarcity of water in the summers (since there is less snowmelt to feed the water bodies).
2. Also, the **faster melting of the glaciers** leads to sudden discharge of a huge amount of water in a short span of time, leading to flash floods. This in turn adversely affects the soil fertility, firstly, due to the huge deposition of debris over the fertile soil and secondly by not allowing the water to seep through and recharge any ground water aquifer.

[7] Drought monitoring and early warning: concepts, progress and future challenges, 2006. WMO-No. 1006.

Therefore, with the increasing water scarcity and threats of climate change looming large, a cataclysmic water crisis seems almost inevitable. This can lead to massive erosion of livelihoods, increase in epidemics, large-scale migration in addition to the more apparent effects such as acute food shortage, depletion of natural resources and extermination of the livestock. Unfortunately, these areas, owing to their inhospitable and relatively inaccessible conditions, have still not found their way into the mainstream developmental activities, thus aggravating the problem further.

DROUGHT VULNERABILITY OF COLD DESERTS

Management of drought and the recognition of desertification as a prolonged disaster event gains importance given the fact that the people in the perilous Himalayan ecosystem are mainly dependent on natural resources as a source of livelihood. Moreover, the impacts of drought go much beyond the loss of human lives. They affect the entire socio-economic structure of a society disrupting the livelihood patterns and inflicting damages, from which people may take several years to recover. Government policies made at the national level are not necessarily applicable to the specific requirements of cold deserts. Drought management initiatives are constrained by the gaps in research and information networks. In addition, implementation of new technology, which has not been adapted for the mountains, often exacerbates the situation.

The Pragya Studies

When we try to comprehend the impact of a drought event in the context of cold deserts, the stakes only get higher and the need for drought management stronger. Realizing this need for attention to drought management in cold deserts, Pragya, an NGO addressing development and environment related issues in the high altitude Himalayan region, has carried out two studies over the years 2006-2008 in the cold deserts region of India – the Western Himalayan districts of Leh (Jammu & Kashmir), Lahaul & Spiti, Kinnaur and Chamba (Himachal Pradesh) to examine the impacts of drought on socio-economic condition and environment to help understand and develop innovative institutional arrangements and decision-support tools.

Objectives and Methodology: The studies were targeted at the following objectives:

1. To quantify the level of environmental threat, with a focus on droughts and desertification, and adaptive capacity in the cold desert regions.
2. To study the existing traditional water conservation and drought management techniques being used by communities in the cold desert region of the Western Himalayas.
3. To assess the socio-economic impacts of drought and existing government interventions and find suitable mitigation measures.
4. To facilitate the development of a suitable drought management strategy, which would combine existing traditional management practices and established conservation techniques, keeping in mind the need for sustainable utilization of a finite natural resource.

The studies were conducted using the methods of participatory rural appraisal (PRA), group interviews through four district level workshops, filling of open-ended questionnaires in eight drought prone villages across the target area; ground surveys involved PRAs blended with scientific field observations for a detailed analytical study of 82 watersheds across Jammu and Kashmir and Himachal Pradesh. The key findings and recommendations of both the studies have contributed to this paper and are summarized hereafter.

Contributors to Drought & Desertification and associated Vulnerability

Drought risk is a product of a region's exposure to the natural hazard and its vulnerability to extended periods of water shortage[8]. Pragya's study of cold desert watersheds assessed their vulnerability to threats (both rapid onset and slow onset) based on various variables like **resource status** (availability of biotic and water resources), **ecological balance** (hydrology, vegetation and soil conditions), **resource stress** (supply of water for drinking and irrigation), **disaster risk** (frequency of occurrence and perception of threat) and **climate change** (change in snow amount, rainfall and availability of water resources). The contribution of environmental degradation, climate change, anthropogenic pressure and others to vulnerability was explored and perceptions of threat of inhabitant communities determined. The study further helped identify the characteristics of cold desert

[8] Donald A. Wilhite, 2000. Moving Toward Drought Risk Management: The Need for a Global Strategy.

watersheds facing maximal degree of environmental threat.

Climate Change

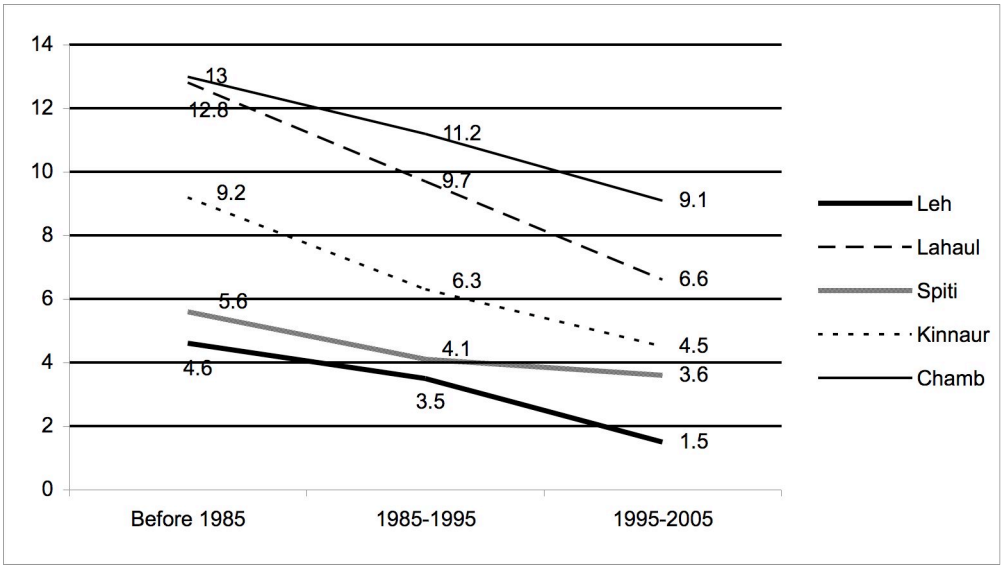
Since mountain ecosystems play a significant role in influencing climatic patterns and are usually the first to feel the effects of even small changes in temperature and humidity, climate change is an escalated phenomenon in cold deserts. The study conducted by Pragya validated the associations between climate change and other social and ecological factors. Climate change in the region is leading to a decline in snow cover and a reduced availability of water for drinking and irrigation, as well as a shrinkage of the natural vegetation such as grasslands and forests that communities depend on, and rendering waste the lands that were productive.

