CHAPTER 07(I)

OBJECTIVE 04

MATERIALS & METHODS

7.2.2. Materials and Methods

MaxEnt software version 3.3.3 was used for projecting the future potential distribution habitat of the Himalayan Pheasants (Satyr Tragopan, Blood Pheasant, Himalayan Monal, and Kalij Pheasant) based on future climate scenario and the present climatic condition (present climate data was downloaded from www.world clim.org). For future climate scenario, a new set of Representative Concentration Pathways (RCPs) scenarios (AR5-2050, downloaded from www.ccafs-climate.org/data) of future climatic models was used, under the RCP-2050 scenarios three general circulation models (GCMs) were used for the projection of the future distribution of the species (adopted by Hu et al., 2015), namely Miroc-esm (Japan Agency for Marine-EarthScience Technology Atmosphere and Ocean ResearchInstitute, and National Institute for Environmental Studies), Hadgem2-AO (National Institute of Meteorological Research/Korea Meteorological Administration) and Gfdlcm3(Geophysical Fluid Dynamics Laboratory, USA). Minimization of biasness of these models was maintained by taking an ensemble of at least three different models (Miroc-esm, Hadgem2-AO, and Gfdl-cm3) based on their mean values (following a similar approach taken by Molloy et al., 2017). These were further used to get a better understanding of the climate change impacts on the distribution of Himalayan Pheasants and their associated elements. The jackknife validation methodology, developed by Pearson et al. 2007, was followed directly for predicting the future potential habitat of the Himalayan Pheasants. The regularization multiplier value was set at 0.1 to avoid over fitting (Phillips et al., 2004). For the projection of future distribution modelling of the Pheasants, the maximum number of background points was set at 1,000 along with the use of threshold feature. The 10-percentile threshold rule was applied, provided 80% of the data for training and the remaining 20% for testing, and total 3 replicates run (as boot strip) was set to avoid overfitting predictors for predicting accurate model (followed by Flory et al., 2012). The final output was divided into the five potential distribution areas that were reclassified with a range between 0-1: a very low potential class (<0.20); a low potential class (0.20-0.40); a moderate potential class (0.40-0.60); a high potential class (0.60-0.80), and a very high potential class (>0.80), followed by Sarman et al. 2015. In the final projected map, as a very low potential class had covered the maximum area under consideration, it was excluded from the results as a suitable future habitat area. Based on a probability threshold of binary habitat and non-habitat charts, potential changes in the future habitat of species compared to the present distribution model for the Pheasants was determined. For that purpose, the 'maximum training sensitivity plus specificity" threshold was observed to produce highly accurate predictions (Jimenez-Valverde & Lobo, 2007). Based on the climate variables selected by Principal Component Analysis (PCA) (Satyr Tragopan -06 climatic variables, Blood Pheasant-10 climatic variables, Himalayan Monal-09 climatic variables, and Kalij Pheasant-09 climatic variables) the future suitable habitat area of the Himalayan Pheasants was projected in the Eastern Himalayas, the Sikkim Himalayas, and the Khangchendzonga Biosphere Reserve, separately. The future projection was performed for different future climate scenarios based on RCP-2050 (RCP 2.6; RCP 4.5; RCP 6.0; RCP 8.5). The four RCPs (RCP 2.6, RCP 4.5, RCP 6.0, and RCP 8.5) scenarios were coded according to the possible range of radiative forcing values in the year 2100 relative to pre-industrial values (+2.6, +4.5, +6.0, and +8.5W.m-2, respectively) [Weyant et al., 2009].

7.2.2.1. Impact of future climate change on gain and loss of suitable habitat of Himalayan Pheasants

Python-based GIS toolkit, SDM projection was used to identify and quantify the regions that had become (i) unsuitable, (ii) suitable, and (iii) remained unchanged areas in the future condition with cross-checking against the present distribution of the Himalayan Pheasants in respect to current climate variables (adopted by Hu et al., 2015).

7.2.2.2. The core distributional shifts

Python-based GIS toolkit, SDM tool-box was used to observe the trend of suitable area changes and the changes were quantified by comparing the centroids of the future and the present suitable area of the Himalayan Pheasants (Brown, 2014). The SDM toolbox quantified the distributional changes between two binary SDMs, and this analysis was based on summarizing the core distributional shift of the range of the Himalayan Pheasants. This analysis focused on the convergence of species' distribution to the centroid and created a vector file having magnitude and direction of predicted change through time for better understanding on the future climatic impact on the Himalayan Pheasants. The core distributional shifts of the Himalayan Pheasants were observed by tracking the changes in centroid among different SDMs based on creating vector files.

CHAPTER 07(I)

OBJECTIVE 04

RESULTS

7.1.3. Results

7.1.3.1. Future spatial distribution model

7.1.3.1.1. Impact of future climate change on distribution of the Blood Pheasant in the Eastern Himalayas

The future suitable habitat area of Blood Pheasant was quantified in the Eastern Himalaya according to different future climate scenario of RCP-2050 (Figure 6.1).

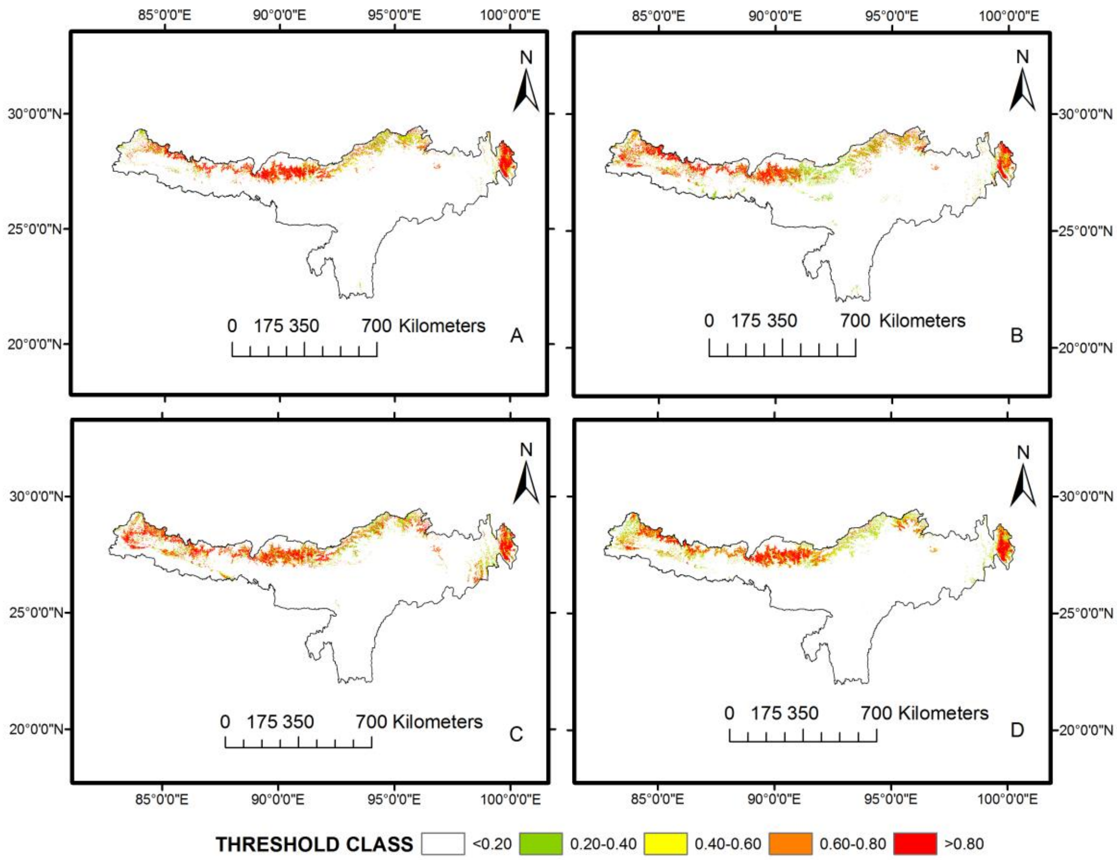


Figure 6.1: Future climate change impact on distribution of the Blood Pheasant in the Eastern Himalayas; ‘A’ depicts RCP 2.6, ‘B’ depicts RCP 4.5, ‘C’ depicts RCP 6.0 and ‘D’ depicts RCP 8.5 respectively

In RCP 2.6, based on threshold categories, the very high potential threshold class of the Blood Pheasant was emerged as the maximum area (33118.27 sq. km) covered in the Eastern Himalaya followed by the low potential threshold class (20438.19 sq. km), the moderate potential threshold class (13851.01 sq. km), and the high potential threshold class (8092.78 sq. km). Similarly, in RCP 4.5, the very high potential threshold class emerged as maximum area (33118.27 sq. km) followed by the low potential threshold class (21421.13 sq. km), the moderate potential threshold class (13421.53 sq. km), and the high potential threshold class (8092.78 sq. km). Again, in RCP 6.0, the similar result obtained; the very high potential class emerged the highest area (33118.27 sq. km) followed by the low potential threshold class (22382.99 sq. km), the moderate potential threshold class (14049.54 sq. km), and high potential threshold class (7894.25 sq. km). In RCP- 0.8, the very high potential threshold class represents the maximum area cover (33118.27 sq. km) followed by the low potential threshold class (22382.99 sq. km), the moderate potential threshold class (14049.54 sq. km), and the high potential class (7894.25 sq. km) [Figure 6.1].

