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Impact Assessment of Land Use/Land Cover Change on Livestock in Bikaner District (Rajasthan) Using Geospatial Techniques

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Abstract

Land use is the manner in which human beings employ the land and its resources. Land use is characterized by the arrangements, activities and inputs people undertake in a certain land cover type to produce, change or maintain it. It is commonly defined as a series of operations on land, carried out by humans, with the intention to obtain products and benefits through using land resources. It is determined by environmental factors such as soil characteristics, climate, topography, and vegetation, but it also reflects land's importance as a fundamental factor of production. Thus understanding past changes in land use and projecting future land use trajectories requires understanding the interactions of the basic human forces that motivate production and consumption. The information about land use/land cover and possibilities for their thoughtful use is essential to meet the increasing demands for basic human needs and welfare. This information also assists in monitoring the spatio-temporal assessment of livestock. In so far as Bikaner is an agricultural district, the significance of livestock for stability and prosperity in the rural areas can hardly be exaggerated as it provides income and employment throughout the year to the small and marginal farmers. Remote sensing and GIS play a very vital role when applied in identifying and delineating the parts of land under different uses and covers, which leads to better management and development of land resources.

Keywords: Land Resources, Land Use/Land Cover, Increasing Demands, Significance of Livestock.

Introduction

Land use is the manner in which human beings employ the land and its resources. It is characterized by the arrangements, activities and inputs people undertake in a certain land cover type to produce, change or maintain it (FAO/UNEP, 1999). While land cover implies the physical or natural state of the Earth's surface. It refers to the surface cover on the ground, whether vegetation, urban infrastructure, water, bare soil or other; it does not describe the use of land, and the use of land may be different for lands with the same cover type.

Land use/land cover (LULC) is obviously determined by environmental factors such as soil characteristics, climate, topography, and vegetation, but it also reflects land's importance as a fundamental factor of production. Thus, understanding past changes in LULC and projecting future land use trajectories requires understanding the interactions of the basic human forces that motivate production and consumption (Turner B.L., Mayer W.B. and Skole D.L. (1994).

Animal husbandry, agriculture and allied activities have been the core livelihood for majority of the rural people since time immemorial. It provides productive employment, especially self employment and the most valuable supplementary income to a vast majority of rural households, majority of who are small and marginal farmers and landless laborers. Livestock provide quality animal protein to human population in the form of milk, eggs, meat and value added products. They also provide draught power, organic manure and raw materials for various industries.

Study Area

Bikaner is one of the desert districts, situated in the Thar Desert towards north-west of Rajasthan extending from 27°11' to 29°3' north latitudes and 71°54' to 74°12' east longitudes. It is bounded by Sri Ganganagar district in the north; Jaisalmer district and Pakistan in the

west; Churu in the east, and Nagaur and Jodhpur districts in the south and south-west. It has a geographical area of 30289.62 sq km and stands at second place in the State with 8.8 per cent of the total area. The district has a dry climate, with large variation of temperature and scanty rainfall. Hot winds blow in summer, sweeping away and creating new sand-dunes (Nigam, M.N. and Tiwari, A.K., 1993). The highest temperature may go up to 48°C during summer and lowest up to freezing point during winter season. The mean annual rainfall in the district is 26.3 cm, mean relative humidity remains below 50 per cent.

Objectives of the Study

To analyze the trends of LULC changes and their effect on structure on livestock in the study area.

Hypothesis

1. The amount of rainfall, area under irrigation and LULC have positive correlation; and
2. The population of sheep has decreased whereas highbred cows and buffaloes increased with the expansion of crop cover.

Methodology

The secondary data have been collected from Department of Land Records and Agriculture, Bikaner; District Statistical Outline, Bikaner; Animal Husbandry Department, Jaipur; Indian Meteorological Department, Jaipur and Rajasthan University of Animal and Veterinary Science, Bikaner. For primary data, toposheets and satellite images have been used.

