Preparation of
Hazard, Vulnerability & Risk Analysis Atlas and report for the state of Himachal Pradesh

Drought Hazard and Agriculture & Livestock Vulnerability Assessment

Composite Final Draft Report

(T6)

Prepared for

Disaster Management Cell, Department of Revenue

Government of Himachal Pradesh, Shimla

Prepared by

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VOLUME GUIDE

This series of reports present detailed technical and methodological documentation of the study entitled “Preparation of Hazard, Vulnerability & Risk Analysis Atlas and Report for the State of Himachal Pradesh” for DM Cell, Revenue Department, Himachal Pradesh.

Volume 1

Hazard Risk

This volume contains Technical papers on hazard risk assessment due to natural and man-made hazards within Himachal Pradesh as presented below.

1. Avalanche Hazard Risk
2. Climate Change & Flood Hazard Risk
3. **Drought Hazard and Agriculture & Livestock Vulnerability**
4. Earthquake Hazard Risk
5. Environmental & Industrial Hazard Risk
6. Forest Fire Hazard Risk
7. GLOF Hazard Risk
8. Landslide Hazard Risk

Volume 2

Vulnerability and Risk

This volume contains Technical papers on the Vulnerability and Risks to key elements at risk within Himachal Pradesh as presented below.

1. Socio-Economic Vulnerability and Risk
2. Building Vulnerability and Risk

Volume
1

Hazard Risk

Drought Hazard and Agriculture & Livestock Vulnerability Assessment

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Executive Summary

The Himachal Pradesh state has diverse geophysical set up with altitude ranging from less than 240 m in the southwestern region to more than 6,600 m beyond Great Himalayan region bordering China. The climate ranges from tropical in the lower attitudes to cold desert climate in the Trans Himalayan region. The western and north-western part gets the highest annual rainfall of more than 2220 mm (facing Dhauladhar Range) while the eastern cold desert region gets the lowest annual precipitation, mostly as snow (<400 mm). The maximum rainfall is contributed by monsoon about (80%) in the western region. The rainfall pattern shows high variability across years and location across the state. In any year, one or the more districts face drought as indicated by last decade's rainfall pattern.

As per the new classification of Himachal Pradesh Agricultural University, Palampur, (HP), the state has been divided in to eight agro-climatic zones. This zonation is mainly based on rainfall pattern and altitudinal ranges. Nearly half the state lies in cold desert zone with low population densities.

Maize, Wheat and Rice are main cereal crops while Apple, Potato and vegetables are the main horticultural crops. As per Land use statistics, only 12 percent of the geographical area is classified as "Net sown area", while about 39% of the land area is classified as "*Other uncultivated/Fallow land*". Only high value horticultural crops including fruits and vegetables can provide sustainable farm incomes. In high altitude districts of Kinnaur and Lahaul& Spiti, cultivable land is less than 2%. The cultivable land is low in the state due to topographical, altitudinal and soil erosion constraints.

The land holding statistics show that nearly 9.68 lakh hectares of land is owned by the farmers. This land includes farming land, plantations and fallow lands as well as some of the waste lands.

With about 5 million rural population and nearly 1 million households, most of the rural households have land, but the size of the holdings and agricultural returns is an issue in this state.

Himachal Pradesh agriculture is traditionally cereal crop based and over last few decades the area under horticulture is increasing in areas suitable for fruits like apple and a variety of vegetables.

The main objectives of this study were to delineate spatial variability of drought risk and to assess vulnerability of crops to natural disasters. Given the spatial diversity in the soil types, altitude, aspect and rainfall pattern, the secondary Block/Tehsil level crop data was used to capture the vulnerability of crops.

Himachal Pradesh has limited availability of continuous time series data on daily precipitation. Also, there are several gaps in available data and at least 30 years of continuous data is required for any drought analysis. Also, the rain gauges are located in select places, with limited coverage in the less populated areas. While tools and methods like Palmer drought index, Standard precipitation indices are available, these methods are difficult to use in data scarce and complex mountainous environments.

As sufficient rainfall gauges are not available to capture the spatial pattern of data, **Aphrodite** precipitation dataset covering 1951-2007 period was used for analysis. This data is available at 0.25 degree resolution with daily rainfall. This data has interpolated the rainfall data from available stations to derive daily rainfall over the period.

The rainfall data was analysed to get annual, monthly and seasonal deciles for each grid point and the results were interpolated as surfaces by krigging. The deciles method provides an easy way to understand the ratio to compare once in a decade's lowest rainfall (1^{st} Decile) with the median (Fifth Decile) rainfall. Lower this ratio (shown as percentage 1D/5D), the drought risk is higher.

Nearly half the state has less than 1,200 mm of annual median rainfall. Given the high slopes, and highly permeable soils, the moisture retention is likely to be low and regular and frequent rainfall is required for water demanding crops. Almost all parts of the state except region around Shimla faces medium to high risks. Parts of Chamba, Kangra as well as Lahaul & Spiti show lowest First decile/Fifth decile rainfall ratios t indicating highest risk of droughts. In high drought risk zones, the once in 10 year drought may be nearly two third of the median monsoon rainfall, such droughts can cause severe distress to the rainfed agriculture

The cereal crop data is available at Tehsil level, but the horticultural data is available at Block level. The past decade's data on cropped area, production and yield were collected from Agricultural department and from National database on district-wise area, production and yield from 1998-2009.

Horticulture data was available at Block level from 2004-2012 period from Horticultural department and it was used to analyse changes in area, yields and production. Since there is considerable increase in area under most fruits, 2013 data on area under different fruit crops was used to estimate losses under different deciles. Changes in yields across years was used to estimate vulnerability.

The crop vulnerability from droughts alone cannot be estimated without detailed data on soils, local meteorology, aspect and slope and crop cultivars. Therefore, the tehsil/block level crop area and production time series was used to estimate the crop vulnerability. This method can be improved if the time series data at block/Tehsil is systematically collected and collated.

Crop losses estimations were done for rice, wheat, Barley, Maize, Rape& Mustard crops. Among horticulture crops, Potato, Apple, Mango and All nuts. For each crop, the First decile to fourth decile losses are presented as maps in the accompanying atlas. Financial losses were also estimated at block/Tehsil level based on average prices of 2013. The results are presented in the maps. The once in cereal 10 year crop losses can be as high a 25% compared to the median crop value. The Maize and wheat shows the highest losses among all the six crops.

Once in a decade horticultural losses can be as high as 50% compared to the median values. These results in indicate the need for irrigation, pest control as well as mitigating impacts of risks like hailstorm etc. As the state is promoting horticulture on horticulture on a large scale, extension activities will require further focus. The decile based methods for assessing the drought risk as well as crop vulnerability are simple and can be improved with systematic collection of data. Strengthening data collection system is necessary to build reliable time series data is necessary.

