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Spatial Analysis of Camel Distribution in Haryana

Vikash Sharma[1], Mohit Kumar[2], Mona Yadav[2], Vikas Sihag[2]

[1]Grujabheswer University of science and technology, Hisar, Haryana, India
[2]Haryana Space Application Center (HARSAC), Department of science and technology, CCS HAU Campus, Hisar-125004, Haryana, India

Abstract: ***Haryana has a small camel 0.386 population (18th livestock census, 2007. In this study the Camel species is analysed, Moran's I coefficient of autocorrelation was used to investigate the spatial distribution of Camel to analyze clustering of the population in Haryana using Tehsil as a real unit. Camel census data was used to link the heterogeneity in the Camel distribution with regard to agro-ecosystems and other environmental factors related to agro-ecological zones in the state of Haryana. Comparatively lower population density (0 - 0.7/ sq. km) of Camel was observed in North eastern Haryana. Moran's I statistic revealed that the distribution of all types of Camel was clustered. The distribution of the camel was characterized in terms of agro-ecosystem prevalent in the area. This ecosystem approach to characterize livestock distribution is useful in livestock production systems research planning.***

Keywords: Camel species, Spatial Analysis, Agro-Ecological Zone, GIS, Livestock Censes

1. Introduction

The state of Haryana has a geographical area of 44.20 lakh hectare. About 86% of the geographical area is cultivable, of which 96% has already been brought under plough. Therefore, there is hardly any scope for bringing additional area under cultivation, except for reclamation of degraded lands affected by water logging, salinity and alkalinity. While crop production has reached at a plateau, livestock production is still growing. Animal husbandry has been taken up as an integral component of diversified agriculture. Haryana has a Small camel 0.386 lakh population (18th livestock census, 2007).

Livestock production systems are determined by factors such as ecological zones, livestock species, desired products, functions, management, markets and government policy (Ruthenberg1980; Simpson 1988). Livestock resources of a region are decided mainly by those factors which determine overall ecological setting for feeding, breeding and rearing of appropriate livestock species for the region. These decisions with respect to choice of livestock and cropping systems are further influenced by several other factors related to infrastructure facilities, socio-economic factors and technological developments. As described by Saxena et al. (2001) these factors include: Infrastructure facilities like animal housing, water availability, feed and fodder availability, transport, trade and marketing, animal products handling, processing and marketing etc.; socio-economic factors like social acceptance for a particular livestock species, financial resource base, land ownership, size and type of land holding, household needs of food, animal products, fuel, fiber and finance, labor availability etc. and technological factors like improved breeds of animals, fodder and crop varieties, mechanization, disease protection, access to veterinary care, access to information etc. Under influence of all above factors, livestock resources remain dynamic in time and space, making it difficult to precisely determine their spread using conventional methods, over a large territory. A geodatabase of livestock in relation to the crop rotation and agro-ecological zones is an essential tool for animal husbandry planning and management.

Agro-Ecological Zones

Haryana is an agrarian State wherein about 85 per cent of its area is under cultivation and engaging about 78 per cent of its population in agriculture. The climate of the State ranges from dry sub humid to hot arid. The annual rainfall varies from less than 300 mm in the south western parts to over 1000 mm in the hilly tracts of the Siwalik. Major parts of the State falls under the most fertile tract of indo-Gangetic alluvial plain. Soil temperature regime is Hyperthermic and the soil moisture regimes are ustic and Aridic. The State has 3 main climatic regions having average annual rainfall and air temperature as under:

An ecosystem is a homogenous geographical area. The production environment of the region in terms of agro-climate, resource endowments and socioeconomic conditions is homogenous, and majority of the farmers have similar production constraints and research needs. Specific advantages of ecosystem approach for research planning (Saxena et al.2001) are: (i) better identification of production constraints and research needs, (ii) better targeting of prospective technologies, (iii) improved assessment of farmers' responses to new technologies, and (iv) wider adoption and larger impact of research outputs.

2. Objectives

The geographical distribution of camels in Haryana in terms of agro-ecological zones and crop based agro-ecosystems would be studied with the following limitations.

Table 1

Climatic Region	Mean Rainfall (mm)	Mean Temperature (C)
Hot Arid Region	300-500	27
Hot Semi-Arid Region	500-700	26
Hot Sub Humid Region	700-1050	24

1) To determine the camel distribution characteristics in Haryana with regard to the different agro-ecological zones.
2) To determine the Camel distribution characteristics in Haryana with regard to the Crop based agro-ecosystems.

3. Material and Methods

Study Area

The study area included the entire state of Haryana extending over an area of 44,212 square km. from $27^0$39' N to $30^0$55'5" N latitudes and $74^0$27'8" E to $77^0$36'5"E longitudes.