The satellite images have been downloaded from the website glcf.umd.edu and these have been masked according to study area. Generation of FCC (False Color Composite) - Downloading site is used to obtain seven separated band image of Landsat using the layer stacking function and the multi-spectral (multi-band) composite image has been made. From this, 4th, 3rd and 2nd bands are used for formation of a standard FCC, and this ware, again used for extracting the LULC classes. Similarly, different band combinations are used for formation of various FCCs. In the end, the total area of different classes have been calculated, and the pattern of LULC at different points of time is studied and LULC maps have been created with the help of above procedure.

Factors Influencing Land use/Land cover

There are three categories of land use and land cover in the study area: Crop cover, Bare land and Grazing land. The LULC is directly influenced by the amount of annual rainfall, area of irrigation, and crop cover.

Amount of Rainfall

The following conclusions are found by the rainfall data of the last 40 years (table 1):

1. Analyzing decadal mean of rainfall since 1973, it is found that in the first decade; mean rainfall was highest 30.53 cm. It is seen to fall down after 1973. From the third decade to the fourth decade, it increased from 27.93 cm to 28.99 cm (2003-2012).
2. It is found that there were 9 years between 1980 and 2006 when the rainfall was less than 20 cm and it was the lowest (6.62 cm) in the year 2002.
3. After the year 2012, the annual rainfall was more than 30 cm in the years 2013 (30.62 cm) and 2014 (30.51 cm).
4. The low rainfall years have least Kharif cultivated area. The lowest cultivated years were 1976, 1984, 1985, 1987, 1990 and 2000.
5. The most Kharif cultivated years were 2001, 2003, 2010, 2011, 2013 and 2014; and during these years the annual rainfall was also high.

Table 1 : Bikaner District - Annual Rainfall (cm)

Year	Rainfall	Year	Rainfall	Year	Rainfll	Year	Rainfall
1973	26.36	1983	51.31	1993	21.55	2003	30.06
1974	23.75	1984	17.79	1994	29.67	2004	15.79
1975	38.09	1985	13.27	1995	31.97	2005	29.67
1976	33.25	1986	23.54	1996	44.60	2006	19.26
1977	39.64	1987	17.40	1997	42.01	2007	28.99
1978	42.22	1988	22.67	1998	32.07	2008	34.64
1979	24.48	1989	27.32	1999	19.90	2009	20.87
1980	19.17	1990	29.31	2000	23.63	2010	42.67
1981	21.59	1991	11.68	2001	27.29	2011	34.06
1982	36.77	1992	38.72	2002	6.63	2012	33.96
Mean Decadal	30.53	25.30		27.93		29.10	

Source: Meteorological Department, Jaipur

Area under Irrigation

Bikaner district is mainly irrigated by IGNP (64.03 per cent) and tube-wells (33.61 per cent). Under the lift irrigation scheme, 41 villages of Lunkaransar tehsil, with an area of 2.59 lac acres, and 35 villages of Bikaner tehsil (3.93 lac acres) are being benefitted.

Table 2: Bikaner District - Source-wise Irrigated Area (2007- 08)

Tehsil	Source (per cent)		
	Wells	Tube-wells	Canals
Bikaner	0.00	73.60	26.39
Lunkaransar	0.03	19.14	80.81
Nokha	1.54	98.45	0.00
Kolayat	0.01	13.12	86.86
Pugal	0.00	0.00	100.0
Khajuwala	0.00	0.00	100.0
Chhatargarh	1.18	0.00	98.81
Dungargarh	14.35	85.64	0.00
Total District	2.36	33.61	64.03

Source: District Statistical Outline, DoES, GoR,Jaipur.

The data given in table 2 clearly reflect the lack of irrigation facilities and ground water in Bikaner district. A number of tube-wells have been dug out in Bikaner, Nokha, Dungargarh and Kolayat Tehsils that have changed the agricultural system in the study area.