Chapter 1: Introduction

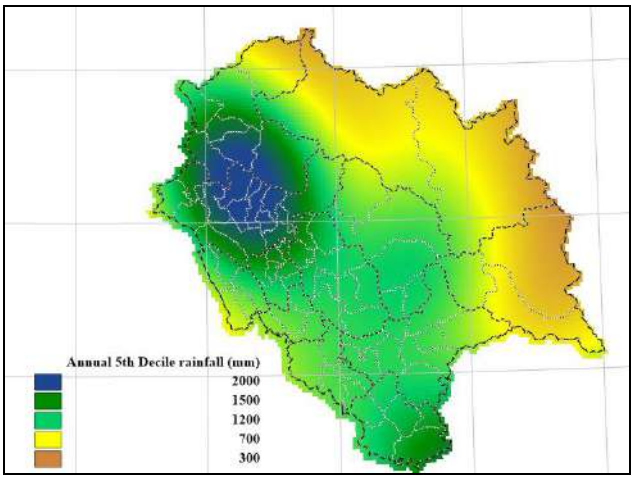
1.1 Terrain and Climate

Himachal Pradesh state ranges in altitude from less than 240 m in the region southwestern region to more than 6600 m beyond Great Himalayan region bordering China. A series of mountain ranges aligned Northwest-Southeast direction control the climate of this state. The Siwalik Hills are located on the Western most part. The climate becomes cooler as one travels from South-west to North-east. There are many permanently snow covered peaks even in the outer Himalayan region (Dhauladhar Range) in Kangra District. Several glaciers are found on northern slopes of Dhauladhar and Greater Himalayas. The climate ranges from tropical in the Shiwalik region to temperate in the middle Himalayan region to cold desert type in Greater Himalayan region. The western region facing the Indus plains has semi-arid to sub-humid climate while Trans-Himalayan region bordering Tibet is cold and arid. Such diversity in altitude and climate is reflected in agriculture and horticulture of this state. Being located far away from the sea and high daily temperature range makes most of the state face low humidity conditions most of the non-monsoon months. The south facing slopes are especially dry due to insolation.

1.2 Rainfall Pattern

The rainfall pattern shows that western and North-western region gets the highest annual rainfall of more than 2220 mm (facing Dhauladhar range) while the eastern cold desert region gets the lowest rainfall (<400 mm). The annual median rainfall reach up to 2,250 mm in some of the valleys. The maximum rainfall is contributed by monsoon (about 80%) in the Western region. In mountainous region with high variability of rainfall dominated by the extremes, the median rainfall represents the rainfall better than the average rainfall. The median (Fifth Decile) precipitation pattern across the state is presented in the following Figure 1.

Figure 1: Annual Median (5th Decile (Rainfall (in mm))



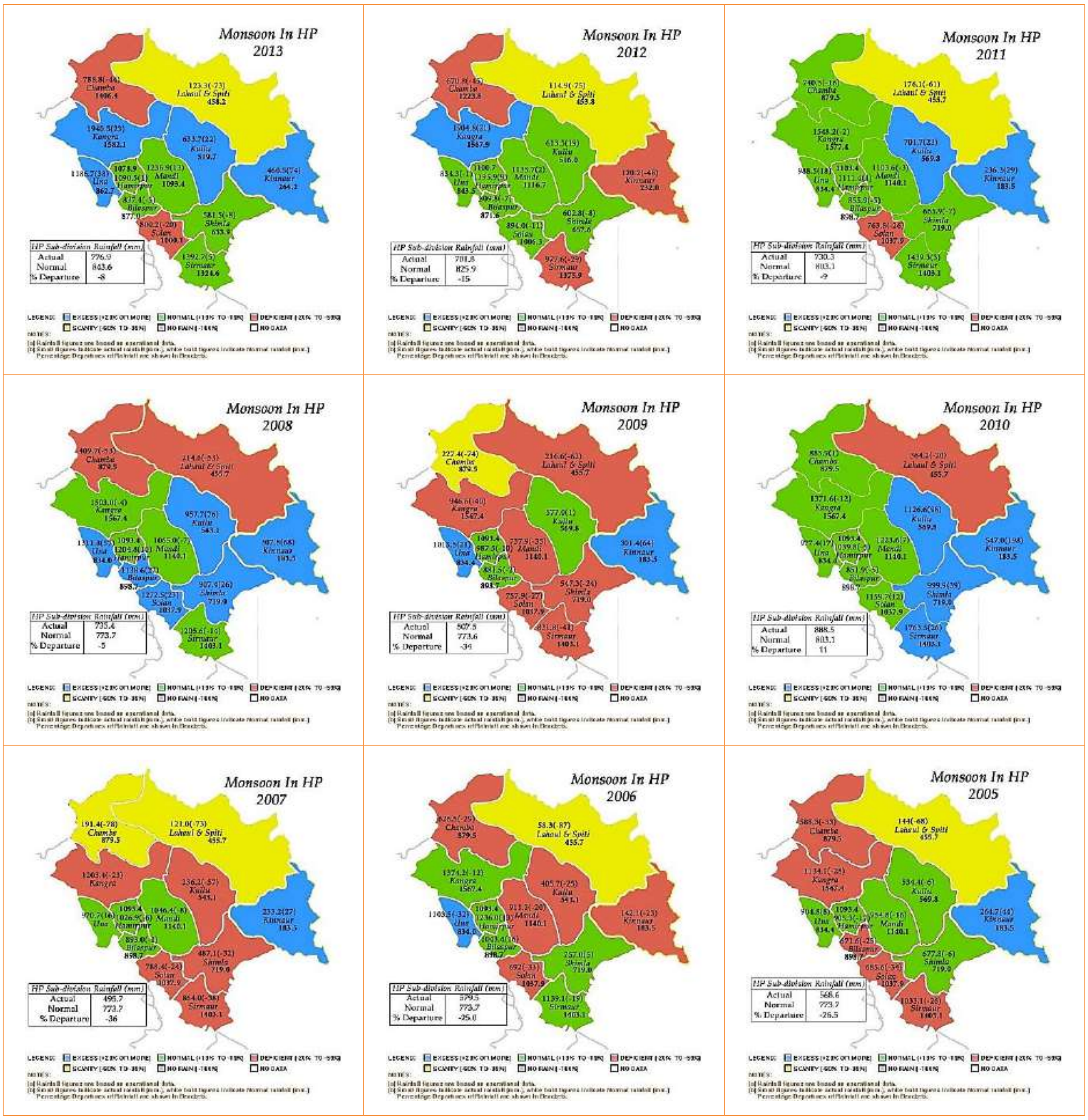
Source: Aphrodite data 1951-2007); TARU Analysis

1.3 Variability

As Himachal Pradesh is bordering the semi-arid plains of Punjab in the south and cold desert of Tibetan plateau in the north, the rainfall pattern shows high variability across years and space in the state. The southern area bordering the plains get higher rainfall due to orographic lift of the humid monsoon winds from the south. The low pressure trough develops along the along the Indogangetic plains which attracts humid air from the south.

