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Assessment of the impact of land use Land cover change on Food Security of District Anantnag of Kashmir Valley

Sheraz Ahmad Lone[1] and Ishtiaq A. Mayer[2]
[1](*Research Scholar, Department of Geography and Regional Development, University of Kashmir-India)*
[2](*Professor, Department of Geography, and Regional Development University of Kashmir-India)*
*Corresponding Author: *Sheraz Ahmad Lone*

ABSTRACT: Land use changes are vital to the food security challenge. Food security has determined the history of mankind. The global population will increase to about 9 billion during the next four decades. Food and feed demands have been projected to double in the 21st century, which will further increase the pressure on the use of land, water and nutrients. The interactions between food security and land use, both now and over the next few decades, are of paramount interest to policy, science and society at large. During the past one decade the study area has undergone many LULC changes due to rapid urban growth, poorly planned infrastructural development and attitude towards horticulture that have adversely affected the food security. For LULC change detection analysis temporal Landsat satellite data captured by Thematic Mapper (TM) were employed. Maximum Likelihood (MLH) supervised classification algorithm was applied to classify the study area, whereas, Post Classification Comparison (PCC) approach was adopted to analyze the LULC changes. Results revealed that over a period of 10 years, a decrease has taken place in agriculture and forest at a change rate of -3.7 % and -2.26 % respectively. On the other hand, horticulture, built up have increased at a rate of 2.17 % and 1.13 % respectively.

Key words: Agriculture, Anantnag, Food Security, LULC

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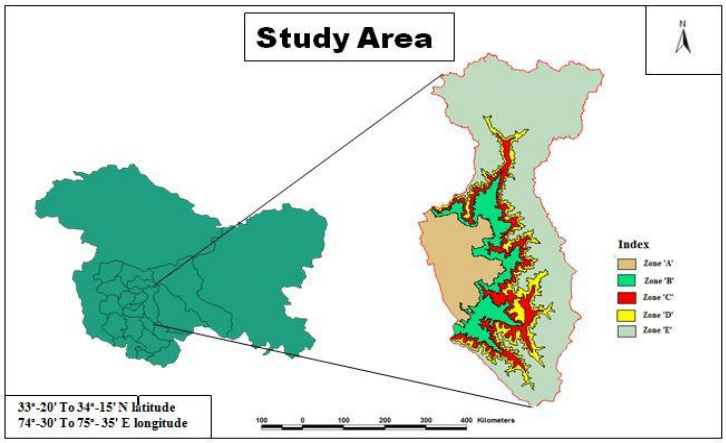
I. INTRODUCTION

The confront to produce about 70% more food by 2050 for a rising and increasingly rich world population has stirred several review papers addressing the different magnitude of the food system and food security [Godfray, et *al*., 2010 and Tilman, et *al.,* 2011]. Food security is determined by food availability, food access, food stability and food utilization [Schmidhuber et al., 2007 and Ericksen, et al., 2008]. Land based production provides the major biophysical basis for food security. Land use land cover change, is central to food security assessments. Land use change may begin from the growing demands for land based products, or from competition for land resources, not only to produce food but also to provide materials and feedstock for the bio-based economy, for nature conservation, urban development and recreational facilities [Lambin & Meyfroid 2011, Smith 2013, Lambin 2012, Smith, et *al*., 2010, Fries, et *al*., 2010]. Food security exists when all people, at all times, have physical and economic access to sufficient, safe and nutritious food to meet their dietary needs and food preferences for an active and healthy life [World Food Summit, 1996]. There were nearly 925 million hungry people in the world [FAO, 2010] and the number has increased drastically. The general trend in cropping land use has been a shift from cereals to non cereals implies low production of food crops. This process has a direct impact on the basic component of food security, i.e., deficiency in food supply. The gap between supply and demand in terms of staple food in various regions has been widened by the changing cropping land use. The dynamics of cropping land use have led to crop diversification, which among small land size holder farmers is incompatible with maintaining or improving household food security when cash crops are included in the new crop mix [Donovan, 1998]. The main concern is that food availability of small farmers gets affected by the displacement of food crops by cash crops [Marteen *et al.,* 1996]. Cereal grains continue to play a dominant role in the diet pattern of people. Of the nearly 2 billion acres of cropland in the world, about seventy two percent is used to produce grain which accounts 55 percent of all food energy produced and are typically divided into food grains for people (wheat, rice and rye) and feed grains for livestock and poultry (oats, barley, sorghum etc), any imbalance in the area devoted to food grains would definitely affect the food security [Snodgrass and Wallace, 1982]. In India the food problem arises from the supply demand gap. There are various causes leading to this gap, but change in land use is most important [Singh and Sadhu, 1986]. In the context of Jammu and Kashmir, the supply demand gap has widened on account of this factor. Assuming 622 grams of food grain