7.3.3.1.2. Impact of future climate change on distribution of the Blood Pheasant in the Sikkim Himalayas

The future suitable habitat area of Blood Pheasant was quantified in the Sikkim Himalaya according to the different future scenario of RCP-2050 (Figure 6.2). In RCP 2.6, the very high potential threshold class of Blood Pheasant emerged as the maximum area (1430.90 sq. km) covered in Sikkim Himalayas followed by the moderate potential threshold class (370.73 sq. km), the low potential class (327.06 sq. km), and the high potential threshold class (198.84 sq. km). Similarly, RCP 4.5, the very high potential threshold class (1730 sq. km) was the highest one followed by the low potential threshold class (691.29 sq. km), the moderate potential threshold class (436.70 sq. km), and high potential threshold class (264.81 sq. km). Again, in RCP 6.0, the similar result emerged; the very high potential threshold class was the maximum area (1526.61 sq. km) followed by the low potential threshold class (559.35 sq. km), the moderate potential threshold class (379.09 sq. km), and the high potential class (299.18 sq. km).

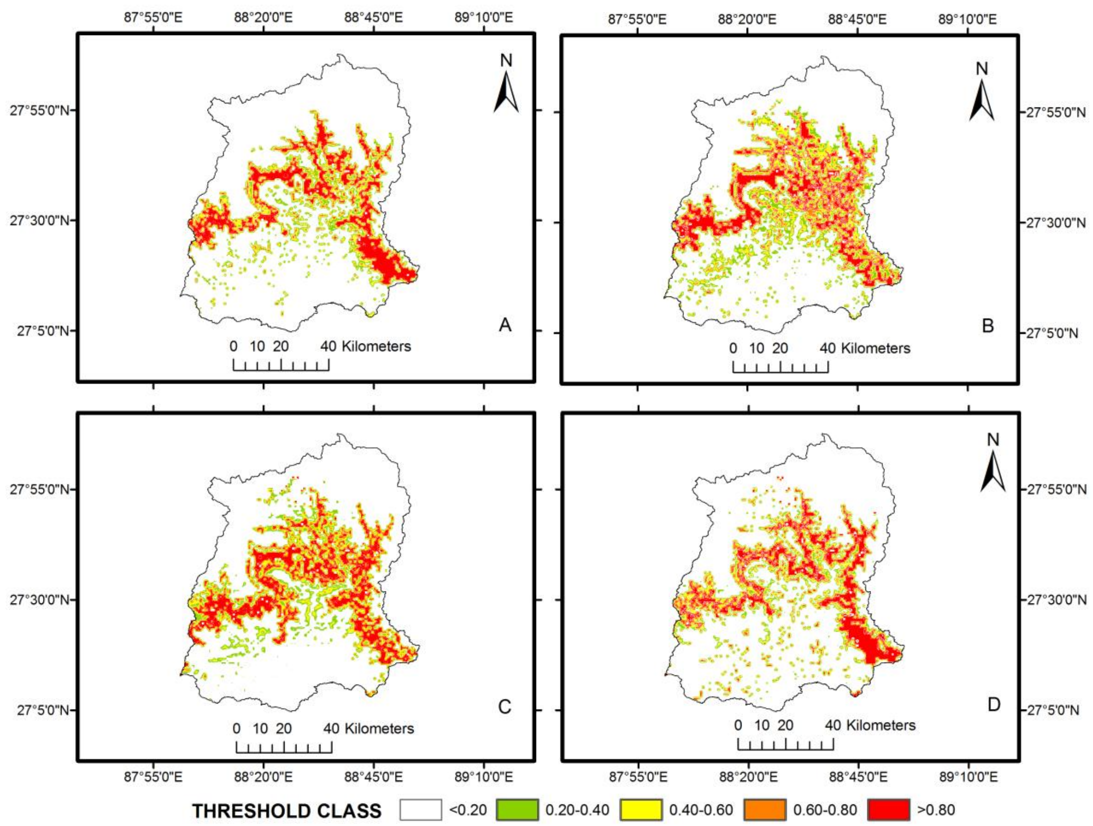


Figure 6.2: Future climate change impact on Blood Pheasant in the Sikkim Himalayas; 'A' depicts RCP 2.6, 'B' depicts RCP 4.5, 'C' depicts RCP 6.0 and 'D' depicts RCP 8.5 respectively

In RCP 8.5, similarly the very high threshold class emerged as the highest area (1573.99 sq. km) followed by the low potential threshold class (288.03 sq. km), the moderate potential class (280.60 sq. km), and the high potential threshold class (222.99 sq. km) (Figure 6.2).

7.3.3.1.3. Impact of future climate change on distribution of the Blood Pheasant in the Khangchendzonga Biosphere Reserve

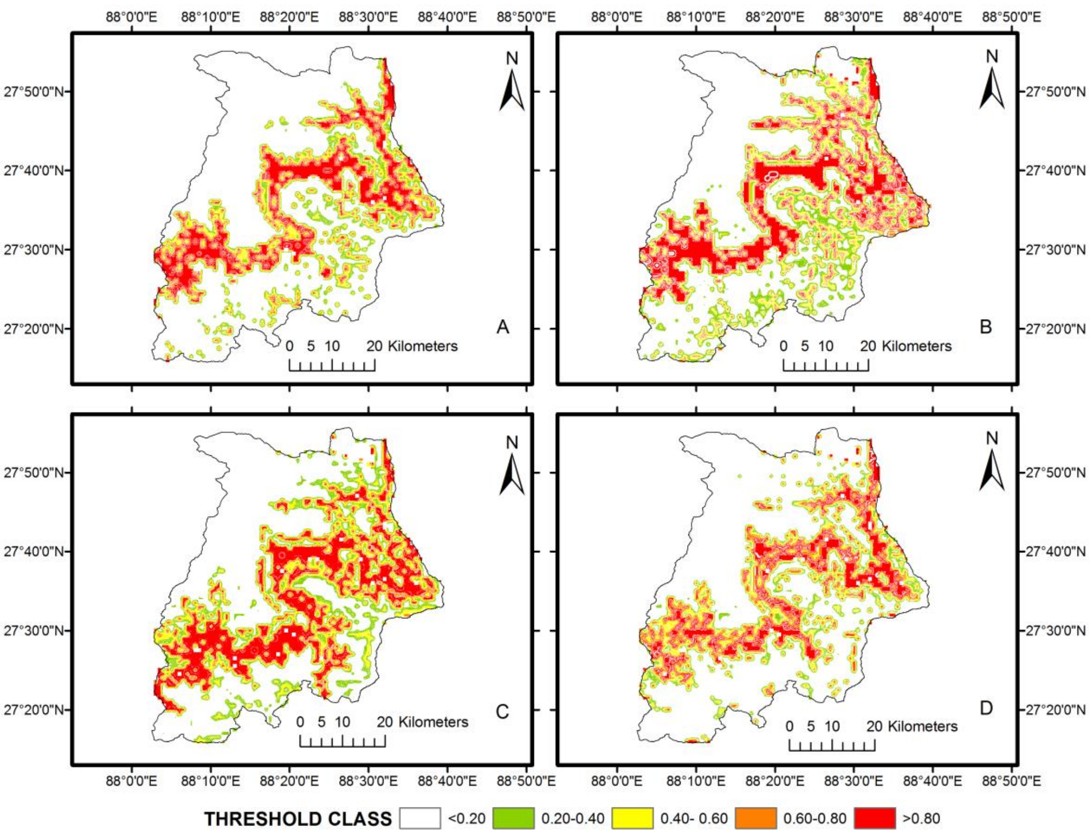


Figure 6.3: Future climate change impact on Blood Pheasant in the Khangchendzonga Biosphere Reserve; 'A' depicts RCP 2.6, 'B' depicts RCP 4.5, 'C' depicts RCP 6.0 and 'D' depicts RCP 8.5 respectively