During most of the years, one or other district of HP faces drought like conditions, especially during monsoons. Last nine year data on monsoon precipitation pattern is presented in the following Figure 2.

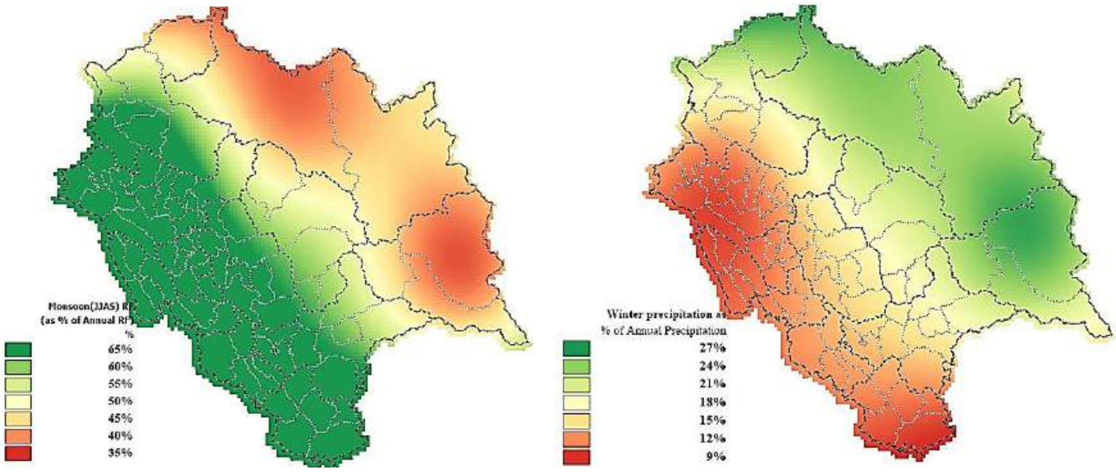
Figure 2: Monsoon Precipitation Pattern



Source: http://weathershimla.nic.in/Monsoon/main.html

The 2009 drought that affected 6 out of 12 districts in the state, was one of the worst droughts during the last decade. The monsoon rains accounts for nearly 35% to 80% of the annual rainfall in the state.

Figure 3: Monsoon and Winter Precipitation as % of Annual Precipitation



Monsoon Precipitation Winter Precipitation

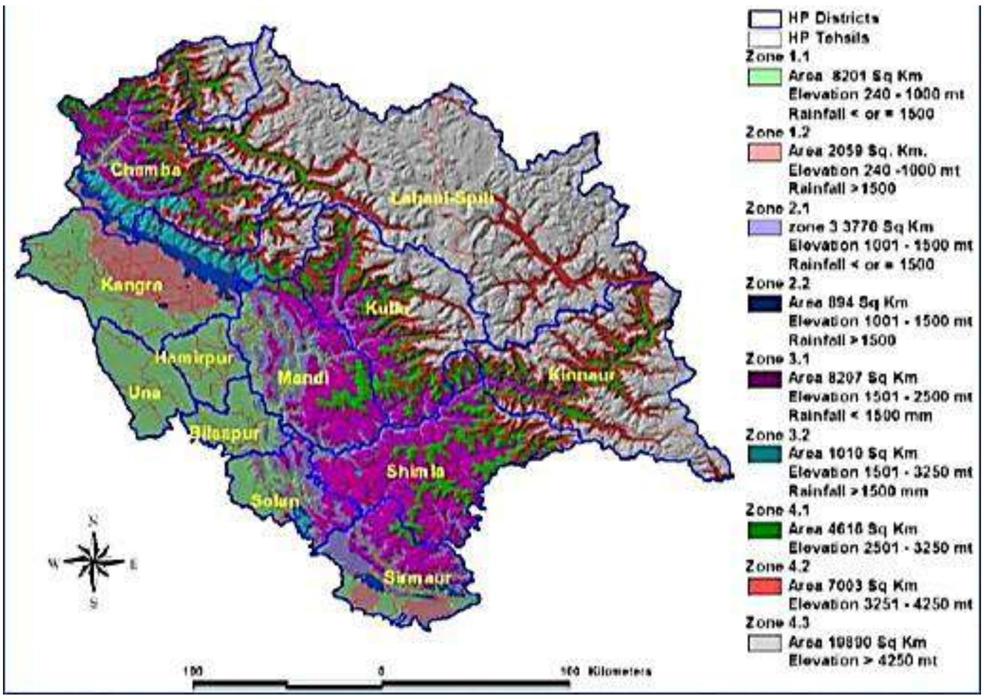
Source: Aphrodite Data (1951-2007), TARU Analysis

While the south western part of the state is dominated by monsoon rains, the north eastern zone gets rain/snow mostly during winters and early summers. Some of the plantation crops like apple, require evenly distributed precipitation, especially during dry Pre-monsoon period for vegetative growth as well as flowering. Similarly, the wheat requires at least three to four rains during the growth period (winter) or irrigation.

1.4 Agro-Climatic Regions

As per the new classification of CSK, Himachal Pradesh Agricultural University, Palampur, (HP), the state has been divided in to eight agro-climatic zones. The map is presented below:

Figure 4: Redefined Agro-Ecological Zone



Source: http://weathershimla.nic.in/fieldObsPDF/Agro%20Climatic%20zones.pdf

The Area, altitude and annual rainfall ranges of each zone is presented in the following Table 1.