Spatial Data

1) Agro-ecozones of Haryana as per the Resource Atlas of Haryana (2004)
2) Crop based agro-ecosystems of Haryana based on IRS-P6, LISS 3 data of the year 2007-08.
3) Administrative boundary of Haryana up to Tehsil level.

Attribute Data

Database of the 18th Livestock census (2007) of Haryana (Department of Animal Husbandry & Dairying and Fisheries, Ministry of Agriculture, Govt. India)

Software

1) Arc Map 10
2) ERDAS Imagine 11.0
3) MS Office 2007

Environmental Characterization of Livestock Distribution

GIS layers of agro-eco zones and crop based agro-ecosystems were combined with the livestock distribution maps for environmental characterization of livestock distribution in Haryana. The flow chart of the methodology for the environmental characterization of livestock distribution is depicted in Figure 1.

Spatial Autocorrelation

Autocorrelation statistic i.e. Moran's I coefficient of autocorrelation was used to investigate spatial autocorrelations based on livestock density and Tehsil location to find out broad trends (dispersed, random or clustered) in the spatial distribution of livestock in Haryana.

Classification and Density Mapping of Different Livestock Species

Density mapping for camel was accomplished using Jenk's Natural Breaks method (Jenk's 1967) and the number of classes was kept at three representing High, Medium and Low densities. The Jenks optimization method, also called the Jenks natural breaks classification method, it is a data classification method designed to determine the best arrangement of values into different classes. This is done by seeking to minimize each class's average deviation from the class mean, while maximizing each class's deviation from the means of the other groups. In other words, the method seeks to reduce the variance within classes and maximize the variance between classes (Jenks 1967).

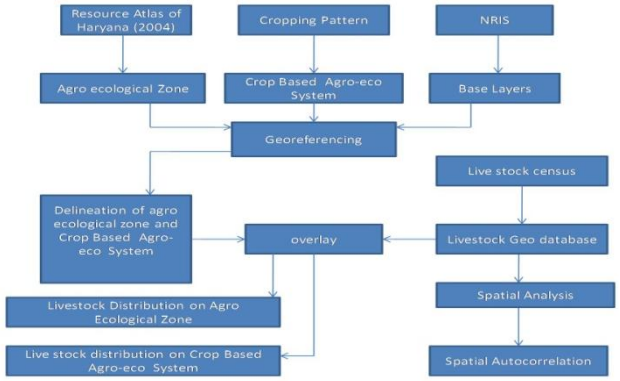

Figure 1

The Global Moran's I statistic was used to measures spatial autocorrelation based on both Tehsil locations and animal density values simultaneously. The z-score and p-value were used to evaluate the significance of Moran's I statistic. The result of spatial auto correction in distribution of domestic animal populations based on Tehsil boundaries are depicted in Table-2.

4. Results and Discussion

Camel density in Haryana is very low comparison of other animals. Range of density of camel is 0 to 4.6 based on natural breaks method as shown in figure 2.