According to the different future scenario of RCP-2050 the future suitable habitat area of Blood Pheasant was quantified in the Khangchendzonga Biosphere Reserve (Figure

6.3). In RCP 2.6, the very high potential threshold class of the Blood Pheasant emerged as the maximum area cover in the Khangchendzonga Biosphere Reserve (678.58 sq. km) followed by the moderate potential threshold class (170.85 sq. km), the low potential threshold class (143.45 sq. km), and the high potential threshold class (91.06 sq. km). In RCP 4.5 the very high threshold class emerged as the highest area (862.33 sq. km) followed by the low potential threshold class (289.32 sq. km), the moderate potential threshold class (181.33 sq. km), and the high potential threshold class (131.36 sq. km). Similarly, in RCP 6.0, the very high potential threshold class emerged as the maximum area (772.06 sq. km) followed by the low potential threshold class (254.66 sq. km), the moderate potential threshold class (217.59 sq. km), and the high potential threshold class (125.72 sq. km). Again, RCP 8.5, the very high potential threshold class shown the highest area coverage (649.56 sq. km) followed by the low potential threshold class (182.94 sq. km), the high potential threshold class (165.2 sq. km), and the moderate potential threshold class (136.2 sq. km) (Figure 6.3).

7.3.3.1.4. Impact of future climate change on distribution of the Himalayan Monal in the Eastern Himalayas

Based on different future climate scenario of RCP-2050, the future suitable habitat area of Himalayan Monal was quantified in the Eastern Himalayas (Figure 6.4). In RCP 2.6, based on potential threshold categories, the low potential threshold class of the Himalayan Monal was emerged as the highest area (16907.48 sq. km) covered in the Eastern Himalayas followed by the moderate potential threshold class (8267 sq. km), the high potential threshold class (3807 sq. km), and the very potential threshold class (852.43 sq. km). Similarly, in RCP 4.5, the low potential threshold class covered the highest area (10132.87 sq. km), followed by the high potential threshold class (7271.18 sq. km), the moderate potential threshold class (6309 sq. km), and the very high threshold class (4345.54 sq. km).

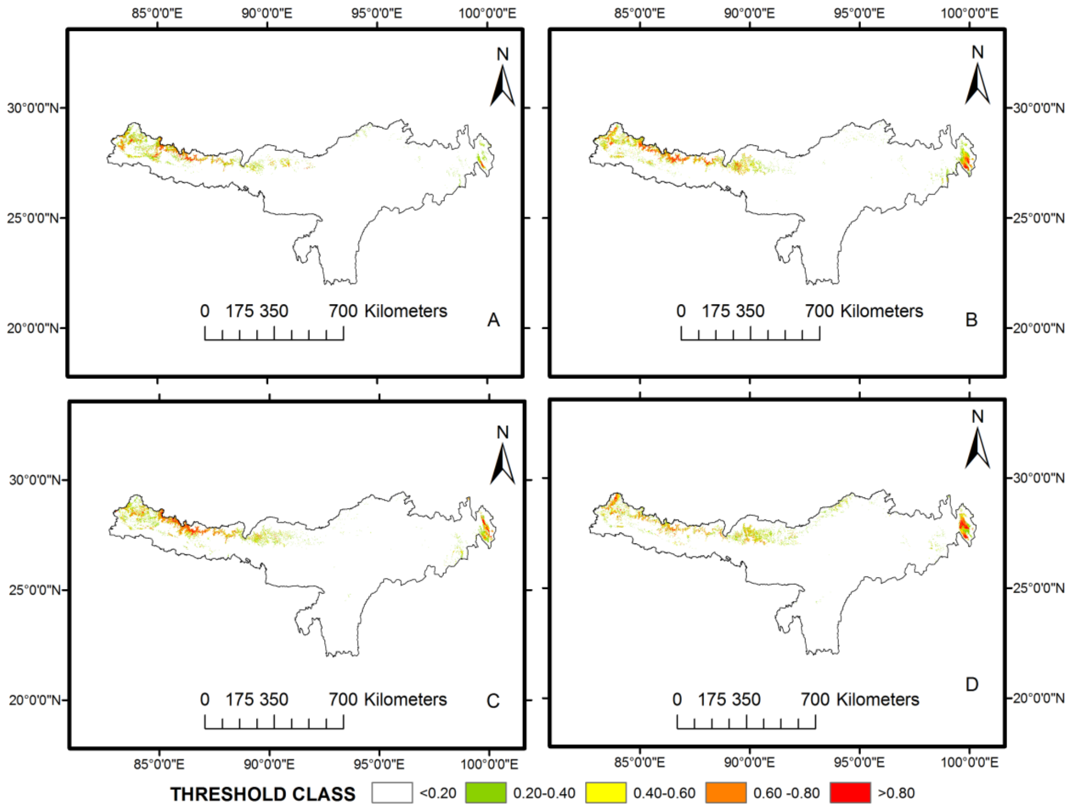


Figure 6.4: Future climate change impact on Himalayan Monal in the Eastern Himalayas; 'A' depicts RCP 2.6, 'B' depicts RCP 4.5, 'C' depicts RCP 6.0 and 'D' depicts RCP 8.5 respectively.

Again, in RCP 6.0, a similar result was obtained; the low potential threshold class emerged as the highest area cover (10601.15 sq. km) followed by the high potential threshold class (7221.80 sq. km) the moderate potential threshold class (5951.65 sq. km), and the very high potential threshold class (4430.55 sq. km). In RCP 8.5, the low potential area emerged as the maximum area (10776.44 sq. km) cover, followed by the high potential threshold class (6869.66 sq. km), the moderate potential threshold class (5712.034 sq. km), and the very high threshold class (4131.024 sq. km) [Figure 6.4].

7.3.3.1.5. Impact of future climate change on distribution of the Himalayan Monal in the Sikkim Himalayas

The future suitable habitat area of Himalayan Monal was quantified in the Sikkim Himalayas following different future climate scenario of RCP-2050 (Figure 6.5). In RCP 2.6, based on potential threshold categories, the low potential threshold class of the Himalayan Monal emerged for highest area cover (835.2052 sq. km) in the Sikkim Himalayas followed by the moderate potential threshold class (509.83 sq. km), the high potential threshold class (245.64 sq. km), and the very threshold class (210.42 sq. km). Similarly, in RCP 4.5, the low potential threshold class was the highest area cover (756.41 sq. km) followed by the moderate potential threshold class (696.15 sq. km), and the very high threshold class (507.98 sq. km) and the very potential threshold class (213.20 sq. km). Whereas, in RCP 6.0, the high potential threshold class emerged as the maximum area cover (429.18 sq. km) followed by the low potential threshold class (389.32 sq. km), the moderate potential threshold class (364.30 sq. km), and the very high potential threshold class (320.73 sq. km). Again, in RCP 8.5, the low potential threshold class emerged for the highest area cover (835.20 sq. km), followed by the moderate potential threshold class (509.83 sq. km), the high potential threshold class (245.64 sq. km), and the very high potential threshold class (210.42 sq. km) [Figure 6.5].