Table 1: Area, Altitude and Annual Rainfall Ranges

Zone	Area (sq.km)	% area of the State	Altitude (m.amsl)	Annual Rainfall (mm)
Zone 1.1	201	0.4	240 - 1000	<1500
Zone 1.2	2,059	4.3	240 -1000	>1500
Zone 2.1	3,770	7.9	1000-1500	<=1500
Zone 2.2	894	1.9	1001-1500	>1500
Zone 3.1	8,207	17.2	1501-2500	<1500
Zone 3.2	1,010	2.1	2501-3250	>1500
Zone 4.1	4,616	9.7	2501-3250	<700
Zone 4.2	7003	14.7	3251-4250	<700
Zone 4.3	19,890	41.7	>4250	<700

Source: http://weathershimla.nic.in/fieldObsPDF/Agro%20Climatic%20zones.pdf

The Zone 1 and 2 have the higher population densities and dominated by cereal and vegetable cultivation, while zone 3 is dominated by fruits and vegetable horticulture. Zone 4 is mostly cold desert with very low population densities. Apple and temperate horticulture is being introduced in parts of this zone

1.5 Cropping Patterns and Changes

Table 2: Trends in Area, Production and Productivity of Selected Principal Crops of HP

Crops	Area (000ha.)			Production (000 MT)			Productivity (kg./ha)		
	1997-98	2007-08	Change	1997-98	2007-08	Change	1997-98	2007-08	Change
Maize	309.4	299.8	-3.10%	647.1	499.2	-25.94%	2091	1598	-23.57%
Paddy	83.04	80.50	-3.01%	107.3	85.65	-20.22%	1293	1031	-20.26%
Wheat	357.7	369.4	0.47%	499.1	495.5	-0.72%	1395	1385	-0.71%
Barley	35.70	23.5	-34.17%	45.10	30.61	-32.15%	1302	857	-34.17%
Potato	18.7	12.5	-33.15%	136.8	154.7	13.91%	7262	12,376	70.42%
Apple	82.30	92.8	12.70%	294.8	348.2	18.11%	3582	3751	4.71%
Ginger	1.7	2.45	41.17%	11.52	17.05	47.82%	6765	7083	4.70%

Source: Directorate of Land Records; Himachal Pradesh, Shimla – 9 and District statistical Office, Una, Kumar & Singh 2013[1]

The time series data indicates the reduction in in both areas as well as yields in cereal crops across the state, while the two horticultural crops are showing increase in both area and productivity. The potato crop shows decrease in area, but increase in yields.

1.6 Land Use

Being mountainous, area available for cultivation is quite low in Himachal Pradesh. The land use pattern is presented in in the following Table 3.

[1] Kumar, S.*& Singh R. 2013: Crop Diversification in Himachal Pradesh with Special Reference to District Una. Journal of Economic & Social Development, Vol - IX, No. 2, Dec., 2013

Table 3: Land use Pattern in Himachal Pradesh

District	Forests	Not available for Cultivation	Other Uncultivated /Fallow Land	Net Area Sown	Total Land
Bilaspur	13%	17%	43%	27%	1,11,776
Chamba	39%	3%	52%	6%	6,92,419
Hamirpur	17%	28%	23%	32%	1,10,221
Kangra	40%	16%	24%	20%	5,77,681
Kinnaur	6%	40%	53%	1.3%	6,24,215
Kullu	2%	14%	16%	68%	54,753
Lahaul & Spiti	15%	61%	24%	0.4%	9,11,195
Mandi	44%	6%	28%	22%	3,97,823
Shimla	26%	6%	55%	13%	5,08,900
Sirmaur	21%	8%	52%	18%	2,24,743
Solan	11%	14%	55%	21%	1,80,923
Una	12%	33%	31%	24%	1,54,923
State Total	**24%**	**25%**	**39%**	**12%**	**45,49,572**

Source: GoHP

Only about 37,664 ha is classified as "Net sown area" in the state for a population of nearly 6.8 million. The land use statistics do not match with crop statistics figures, which need to be resolved. Only high value crops like fruits and vegetables can provide sustainable farm incomes. In high altitude districts of Kinnaur and Lahaul& Spiti, cultivable land is less than 2%. Only in Kullu district, the cultivable land is more than two thirds of the land area.

1.7 Land Holding Pattern

The cultivable land is low in the state due to topographical, altitudinal and soil constraints. Nearly 87 percent of the land holdings are marginal or small. Most the holdings are highly fragmented, and the cereal cultivation is often done for self-consumption only.

Table 4: Land holding pattern in Himachal Pradesh (2005 Agricultural Census)

Size Class (in ha.)	No. of Holdings	% of total Holdings	Area (ha)	% Total Area
Marginal (<1)	6,36,619	68.21	2,58,247	26.67
Small(1-2)	1,75,651	18.82	2,44,741	25.27
Semi-Medium (2-4)	88,447	9.48	2,40,355	24.82
Medium (4-10)	29,136	3.12	1,64,994	17.04
Large (>10)	3,530	0.38	60,006	6.20
Total	**9,33,383**	**100.00**	**9,68,344.70**	**100.00**

Source: Directorate of Land Records, H.P.

With about 5 million rural population and nearly 1 million households, most of the rural households have land, but the size of the holdings and agricultural returns is an issue in this state.

1.8 Cropping pattern

Himachal Pradesh agriculture is traditionally cereal crop based and over last few decades the area under horticulture is increasing in areas suitable for fruits like apple and a variety of vegetables. The cropping pattern is presented in the following Table 5.

Table 5: Area and Production of Food Grains (2008-09)

Crop	Name of the Crop	Area ('000ha)	Prodn ('000MT)	Yield MT/ha
		Kharif		
Kharif	Maize	297.72	676.64	2.3
Kharif	Paddy	77.71	118.28	1.5
Kharif	Ragi (Millet)	2.71	3.10	1.1
Kharif	Other Millets	6.67	5.09	0.8
Kharif	Pulses	19.90	10.48	0.5
Total Kharif		404.71	813.59	2.0
		Rabi		
Rabi	Wheat	348.76	531.49	1.5
Rabi	Barley	20.23	26.40	1.3
Rabi	Gram	1.46	1.60	1.1
Rabi	Pulses	13.85	26.48	1.9
Total Rabi		384.30	585.97	1.5
Total (Kharif + Rabi)		**789.01**	**1399.56**	**1.8**

Due to hilly terrain, shallow soils and small holdings, the yield is low and marginal quality, large proportion of farmers can only hope to produce cereals sufficient for self-consumption only. The area n production of commercial crops is presented in the following Table 6.

Table 6: Area and Production of Horticulture crops (2008-09)

Name of the Crop	Area ('000ha)	Production ('000MT)	Yield MT/ha
Commercial Crops			
Potato	15.98	173.63	10.9
Ginger (Dry)	3.50	41.60	11.9
Vegetable	58.74	1090.33	18.6
Total	**78.22**	**1305.56**	**16.7**
Production of Fruits			
Apple	94.726	510.161	5.4
All Fruits	204.420	628.076	3.1

Source: Planning Department 2014[2]

Himachal is known for Apple, monsoon vegetables as well as seed potatoes. Nearly half of the area under fruits is under Apple orchards.

1.9 Objectives

The main objectives of this study are:

- Delineate the spatial variability in drought patterns
- Estimate vulnerability of crops.

[2] http://hpplanning.nic.in/statistics&data.htm as viewed on 10AUG2014

Chapter 2: Data sources

2.1 Aphrodite Data Sets

Since the meteorological data is available from only few stations across the state, gridded data set of 1951-2007 was used for analysis. Due to high variability of yields due to climatic, slope and aspect in the state, crop models may not be idea for analysis the vulnerability of crops. Also, plantation crops respond to

The past decade data on cropped area, production and yield were collected from Agricultural department and from National database on district-wise area, production and yield from 1998-2009 was used. Taluka level data on agriculture as well as block level data on horticulture was used.