Table 1. Climate change and its impacts (25 watersheds in J&K and 57 watersheds in H.P.)

	Change in snow cover			Change in water resources
District	Decrease in no. of winter days	Decrease in no. of snowfall days	% Reduction in snowfall amount	% Reduction in spring water
Leh (25)	33.6	10.12	64	8
Lahaul (18)	35	9	50	13.23
Spiti (16)	41.25	10.6	14.58	14
Kinnaur (13)	25.4	8	48.5	16.54
Chamba (10)	30	7	29.3	21.5

Apart from the apparent decrease in the amount of snowfall in the region (Table 1), people have observed a change in the timing of snowfall, which is of graver concern. Skewed timing of snowfall (for e.g. less snowfall in January and more snowfall in March) translates into quicker melting as spring approaches, resulting in temporary floods and plausible drought due to reduced water through snow melt in the near future. Table 1 also draws a direct relationship between decrease in precipitation and a decrease in water in springs, which are the primary source of water in many cold desert villages.

Fig 3. District-wise changes in amount of snowfall (in feet) over 30 years



An overall trend of decrease in the amount of snowfall (in feet) was observed (Figure 3). Leh recorded the highest percentage decrease (67.4%) in the amount of snowfall over a period of 30 years while the decrease was least in Chamba (30%). It is important to note that the percentage decrease were significant in Kinnaur (51.1%) and Lahaul (48.4%). This downward trend in the amount of snowfall, the primary form of precipitation in the cold desert regions, is critical for the local communities who rely upon streams of glacial melt and natural springs for fulfilling all their water needs. Even a small decrease in the water flow has grave impacts on an entire village that may have only one source of water for domestic and irrigation purposes. The effects of climate change in causing reduction in natural resource base available for use by the resident communities, is also highlighted by the positive correlation between climate change and resource stress.

Eco-degradation and Anthropogenic Pressure

Another aspect of desertification is the degradation of natural resources like land (in the form of creation of vast tracts of non-arable wastelands and degraded rangelands) and water (reduction in water flow in springs and streams). The study by Pragya brought out a strong positive correlation between anthropogenic pressure and eco-degradation. Rise in the density of agriculture, increase in population, development of the region and large amount of tourist in-flows, has been causing an impact on the available resources and the per capita share of these resources. Overuse and inappropriate use of resources to accommodate the increasing population and resource demands is leading to resource degradation and stress. This is serving to push the cold desert ecosystems further towards the collapse threshold, and reducing the adaptive capacity of the socio-ecological system, while also increasing their susceptibility to drought events.

Table 2. Process of degradation and their impacts (25 watersheds in J&K and 57 watersheds in H.P.)

District	% Degraded forest	% Degraded grassland	Irrigation sources dried up (no.)	Drinking sources dried up (no.)
Leh (25)	78.82	13.37	8	15
Lahaul (18)	92.58	33.9	4	9
Spiti (16)	71.05	45.03	5	13
Kinnaur (13)	70.75	50.07	6	8
Chamba (10)	80.79	Negligible	7	11

The extent of eco-degradation varies in the different cold desert districts of Lahaul & Spiti, Kinnaur and Chamba, and the altitude belts within them. The high (3300-3700 m) and very high altitude stretches (>3700 m) face severe degradation of natural resources, as a consequence of the high dependence of inhabitant communities on the natural resources and the associated stress on the natural environment. For example, in Leh, there is a higher level of degradation in the higher altitudes (>3700 m) due to impact of climate change on the already fragile ecosystem and in the middle lower altitude where population density and developmental pressures are higher. These conditions reduce the resilience of the natural system to cope with the increasing magnitude of environmental threats and make the communities more vulnerable to drought and other related disasters.

Altitude and Development Status

The altitude of a settlement has a strong influence on its vulnerability to environmental threats. Watersheds with very high levels of threat were found to lie in two altitude belts: above 3700m and 3000-3300m. These altitude belts are characterized by moderate to high levels of degradation and disaster risk, subjected to high anthropogenic pressure and consequently high resource stress as well, and experience high to very high impacts of climate change. These areas are beleaguered with minimal infrastructure, inadequate developmental agencies, and lack of educational/vocational facilities. Therefore, natural hazards such as drought pose an additional challenge to the people in the Himalayas who are not well equipped to deal with them. Development status, on the other hand, was found to have a positive correlation with the impacts of climate change. Areas with higher levels of development tend to show enhanced pressure on the hydrology, drying up of water resources and growing distance from glaciers.

