Project Update: April 2019

Introduction

Pangolins, or scaly anteaters (Mahmood et al. 2012), are shy, nocturnal, non-aggressive, burrowing small mammals (Suwal 2011) and adopted to have highly specialized diet of ant and termites (Prater 1980). Among the eight species of the pangolins globally, four each species is recorded from Asia and Africa (Hussan et al. 2013). Population of Asian pangolins (Mishra and Panda 2011) including Chinese pangolin is thought to have declined significantly in many areas due to hunting and trade (Katuwal et al. 2015). In the context of Nepal only Chinese pangolin (CP) (*Manis pentadactyla*) and Indian pangolin (*Manis crassicaudata*) (IP) are recorded (Jnawali et al. 2011). Gaurishankar Conservation Area (GCA); the study site harbor Chinese pangolin. GCA is the youngest protected area of Nepal located in Dolakha district. National Pangolin Survey 2016 reported Chinese pangolin presence in Dolakha district but very limited study on Pangolin had been made in GCA specifically. National Pangolin Survey 2016 has identified GCA as one of the vulnerable sites of pangolin poaching that finding was merely based on consultation and anecdotes (Kaspal et al. 2016). Thus, the finding of this study will be a milestone for the pangolin conservation in the area.

Objectives completed:

1. Consultation with the members of Gaurishankar Conservation Area Project (GCAP), Pipaldada Community Forest (PCF) and other local expertise and local stakeholders.
2. Selection of 15 citizen scientists based on above consultation.
3. Training the selected citizen scientists.
4. Collection the spatial distribution of Chinese pangolin in the area.
5. Gathering the people perception on the distribution and illegal trade activities.

Methodology:

1. Consultation with the local conservation institution, local expertise and stakeholders: On 17 November 2018, permit letter was collected from Department of National Park and Wildlife Conservation (DNPWC). Simultaneously, the color poster on pangolin conservation (n=500) and "Save Pangolin" T-shirt (n=50), flex was also made. My team and I moved to GCA on 25 November 2018, met with the members of GCAP and PCF for the consultation. The objective of the study was discussed on the consultation. We gathered the information on the potential sites of CP, illegal trading sites of pangolin its parts and derivatives.

2. Selection of 15 citizen scientists: On 2 December 2018, 15 citizen scientist were selected for the training (6 from Pipaldada Community Forest; prime habitat of CP of Sindhupalchowk district, 5 from Tatopani of GCA; hub for illegal trade activities and 5 prime habitat of CP of GCA) from the consultation.

3. Training the selected Citizen scientists: Training was organized for 5 days. For two days, theoretical session was conducted and on the remaining day's practical

classes was done. T-shirt for the trainee was distributed along with the color poster. Pre (17 December 2018) and post questionnaire (6 April 2019) was also distributed to check the success of the training. The training was organized on 17 December 2018 to 21 December 2018 and certificate to the trainee was also provided. During the training the ecology, biology, conservation status, legal provision, illegal trade activities along with the technique of collecting the spatial distribution data and monitoring of CP was also given. Spatial distribution form and questionnaire form was also given to the trainee. Three group of each five members was also separated during the training to gather the information on what activities are needed for the CP conservation in the area and any conservation program on CP had been conducted by any local institution and communities or not till the date. The training was organized in Narayanthan of GCA.

4. Collection of spatial distribution of CP: Consultation meeting identified Laduk, Suri, Bulun, Oran, Chankhu and Khare as a potential sites of CP so these sites were studied. According to the report of National Pangolin Survey 2016, pangolin is distributed below the elevation of 2000m so only the study was made below 2000m. The survey was undertaken from 5 January 2019 to 23 February 2019. During the research, 500m line transects was laid out. Three plots (each of 100m X100m) were drawn along each 500m line transect; each plot drawn at the equidistance of 100m. Each plot was monitored for six days. On the first day, only old burrows were searched; on the second days afterward active burrows were recorded. Marking for each days was done with the help of stick and ribbon. Only stick was used to mark the old burrows (first day), stick with white ribbon was used to mark the active burrow (for second day), stick with pink ribbon for third day, stick with purple ribbon for fourth day and stick with red ribbon for fifth day and stick with yellow ribbon for sixth day. Coordinate, slope, aspect, elevation, proximate variables, major vegetation, threats etc. of the study sites was recorded. We worked on 37 line transects laying 111 plots. The data of spatial distribution was analyzed at the beginning of April 2019.

5. Gathering people perception on threats of CP: Questionnaire survey with local people was done to gather the information on local distribution, threats and status of CP in the area. There are 13,438 households in GCA according to the census 2011 A.D. Number of households for the analysis was chosen using Slovin's formula. According to the formula, 388 households should be selected for the analysis hence, we choose 400 households for collecting people perception on the threats of CP in the sites. Snowball sampling was done as our main target is to collect illegal trade activities of CP which is the prime threats of the target species. The semi-structured questionnaire was done during the beginning of March to the end of March 2019.