For fruit crops, data from 2004-2012 period was collected from Horticultural department and it was used to analyse changes in yields and production. Since there is considerable increase in area under most fruits, 2013 data on area under different fruit crops was used to estimate losses under different deciles. While the older time series data may not be reliable due to changes in production, yield data was analysed to analyse the vulnerability.

Chapter 3: Methodology

Two separate exercises were carried out: the first exercise assessed drought risks while the second assessed the vulnerability of crops to various natural risks.

3.1 Drought Risk

The 1951 to 2007 gridded precipitation pattern at 0.25 degrees was used to analyse the precipitation pattern across the state. This data has about 25 km spacing with daily rainfall data for 57 years, sufficient to analyse the trends across the seasons.

The data was analysed to estimate annual, monthly and seasonal deciles for each grid point and the results were interpolated as surfaces by krigging. The ratio of First decile (1D) rainfall to Median rainfall (5D) was used to understand the extent of reduction of rainfall compared to median. This ratio serves as an indicator for assessing spatial pattern of drought risks. While tools and methods like Palmer drought index, Standard precipitation indices are available, these methods are difficult to use in data scarce and complex mountainous environments. This methods provides an easy way to understand the drought intensity based 1D/5D rainfall. Lower this ratio (shown as percentage 1D/5D) the drought risk is higher.

3.2 Crop Vulnerability

As reported earlier, Himachal Pradesh's cash economy is dominated by horticulture. Due to mountainous situation and domination of marginal and small holdings, cereal crops are grown mostly to meet the self-consumption needs by more than 75% of the households. Also, it is difficult to use crop models in this spatially diverse slope, altitude and aspects. Also, in case of plantation fruit crops, the distribution of rainfall and temperature determines the crop yields. Assessing the vulnerability of crops to droughts with the crop models may not yield satisfactory results and also will not capture ground level situations. Therefore the actual area production and yield data was used to identify agricultural and horticultural vulnerability. This analysis represents the agricultural vulnerability from rainfall, extreme weather events (e.g. hailstorms), temperature and geo-physical diversity. Since the cereal crop data was available at Tehsil level and horticultural data was available at CD block level, these reporting units were used for reporting and presentation in maps.

3.3 Limitations

Himachal Pradesh has limited availability of time series data on daily precipitation. Also, there are several gaps in available data and at least 30 years of continuous data is required for any drought analysis. Also, the rain gauges are located in select places, with limited coverage in the less populated areas, (Agro-climatic zone of 4.1, 4.2 and 4.3) limits the quality of spatial analysis. Therefore, gridded precipitation data series was used. This is interpreted data and not actual rainfall at the grid centers. As the rain-gauge network improves, it may be better to use the actual data.

The crop vulnerability from drought alone cannot be delineated without detailed data on soils, local meteorology, aspect and slope as well as crop types. A variety of cultivars are used in these regions and therefore crop model results are expected to be erroneous, unless the state is subdivided in to at least 1000 classes and the crop loss estimation is done. It is beyond the scope of this exercise. Therefore, the crop area and production time series was used to estimate the crop vulnerability. In some cases, disaggregation from district data had to be done. This method can be improved if the time series data at block/Tehsil is systematically collected and collated.

The administrative divisions, especially Tehsils, have been subdivided and now there are 117 Tehsils from about 103 a decade back. This makes it difficult to analyse the time series data. Detailed maps and schema of subdivisions were not available. To overcome this challenge, time series data of yields was used to develop loss estimates.

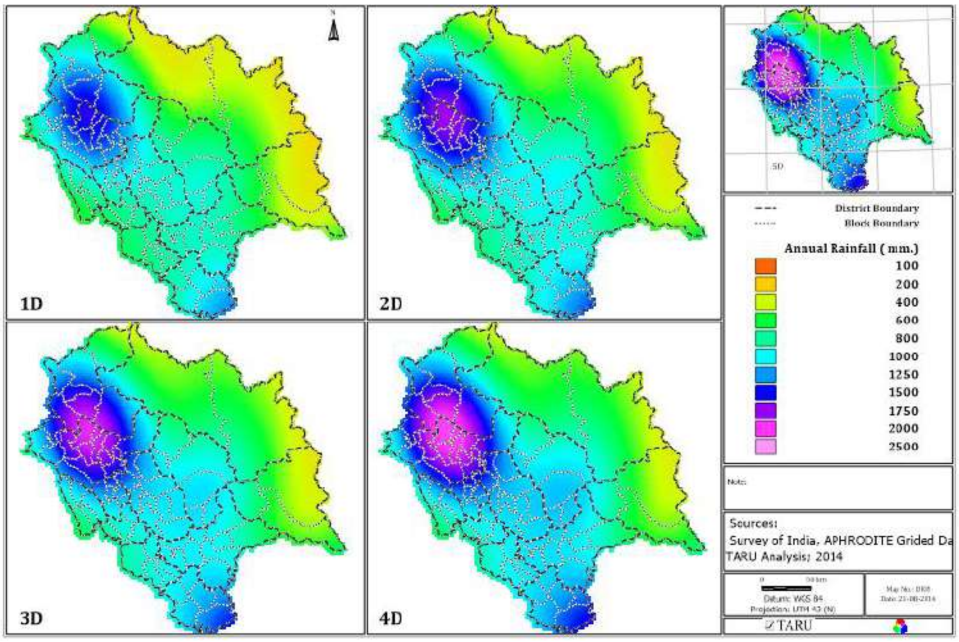
Area under particular crop changes over years depending on farmers' assessment of rainfall and market situations. The net sown area also can change, resulting in loss of potential production. In other cases, the crop shift can occur without change in total cropped area under all crops. The yields also change over years due to changes in varieties or due to use of different technologies. If at least one decade data is available at Block/Tehsil level, both these factors can be assessed more accurately. This model can be further improved of more disaggregated data is collected annually. The Agricultural universities can conduct such research and improve the model.

Chapter 4: Results

4.1 Drought intensity across the state.

The following map shows the median (Inset) and 1D to 4D annual precipitation pattern across the state. This map is derived by krigging the gridded data.