Desertification and Resource Stress

The mountain communities in the region depend almost entirely on the limited natural resources for sustenance. They depend on natural sources for water, agriculture for food and wild medicinal plants for medical remedies. Arid conditions, low soil fertility and a fragile ecosystem result in low carrying capacity. Farming activities have to be restricted to the summer months and there is only one short growing season. In addition, precipitation levels are negligible with an average annual rainfall of 100mm, making water a scarce resource. Increasing desertification and resultant depletion of natural resources directly affects the socio-economic fabric of the people. This *societal vulnerability* [9] to changes in natural resource wealth is one of the main concerns of these communities.

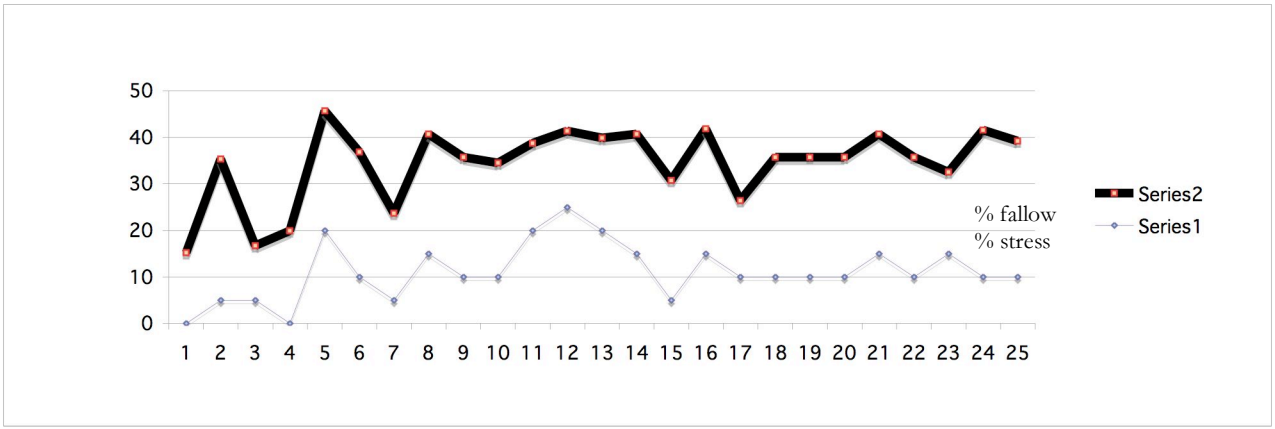
Resource Stress for these high altitude mountain communities is measured by access to water for drinking and irrigation, availability of productive/unproductive land resources and per capita availability of natural resources.

[9] Weichselgartner J., 2001. Disaster mitigation: the concept of vulnerability revisited. Disaster Prevention & Management 10 (2): 85-94.

Resource stress has a close linkage with climate change and the consequent changes in the eco-hydrological parameters. It is also influenced by the developmental patterns, resource consumption and the increasing population pressure. For example, the resource stress is found to be more in the middle and lower altitude belts of Ladakh (2000 – 3300 m) where developmental stress is more and it dimnishes towards higher altitudes.

The impact of climate change and increasing threat of drought and desertification gets translated into economic difficulties for the indigenous communities. The study of increasing water stress for irrigation in Leh (fig. 4) resulting from increasing agricultural land and hence the demand for irrigation water has a strong association with the amount of productive land lying fallow in the concerned watersheds. This huge amount of unproductive resource depict the resource stress in the area.

Fig 4. Fallow Land and Irrigation Stress in Leh, J&K



Levels of Threat and Insecurity

Local communities' were drawn out on their perceptions of high and low drought prone areas in the four cold desert districts (Lahaul & Spiti and Kinnaur in Himachal Pradesh, Ladakh in Jammu & Kashmir), in order to elicit the degree of insecurity suffered by them as a result of the increasing frequency of droughts and escalating desertification in the cold deserts. The findings have been summarized in Table 3.