Data Analysis:

Data were analyzed in R (R Development Core Team 2018) and ArcGIS 10.2.
Multiple Correspondence analysis was done to understand the correlation of number of active burrows with different environmental variables (habitat types, soil color, aspects).

The following correspondence analysis was used as the specified environmental variables was factor/qualitative variables.

Bayesian Binomial regression was used to know the most impacted proximate variable for the distribution of CP in the area. The dependent variable was in the term of absence and presence (0 and 1) so this regression is best for the data. The dependent variable showed binomial and normal distribution. The linear model of different proximate variable (distance to water bodies, distance to human settlement, distance to livestock, distance to ant nest or termites mounds, and distance to road) was also fitted. Uninformative prior was used as there was no information available on the priors. Prior for coefficient/beta (beta for intercept and other proximate variables) was also specified with mean 0 and variance 1000.

Occupancy of CP: Monitoring of CP was done for six days (first day for recording old burrows and remaining days for recording active/new burrows). Only active burrows were taken into consideration/during analysis. Hence, occupancy with elevation, slope and quadratic slope was done. The model we considered assume occupancy was either constant across the sites psi (.) or varies according to the elevation, slope and quadratic slope. Detectability p (.) was kept constant throughout the model. Model selection was based on Akaike's Information Criteria for small size (AIC), which select the most parsimonious model, balancing model fit and parameter decision.

Habitat Suitability Index: Variables namely elevation, slope, aspect and land use were used to calculate the binary and weighted habitat suitable index. All these values were based on the field survey. The weighted contribution percentage is used through deep consultation with the expert. The elevation raster is downloaded from https://earthexplorer.usgs.gov/. The slope, aspects is calculated from the downloaded elevation raster and Normalized Difference Vegetation Index (NDVI) is calculated for the land use. The variables which are likely for the pangolin are noted as 1 otherwise 0 for the binary habitat suitability Index. Likewise, for the weighted habitat suitability analysis, the variables which are best favorable for pangolin are noted as 4, better habitat as 3, medium habitat as 2 and worse habitat as 1. Weighted percentage for the Aspect was determined to be 5%, for Slope 25%, for Elevation 55% and for Habitat types (Land use) 15%.

Principal Component Analysis: Threats (livestock dropping, cattle/livestock, logs, tree stumps and intensity of red soil extraction= absence/low/medium/high) with number of active burrows was analyzed using Principal Component. All the threats variables were count while red soil extraction was qualitative variables.

Results:

1. Density of CP in the study sites

During the survey, 138 active burrows were recorded from 37 line transects (111 plots). Highest density of the active burrows was reported from Laduk with the density of 0.0057 per hectare while least density was reported from Bulun having density 0.002 per hectare (Figure 1).