Figure 5: Annual Median and 1st Decile to 4th Decile Rainfall

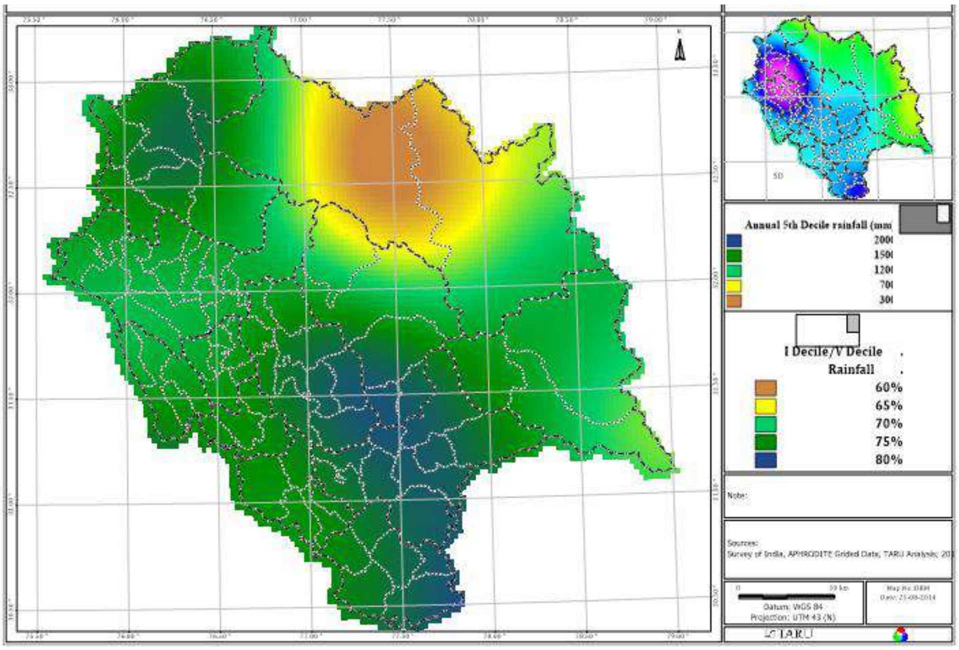


Source: Aphrodite Gridded data (1951-2007)

The results show that the once in 10 year rainfall can be significantly lower than the median rainfall. Nearly half the state gets less than 1200 mm of annual median rainfall. Given the high slopes and skeletal soils, the moisture retention is likely to be low and regular and frequent rainfall is required for water demanding crops.

The Ratio of 1D/5D provides picture of variation in annual rainfall across the state. The map below presents the variability of the rainfall across the state.

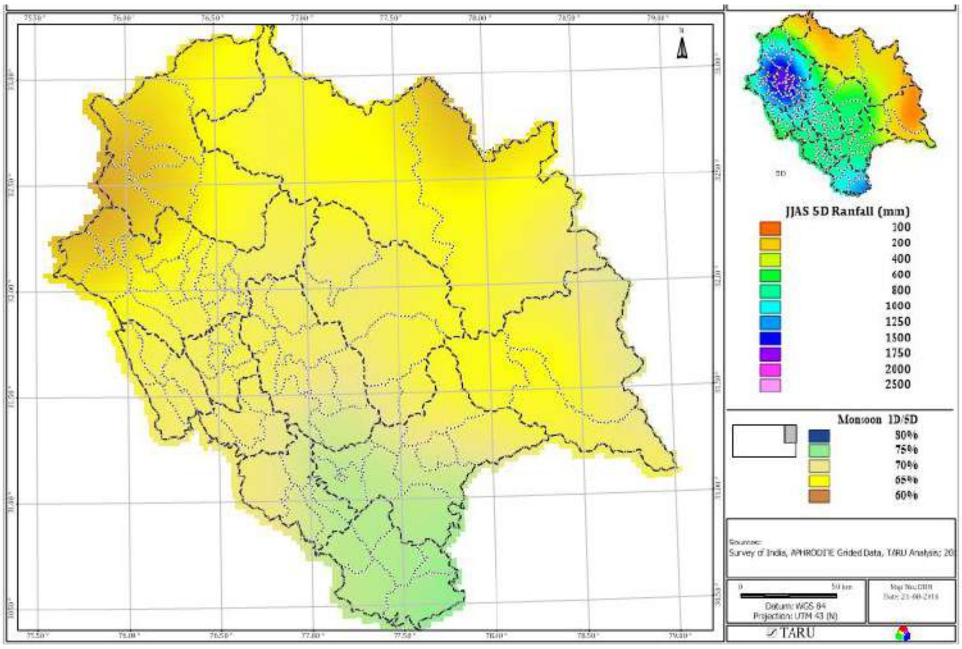
Figure 6: Annual 1D/5D Rainfall



Shimla, Kangra Chamba and parts of Sirmaur districts show lowest reduction in 1D rainfall compared to the median rainfall. In other districts, the ratio is about 70 to 75%.

The annual ratio is unable to capture that the possible drought intensity in a 10 year cycle. Therefore the Monsoon median and Monsoon 1D/5D was used to understand drought vulnerability across regions. The picture of this ratio across the state is presented in the following figure.

Figure 7: Monsoon 1D/5D ratio (June, July, August & September)



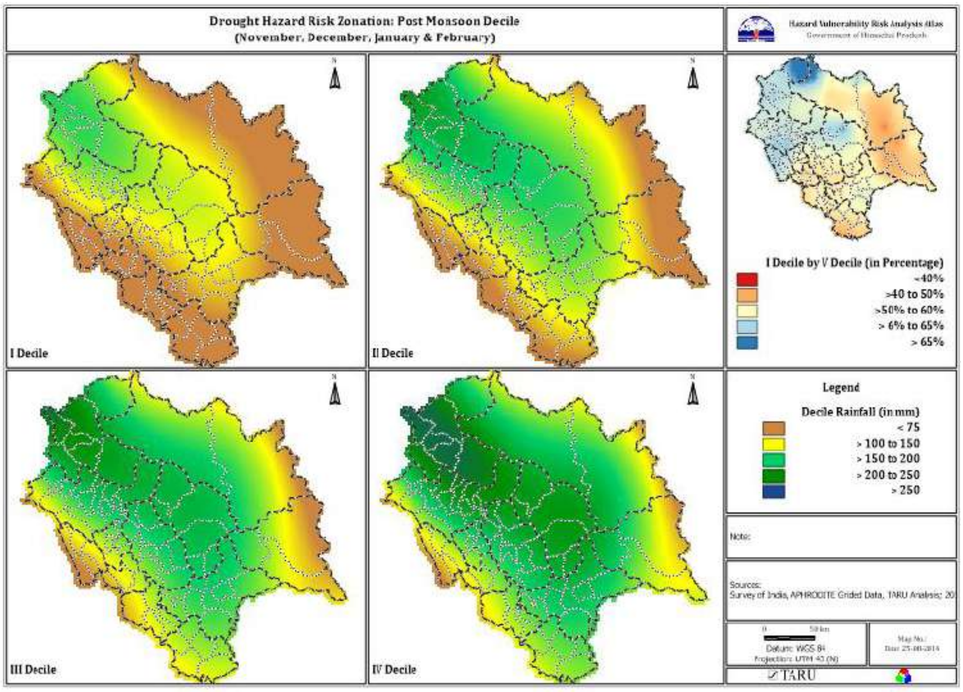
Source: Aphrodite Gridded data (1951-2007)

The map indicates that almost all parts of the state except region around Shimla faces medium to high drought risks in monsoon rainfall. Parts of Chamba and Kangra as well as Lahaul & Spiti show lowest ratios indicating highest risk of droughts. The Shiwalik region has medium risk while parts of Kinnaur also has medium risks.