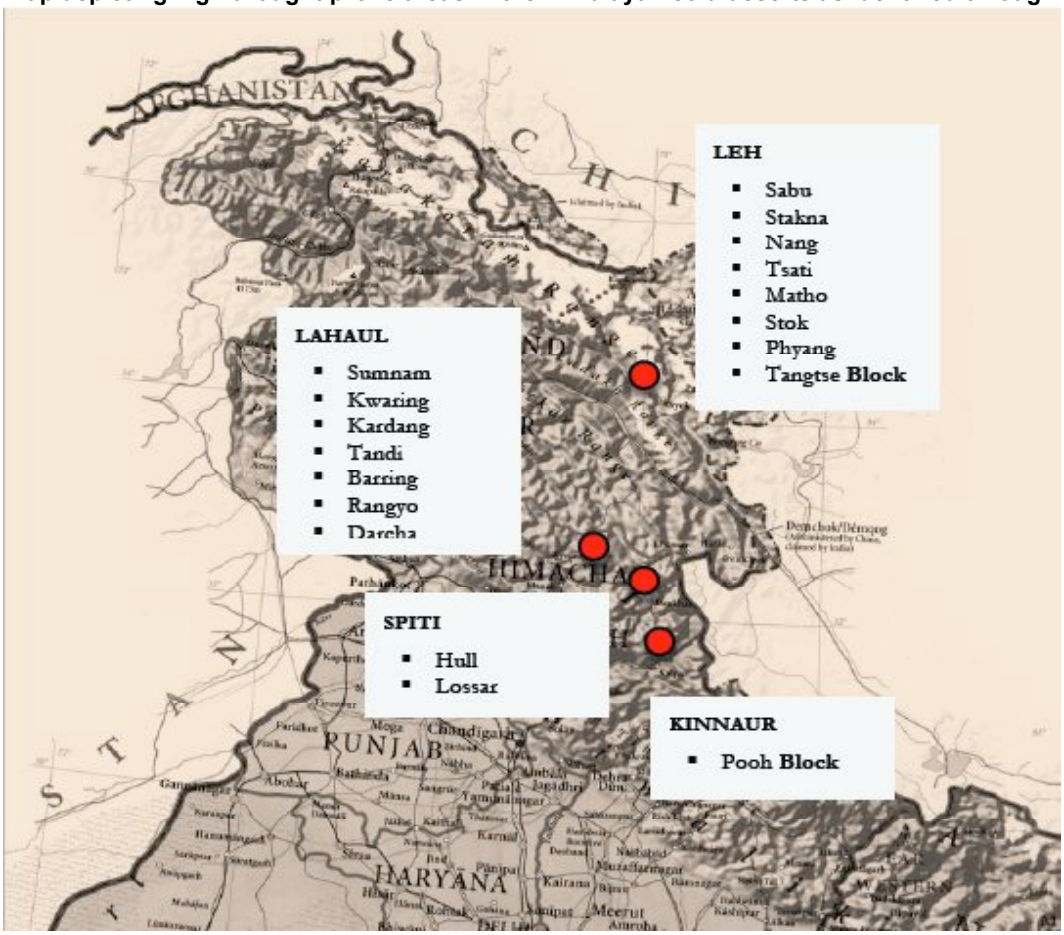
Table 3. Perceptions of drought-prone areas

District/ Block	Vulnerability	
	High drought prone	Low drought prone
Lahaul	**Characteristics:** 1. Absence of glaciers 2. Sparse rainfall 3. Rapid run-off of snowmelt 4. Failure of traditional snow harvesting measures[10] ***Affected users:*** 1. *Farmers (for irrigation)* 2. *All villagers (for drinking water)* 3. *Livestock*	**Characteristics:** 1. Presence of perennial streams (*nallah*) 2. Presence of glaciers 3. Well-defined system of channels (*kuhls)* 4. Presence of grasslands 5. Ample fodder available ***Affected users:*** *Women*
Leh	**Characteristics:** 1. No opportunity for cultivation of potatoes and peas (high water demanding crops) 2. Less to no livestock ***Affected Users:*** *All villagers*	**Characteristics:** 1. No conflicts over water 2. Higher agricultural output due to greater availability of water
Spiti	**Characteristics:** 1. Conflicts due to limited water resources and unequal water distribution 2. Drying up of available sources of water ***Affected users:***	**Characteristics:** 1. No conflicts over water 2. Developed network of *kuhls* because of better availability of water ***Affected users:***

[10] This was observed to be due to reduced snowfall as well as a change in snowfall patterns. Before 1969, the first snowfall each winter would occur in the month of November; in this decade, the onset of winter and the first snowfall occurs in the month of December.

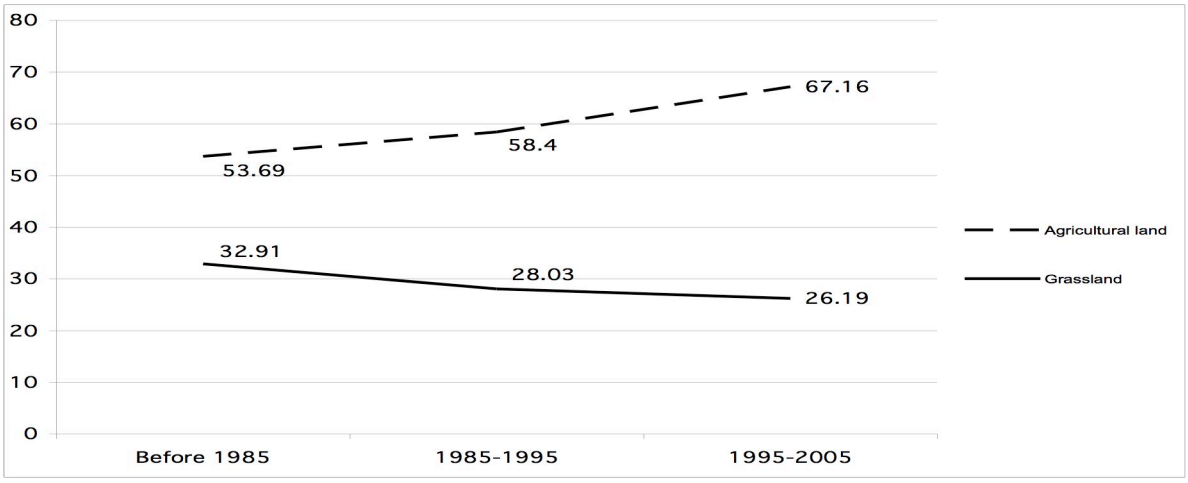
	1. *Farmers (for irrigation)* 2. *All villagers (for drinking water)* 3. *Livestock and wild animals*	1. *Farmers* 2. *All villagers*
Kinnaur	**Characteristics:** 1. Forced to reduce land under cultivation and leave more land fallow 2. Fallow land rapidly degrades into wasteland ***Affected users:*** 1. *Farmers (for irrigation)* 2. *All villagers (for drinking water)*	**Characteristics:** 1. All available landholding may be cultivated 2. Better economic status since higher cop yields and cash cropping are possible