1. After the year 2000, the area under tube-well irrigation has increased in Nokha, Dungargarh and Bikaner tehsils. Owing to this, the crop cover is also found to be greater than before.
2. High variation in irrigated area can be attributed to high fluctuation in water supply through Indira Gandhi Canal System, which itself varies with amount of rainfall.
3. Karl Pearson correlation coefficient between annual rainfall and Kharif cropped area was calculated, and was found to be 0.59. This medium positive correlation indicates towards dependence of Kharif cropped area on rainfall, despite the development of vast canal infrastructure.

Crop Cover

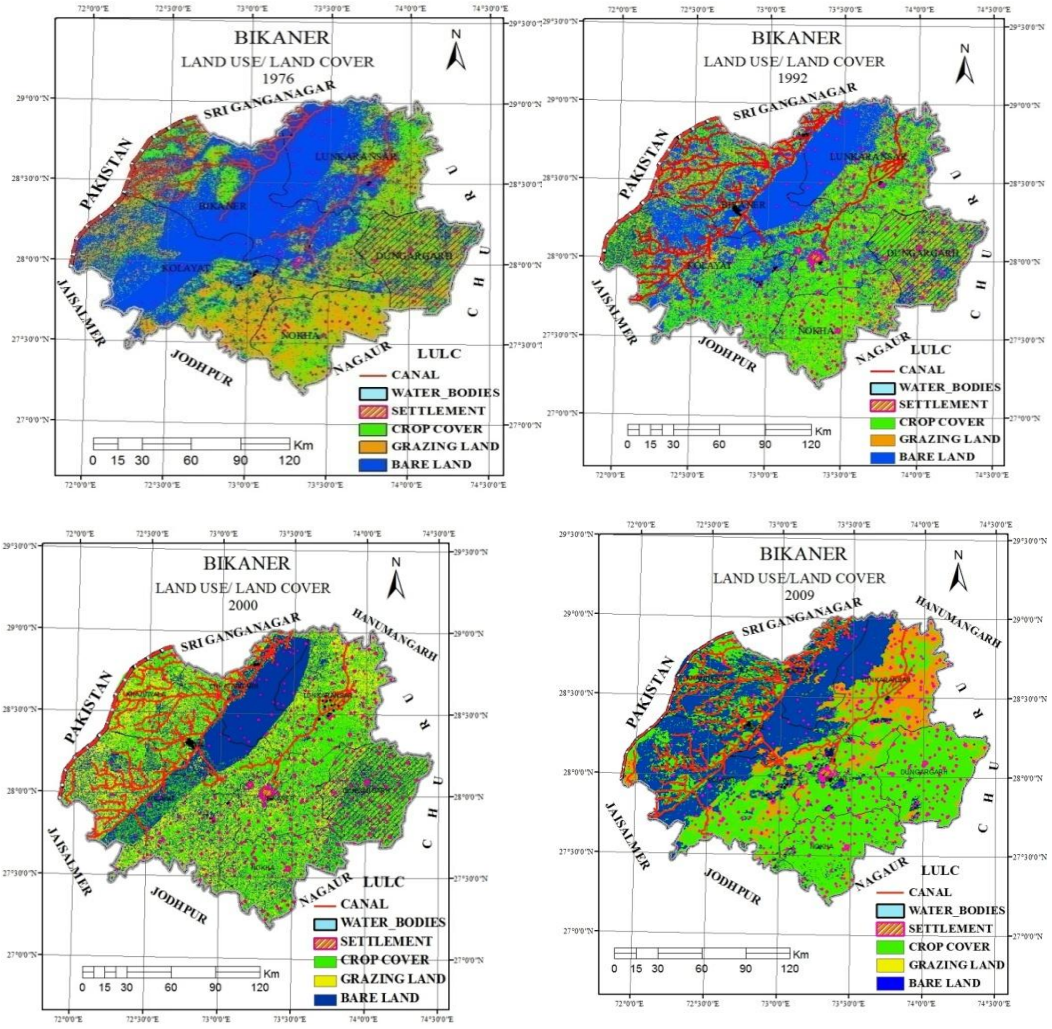
During 1976-1992 there was a growth of 67.37 per cent in crop cover, that is, the highest for the study area and will, perhaps,remain so. This phenomenal growth is attributable to the Green Revolution facilitated initially by IGNP (table 3 & figure 1).