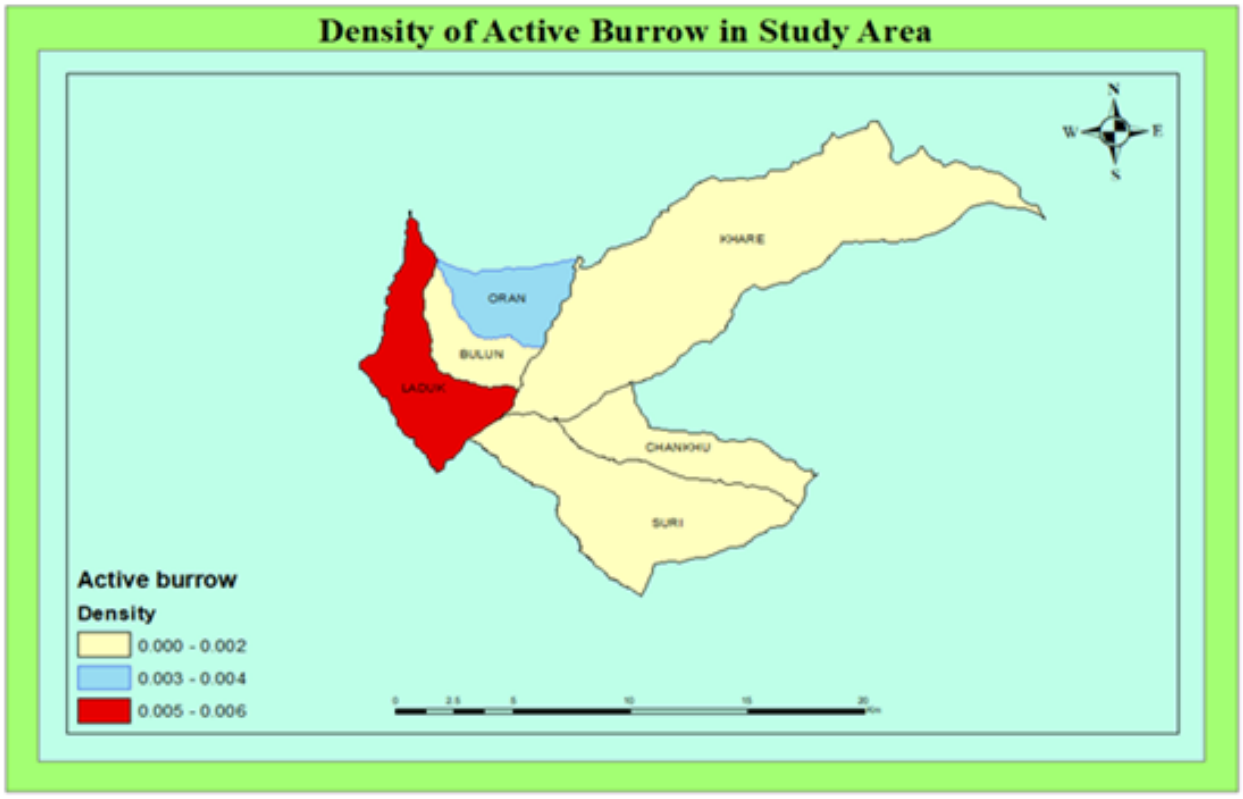

Figure 1. Density of CP in the study site of GCA.

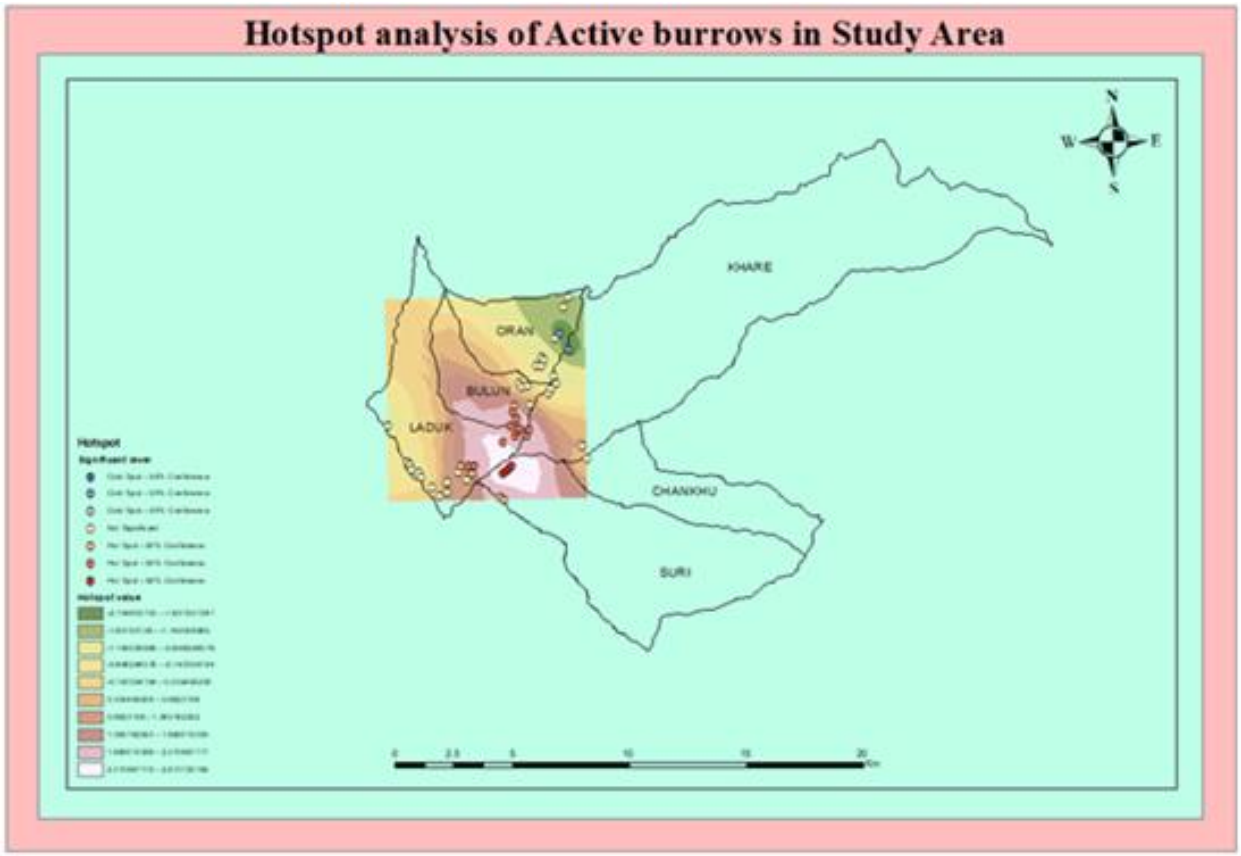

Figure 2. Hotspot analysis of CP in the study area

Laduk and Suri were the hotspots of CP in the study area which need regular monitoring and immediate conservation activities for the conservation of targeted species (Figure 2), so students of this sites will be used for "Pangolin Conservation Eco-Club".