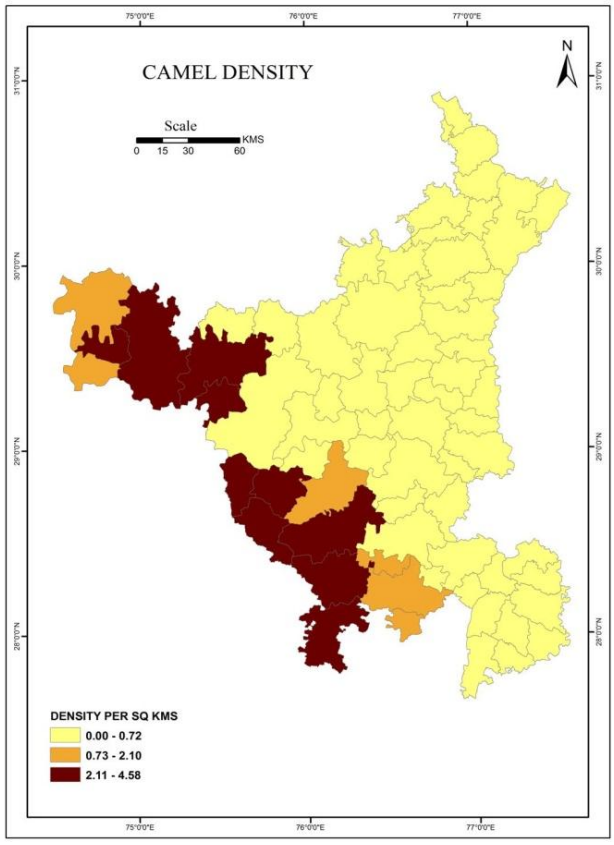

Figure 2

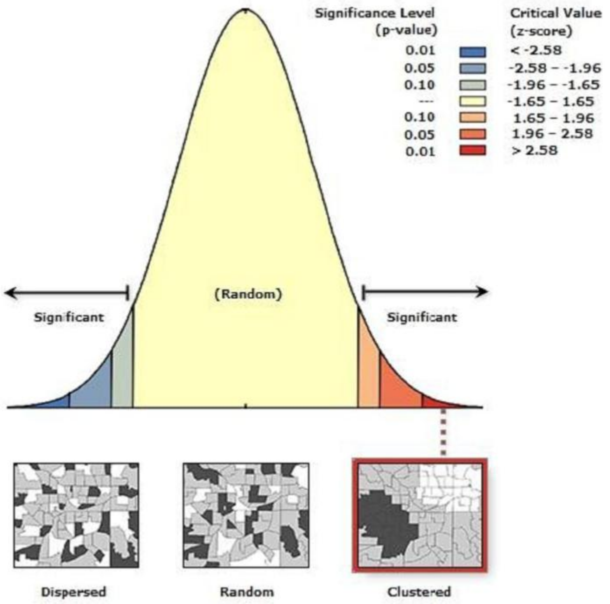

Figure 3

Spatial Autocorrelation Report of Camel Density
Moran's Index: 0.535123
z-score: 6.200147
p-value: 0

High (2.2-4.6) density lies only three agro-ecological zones and only three Crop based agro-ecosystem zones; Rugged hilly terrain of Aravali range, hot and semiarid, little to moderate available moisture and its 90-120 days growing season, second one is Aeo-fluvial plain, hot and dry, little available moisture, 60-90 days growing period and third is Aeolian plain, hot and dry, insignificant available moisture, < 60 days growing period. Crop based agro-ecosystem zones are Cotton-Wheat, Bajra/Jawar/Guwar/Fallow-Wheat/Others and Bajra/Fallow-Mustard Show in table1. High density of camel lies nine tehsil: Rania, Sirsa (Sirsa district), Fatehabad (Fatehabad district), Siwani, Tosham, Loharu and Dadri, (Bhiwani district) and Mahendergarh and Narnaul (Mahendergarh district).

Medium density of camel lies in only five tehsils show in table1 .Its lie in three agro-ecological zones and three Crops based agro-ecosystem zones. Medium density lies in southern and western part of Haryana state.

Low (0.-0.5) density of camel lies above half state. Its lie in seven agro-ecological zones and four Crop based agro-ecosystem zone shows in figure4 and table1.

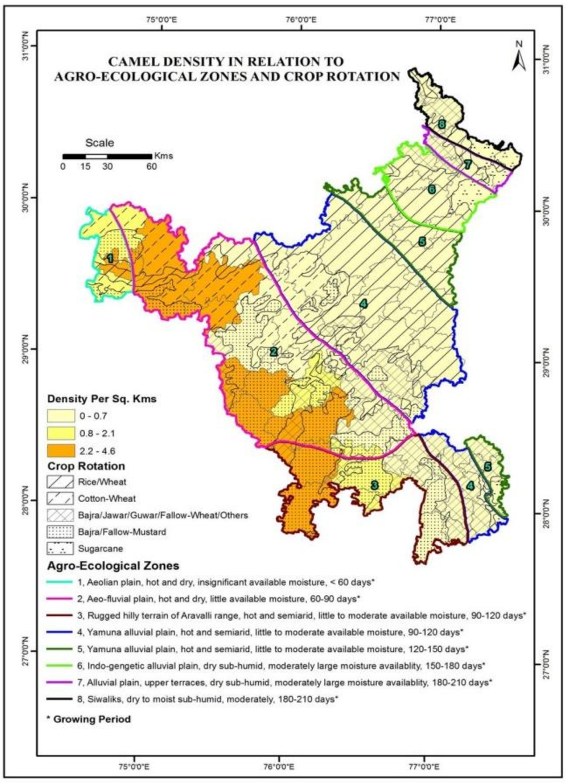

Figure 4

Table 2: Camel density in relation to agro-ecological zones and Crop based agro-ecosystem