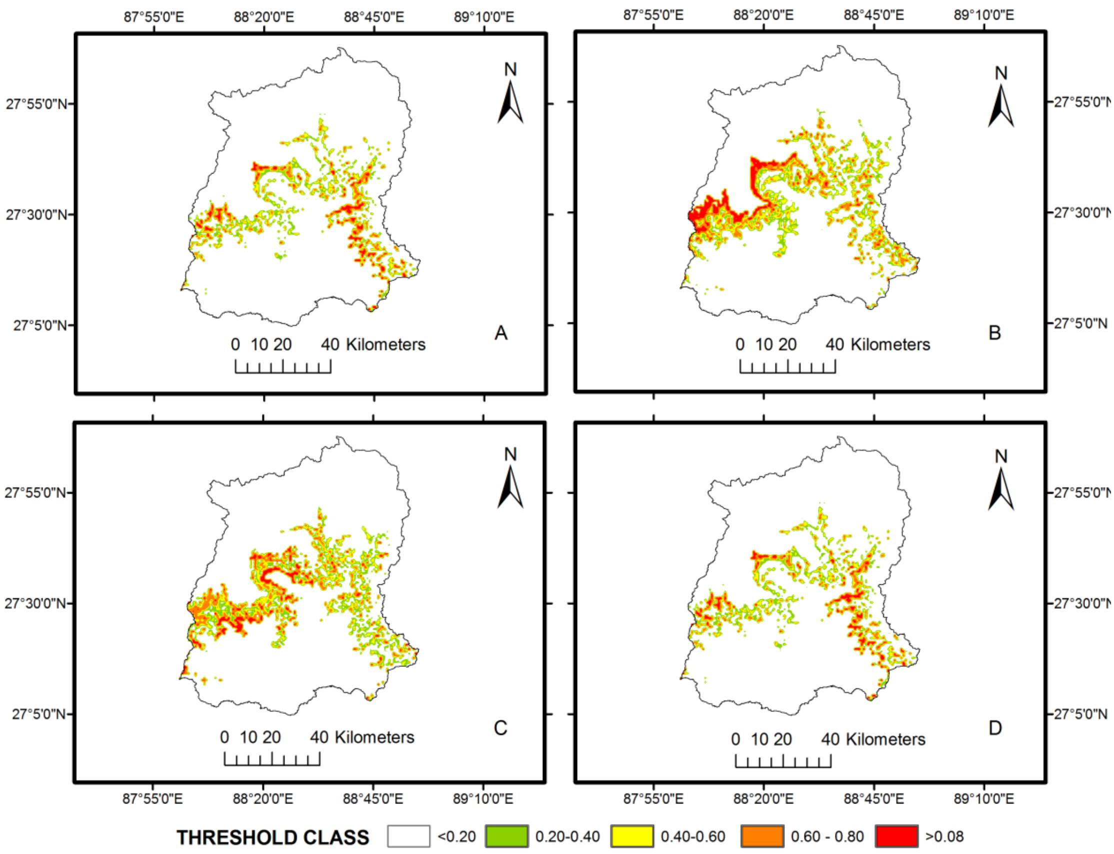


Figure 6.5: Future climate change impact on Himalayan Monal in the Sikkim Himalayas; 'A' depicts RCP 2.6, 'B' depicts RCP 4.5, 'C' depicts RCP 6.0 and 'D' depicts RCP 8.5 respectively.

7.3.3.1.6. Impact of future climate change on distribution of the Himalayan Monal in the Khangchendzonga Biosphere Reserve

Based on different future climate Scenario of RCP-2050 the future suitable habitat area of the Himalayan Monal was quantified in the Khangchendzonga Biosphere Reserve (Figure 6.6). In RCP 2.6, according to different threshold classes, the low potential threshold class of Himalayan Monal emerged for the highest area cover (195.34 sq. km) in the Khangchendzonga Biosphere Reserve followed by the

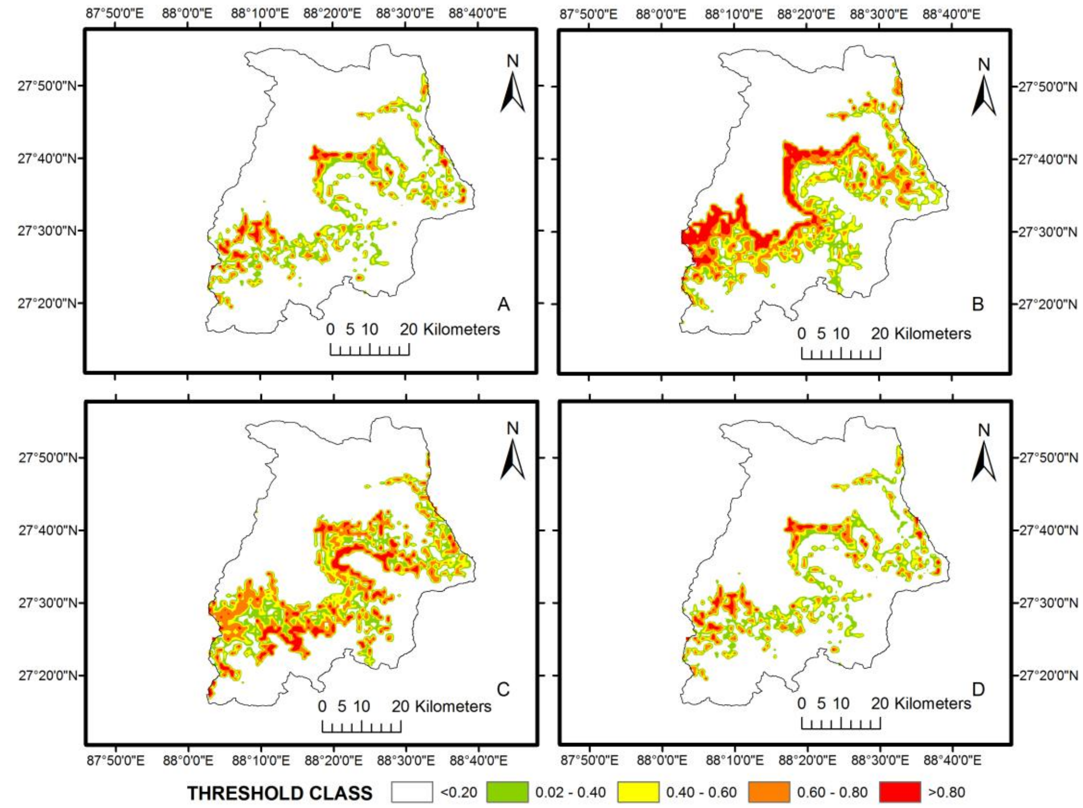


Figure 6.6: Future climate change impact on Himalayan Monal in the Khangchendzonga Biosphere; A depicts RCP 2.6, B depicts RCP 4.5, C depicts RCP 6.0 and D depicts RCP 8.5 respectively.

high potential threshold class (124.50 sq. km), the moderate potential threshold class (122.09 sq. km), and the very high potential threshold class (93.17 sq. km). In RCP 4.5, the very high potential class emerged for the maximum area cover (261.86 sq. km) followed by the very high potential threshold class (230.53 sq. km), the low potential threshold class (194.39 sq. km), and the moderate potential threshold class (179 sq. km).

Again, the similar result obtained in RCP 6.0, the high potential threshold class (247.93 sq. km) emerged for the highest area cover followed by the very high potential threshold class (214.23 sq. km), the low potential threshold class (189.36 sq. km), and the moderate potential threshold class (170.90 sq. km). In RCP 8.5, the very low potential threshold class emerged for the highest area cover (190.17 sq. km) followed by the very high potential threshold class (131.53 sq. km), the moderate potential threshold class (123.61 sq. km), and the high potential threshold class (122.82 sq. km) [Figure 6.6].

7.3.3.1.7. Impact of future climate change on distribution of the Kalij Pheasant in the Eastern Himalayas

Based on different future climate scenario of RCP-2050 the future suitable habitat area of the Kalij Pheasant was quantified in the Eastern Himalayas (Figure 6.7).