Fig 5. Map depicting high drought-prone areas in the Himalayan cold deserts as identified through PRAs



In the district of Leh, there has been a steady increase in the land area under agriculture in cold deserts; this has been accompanied by a decrease in the area of grasslands (Fig 6). Reduction in grassland acreage can spell doom for nomadic communities in the Himalayas, for whom pastoral's is the sole livelihood option.

Fig 6. Changes in area (ha) of grasslands and agricultural land in 25 villages of Leh over 30 years



- *Observations in the villages of Tandi and Sumnam (Lahaul valley, Himachal Pradesh):* People of these villages have observed visible changes in climatic conditions due to global warming (lower snowfall from 12 feet to 3-4 feet and warmer summers), and expressed their fear of the potential impacts of receding glaciers like decrease of water in streams[11].
- *Observations in village Umla, (Leh District, Jammu & Kashmir):* People of Umla have recorded a decrease in water flow in the main sources of water (streams and springs). Also, a drastic fall in the water table has been noted (for setting up a hand pump, people have to dig up to 60 feet deep as opposed to digging 20 feet a few years ago). With warmer winters, there has been a perceptible decrease in snowfall and reduced availability of water.
- *Observations in village Yulla, (Kinnaur District, Himachal Pradesh):* Inhabitants expressed their feeling of '*inability to cope'* with decreasing water resources and felt that they could not change the situation and it was best to leave things '*to rest on the mercy of God*'. This highlights an important fact that although slow onset disasters are best tackled when the affected communities are well prepared and less vulnerable, the community themselves do not feel so and do know *know* how they can cope. This lack in transfer of disaster management principles from the research and policy tables to villagers is a serious gap which affects vulnerability and hence impacts the consequences of an event as and when it occurs.

Impacts of Droughts and Desertification

The impacts of drought are largely nonstructural and spread over a larger geographical area than damages from other natural hazards. The slow onset nature of droughts adds to the severity of the problem. Like most of the other natural disasters, the impacts of an event like drought go much beyond the usual loss to life and property. Droughts cause misery to both human and livestock population, accelerate degradation of natural resources and put a heavy pressure on government's resources through the need for providing relief measures. The impacts of drought as felt by local populations in the area have been summarized in Table 4.

Table 4. Impact assessment

Place	Impacts
Keylong	**Social:** 1. Adaptations with respect to crops cultivated- those requiring less water are grown more. 2. Increase in level of poverty as a result of lower yields and inability to cultivate cash crops, which has a direct impact on the quality of life. 3. Escalating conflicts due to limited water resources. 4. Shortage of fuel wood that has an impact on energy availability and quality of life. **Economic:** 1. Income levels are adversely affected due to reduced crop yields. 2. Shortage of fodder compels people to sell their livestock. 3. Agricultural land productivity decreases because of less organic matter, soil erosion and low moisture content. **Environmental:** 1. Impacts are gradual. More pronounced after prolonged drought.

[11] In village Sumnam, the only source of water for household, agricultural and livestock needs is a single spring7-8 miles from the village. A perceptible decrease in water flow has been observed in the past few years.

	2. Reduced forest productivity. 3. Increase in soil erosion by wind.
Leh	**Social:** 1. Affects access to food and food security. 2. Affects health because nutritious food is not available. 3. With lowered income, villagers cannot send their children to school, affecting their education. **Economic:** 1. Reduction in agricultural output leading to decrease in household income. **Environmental:** 1. Reduction in snowfall. 2. Very high temperatures in summers and equally severe winters. 3. More lands rendered wastelands and non-arable.
Spiti	**Social:** 1. When agricultural failure occurs, men are forced to migrate in order to supplement the family income. 2. Escalating conflicts over sharing of the limited water resources. 3. Reduced household incomes affect education (unable to buy enough books, pay school fees, school uniforms) and lead to dropouts. **Economic:** 1. Reduction in area under cultivation. **Environmental:** 1. Reducing snowfall over the last few years. 2. Indirect impacts on wildlife.

Kinnaur	**Social:** 1. Conflicts escalate as a result of water stress, even after State's provision of water through tankers. **Economic:** 1. Occupational diversity to combat agricultural failure (often sell their livestock to tide over winter). 2. Affects both quality and quantity of crops (esp. wheat) translating into decrease in value of the crop. 3. As water availability decreases preferences is given to cash crops to get quick returns. **Environmental:** 1. Pressure on pastureland increases as water decreases increases. 2. Reduction in water resources like streams and springs.