Camel Density (Per sq. Km)	Tehsil	Agro-ecological zones	Crop based agro-ecosystem
High (2.2-4.6)	Rania, Sirsa, Fatehabad, Siwani, Tosham, Loharu, Dadri, Mahendergarh, Narnaul	Aeolian plain, hot and dry, insignificant available moisture, < 60 days growing period. Aeo-fluvial plain, hot and dry, little available moisture, 60-90 days growing period. 3. Rugged hilly terrain of Aravali range, hot and semiarid, little to moderate available moisture, 90-120 days growing period.	1. Cotton-Wheat 2. Bajra/Jawar/Guwar/Fallow-Wheat/Others 3. Bajra/Fallow-Mustard
Medium (0.8-2.1)	Ellenabad, Dabwali, Bhiwani, Kosli, Rewari, Bawal	1. Aeolian plain, hot and dry, insignificant available moisture, < 60 days growing period. 2. Aeo-fluvial plain, hot and dry, little available moisture, 60-90 days growing period. 3. Rugged hilly terrain of Aravali range, hot and semiarid, little to moderate available moisture, 90-120 days growing period	1. Cotton-Wheat 2. Bajra/Jawar/Guwar/Fallow-Wheat/Others 3. Bajra/Fallow-Mustard
Low (0-0.7)	Ambala, Assandh, Ballabgarh, Barara, Bawani Khera, Beri, Chhachhrauli, Faridabad, Ferozepur Jhirk, Ganaur, Gharaunda, Gohana, Guhla, Gurgaon, Hansi, Hathin, Hisar, Hodal, Indri, Israna, Jagadhri, Jhajjar, Jind, Julana, Kaithal, Kalka, Karnal, Kharkhoda, Maham, Naraingarh, Narwana, Nilokheri, Nuh, Palwal, Panchkula, Panipat, Pataudi, Pehowa, Punahana, Ratia, Rohtak, Safidon, Samalkha, Shahbad, Sohna, Sonipat, Taoru, Shahbad, Sohna, Sonipat, Taoru, Thanesar, Tohana.	2. Aeo-fluvial plain, hot and dry, little available moisture, 60-90 days growing period. 3. Rugged hilly terrain of Aravali range, hot and semiarid, little to moderate available moisture, 90-120 days growing period 4. Yamuna alluvial plain, hot and semiarid, little to moderate available moisture, 90-120 days growing period 5. Yamuna alluvial plain, hot and semiarid, little to moderate available moisture, 120-150 days growing period. 6. Indo-gangetic alluvial plain, dry sub-humid, moderately large moisture availability, 150-180 days growing period. 7. Alluvial plain, upper terraces, dry sub-humid, moderately large moisture availability, 180-210 days growing period. 8. Siwaliks, dry to moist sub-humid, moderately, 180-days growing period.	1. Cotton-Wheat 2. Bajra/Jawar/Guwar/Fallow-Wheat/Others 3. Bajra/Fallow-Mustard 4. Sugarcane

5. Conclusion

The geographical distribution of livestock resources in Haryana in terms of agro-ecological zones and crop based agro-ecosystems were studied to determine the distribution characteristics of camel in Haryana with regard to the different agro ecological zones. The livestock data from 18th Livestock census of Haryana 2007 (Department of Animal Husbandry & Dairying and Fisheries, Ministry of Agriculture, Govt. India) was used to create Haryana Livestock Geodatabase having Tehsil wise population of Camel. This livestock geodatabase is a ready source of livestock census in relation to the map of Haryana where queries related to livestock populations at district and Tehsil level can be answered. The broad spatial distribution trends of the different livestock species in Haryana using Tehsil as the areal unit were identified and livestock distribution maps for each species were created using Jenk's Natural Breaks method with three classes representing High, Medium and Low densities. Moran's I Statistic investigated if the spatial distribution of various domestic animal species and breeds in

Haryana, was clustered, random or dispersed. The Global Moran's I statistic was used to measures spatial autocorrelation based on both Tehsil locations and animal density values simultaneously. The z-score and p-value were used to evaluate the significance of Moran's I statistic. The Moran's I statistic revealed that the distribution of all the animal species studied was clustered except indigenous female cattle which were found randomly distributed. Clustered distribution of all animal species was highly significant (p = 0.000019, Z score = 4.281135). Heterogeneity in livestock distribution was analyzed in relation to the five major cropping patterns representing crop based agro-ecosystems and the eight agro-ecological zones of Haryana based on soil, physiography, bio-climate and length of growing period. The five major crop rotations were Rice/Wheat, Cotton-Wheat, Bajra/Jawar/Guwar/Fallow-Wheat/Others, Bajra/Fallow-Mustard and Sugarcane. Camel population is mainly restricted to western parts of Haryana adjoining with Rajasthan. This area is characterized by hot and dry aeo-fluvial plains with mainly Bajra/Mustard and Cotton-Wheat crop rotation.

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Author Profile

Vikash Sharma received M.Sc degree in Geography with specialization in Agriculture, Remote sensing GIS from Kurukshetra University, Kurukshetra, India in 2007. And also received M.Tech degree in Geoinformatics form Guru Jambheswer University of Science & Technology, India in 2011. Presently working as a senior GIS executive in Ramtech Software Solutions Pvt. Ltd. (Noida, India)