consumption per capita per day to be standard norm, then two lakh tons of food grains would have to be imported to meet the growing demand for food in the state [Ali, 1992] and since 1990's the demand has increased many folds because of population growth, land use/land cover changes and other factors.

II. STUDY AREA

Anantnag district is situated in the southern region of the Kashmir valley between geographical coordinates of 740-30' to 750-35' East longitude and 330-20' to 340-15' North latitude, at an altitude of 5,300 feet (16,00 mts) above mean sea level, at a distance of 33 miles (53kms) from main city Srinagar and is situated on the right bank of the river Jhelum (Vyeth). The entire southern sector of the district was contiguous with tehsils of Reasi, Banihal and Kishtwar of Jammu province, and eastern sector is contiguous with tehsil Kargil of Ladakh division comprises of thick forests and mountains.



Source: Generated from SOI Toposheets, 1971

Figure. 1

The northern and western sides of this district were bounded by Pulwama district while Kulgam district falls in its west. The total area of the study area was 2917 Km^2 and have a population of 1078692 (J&K census, 2011). For in depth research analysis the study area has been delineated into five altitudinal zones [Fig. 1 &Table 1] that were generated from contour DEM with a contour interval of 250 meters ranging from 1500 meters upto 5385 meters above mean sea level. Zone 'A' occupies an area of 445.5 Km^2 accounting 15.3 percent of the total area of the study area, while as zone 'E' occupies the largest area of 1496.7 Km^2 accounting 51.3 percent to total area.

Table 1: Altitudinal Zone Wise Area of District Anantnag

Altitudinal Zone (Meters)	Area in Km^2	Total Area (%)
Zone 'A' (1500-1750)	445.5	15.3
Zone 'B' (1750-2000)	347.4	11.9
Zone 'C' (2000-2250)	306.1	10.5
Zone 'D' (2250-2500)	321.2	11.0
Zone 'E' (Above 2500)	1496.7	51.3
Total	2917 Km^2	100.0

Source: *Computed from contour DEM*

III. MATERIALS AND METHODS

Multi temporal satellite data set of LISS III of August, 2001 and LISS III mosaic scenes of August, 2010 were use for the land use land cover change detection in the study area. Secondly, digital topographic maps digitized from hardcopy of survey of India topographic maps with scale of 1:50,000 were use mainly for geometric correction of the satellite images, for ground truth information and also for the delineation of study area.

Table -2 Type and Source of Data Sets Used

S. No	Data set	Type of Data	Source	Date of acquisition
1	**Topographic maps**		Survey of India	1971
2	**IRS-1C LISS3**		NRSC INDIA	August, 2001
3	**IRS-P6 LISS3**		NRSC INDIA	August, 2010
4	**Primary data**	l	Ground truthing	2014, 2015
5	**Secondary data**	Agricultural Productivity	Financial Commissioners Office, Srinagar	2001- 2011
			Field Survey	2014-2016
		Population variables	Census of India, J&K Series, Srinagar/Jammu,2011	2011

Finally, ground information was collect between 2009 and 2010 for the purpose of digital supervised classification and classification accuracy assessment. The summery of the dataset used in the present study were giving table 2.