Table 5. Community adaptations

Place	Impacts
Keylong	1. Alternative livelihood options are taken up (e.g. General Reserve Engineer Force— GREF). 2. Selling of livestock to tide over fodder shortage. 3. Shift towards cash crops and vegetables. The money earned is used to buy food grains.
Leh	1. Crops like *Alfalfa* are now cultivated and used for fodder. 2. *Salix* leaves and bark are also used as a supplement fodder in lean periods.
Spiti	1. Migration of male members of the society in order to supplement the family income. 2. Reduction in area under cultivation. 3. Fodder resources are already inadequate. In the event of a drought, black gram (less water requiring) are ground and fed.
Kinnaur	1. Occupational diversity to combat agricultural failure (villagers often sell their livestock to tide over winter). 2. As water availability decreases preferences is given to cash crops to get quick returns. 3. In village Asrang, which was earlier too high for apple cultivation, orchards are being laid out because of increasing annual mean temperatures. Also, increasing snowmelt has resulted in more water availability for irrigation.

- *Observations in village Tandi:* The impacts of drought were felt most on availability of drinking water for humans and livestock. When rains do not occur on time, crop productivity gets affected, reducing both quality and quantity of the produce. This in turn affects the economic situation of a household. Most respondents linked this economic upheaval to eventual deprivation of the opportunity to send their children to better schools. Usually during one dry year, the community becomes economically weak but still have some savings (in cash or kind) to survive and to normalcy in the next year, so the effect has not really dragged them into poverty.
- *Observations in village Sumnam (Lahaul district, Himachal Pradesh):* The people recorded an effect on the overall standard of living through reduced availability of food. When water access decreases, people tend to sell their livestock, as they are unable to buy commercial fodder. People opt for other avenues of opportunity such as small-scale business and the government sector. The people also displayed awareness regarding the importance of education in such situations – a person with higher qualifications does not need to depend upon the vagaries of nature and agriculture and can get a stable job with an assured income.
- *Observations in village Umla, Leh:* People have reduced the area under cultivation due to water scarcity. In past

years, they have gone to the extent of selling or slaughtering livestock to tide over lean periods. When they experience acute drinking water shortage and livestock needs, resources are shared with neighbouring villages; however this does not extend to water needs for irrigation. These responses highlight the fact that drought has severe repercussions on the social and economic lifestyle of affected populations and slow, yet significant impacts on environmental systems.

DROUGHT MANAGEMENT MEASURES

Drought management interventions in India have been evolving continuously as new socioeconomic and technological developments occur. Although about 68% of the geographical area is prone to droughts, the drought vulnerability index (persons killed per million exposed) for India is as low as 0.58. This shows that India's drought management initiatives have borne results over the past years. The basic drought management approach followed in India follows a typical drought cycle of prevention, mitigation, preparedness, monitoring and prevention[12]. In the context of desertification, India is a party to the United Nations Convention to Combat Desertification (UNCCD). As a party to the initiative, it has taken various initiatives either direct such as programmes to reduce desertification or indirect ones like afforestation measures exemplified by the setting up National Afforestation and Eco-development Board (NAEB) for the regeneration of degraded forest areas and lands adjoining forest areas, national parks, sanctuaries and other protected areas as well as the ecologically fragile areas like the Western Himalayas, Aravallis, Western Ghats etc. The major policy interventions are as listed below:

1. **Desert Development Programme(DDP):** This programme was an outcome of the recommendations in the report of the National Commission on Agriculture (1966) for starting a separate programme for desert areas including cold deserts. In the cold deserts, due to less rainfall, crop cultivation and afforestation could be taken up only through assured irrigation. In these areas, the main activity was water resources development by construction of channels for diversion of water flow from the glaciers and springs to the fields and lift irrigation works in the valleys. The objectives of DDP included developing desert areas on a watershed basis by the sustainable utilization of natural resources and improving the socio economic conditions of poor and disadvantaged sections of the village community, through creation, widening and equitable distribution of the resource base and increased employment opportunities. The main activities undertaken under the DDP program are afforestation, ground water development and utilization, construction of water harvesting structures, rural electrification for energizing tube wells and pump sets and development of agriculture, horticulture and animal husbandry[13].

2. **Drought Prone Area Development Programme (DPAP):** The DPAP aims at restoration of ecological balance by harnessing, conserving and developing natural resources, *i.e.,* land, water, vegetative cover and raising land productivity[14]. The main objectives of the programme are to minimize the adverse effects of drought on agricultural, water and livestock resources through integrated development of the natural resources base by adoption of appropriate technologies. The area covered so far by the DPAP has only been about 10% of the geographical area of the blocks selected for DPAP.

3. **Watershed Development Programmes (WDP)[15]:** The WDP aimed at development of water resources by construction of channels for diversion of water flow from the glaciers and springs to the fields and lift irrigation works in the valleys. Currently, due to retreating glaciers, the *kuhls* built previously are no longer adequate in numbers and their distribution is skewed, with their increase is not in tandem with the spread in habitation. The shift from subsistence agriculture to niche agriculture has resulted in change of land use with introduction of commercial species with a higher water requirement. The traditional institutional framework for water management is eroding, and indigenous water management techniques are becoming grossly inadequate for the presents needs adding to the hydrological pressure. Although the WDP has had a positive impact on the agriculture of the area but it was not a huge success as far as employment and income generation were concerned.[16]