Table 3: Bikaner District - Land use/Land cover

Type of LULC	Area (km^2)			
	1976	1992	2000	2009
Crop Land	6159.72	10309.38	9973.91	10078.49
Range/GrazingLand	9769.38	11048.91	11965.49	10897.38
Bare Land	14264	9697.02	9058.47	9480.96
Settlements	92.04	216.69	272.30	318.87
Water-bodies	4.01	17.62	19.45	13.92
Canal Length (km)	1018.36	1642.68	1862.88	1988.86

Source: Data calculated with help of Satellite Imagery

Fig 1 : Bikaner District - LULC Pattern (1976 - 2009)



Impact of Land use/ Land cover on Livestock

Growth of Livestock

The growth of livestock varies in Bikaner district and Rajasthan. The growth was 6.93 per cent and 30.49 per cent respectively in 1966. It was 4.39 times higher in the State than the study area. According to livestock census, 1972, the growth rate was -19.59 per cent in Bikaner district, while it was 12.10 per cent in Rajasthan. But in the year 1977, it increased tremendously with 70.78 per cent in the study area, whereas it was only 6.92 per cent in Rajasthan (Livestock Census, Rajasthan). In the year 2003, the growth rate declined in both of the areas. It was -3.74 per cent in Bikaner district and -9.60 per cent in Rajasthan. In the year 2012, the growth rate of Rajasthan declined to 1.88 per cent while that of Bikaner district increased to 8.27 per cent (table 4).

Table 4: Bikaner District and Rajasthan - Growth of Livestock

Year	Bikaner District		Rajasthan	
	Number (Lakh)	Growth Rate (Per cent)	Number (Lakh)	Growth Rate (Per cent)
1961	10.45	-	335.09	-
1966	11.17	+6.93	374.76	+11.83
1972	8.98	-19.59	388.78	+3.74
1977	15.34	+70.78	413.59	+6.38
1988	16.93	+10.32	409.01	-17.62
1992	20.06	+18.50	477.73	+16.80
1997	25.31	+26.13	543.48	+13.76
2003	24.36	-3.74	491.46	-9.57
2007	25.61	+5.13	566.63	+15.29
2012	27.73	+8.27	577.32	+1.88

Source: Livestock Census, Animal Husbandry Department, GoR, Jaipur

After the year 1972, due to well developed irrigation system (IGNP), there has been stability in the fodder production. As cows and buffaloes are fodder dependent animals, their growth rates remained positive during all these years. In fact, there has been considerable increase (25 per cent and 47 per cent respectively) in their growth rates in the year 2012. The growth rate of natural ruminant is continuously negative after year 1997 due to decrease in grazing land and moving of cattle raisers towards agriculture while these factors did not affected the growth rate of other ruminants like goat to that extent of sheep as it is useful in both milk and meat purposes. The continuous negative growth rate of camel after year 2003 is due to its smuggling for meat and decrease of demand in agricultural sector.

The increment in number and density of bovines took place due to tube-well irrigation resulting expansion in cultivated area, shrinkage of grazing land and pastures and urbanization corresponding increased demand of dairy products while it caused a drastic downfall in sheep population and density. The camel population has decreased considerably due to its smuggling and high maintenance cost.

Structure of Livestock

According to the livestock census 1961, the share of cow population was 41.18 per cent followed by 41.16 per cent of sheep, 9.91 goats, 3.68 per cent buffalo and 3.66 per cent of camels in Bikaner district (table 5). The share of cow population was in decreasing trend till 1992, it declined to 22.11 per cent in 1997 and again it increased to 32.67 per cent in 2012. It is caused by increase in number of hybrid cows. During 1961-2012, cow population has doubled 430,516 (1961) to 906075 (2012). Buffalo was not so important in the composition of total livestock in 1961. Its share was 3.68 per cent (38,522) in 1961; has gone up to 6.97 per cent in (193,433) 2012. This growth shows that the domestication of buffalo is increasing for better milk yield and long lactation period. It increased by 5.02 times which is higher than the growth of cow. Sheep was the second (41.1 per cent) important domestic animal but after that they were continued to be at the first place out of the total livestock till 2003 (38.12 per cent). After that it is showing a decreasing trend 31.22 per cent in 2007 and 23.54 per cent in 2012. The number of sheep has increased by 1.5 times during the same period. Goat has a significant position among the domestic animals of Rajasthan. It was at 3rd position (9.91 per cent) in 1961, has come at 2nd position (22.38 per cent) in 1977 and continued to be at first place (35.51 per cent) till 2007 and (34.68 per cent) in 2012. It is also important to note here that goat population has increased by 9.27 times during the period of 1961-2012.