Food requirement has been calculated by using the standard consumption intake of rice and maize per person/day (370 grams/person/day) fixed by Swaminathan (2000), Indian council of medical research (ICMR) and world health organization (WHO, 1978 and 2000).The formula used to calculate food requirement is:

$$\mathbf{FR_y = Tp \times I \times 365} \text{ .....[1]}$$

Where, FR_y = Food requirement in a year; Tp= Total Population and I= intake needed per person per day (standard norm)

The food deficit has been worked out by using the domestic production data and the formula [2] given below.

$$\mathbf{FD_y = \frac{F_r - Dp_y}{F_r} \times 100} \text{.....[2]}$$

Where, FD_y = Food deficit in a year 'y', 'F_r' is food requirement, and Dp_y = Domestic Production in the year

IV. RESULTS AND DISCUSSIONS

The land use/land cover statistics of 2001 in the study area is given in the table 3. Dense forests were the dominant land use category followed by the Scrub.

Table 3: Altitudinal Zone Wise Land use/Land cover of District Anantnag (2001)

Land Use/ Land Cover Category	zone 'A'		zone 'B'		zone 'C'		zone 'D'		zone 'E'		Total	
	Total Area (Hac)	Percentage of Total Area	Total Area (Hac)	Percentage of Total Area	Total Area (Hac)	Percentage of Total Area	Total Area (Hac)	Percentage of Total Area	Total Area (Hac)	Percentage of Total Area	Total Area (Hac	Percentage of Total Area
Dense Forest	0	0	600.36	2.148	6373.43	26.77	12052.33	47.59	44866.21	31.40	63892.3	**24.79**
Sparse Forest	18.0	0.05	848.57	3.037	2414.51	10.14	2772.36	10.95	16732.33	11.71	22785.8	**8.84**
Scrub	20.7	0.05	1500	5.368	7641.44	32.09	8902.08	35.15	28380.53	19.86	46444.8	**18.02**
Horticulture	17410.3	46.1	9234.71	33.04	1150.11	4.83	117.81	0.47	18.32	0.01	27931.3	**10.84**
Agriculture	15618.6	41.3	12896.24	46.14	3383.46	14.21	383.53	1.51	43.47	0.03	32325.3	**12.54**
Built up	4040.3	10.7	1081.69	3.871	330.6	1.39	115.18	0.45	0	0.00	5567.8	**2.16**
Water body	371.9	0.99	114.48	0.410	213.66	0.90	204.21	0.81	1166.01	0.82	2070.3	**0.80**
Wasteland	271.7	0.72	1668.83	5.972	2304	9.68	777.06	3.07	38353.59	26.84	43375.2	**16.83**
Glacier	0	0	0	0	0	0	0	0.00	13331.97	9.33	13332.0	**5.17**
Total	**37751.3**	**100**	**27944.88**	**100**	**23811.21**	**100**	**25324.56**	**100.0**	**142892.4**	**100.0**	**257724.**	**100.00**

Source: *Computed from IRS-1C LISS III Satellite Data, 2001*

Dense forests consist of 63892.3 hectares, comprising 24.79 percent of the study area. Scrub was the second dominant land use category with an area of 46444.8 hectare, comprising 18.02 percent of the study area. Agriculture consists 12.54 percent with an area of 32325.3 hectares of the study area. Horticulture/plantation is mainly confined in lower zones, occupied an area of 27931.3 hectares (10.84 percent). Glaciers were mainly found at reaches of Greater Himalayas but most of them was present in the lidder valley [Fig.2a]

The area under different land use/land cover classes shows inter zonal variation in the study area. Dense forests were mostly confined in zone 'C', zone 'D' and zone 'E' with 26.77 percent, 47.59 percent and 31.40 percent respectively. Glaciers were present only in zone 'E' with 13332.0 hectares, however, agriculture, horticulture and built up were mostly found in lower zones table 3.