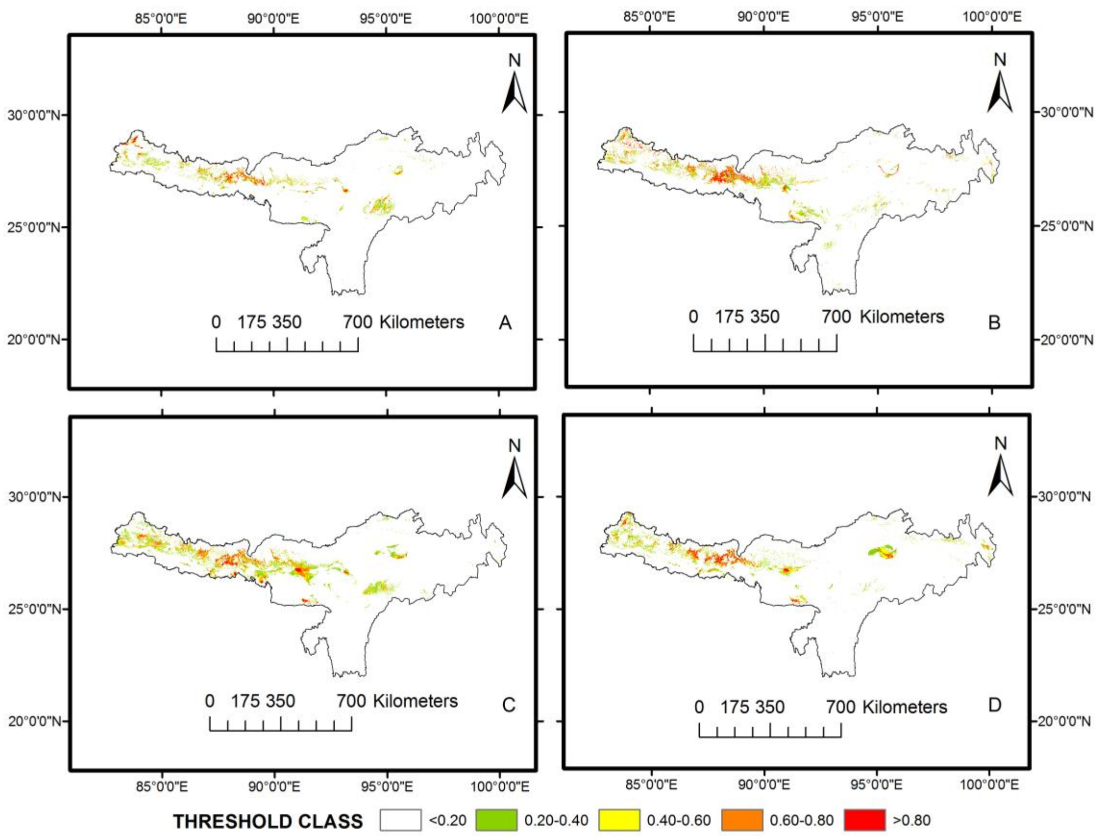


Figure 6.7: Future climate change impact on Kalij Pheasant in the Eastern Himalayas; 'A' depicts RCP 2.6, 'B' depicts RCP 4.5, 'C' depicts RCP 6.0 and 'D' depicts RCP 8.5 respectively

In RCP 2.6, the low potential threshold class of the Kalij Pheasant emerged highest in area coverage (10065.14 sq. km) in the Eastern Himalaya followed by the high potential threshold class (5496.91 sq. km), the moderate potential threshold class (5440.33 sq. km), and the very high potential threshold class (4461.54 sq. km). Whereas, in RCP 4.5, the low potential threshold class was the highest cover area (22284.27 sq. km) followed by the moderate potential threshold class (12222.36 sq. km), the high potential threshold class (10898.45 sq. km), and the very high potential threshold class (6487.018 sq. km).

Similarly, in RCP 6.0, the low potential threshold class was the highest cover area (7063.85 sq. km) followed by the moderate potential threshold class (30470.23 sq. km), the high potential threshold class (14983.35 sq. km), and the very high potential threshold class (6685.03 sq. km). In RCP 8.5, a similar result emerged; the low potential threshold class was the highest cover area (62645.87 sq. km) followed by the moderate potential threshold class (22385.3 sq. km), the high potential threshold class (9910.76 sq. km), and the very high potential threshold class (5488.02 sq. km) [Figure 6.7].

7.1.3.18. Impact of future climate change on distribution of the Kalij Pheasant in the Sikkim Himalayas

Based on different future climate scenario of RCP-2050, the future suitable habitat area of the kalij Pheasant was quantified in the Sikkim Himalayas (Figure 6.8). In RCP 2.6, the low potential threshold class was of the Kalij Pheasant emerged highest for maximum area cover (522.7852 sq. km) in the Sikkim Himalayas followed by the moderate potential threshold class (458.01 sq. km), the high potential threshold class (455.24 sq. km), and the very high potential threshold class (147.12 sq. km).

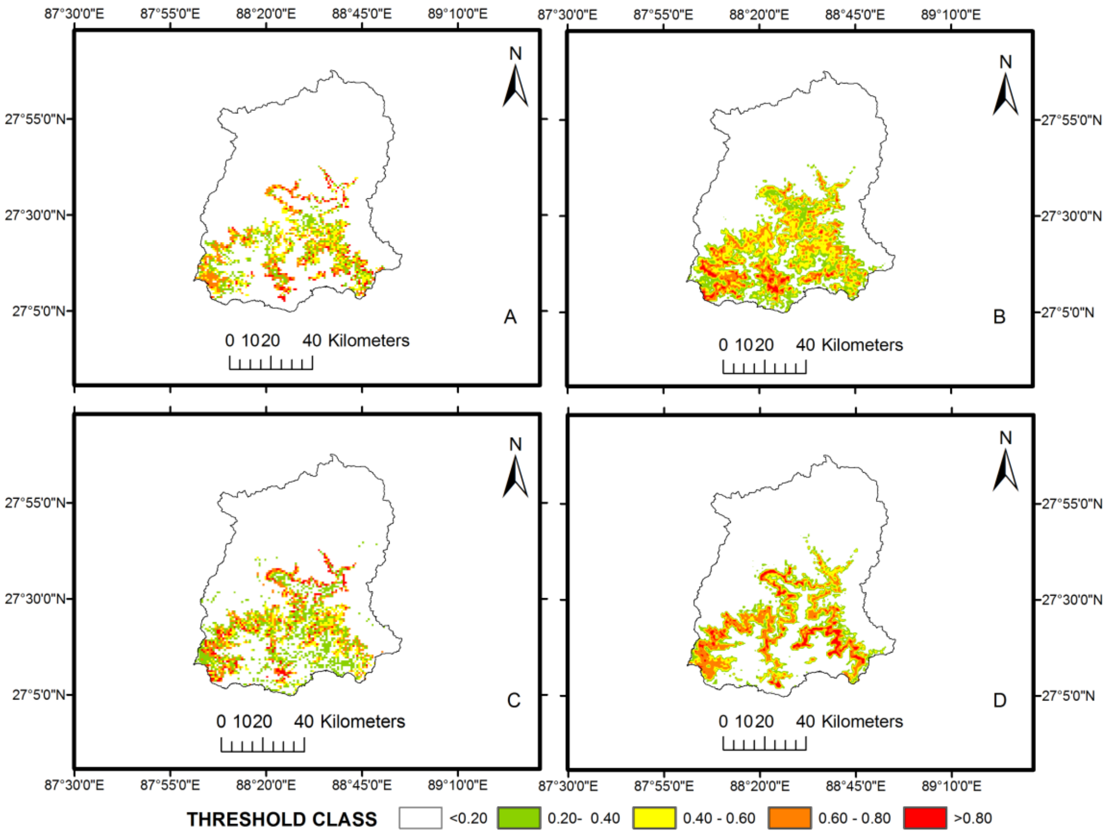


Figure 6.8: Future climate change impact on Kalij Pheasant in the Sikkim Himalayas; 'A' depicts RCP 2.6, 'B' depicts RCP 4.5, 'C' depicts RCP 6.0 and 'D' depicts RCP 8.5 respectively

Whereas, in RCP 4.5, the very high potential threshold class was the highest area cover (1910.35 sq. km) followed by the low potential threshold class (773.06 sq. km), the moderate potential threshold class (535.19 sq. km), and the high potential threshold class (295. 47 sq. km). Again, in RCP 6.0, the low potential threshold class emerged as the maximum area cover (915.10 sq. km) followed by the moderate potential class (458.94 sq. km), the high potential class (405.27 sq. km), and the very high potential class (218.36 sq. km). Whereas, in RCP 8.5, the high potential threshold class emerged as the highest area cover (608.83 sq. km) followed by the low potential threshold class (497.80 sq. km), the very high potential class (453.38 sq. km), and the moderate potential class (360.83 sq. km) (Figure 6.8).

7.1.3.1.9. Impact of future climate change on distribution of the Kalij Pheasant in the Khangchendzonga Biosphere Reserve

The future suitable habitat area of the Kalij Pheasant was quantified in the Khangchendzonga Biosphere Reserve, based on different future climate scenario of RCP-2050 (Figure 6.9).