2. Distribution of CP:

The number of active burrows was negatively correlated with the litter condition in the study sites during the study period. First axis contributed around 31% of the variability while nearly 25% of the total inertia was contributed by the second axis. Number of active burrows was positively correlated with first and second multiple correspondence axis while litter condition was negatively correlated with first and second multiple correspondence axis (Figure 3).

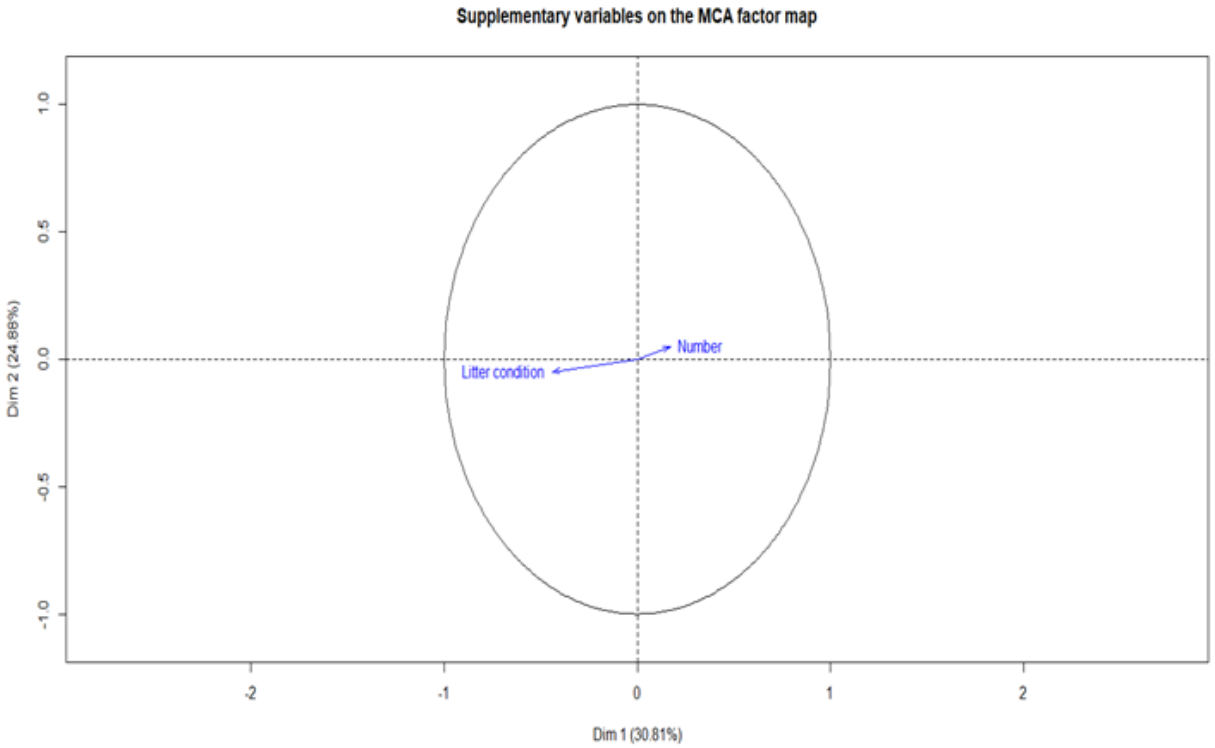

Figure 3. Correlation of number of active burrows with the litter condition

Red soil, major vegetation *Schima wallichii* and *Choerospondias axillaris*, habitat types (cultivated land) and south facing slope were positively correlated with each other and also positively correlated with the number of active burrows. These variables also showed positive correlation with first multiple correspondence axis (Table 1 and 2). Likewise, brown soil, east and west facing slopes, forest habitat with *Pinus roxburghii* were positively correlated with each other and with litter condition while these variables showed negative correlation with first axis (Table 1 and 2). Similarly, Red soil, major vegetation *Schima wallichii* and *Choerospondias axillaris*, habitat types (cultivated land) and south facing slope were highly negative correlated with brown soil, east and west facing slopes, forest habitat with *Pinus roxburghii.* (Figure 2 and 3).