[12] Samra, J.S., 2004. Review and Analysis of Drought Monitoring, Declaration and Management in India, Working Paper 84, Colombo, Sri Lanka: International Water Management Institute.
[13] www.planningcommission.nic.in
[14] Perumula, Gopinath, Ed. Menon, S., 2009. Watershed as a Development Intervention for Providing Livelihood Security in India. Watershed Management: Case Studies, The ICFAI University Press, 2008.
[15] Ministry of Rural Development [http://rural.nic.in/annualrep0304/chapter20.pdf]
[16] Department of Land Resources [http://dolr.nic.in/TechCommitteeReport1994/P10-15Ch3_ImpactReview.pdf]

4. **Integrated Wasteland Development Program (IWDP):** The IWDP aims to arrest rainwater run off and conserve it in situ where it falls to control soil erosion and conserve water and soil and thus lead to improved green cover and improved land productivity. Under this programme, wastelands development was targeted in an integrated manner based on village micro watershed plans. These plans were prepared after taking into consideration the land capability and site conditions and in consultation with the local people about their needs. The local people using low cost technologies that are locally available execute the watershed projects.

Strategy to Combat Desertification (GOI)

Develop the natural resource (NR)
1. Conservation of land, water and perennial biomass
2. Treatment of problem lands
3. Expand horticulture, forestry and agro forestry
4. Develop need-based NRM related infrastructure

Management of developed NR
1. Formal allocation of user rights
2. System of management of assets created (e.g. user charges)
3. Sustainable use of developed NR (e.g. social regulation)

Non-farm livelihoods
1. Diversification and link to markets
2. Up scaling of successes

5. **National Programme for Combating Desertification** was the initiative taken under the 10th five-year plan. Under this scheme, the affected States can take up specific activities for mitigating drought through the participatory process. The tentative allocation for the for the period of 2002-2007 was Rs 100 crores. Currently, the plan is under its first phase of the long-term strategy. (2007-2022). The objectives of the programe include of a community based approach to development, improve the quality of life of the local communities, awareness raising, drought management preparedness and mitigation, R&D initiatives and interventions which are locally suited, and strengthening self governance leading to empowerment of local communities.

6. **Specific provisions in other policies[17]:**
   - *National Environmental Policy 2006* recognizes that, "while conservation of environmental resources is necessary to secure livelihoods and well-being of all, the most secure basis for conservation is to ensure that people dependent on particular resources obtain better livelihoods from the fact of conservation, than from degradation of the resource."
   - *National Food security Mission* aims at (among others) restoring soil fertility and productivity at individual farm level.
   - *Green India Scheme (proposed)* as per which an additional 6 million ha land is proposed to be afforested.
   - *National Water Policy 2002* lays stress on better irrigation policies involving community participation.
   - *National Forestry Action Programme* prepared by the Ministry of Environment and Forests as a long-term perspective plan for the afforestation of the forest land in the country in a sustainable manner.

Other government initiatives with regard to droughts and desertification are National Watershed Development Project for Rainfed Areas (NWDPRA), Watershed Development Programme for Shifting Cultivation (WDPSC) and Integrated Afforestation and Eco-development Project Scheme (IAEPS). Schemes and programmes like Food for Work Programme, National Rural Employment Guarantee Scheme (NREGS), Employment Assurance Scheme (EAS), Jawahar Gram Samridhi Yojna (JGSY), Pradhan Mantri Gram Sadak Yojna (PMGSY), Swarnajayanti Gram Swarozgar Yojna (SGSY) and Annapurna Scheme cater to crosscutting issues of livelihood options, economic welfare etc.

Addressing Droughts in Cold Deserts

Pragya's participatory study also brought out local perceptions about existing government schemes and initiatives. The study revealed the local awareness of drought management policies and their understanding of pre and post drought management measures. The findings are summarized in Table 6. Many respondents were of the opinion that in order to enhance the efficacy of the relief measures, the amount of **subsidy should be increased** and so should be the amount of **ration per card**. People across the villages believed that all the projects in the area should undergo **regular review process** with a **rigorous feasibility check** before implementing any new technology. They also believe that a **water committee** comprising the village youth and certain knowledgeable elders, researchers and villagers must be formed. While they gave suggestions, these

[17] http://www.indiaenvironmentportal.org.in/files/Trans%20Himalayan.pdf

communities were largely found to be unaware of the State programmes, thus leading to the conclusion that the **government policies need to be more accessible**. In addition, a substantial stress needs to be laid upon convincing the policy and decision makers that investments in **mitigation** are more cost effective than post-impact assistance or relief programs.