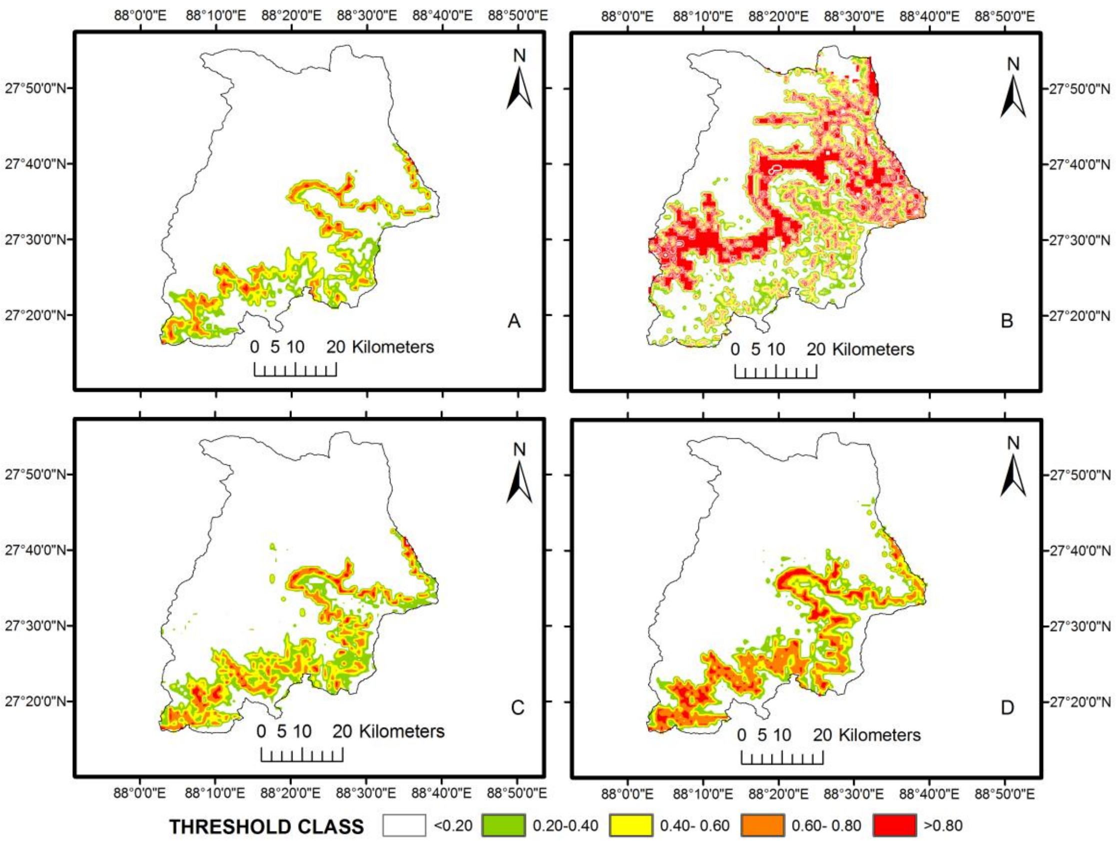


Figure 6.9: Future climate change impact on Kalij Pheasant in the Khangchendzonga Biosphere Reserve; 'A' depicts RCP 2.6, 'B' depicts RCP 4.5, 'C' depicts RCP 6.0 and 'D' depicts RCP 8.5 respectively.

In RCP 2.6, the low potential threshold class of the Kalij Pheasant emerged as maximum for its area cover (151.48 sq. km) in the Khangchendzonga Biosphere Reserve followed by the high potential threshold class (130.64 sq. km), the moderate potential threshold class (120.22 sq. km), and the very high potential threshold class (72.13 sq. km). Whereas, in RCP 4.5, the very high potential threshold class was the highest for its area cover (871.19 sq. km) followed by low potential threshold class (283.68 sq. km), the high potential threshold class (187.77 sq. km), and the moderate potential threshold class (182.94 sq. km).

Again, in RCP 6.0, the low potential threshold class emerged highest for its maximum area cover (280.52 sq. km) followed by the high potential threshold class (165.11 sq. km), the moderate potential threshold class (135.45 sq. km), and the very high potential threshold class (103.39 sq. km). In RCP 8.5, the high potential threshold class emerged at the top for its the highest area cover (219.61 sq. km) followed by the low high potential threshold class (196.36 sq. km), the very high potential threshold class (179.53 sq. km), and the moderate potential threshold class (120.23 sq. km) [Figure 6.9].

7.3.3.1.10. Impact of future climate change on distribution of the Satyr Tragoapn in the Eastern Himalayas

Based on the different future scenario of RCP-2050, the future suitable habitat area of Satyr Tragopan was quantified in the Eastern Himalaya (Figure 6.10). In RCP 2.6, based on threshold categories, the low potential threshold class area (28023.44 sq. km) of Satyr Tragopan was emerged as the highest area covered in the Eastern Himalaya followed by the high potential threshold class (10167.7 sq. km), the moderate potential threshold class (4967.47 sq. km), and the very high potential threshold class (2279.25 sq. km). Similarly as the result shown in RCP 4.5, the low potential threshold class was quantified the highest area (24809.06 sq. km), followed by the moderate potential threshold class (13532.43 sq. km), high potential threshold class (5020.81 sq. km), and very high potential threshold class (2381.087 sq. km).

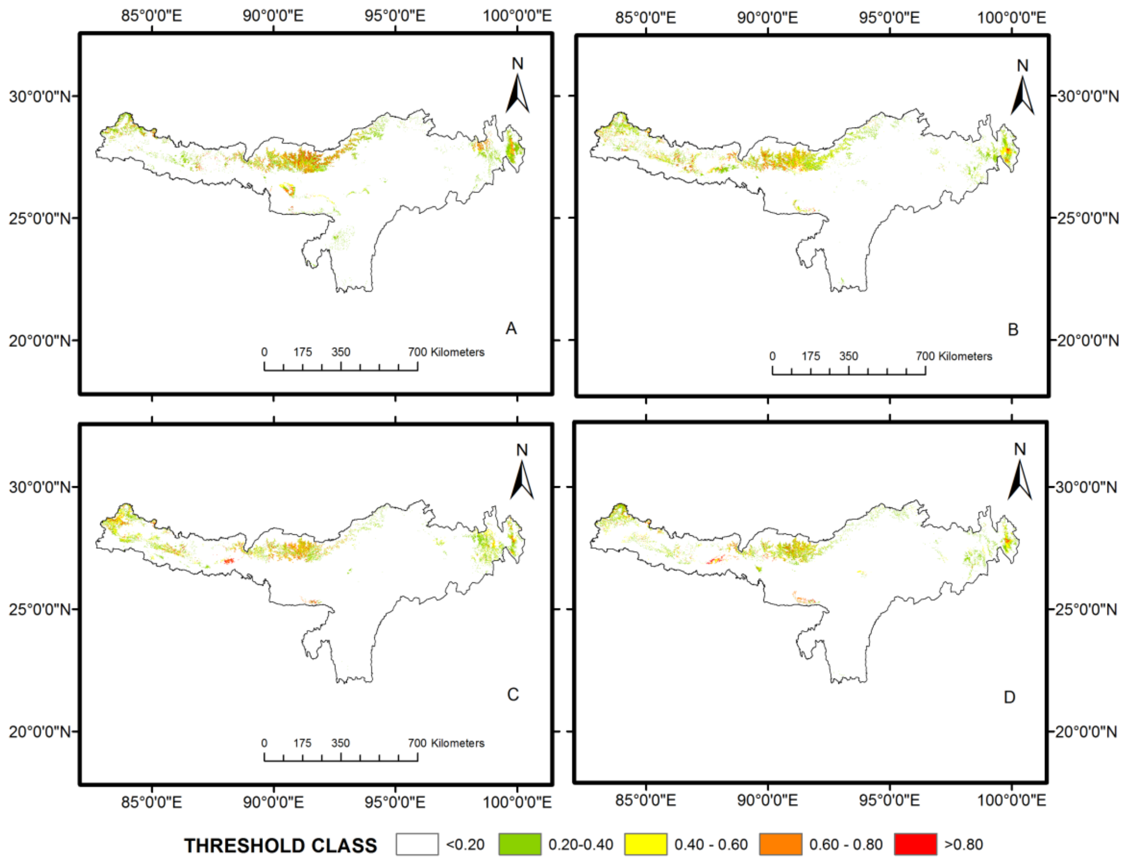


Figure 6.10: Future climate change impact on distribution of the Satyr Tragopan in the Eastern Himalayas; ‘A’ depicts RCP 2.6, ‘B’ depicts RCP 4.5, ‘C’ depicts RCP 6.0 and ‘D’ depicts RCP 8.5 respectively

Again, in RCP 6.0, the low potential threshold class (19570.82 sq. km) was the highest area covered in the Eastern Himalaya followed by the moderate potential threshold class (10805.42 sq. km), high potential threshold class (5149.324 sq. km), and very high potential threshold class (2307.53 sq. km). In RCP 8.5, the low potential threshold class (17439.5 sq. km) was quantified as maximum followed by the moderate potential threshold class (8305.52 sq. km), high potential threshold class (3503.74 sq. km), and very high potential threshold class (1631.04 sq. km) (Figure 6.10).