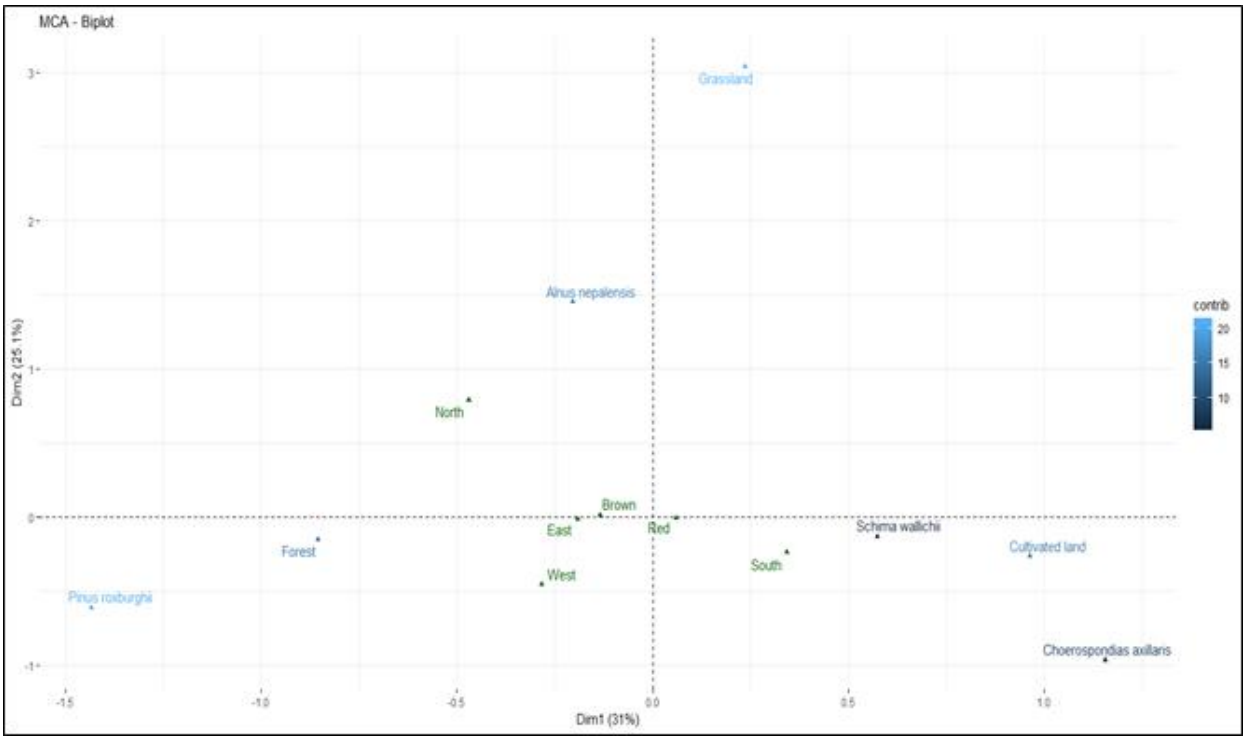

Figure 3. Correlation with different environmental variable and with Multiple Correspondence axis.

Table 1. Contribution, quality of representation and correlation of different variables with Multiple Correspondence axis.

Categories	**Dim.1**	**ctr**	**cos2**	**v.test**	**Dim.2**	**ctr**	**cos2**	**v.test**
Cultivated land	0.953	25.470	0.691	8.721	-0.289	2.909	0.064	-2.648
Forest	-0.858	24.087	0.749	-9.076	-0.130	0.688	0.017	-1.378
Grassland	0.329	0.443	0.007	0.896	3.026	46.403	0.616	8.233
Schima wallichii	0.554	8.986	0.252	5.264	-0.149	0.801	0.018	-1.413
Choerospondias axillaris	1.153	8.555	0.146	4.012	-1.067	9.063	0.125	-3.710
Pinus roxburghii	-1.458	32.306	0.650	-8.455	-0.559	5.876	0.095	-3.241
Alnus roxburgii	-0.104	0.153	0.003	-0.575	1.404	34.260	0.544	7.734

The above table showed, the contribution of cultivated land for the first axis was highest (25.470) while least contribution was made by major vegetation *Alnus roxburghii* (0.153). Forest habitat types (0.749) showed good representation on first axis while poor representation was made by *Alnus roxburghii* (0.003).

Table 2. Contribution and correlation of different variables with Multiple Correspondence axis.

Supplementary categories	Dim.1	cos2	v.test	Dim.2	cos2	v.test
East	-0.189	0.005	-0.751	-0.017	0.000	-0.066
North	-0.444	0.060	-2.575	0.797	0.194	4.624
South	0.334	0.114	3.535	-0.246	0.062	-2.603
West	-0.302	0.014	-1.251	-0.448	0.031	-1.857
Brown	-0.147	0.010	-1.025	0.048	0.001	0.333
Red	0.065	0.010	1.025	-0.021	0.001	-0.333

The table showed, major contribution for the first axis was made by South facing slope (0.114) while least by east facing slope (0.005).

Table 3. Binomial distribution of CP with proximate variables: Different proximate variables (Distance to Water bodies, Distance to nearest Human Settlement, Distance to ant or termites mound, Distance to nearest Livestock and Distance to Road) were compared with the presence/absence of CP in the plots.