Table 6. Drought management measures

Place	Pre-drought (mitigative and preventive)	Post-drought (relief and recovery)
Keylong	**Existing measures:** - Selling livestock if adequate snowfall does not occur from Nov-Jan. - Meetings of the Gram Sabha, Aapda Prabandhan Samiti (comprising govt. and local representatives). - Adoption of water conservation measures like use of sprinklers and channelization of unused water towards barren areas. - Haryali programme, NREGS; DDP (not very effective however, because of funds release issues); Horticulture Technical Mission (difficult for hill areas, since large areas of land are required). - Reducing area under cultivation. - Well-defined water distribution system. **Suggested Measures:** - Emphasis on snow harvesting, artificial glaciers, spring revitalization, poly/pang grass lining of kuhls. - Tanks constructed at the Panchayat level. Small polytanks (2m*2m*1.5m) to irrigate every 2-3 fields. - Subsidies that encourage adoption of new technologies, such as lift irrigation. - Sub-committee of Gram Sabha to monitor drought issues and take action when required. - Storage of spring water in nallahs and distribution through pipes. - Planting of willow and Seabuckthorn to retain water. - Govt intervention for high cost structures.	**Existing measures:** – NREGS – Drought relief/subsidy from govt. according to magnitude of crop loss. – Relief from NGOs, celebrities. – Fodder from Animal Husbandry Dept. – Water sharing based on landholding. – Govt. loan of up to 3 lakhs at 7% interest pa. – In 2000-2004 there was severe water shortage in the entire Lahaul valley and the govt. took the measure of dropping food. Compensation was given according to the crops. Small land–holding farmers were provided with more land for free (i.e. farmers with 2-5 bighas were given land to make it up to 8-10 bighas of land) **Suggested Measures:** – More subsidy – No. of ration cards should be increased or new cards distributed.
Leh	**Existing measures:** - Zings have been constructed to conserve water. - Water distribution by land holding, ensured by watchman (*sushpord*). - Watermark in the kuhl that indicates the onset of water scarcity. - Spring protection- according to local belief, polluting the spring will contribute to water depletion. **Suggested Measures:** - Construction of more zings for water storage. - Artificial glaciers to support existing natural glaciers. - Formation of a water committee comprising youth, elders, researchers and govt officials.	**Existing measures:** - Compensation and aid (ration) from the govt. - Community storage of seeds and fodder. - Govt. assistance for kuhl repair. - 'Yarpa' local fodder sp. is grown under water stress. Foliage of Salix trees are used as fodder when there is water stress.
Spiti	**Existing measures:** - Use of local grass lining to reduce seepage. **Suggested Measures:** - Setting up of seed banks for fodder and major crops.	**Existing measures:** - Govt. compensation in case of crop failure/ drought. However, compensation is given out when the fields are completely dry.
Kinnaur	**Existing measures:** – Water distributed according to land-holding. – Community contributions to repair pipes and kuhls – Moss used to plug gaps in kuhls to control seepage. **Suggested Measures:** – Recharge water source through govt projects. – Building tanks where water /snow could be stored. – Construction of retaining walls and check dams.	**Existing measures:** – Tankers were deployed by community (in yr. 2000) during drought, for apple orchards. – Govt. gave pipelines for kuhl, and some compensation. – Govt subsidy and purchase of peas crop on event of floods that hampered marketing. – Govt assistance for transportation. – Govt procurement of Rajma and potatoes for seed stocks.

Mitigation Measures for Slow-Onset Disasters

In spite of the extensive impacts of slow onset disasters, as discussed above, they have not received as much attention as rapid onset disasters because of their slow nature of onset and the difficulty in quantifying their impacts. Notwithstanding the success of various government initiatives, the cold deserts in particular have received inadequate attention.

The disparity between the success rate of various projects implemented in the cold desert and other drought prone regions of the country are visible. Most projects reviewed were found to be better suited for implementation in the hot and arid areas of the country, for e.g. under the Horticulture Technical Mission, large areas of land are required which is difficult in hilly areas. The understanding that the Himalayan ecosystem with its unique features needs projects that are tailor made to suit the need of the areas is not reflected in several schemes. The policies made so far, lack the far sightedness that would make for a better risk management rather than crisis management.

Potential measures to mitigate slow-onset disasters and their impacts:

Institutional:

1. Establishing better connectivity between the affected districts and the respective state headquarters.
2. A revised and exhaustive community based vulnerability assessment and prioritization of drought prone regions.
3. A unified system of drought preparedness, preparation, Early Warning System (EWS), response & rehabilitation.

Technological:

1. Existing technologies need to be merged with indigenous and local wisdom of the people.
2. Development of cost effective snow storage technology to supplement and revitalize existing water resources.
3. Promoting sustainable technologies like artificial glaciers and the other small-scale measures like increasing the number of *zings* and ensuring maintenance of existing ones.
4. Development of a sound EWS.

The results of the survey indicate that people are still heavily dependent on the government as far as drought management is concerned. Apart from the monetary assistance, they also look to the government agencies to carry out recovery work. Capacity building at the village level in the form of understanding slow onset disasters and mitigation measures (proper utilization of water resources, building seed and food storage facilities etc.) is required. Also, there is a visible lack of awareness regarding schemes and policies at the local level. As the Hanumanth Rao Committee[18] pointed out, in as early as 1995, one of the reasons for the inefficient implementation of the watershed development programmes has been the lack of community involvement. This aspect has also been observed during Pragya studies. Although ensuring active community participation is a challenging task, it must be adequately addressed because unless the affected populations realize their role in mitigation of slow onset disasters, it is not possible to address the problem efficiently. Capacity building at the grassroots level is imperative for any reduction in impacts and decrease in vulnerabilities of the affected populations. Most existing schemes focus on improvising on existing technologies and introducing new ones while neglecting the aspect of capacity building, which is actually required to make them sustainable.

There is a need to establish a research institute analogous to the Central Arid Zone Research Institute Jodhpur. This is important in the light of the fact that the nature of a cold desert is different than the other arid region of the country, and hence calls for separate research initiatives.

[18] http://dolr.nic.in/TechCommitteeReport1994/TechCommitteeReport1994.htm