7.3.3.1.11. Impact of future climate change on distribution of the Satyr Tragoapn in the Sikkim Himalayas

Based on different future climate scenario of RCP-2050, the future suitable habitat area of the Satyr Tragopan was quantified in the Sikkim Himalayas (Figure 6.11).

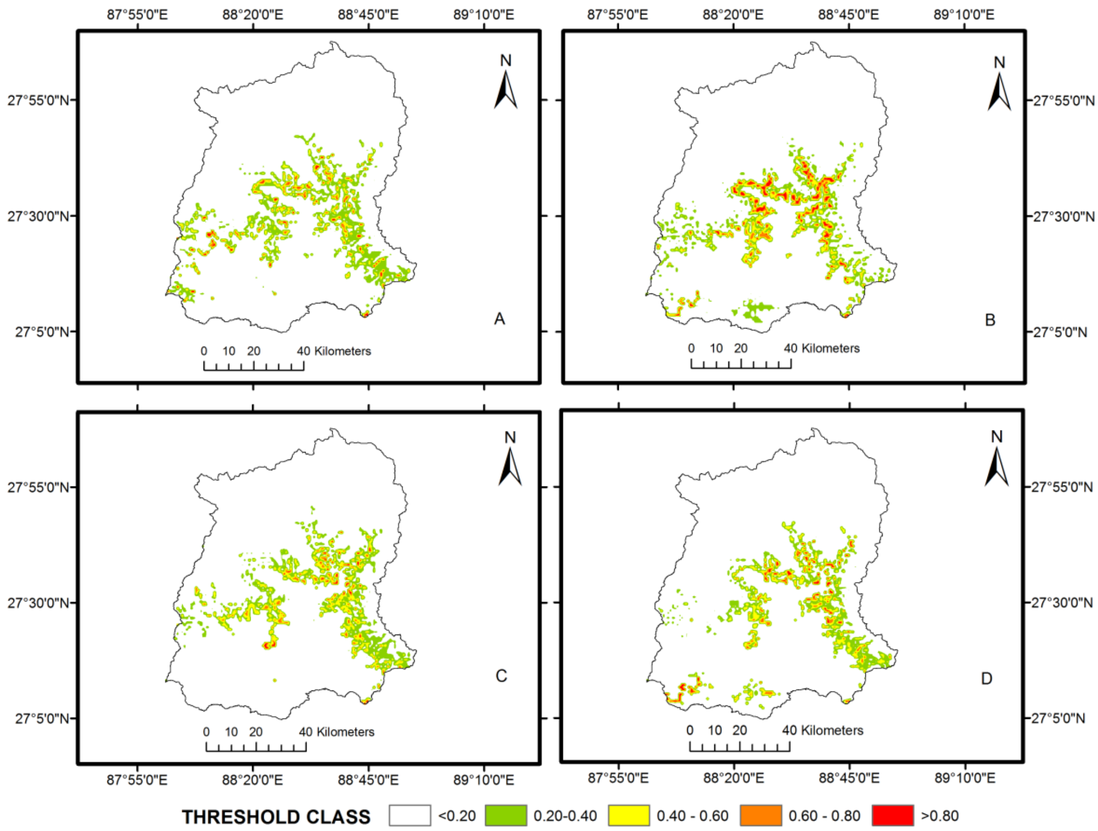


Figure 6.11: Future climate change impact on distribution of the Satyr Tragopan in Sikkim Himalayas; 'A' depicts RCP 2.6, 'B' depicts RCP 4.5, 'C' depicts RCP 6.0 and 'D' depicts RCP 8.5 respectively.

In RCP 2.6, the low potential threshold class area of the Satyr Tragopan (627.26 sq. km) was emerged as highest area covered in the Sikkim Himalaya followed by the moderate potential class (158.203 sq. km), high potential class (147.10 sq. km) and the very high (123.97 sq. km). Whereas, in RCP 4.5, a similar result was obtained as the low potential threshold area (519.94 sq. km) was the maximum, followed by the moderate potential class (259.97 sq. km) but the very high threshold area emerged greater than that in the high potential threshold class (139.7 sq. km). In RCP 6.0, the low potential threshold class emerged as the highest area ((513.53 sq. km) followed by the moderate potential threshold class (280.36 sq. km), the high potential threshold class (168.40 sq. km) and very high potential threshold class (80.50 sq. km). In RCP 8.5, a similar result was obtained; the low potential threshold class emerged with the maximum area (385.79 sq. km) followed by the moderate potential threshold class (234.99 sq. km), the high potential threshold class (164.68 sq. km) and the very high potential threshold class (129.52 sq. km) (Figure 6.11).

7.3.3.1.12. Impact of future climate change on the distribution of the Satyr Tragoapn in the Khangchendzonga Biosphere Reserve

Based on different future climate scenario of RCP-2050 the future suitable habitat area of Satyr Tragopan was quantified in the Khangchendzonga Biosphere Reserve (Figure 6.12). In RCP 2.6, the low potential threshold class emerged with maximum area (230.77 sq. km) covered in the Khangchendzonga Biosphere Reserve, followed the moderate potential threshold class (80.93 sq. km), and high potential threshold class (80.93 sq. km), as equal coverage, and very high potential threshold class (60.09 sq. km) was the lowest. Similarly, in RCP 4.5, the low potential threshold class (194.71 sq. km) calculated as the highest cover area followed by the moderate potential threshold class (137.82 sq. km), very high potential threshold class (88.94 sq. km), and high potential class (65.70 sq. km). Whereas, in RCP 6.0, the low potential threshold class (196.31 sq. km) emerged as the highest area followed by the moderate potential threshold class (108.17 sq. km), high potential threshold class (89.74 sq. km), and very high potential threshold class (26.44 sq. km).