Variable	Mean	SD	Naive SE	Time-series SE
beta[1]	1.0329	0.4359	0.003559	0.008284
beta[2]	3.6659	0.7824	0.006388	0.018739
beta[3]	-2.0604	0.5261	0.004296	0.010510
beta[4]	0.6040	0.6060	0.004948	0.007898
beta[5]	-0.7775	0.3481	0.002842	0.006437
beta[6]	-0.6306	0.3773	0.003081	0.005370

Variables	2.5%	25%	50%	75%	97.5%
beta[1]	0.2377	0.7308	1.0098	1.3154	1.93672
beta[2]	2.2794	3.1124	3.6066	4.1731	5.32860
beta[3]	-3.1621	-2.4022	-2.0364	-1.6902	-1.12072
beta[4]	-0.3120	0.1551	0.5118	0.9515	2.01277
beta[5]	-1.4801	-0.9944	-0.7760	-0.5590	-0.07253
beta[6]	-1.3486	-0.8816	-0.6439	-0.3941	0.16225

Note: beta [1] = intercept, beta [2] = Distance to Water bodies, beta [3] = Distance to nearest human Settlement, beta [4] = Distance to ant nest or termites mounds, beta [5] = Distance to nearest Livestock, beta [6] = Distance to Rural Road.

Distance to Water bodies had high impact upon the distribution of CP while low impact was due to Distance to nearest Livestock. Water bodies was positively significant with distribution of CP whose sample mean was 3.6659 between 2.2794 and 5.32860 credible interval. Distance to nearest Human Settlement was negatively associated (-2.0604) with the distribution of CP between -3.1621 and -1.12072 credible interval (Table 3; Figure 5). The figure illustrated good mixing at 2001:7000 iterations.

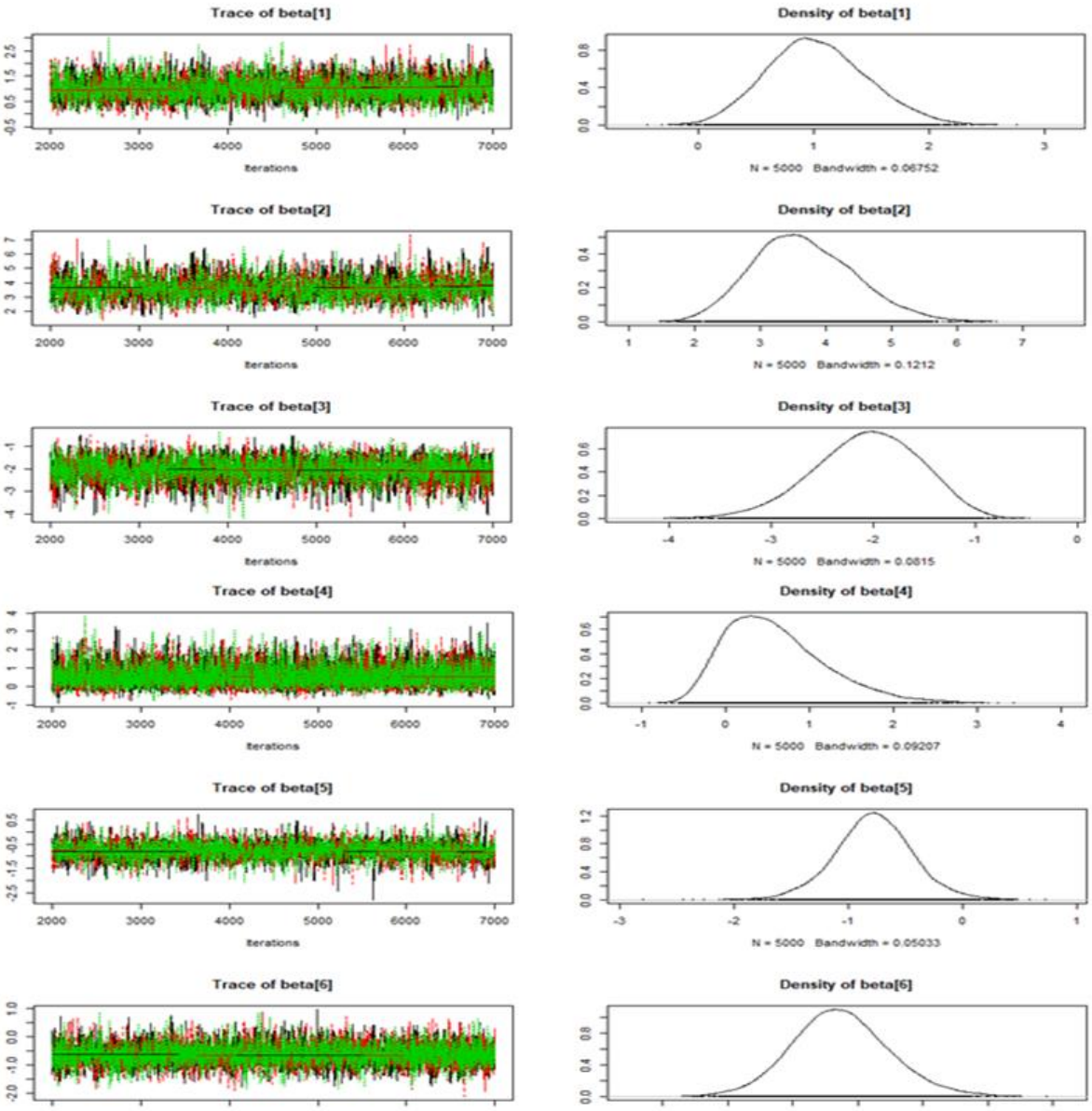

Figure 5. Mixing of the chains along with the density of different proximate variables.