Shiwalik region of Hamirpur faces summer water shortages due to lack of any perennial sources. Since the soils in Hamirpur and Sandy and shallow, the meteorological droughts can translate in to agricultural droughts. In high risk zone, the once in 10 year drought may be nearly two third of the median monsoon rainfall, which can cause severe distress to the rainfed agriculture.

Winter rainfall is important for the wheat and other Rabi crops. At least three to four rains/irrigation are required to support winter wheat in this region. The winter sowing starts from Late October therefore November to February rainfall deciles are presented in the following Figure 8.

Figure 8: Winter Rainfall Pattern (November, December, January and February)



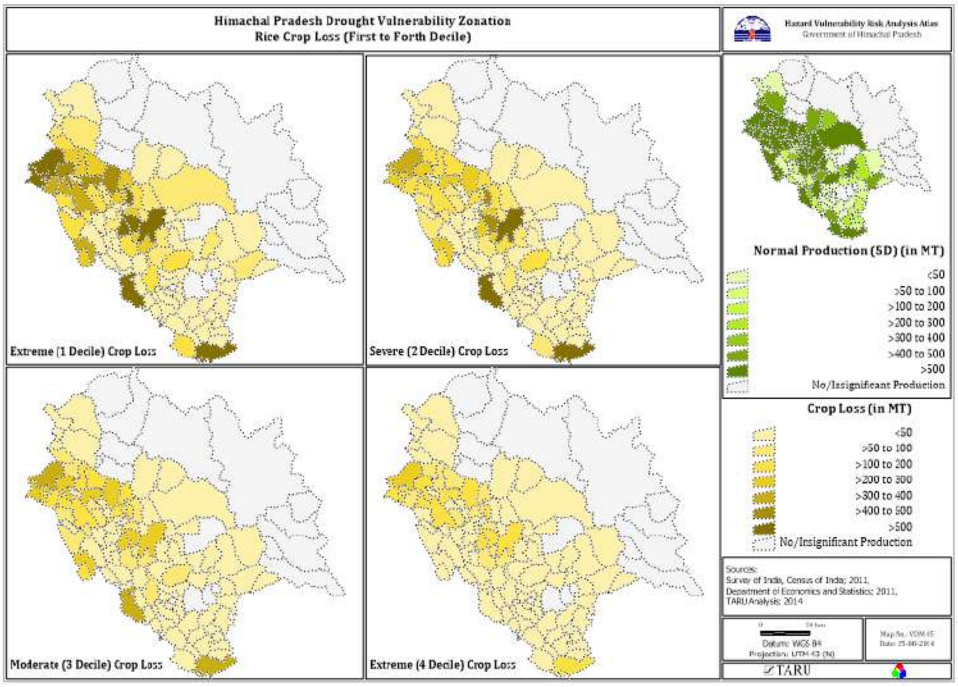
Source: Aphrodite data (1951-2007); Taru Analysis

Both Shiwalik as well as cold desert zone shows lower rainfall compared to the Central mountain region. The highest risk of lower rainfall can be observed in the southern and south eastern parts of the state. The cold desert region cannot grow any crops due to cold winters, and the precipitation occurs as snow in the cold desert region. However, the snowmelt supports the next year's summer crops to a great extent.

4.2 Crop losses

Crop losses estimations were done for rice, wheat, Barley, Maize, Rape& mustard. Among horticulture crops, Potato, Apple, Mango and All nuts. For each crop, the first decile to fourth decile losses are presented as maps in the accompanying atlas. A sample map for the rice crop is shown in the following Figure 9.

Figure 9: Rice Crop Losses across Districts (1D to 4D and Normal Production (5D) (in Tonnes)



Source: Agricultural Department Time series data; TARUI Analysis

Since the crop areas change over years, depending on rainfall and well as shift of framer preferences, 2011 year cereal crop area was used for calculating the normal production based on 5th decile.

The total losses under 1-4 Deciles as well as normal production is presented in the following table. This table data is the maximum loss if the whole state faces 1D crop loss situation, which is not generally possible and should be taken as a theoretical maximum loss only.

Crop	Normal area ('000 ha)	Loss (in '000 MT)				Normal production (in '000 MT)
		1D	2D	3D	4D	
Rice	82	14	9	6	3	121
Wheat	375	175	103	58	27	517
Maize	318	146	75	33	13	722
Barley	25	8	6	3	1	29
Rape & Mustard	11	2	1	1	0	5
Potato	13	33	25	17	9	118

Source: Agricultural department data; TARU Analysis 2014

The rice shows least losses probably since most of it is grown in best irrigated lands and even with lowest rainfall, the local irrigation systems are able to provide sufficient irrigation. The wheat yields depend on both the winter rainfall as well as the temperature across the season. These crop losses were also converted to financial losses. The average price used for calculation in provided in the following Table 7.

Table 7: Rates Used for Calculation of Crop Losses

Crop	Rate/Tonne
Barley	12,000
Maize	14,000
Potato	15,000
Rapeseed & Mustard	38,000
Rice	20,000
Wheat	15,000

Source: Mandi Data; 2014

These prices were based on Mandi rates collected from various sources. The financial losses assessed from the crop volume losses is as follows.

Table 8: Financial Losses Under first to fourth Decile and Normal Value of Production

Crop	Loss				Normal Production
	1D	2D	3D	4D	
Barley	970	670	372	132	3,421
Maize	20,395	10,532	4,601	1,870	1,01,019
Potato	4,964	3,777	2,568	1,387	17,673
Rape & Mustard	766	505	312	150	1,804
Rice	2,852	1,865	1,282	673	24,146
Wheat	26,245	15,511	8,740	4,030	77,601
Total	56,194	32,860	17,874	8,241	2,25,665
Percentage loss	25%	15%	8%	4%	-

Source: Agricultural department data; TARU Analysis 2014

The Maize and wheat shows the highest losses among all the six crops. The normal value of the crops is about ₹ 2,256 Crores.

Similar analysis was done for fruit crops also. The fruit production losses are due to a variety of factors ranging from previous year's rainfall, temperature hailstorm during fruit season etc. The following table presents the production losses under first to fourth deciles.