Fig.2: Altitudinal Zone Wise Land use/Land cover Change of Anantnag District [2001-2010]

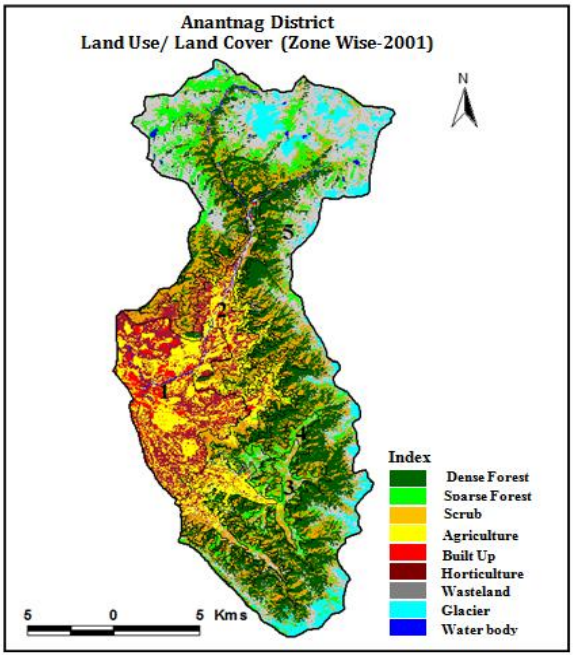


Fig. 2a

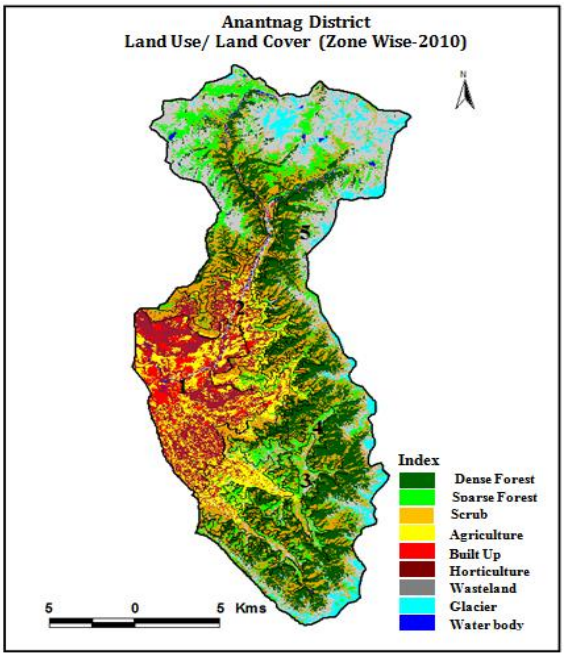


Fig. 2b

The land use/land cover map of 2010 has been generated from the satellite data and was presented in the table 4. Horticulture occupied 33529 hectares and constituted 13.01 percent area while as sparse forest consists 27301 hectares which constitute 10.59 percent of the study area. Area under agriculture in the study area has been decreased consisting of 22794.4 hectares and water body have least coverage of an area (0.75 percent). Glacier s were mainly confined in higher reaches covering an area of 10639.9 hectares (4.13 percent) followed by built up with an area of 8485.04 hectares (3.29 percent) fig 2b.

Table 4: Altitudinal Zone Wise Land use/Land cover of District Anantnag (2010)