Camel is an important draught animal in the study area. It increased by 1.20 times only during 1961-2012. Its number was in increasing trend till 1972 (5.78 per cent) but later it declined due to introduction of the Green Revolution and mechanization in agriculture and at present its share among the total livestock is very negligible (1.66 per cent). Therefore, it is important to note that the share of buffalo and goat is increasing while the significance of cow, sheep and camel is decreasing in the study area.

Table 5: Bikaner District - Livestock Wealth

Year	Cow	Buffalo	Sheep	Goat	Camel	Total	Percentage of Raj
1961	430516 (41.18)	38522 (3.68)	430232 (41.16)	103674 (9.91)	38360 (3.66)	1045233	3.95
1966	355704 (31.82)	44743 (4.0)	533517 (47.73)	132694 (11.89)	47184 (4.22)	1117760	3.23
1972	223396 (24.85)	28976 (3.22)	401783 (44.7)	189396 (21.07)	51977 (5.78)	898760	2.32
1977	284462 (18.53)	42347 (2.75)	797374 (51.94)	343533 (22.38)	60749 (3.95)	1534983	3.71
1988	452210 (26.7)	55483 (3.27)	826134 (48.78)	297883 (17.59)	52218 (3.08)	1693431	4.13

1992	455263 (22.68)	72211 (3.59)	953125 (47.49)	453875 (22.61)	57504 (2.86)	2006855	4.14
1997	559709 (22.11)	107402 (4.24)	1147992 (43.35)	642403 (25.37)	60678 (2.39)	2531365	4.65
2003	608597 (24.98)	132732 (5.44)	928892 (38.12)	686507 (28.17)	61861 (2.53)	2436320	4.95
2007	671078 (26.20)	131272 (5.12)	799728 (31.22)	909622 (35.51)	49615 (1.93)	2561315	4.52
2012	906075 (32.67)	193433 (6.97)	653028 (23.54)	961907 (34.68)	46209 (1.66)	2773315	4.80

Source: Livestock Census, Animal Husbandry Department, GoR, Jaipur

The share of livestock of Bikaner district shows a growing trend since 1972 (2.32 per cent) to 2003 (4.95 per cent), later in 2012 it shows a decreasing trend (4.52 per cent). The share of cow population was in decreasing trend, it was 41.18 per cent in 1961 and 22.11 per cent in 1997 and a slight growth by 2.87 per cent with 24.98 per cent share while cow population increased by 1.41 times during 1961-2007 period from 460516 in 1961 to 671078 in 2007. Buffalo was not so important in the composition of total livestock in 1961. Its share was 3.68 per cent in 1961 which has increased by 5.12 per cent in 2007. This growth shows that the domestication of buffalo is increasing for better milk yield and long lactation period. It increased by 3.44 times which is 2.43 times higher than the growth rate of cow. The sheep was the second important domestic animal but after that they are continued to be at the first place out of the total livestock. The share was highest 51.94 per cent in 1977 and it was 31.22 per cent in 2007. The number of sheep has increased by about twice during the same period.