Table 4. Occupancy of CP with elevation, slope and quadratic slope:

Model	**df**	**AIC**	**Delta**	**ModelLik**	**ModelWt**
psi (Slope) p(.)	3	467.224	0.000	1.000	0.574
psi (Elevation_Slope) p(.)	4	468.869	1.645	0.439	0.252
psi (Slope2) p (.)	4	470.244	3.020	0.221	0.127
psi (Slope2_Elevation) p (.)	5	472.231	5.007	0.082	0.047
psi (.)p (.)	2	516.895	0.000	0.000	0.000
psi (Elevation) p (.)	3	518.785	0.000	0.000	0.000

Pangolin active burrow were detected at 59 of the 111 plots, yielding a naïve occupancy estimate of 0.52; however, we suspected that model with the probability of occupancy for Slope and null probability of detectability was the best fitted model (AIC=467.224).

3. Habitat Suitability Index:

Land use, slope, aspect and elevation variable was used for analysis Habitat Suitability Index had found 94% of the habitat was unsuitable for CP while remaining 6% was suitable for CP in the study site. Likewise, the weighted suitability index showed 40% of the habitat was worse habitat followed by 54% the medium habitat and 4% the better habitat and 2% the best habitat for CP.

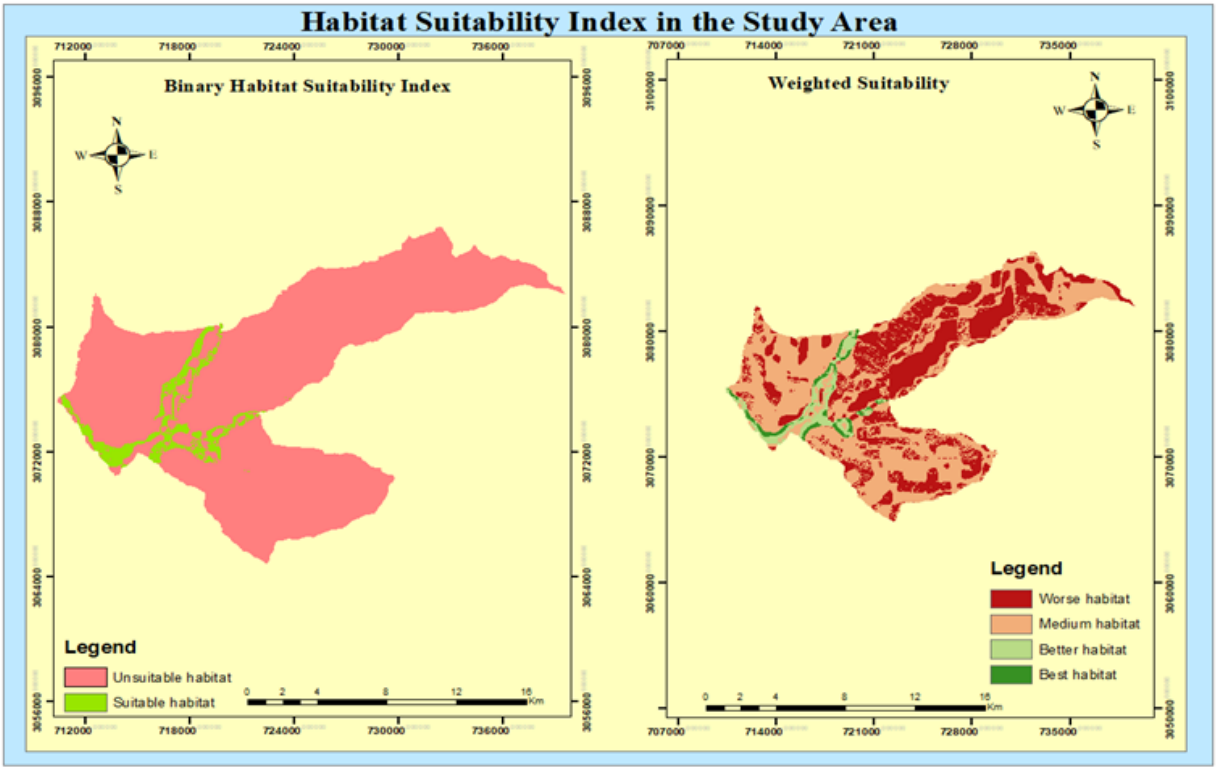

Figure 6. Binary Habitat Suitability Index of CP in the Study Site.