Table 9: Normal Production and Loss for Fruits and Nuts (in '000 MT)

Crop	Loss				Normal Production	1D loss as % of Normal Production
	1D	2D	3D	4D		
Apple	303	280	248	138	739	41%
Mango	7	6	5	3	25	29%
Lime	2	1	1	0	6	30%
Citrus fruits	4	3	1	1	13	31%
Pear	18	16	15	10	35	50%
Plum	4	3	3	1	16	26%
All nuts	1	1	0	0	3	41%

Source: Horticultural department data; TARU Analysis 2014

The loss on Apple crop is maximum and it is the most important fruit crop in the state. The price of Apple depends on the quality and estimation of losses are based on the lower quality of apple. The price of the premium quality apple can be as high as 10 times that of the lower quality apple. The proportion of the production of the premium quality is quite small and the plantations in lower altitudes are reportedly affected by the increasing temperatures. The financial losses are based on the following prices:

Table 10: Crop Prices Used for Estimation of Financial Losses

Crop	Price/T
All Nuts	2,00,000
Apple	50,000
Citrus fruits	45,000
Lime	45,000
Mango	20,000
Pear	35,000
Plum	25,000

The financial losses among fruit crops is presented the following Table 11. These losses are based on whole state falling within the same decile, hence represent maximum loss possible if all districts face similar losses. It is suggested that the Block level outputs are used based on the deciles for that particular block.

Table 11: Normal crop value and loss (₹ Crore) at State level

Crop	Normal Value	Loss			
		1D	2D	3D	4D
Apple	3,694	1,514	1,398	1,242	689
Mango	51	15	12	10	5
Lime	27	8	4	2	1
Citrus fruits	59	18	12	6	4
Pear	123	62	57	51	37
Plum	40	10	9	7	2
All nuts	70	21	16	10	4

Source: Horticultural department data; TARU Analysis 2014

The losses to Apple crop is in most significant and a variety of weather conditions as well as diseases can cause losses to apple crop. Since Apple is most important crop financially for the farmers as well as for the primary sector, it may be worth investing on loss reduction measures, especially disease and hailstorm losses.

Chapter 5: Livestock

Unlike the agricultural data at Tehsil levels, the livestock data as well as casualty data are not readily available. The Livestock Census provides the basic statistics only once in five years. Also, the fatality from wild animal (mainly Leopards) attack is significant. The total revenue of Himachal Milk federation was only 28.8 crores[3], which indicates that milk production is not an important source of income or most of the milk produced in marketed through informal channels in rural areas. Himachal is one of the states which supplies goats to large markets, but the only limited statistics is available. The meat production from recognized sources is presented in the following Table:

Table 12: Meat Production from Recognised Sector in Himachal Pradesh (2010-11)

No. of Animals Slaughtered	(In '000 Nos.)		Himachal	India
		Sheep	32	28,882
		Goat	120	82,171
		Pig	2	10,677
Average Yield Rate per Animal	(In Kg.)	Sheep	18	13
		Goat	20	10
		Pig	38	38
Meat Production	(In '000 Tonne)	Sheep	1	369
		Goat	2	846
		Pig	0.1	402

Source: Ministry of Agriculture, Govt. of India, Himachalstat website[4]

A considerable proportion of meat on hoof is exported from Himachal Pradesh. The meat production from recognized sector forms a small proportion of the total meat production. Anecdotal evidence on livestock status from media[5] indicates the following:

- Five out of 12 districts have shown absolute decline in livestock population
- Bilaspur, Chamba, Kullu, Hamirpur and Una districts have shown decline in livestock population
- The livestock population decreased from 5.01% in 1982 to around 4% in 2009-10 in district Hamirpur
- Himachal has accounted for 1.1% of country's livestock population as compared to human population of 0.6% of India's population

[3] http://hp.gov.in/hpmilkfed/page/Revenue-Generation.aspx

[4] http://www.himachalpradeshstat.com/agriculture/2/animalhusbandrylivestock/48/meatproduction19712014/449517/stats.aspx

[5] http://www.divyahimachal.com/himachal-news-2/livestock-population-declining-in-himachal/ dated 22Sep2014

The stall-fed livestock as well as animals owned by farmers depend significantly on the grazing land. Even during worst droughts, the wild grass production from common lands do not reduce significantly. So impact of droughts on livestock may not be high. Other risks like landslides are local in nature and estimating losses is not possible.

A significant proportion of livestock is managed by the transhumant herder communities, who travel beyond the state boundaries during part of the year. The risk exposure of these animals depend on their presence in the area of the disaster event, which varies with the season. So the basic livestock statistics based on animal census is presented in the map. Also district wise maps of animal unit population, based on standard calculation, as well as the grazing land per animal across districts are shown in maps.

Chapter 6: Conclusions

One or more districts in the state suffer from droughts every year over last decade. While the drought assessment by IMD is based on the average rainfall, median value based assessment may be more effective for assessing drought risks in hilly terrains dominated by the extreme rainfalls. The analysis shows that the contribution of monsoon ranges from 80% in case of lower Himalayas to less than one third in case of Trans-Himalayan Region. Winter snowfall is more important for this region.

A decile based drought assessment has been for the state under this exercise. The results indicate that cold desert shows the lowest 1D/5D ratio. The monsoon rainfall variability is high in most parts of the state except in the region around Shimla. The decile based method is quite useful and can be followed in this state facing high variability, which can be used to understand meteorological drought risks.

The crop loss estimations show that wheat and maize show highest losses per decade. Similarly most of the loss in fruits is accounted by Apple crop and it needs special attention to reduce the losses.

While state level aggregated outputs provide the theoretical maximum losses, it should not be used for estimating actual losses at state level, instead the losses can be used based on rainfalls at Tehsil/District level. Tehsil (Cereal crops) and Block (Fruit crops) level losses can be used for prioritizing mitigative action. This method provides crop/ administrative division level priority areas based on the losses.

It is necessary to collect and collate the agricultural information (time series as well as at least up to block/tehsil level) and make it available in the public domain so that the farmers, extension workers and the researchers can use the data and generate user friendly outputs that can help in designing mitigative action. Since more than two thirds of the population depends on primary activities for their livelihoods, readily available information at sub- district level can significantly help in planning risk mitigation in agriculture sector. The potential data can include seasonal rainfall in monthly deciles at Taluka level, historical performance in agriculture through maps, possible mitigation measures based on weather data for each month.

Livestock data collection system is limited to decadal livestock census. The data on fatality or milk production at Block/Tehsil level is not available. In absence of this data, vulnerability of livestock to natural disasters cannot be calculated. It is suggested that the livestock data collection system may be strengthened.

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