There has been continuous decrease in livestock percentage of Bikaner and Kolayat while Nokha has seen continuous increment in its respective livestock trend. Other tehsils have seen flexible trends in their respective livestock percentages. In Nokha and Dungargarh tehsils both number and density of cow and buffaloes increased due to tube-well irrigation causing increment in cultivated area. The urbanization and the corresponding increased demand of dairy products led to increased cow and buffalo density in Bikaner tehsil. Urbanization and increment in crop land has led to huge decrease in sheep density in Bikaner tehsil. Dungargarh, Kolayat, Khajuwala and Nokha tehsils have seen continuous decrement in sheep density due shrinkage of grazing land and pastures. Lunkaransar, Pugal and Chhatargarh tehsils have reported mix patterns in sheep density. Dungargarh, Bikaner, Pugal and Khajuwala tehsils accounts for decrement in goat density due to their preference towards bovines. Nokha, Lunkaransar and Kolayat have reported continuous increase in goat density. The density of camel has decreased considerably in all tehsils due to its smuggling and high maintenance cost.

Conclusion

The following conclusions are obtained from the study-

1. If there is low rainfall (drought) in one or more years between two livestock censuses, then the trend of number of livestock changes in the consequent census. The census data indicates a decline trend in the growth rate of all the animals, as it did happen in 2007 livestock census.
2. The number of cattle, buffaloes and goat increases with growth in crop cover.
3. In 2012, the tehsils with low crop cover (that compared the previous year), such as Pugal, showed a rise in number of sheep. Conversely, tehsils like Bikaner, Nokha and Dungargarh, showing sharp rise in crop cover, also show a corresponding decline in the number of sheep.
4. Due to low rainfall in the year 2006, the share of irrigated tehsils in the total crop cover of the district shoots up.

The years 2003, 2012 etc., being normal rainfall years, show a declined share of these tehsils in the total Crop cover of the district. This is so because the Crop cover in other tehsils increased in these years. In 2006, major tehsils with irrigation facilities were Lunkaransar, Nokha and Dungargarh, resulted in higher Crop cover.

The following correlation indicates the positive hypothesis as taken for the study:

There was a total increase of 170.92 per cent in crop cover area between the years 1977 and 2012 (table 6). This increase was about 22.5 times in case of *Rabi* crop, as compared to the *Kharif* crop. The reason for this is attributable to extension of irrigation system. *Kharif* crop over a vast area is still rain-based.

Table 6: Bikaner District - Growth in Crop Cover

Year	Kharif	Rabi	Total
1977	5556.72	124.02	5680.74
2012	12024.15	3366.35	15390.5
Growth Rate (per cent)	116.39	2614.36	170.92

Source: District Outline, DoES, GoR, Jaipur

When the crop cover is compared with livestock, it resulted a simultaneous increase of 183.11 per cent in the number of cattle, 234,035 per cent in buffaloes and an increase of 152.45 per cent in the number of goat (table 7). This shows direct relationship of these livestock with crop cover. At the time, during this duration the growth rate of camels was -34.84 per cent and that of sheep -26.13 per cent, which indicate inverse relationship of numbers of these animals with crop cover change.

Table 7: Bikaner District - Growth of Livestock

Year	Cow	Buffalo	Sheep	Goat	Camel	Total
1977	284462	42347	797374	343533	60749	1530442
2012	805352	141589	588985	867244	39587	2455420
GrowthRate (Per cent)	183.11	234.35	-26.13	152.45	-34.84	60.44

Source: Animal Husbandry Department, Govt. of Rajasthan, Jaipur

Suggestions

1. The livestock economy of the district is still highly dependent on rainfall variations. The number of animals decrease in years of low rainfall and weak monsoon. In order to ensure security and sustainable development of livestock and its economy, range lands may be developed in irrigated areas. Production of fodder would require lesser irrigation water while, at the same time, ensuring greater food security for the livestock. Provision of fodder depots for drought years should be encouraged.
2. The study area has been traditionally suitable for animal-rearing. So, animal-based industries should be encouraged here. This will not only provide conservation to natural ruminants like sheep, which can survive in conditions of low rainfall, but also provide additional income to the farmers.
3. In order to check the decline of crop cover during the years of low rainfall, dry farming methods should be employed in the study area. This will not only ensure crop yields but also enable available water to utilize it in other sectors.

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