Land Use/ Land Cover Category	zone 'A'		zone 'B'		zone 'C'		zone 'D'		zone 'E'		Total	
	Total Area (Hac)	Percentage of Total Area	Total Area (Hac)	Percentage of Total Area	Total Area (Hac)	Percentage of Total Area	Total Area (Hac)	Percentage of Total Area	Total Area (Hac)	Percentage of Total Area	Total Area (Hac)	Percentage of Total Area
Dense Forest	0.00	0.00	433.42	0.84	3948.5	16.6	10670	42.1	43022	30.11	58074.4	**22.53**
Sparse Forest	39.59	0.1	906.95	3.25	4539.8	19.1	3701.07	14.6	18113.65	12.68	27301.0	**10.59**
Scrub	30.00	0.1	1734.6	8.00	7840.9	32.9	9191.6	36.3	28715.	20.10	47513.0	**18.44**
Horticulture	19498.6	51.7	12086.6	46.83	1750.11	7.4	161.81	0.6	31.9	0.02	33529.0	**13.01**
Agriculture	11902	31.5	8695.24	25.39	1783.86	7.5	338.25	1.3	74.47	0.05	22794.4	**8.84**
Built Up	5632.52	14.9	2006.07	8.25	660.41	2.8	180.46	0.7	5.58	0.00	8485.04	**3.29**
Water body	307.9	0.8	111.48	0.40	195.3	0.8	204.21	0.8	1103.4	0.77	1922.3	**0.75**
Wasteland	340.04	0.9	1970.45	7.05	3092.15	13.0	877.06	3.5	41185.	28.82	47464.9	**18.42**
Glacier	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	10639	7.45	10639.9	**4.13**
Total	**37751.3**	**100**	**27944.8**	**100**	**23811.2**	**100**	**25324**	**100**	**142892**	**100**	**257724**	**100**

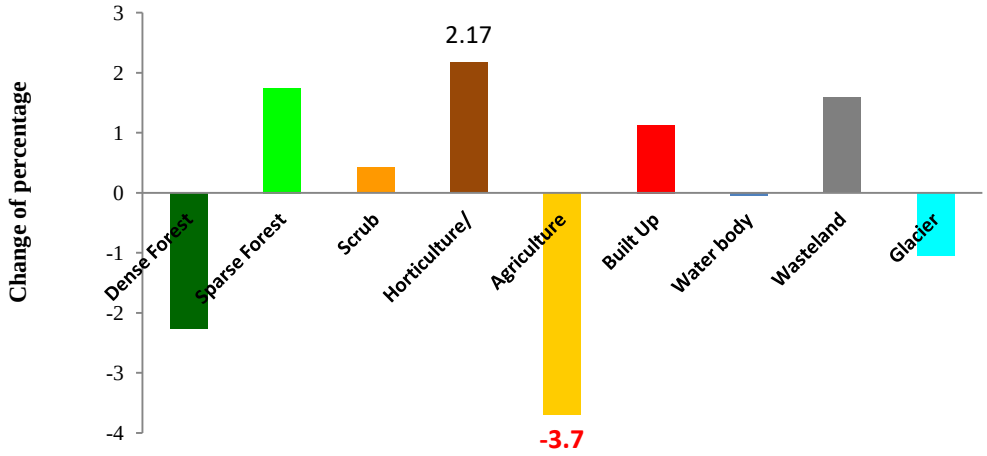
Source: *Computed from IRS-P6 LISS III Satellite Data, 2010*

In zone 'A' horticulture was the dominant land use category followed by agriculture and built up with 51 percent, 31.5 percent and 14.9 percent of the total area respectively.

IV.I ALTITUDINAL ZONE WISE LAND USE/LAND COVER CHANGE, 2001-2010

The land use land cover change that has occurred in the study area from 2001 to 2010 is shown in the table 4.3. Some land use classes have depicted a positive change while others have negative Change fig.3.

Figure 3: Altitudinal Zone Wise Land use/Land cover Change of District Anantnag (2001-2010)



The study shows that out of all land use land cover classes maximum decline were observed in Agricultural land as the bases of all food crops. Agriculture being the dominant activity in the study area has witnessed change of -3.7 percent. Agriculture was decreasing in the study area at the cost of expansion in horticulture and built up [table 5]. The unchecked population growth and expansion of urban centres like Anantnag, Bijbehara, Dooru and Achabal towns have put more pressure on agricultural (paddy) land. Laying out of railway line and extension of NH1A and NH1B in the study area is another cause. Highest decrease were observed in zone 'B' and zone 'A' with -15.03 percent and -9.84 percent respectively [fig.3].