4. Threats to CP in the study area

The first principal axis showed nearly 47% of the total inertia while second axis showed nearly 21% of the variation. Number of active burrows were negatively correlated with first and second principal axis while logs, number of cattle/livestock, tree stumps, livestock dropping were positively correlated with first principal axis while logs and cattle/livestock were negatively correlated with second axis and livestock dropping and tree stumps were positively correlated with second axis. Number of active burrows were negatively correlated with the major threats (livestock dropping, tree stumps, number of cattle/livestock and Logs). Likewise, the intensity of red soil was studied as absence, low, medium and high and observed the number of active burrows were present highly when

the red soil extraction is absence followed by low extraction of red soil (Figure 7). The circle illustrated the capture of data (plots) at 95% significant level.

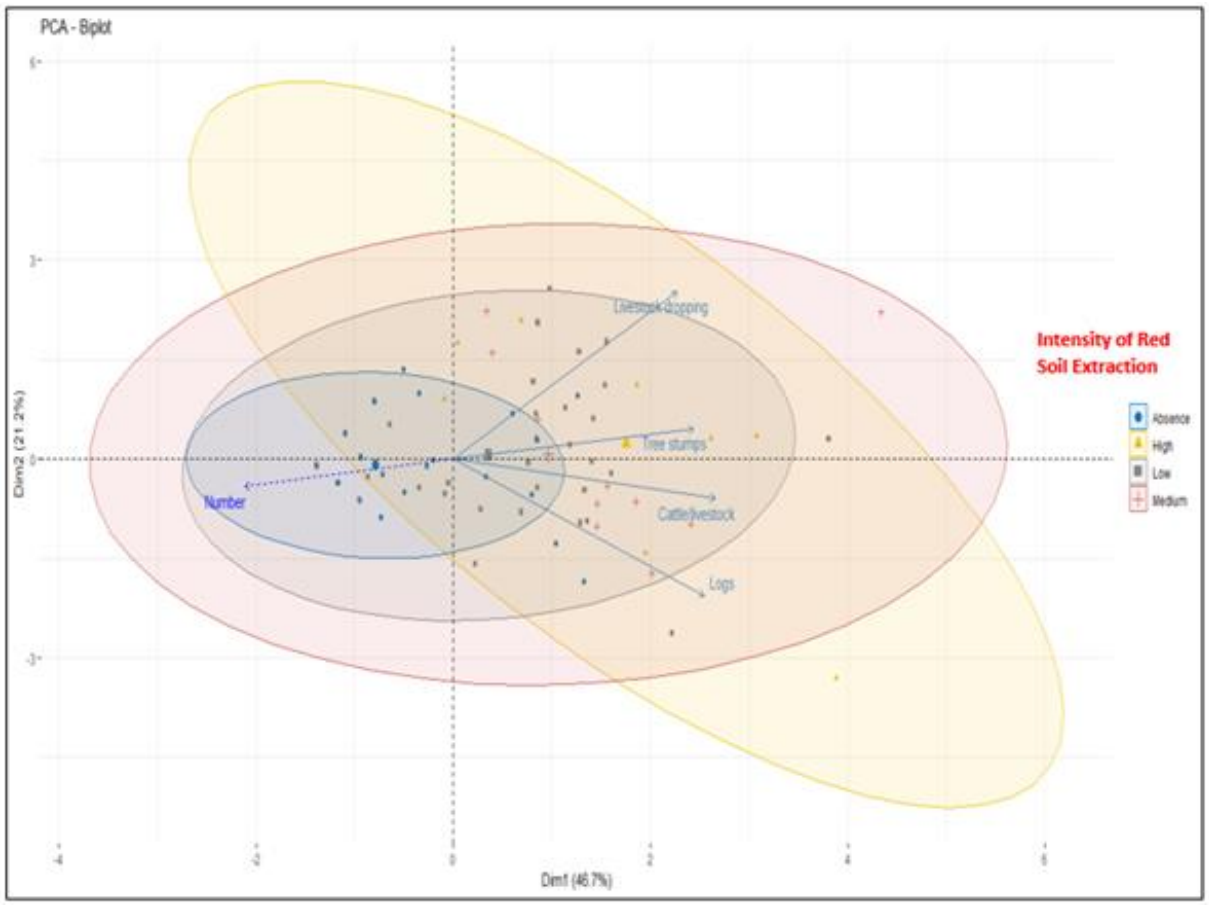

Figure 7. Threats of CP in the study area

Pictures:

Old and active burrows observed for six days.

Theoretical class during training.

Practical session during the training.

Certificate distribution to the trainee.

Undergoing activities:

1. Analysis of pre and post questionnaire of training
2. Data entry of questionnaire with local people on distribution and threats of CP in the study localities.