Table 5: Altitudinal Zone Wise Land use/Land cover Change of Anantnag District (2001-2010)

Land Use/ Land Cover Category	zone 'A'		zone 'B'		zone 'C'		zone 'D'		zone 'E'		Total	
	Total Area (Hac)	Percentage of Total Area	Total Area (Hac)	Percentage of Total Area	Total Area (Hac)	Percentage of Total Area	Total Area (Hac)	Percentage of Total Area	Total Area (Hac)	Percentage of Total Area	Total Area (Hac	Percentage of Total Area
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Sparse Forest	18.0	0.05	848.57	3.037	2414.51	10.14	2772.36	10.95	16732.33	11.71	22785.8	**8.84**
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Glacier	0	0	0	0	0	0	0	0.00	13331.97	9.33	13332.0	**5.17**
Total	**37751.3**	**100**	**27944.88**	**100**	**23811.21**	**100**	**25324.56**	**100.0**	**142892.4**	**100.0**	**257724.**	**100.00**

Source: *Computed from IRS-1C LISS III Satellite Data, 2001 and IRS-P6 LISS III Satellite Data, 2010.*

V. AREA UNDER PADDY AND MAIZE

Area under paddy decreases with increasing altitude while as area udder maize crop increases. Maximum area under paddy was observed in zone 'A' 1100.5 hectares (58.62 percent) fallowed by zone 'B' with 404.2 hectares while as in zone 'C' and zone 'D' maize were dominated crop consisting of 350 hacters and 48.1 hacters of the total area of zone respectively.

Table 6 :Altitudinal Zone wise Area under Paddy and Maize in District Anantnag

Altitude Zones (Meters)	Area in Hectares					
	Total Area	**Un cultivable Area**	**Total cultivable Area**	**Area under Paddy**	**Area under Maize**	**Others**
Zone 'A' (1500-1750)	**3514.3**	**1636.9** (46.58)	**1877.4** (53.42)	**1100.5** (58.62)	**150** (8.6)	**626.5**
Zone 'B' (1750-2000)	**1731.21**	**626.81** (36.21)	**1104.4** (63.79)	**404.2** (36.6)	**297** (26.89)	**353**
Zone 'C' (2000-2250)	**620.11**	**174.11** (28.08)	**446** (71.92)	**0** (0)	**350** (78.48)	**83**
Zone 'D' (2250-2500)	**90.6**	**28.5** (31.46)	**62.1** (68.54)	**0** (0)	**48.1** (77.46)	**4**
Total	**5956.22**	**2357.02** (39.57)	**3599.2** (60.43)	**154.7** (47.36)	**695.1** (19.3)	**1066.5**

Source: *Village Amenity Directory & Field Survey 2016*

The productivity and production of paddy and maize witnesses altitudinal variation due to geographical constraints like climate, soil fertility, slope.

Table 7: Altitudinal Zone wise Productivity and Production of paddy and Maize in District Anantnag

Altitude Zones (Meters)	Productivity of Paddy Qtl/Hac.	Productivity of Maize Qtl/Hac.	Production of paddy (Qtl)	Production of Maize (Qtl)	Total Production (Qtl)
Zone 'A' (1500-1750)	51.4	14	56565.7	2100	**58665.7**
Zone 'B' (1750-2000)	38.2	12	15440.44	3564	**19004.4**
Zone 'C' (2000-2250)	0	13	0	4550	**4550**
Zone 'D' (2250-2500)	**0**	**10**	**0**	**481**	**481**

Source: *Computed from Table 5.5 and Field Survey 2014*

The productivity of Paddy was found highest in zone 'A' and zone 'B' while as zone 'C' and zone 'D' were dominated with maize cultivation (table 5.6). The total production of paddy and maize were found maximum in zone 'A' (58665.7 quintals) and zone 'B' (19004.4 quintals) while as lowest production were observed in zone 'D' (481 quintals).

VI. FOOD REQUIREMENT ANALYSIS

The total food requirement in the study area was 134885.2 quintals. However, it is more in zone 'A' (85009.92 quintals) on account of its more population [table 8]. The requirement in absolute values is low in zone 'C' (11136.22 quintals) and zone 'D' (1906.90 quintals) because of being less populated. The total domestic production is equivalent to fifty nine percent (80601.14 quintals) of the requirement.

Table 8 : Altitudinal Zone wise Food Requirement, Domestic Production and Food Deficit

Altitude Zones (Meters)	Human Population	Food Requirement	Domestic Production	Food Deficit (%)
Zone 'A' (1500-1750)	74947	85009.92	58665.7	**30.90**
Zone 'B' (1750-2000)	59273	36832.19	19004.44	**48.40**
Zone 'C' (2000-2250)	19246	11136.22	4550	**59.14**
Zone 'D' (2250-2500)	4412	1906.90	481	**74.78**
TOTAL	**157878**	**134885.2**	**80601.14**	**40.24**

Source: *Computed from Table 5.6 and Formula 1 and 2*

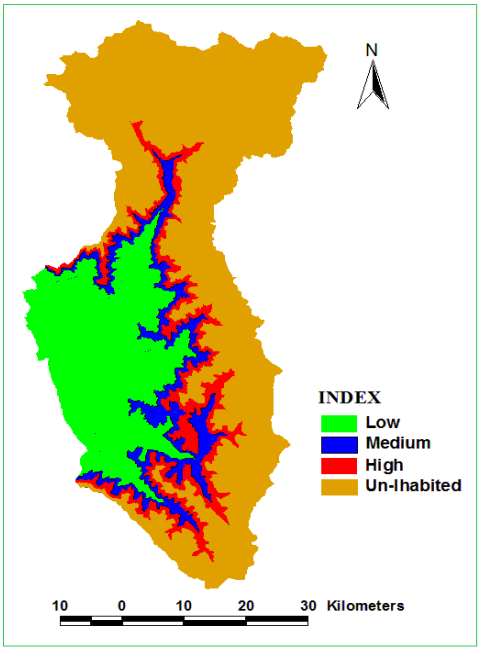
VII. IDENTIFICATION OF FOOD SECURITY VULNERABLE ZONES

The composite index (CI) was used to classify the zones into three vulnerable categories based on food deficit index (highest rank ,low food deficit) [table 9 and fig. 4]. The Zone 'D' was found high vulnerable (CI 4), while as zone 'C' was in medium vulnerable zone (CI 3). However zone 'A' and zone 'B' were found in low vulnerable zone (CI 2).The reasons are attributed low productive soils, low irrigation facilities, and Socio-economic backwardness, traditional practices in place and low awareness regarding scientific methods and HYV seeds and most important the conversion of agricultural land into horticulture and other land use classes.

Table 9: Altitudinal zone wise food security vulnerable zones.

Altitude Zones (Meters)	CI	Vulnerability of food deficit
Zone 'A' (1500-1750) Zone 'B' (1750-2000)	**2**	**Low**
Zone 'C' (2000-2250)	**3**	**Medium**
Zone 'D' (2250-2500)	**4**	**High**

Fig. 4: Altitudinal zone wise food security vulnerable zones



Source: Based on field Survey, 2016

VIII. CONCLUSION AND SUGGESTION

Land use/Land cover analysis depicted wide variations at zone level. The highest decrease was witnessed in paddy land category in zone 'B' (15.03 percent) and zone 'A' (9.84 percent) as compared to zone 'D' (0.18 percent), however, horticulture was increased maximum in zone 'B' (10.2 percent) and minimum in zone 'D' (0.17 percent). Zone 'D' and zone 'E' reflected dense forest conversion into spare forest due to high pressure of population. Built up category was found to increase at an alarming rate in the plains areas at the cast agriculture land. These changes in land use categories had created food shortage in the state in general and in the study area in particular. The highest food deficit were found in zone 'D' (74.78 percent) and zone 'C' (59.14 percent) and lowest was observed in zone 'A' (30.9 percent). The study area was divided into three vulnerable food deficit zones i.e. high (zone 'D' and zone 'C'), medium (zone 'B') and low (zone 'A'). Novel land systems should be designed that are adapted to the local context and framed within the global socio-ecological system. Such land systems should explicitly account for the role of land governance as a primary driver of land system change and food production.

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