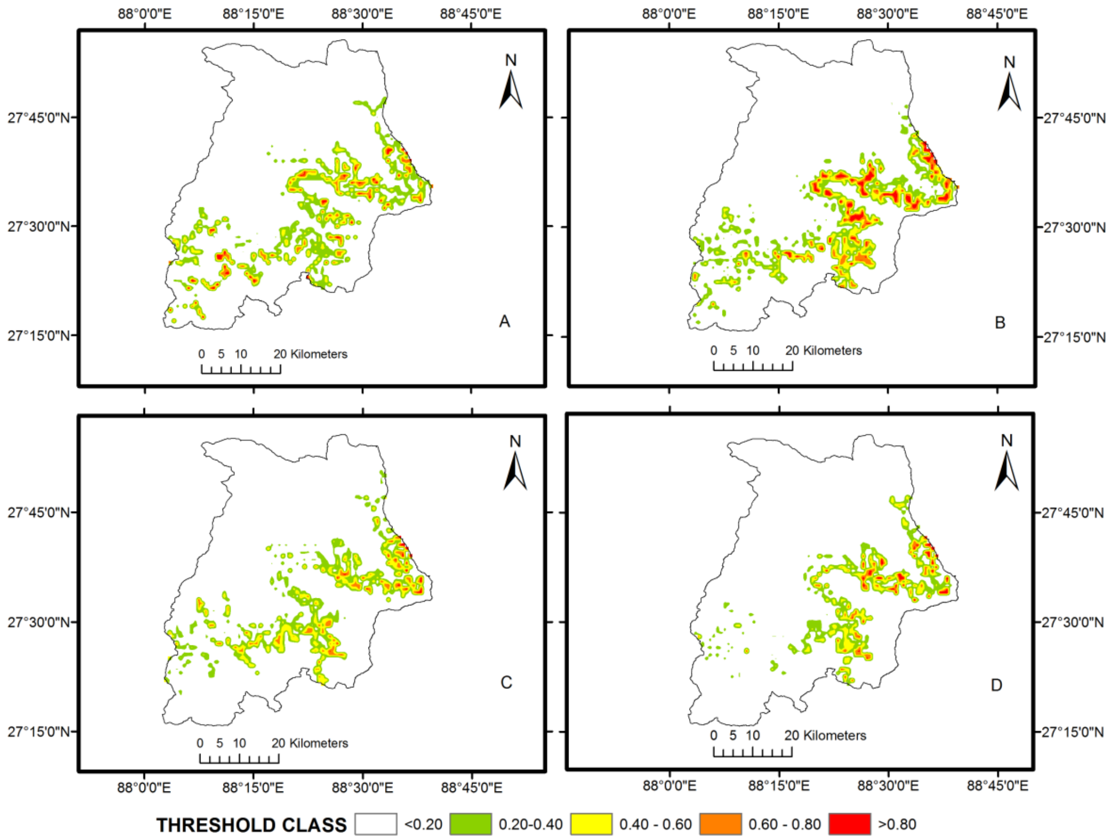


Figure 6.12: Future climate change impact on distribution of the Satyr Tragopan in the Khangchendzonga Biosphere Reserve; 'A' depicts RCP 2.6, 'B' depicts RCP 4.5, 'C' depicts RCP 6.0 and 'D' depicts RCP 8.5 respectively.

A similar result was shown in RCP 8.5; the low potential threshold class (145.83 sq. km) emerged with the maximum coverage area followed by moderate potential threshold class (95.35 sq. km), high potential threshold class (48.07 sq. km), and very high potential threshold class (43.26 sq. km) [Figure 6.12].

7.1.3.2. Future gain and loss of suitable habitat of the Himalayan Pheasants

7.1.3.2.1. Impact of future climate change on gain and loss of suitable habitat of the Blood Pheasant in the Eastern Himalayas

The gain and loss of suitable habitat area of Blood Pheasant were predicted using Python-based GIS toolkit, SDMtool-box, for the future climatic scenario/year combination RCP-2050.

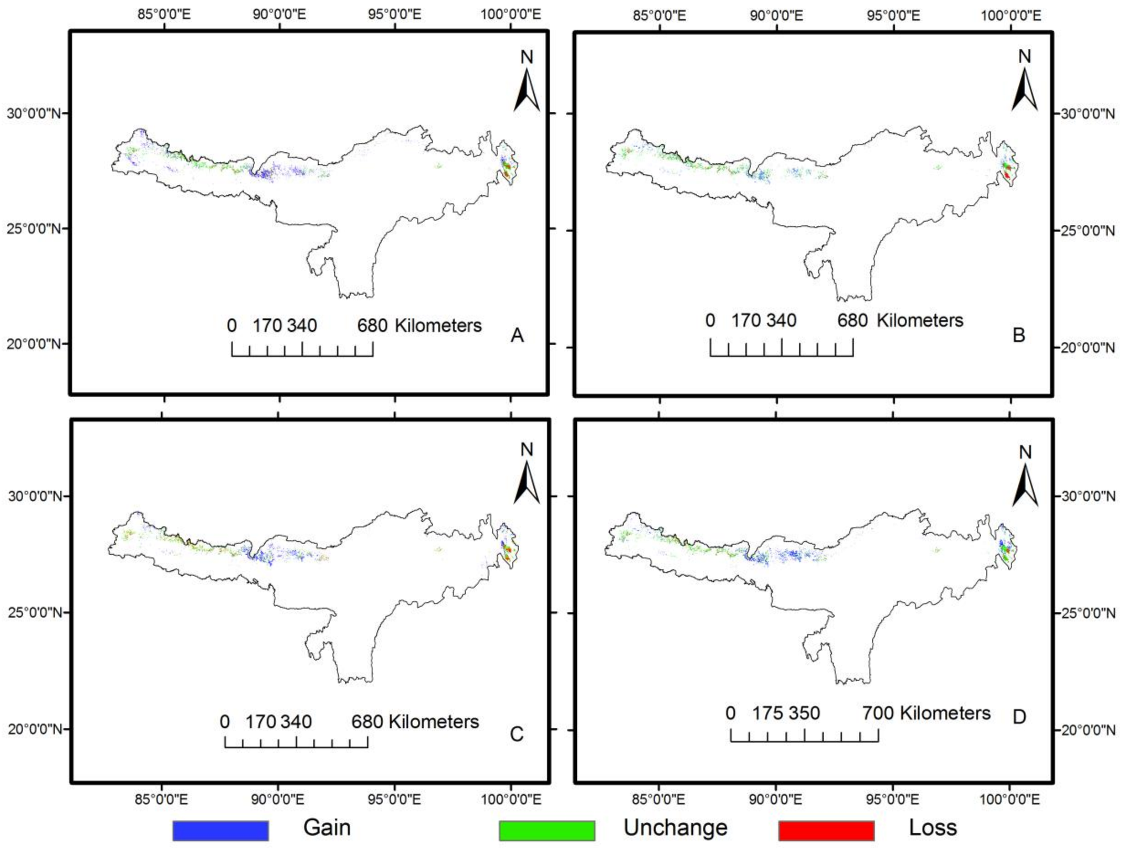


Figure 6.13: Gain and loss in sq. km of suitable habitat of Blood Pheasant in the Eastern Himalayas

Based on RCP-2050 models, the highest predicted gain area is found to be increased by 5814.71 sq. km or 1.11% of the present suitable area under RCP 8.5 followed by RCP 2.6 (5622.59 sq. km or 1.08%), RCP 6.0 (4574.49 sq. km or 0.87%), and RCP 4.5 (3090.93 sq. km or 0.59%), whereas the highest predicted loss area is found to be decreased by 3680.08 or 0.70% under RCP 2.6 followed by RCP 4.5 (3607.51 sq. km or 0.69 %), RCP 6.0 (3578.70 sq. km or 0.68%), and RCP 8.5 (3013.02 sq. km or 0.58%). However, the maximum suitable habitat area of the species, 2138.90 sq. km or 0.41% will remain unchanged in both the present and future climate scenario based on RCP 8.5 followed by RCP 6.0 (1573.21 sq. km or 0.30%), RCP 4.5 (1544.40 sq. km or 0.29), and RCP 2.6 (1471.82 sq. km or 0.28%). Overall, the maximum total suitable habitat area would have increased by 2801.69 sq. km or 0.53% under RCP 8.5 followed by RCP 2.6 (1942.51 sq. km or 0.38%) and RCP 6.0 (995.79 sq. km or 0.19%), whereas, the model RCP 4.5 would have decreased area by 516.58 sq. km or 0.1% of the present suitable area of Blood Pheasant in the Eastern Himalayas (Table 6.1, Figure 6.13).

Table 6.1: Predicting dynamic changes in suitable habitat area for Blood Pheasant in the Eastern Himalayas under different future climate scenario/year combination

Area (sq. km)						**Proportion of area (%)**			
Model	**Future**	**Loss**	**Gain**	**unchanged**	**Total**	**Loss**	**Gain**	**Unchanged**	**Total**
RCP 2.6	10774.50	3680.08	5622.59	1471.82	1942.51	0.70	1.08	0.28	0.38
RCP 4.5	8242.84	3607.51	3090.93	1544.40	-516.58	0.69	0.59	0.29	-0.1
RCP 6.0	9726.40	3578.70	4574.49	1573.21	995.79	0.68	0.87	0.30	0.19
RCP 8.5	10966.62	3013.02	5814.71	2138.90	2801.69	0.58	1.11	0.41	0.53

7.1.3.2.2. Impact of future climate change on gain and loss of suitable habitat of Himalayan Monal in the Eastern Himalayas

The gain and loss of suitable habitat area of Himalayan Monal were predicted using Python-based GIS toolkit, SDM tool-box, for the future climatic scenario/year combination RCP-2050.

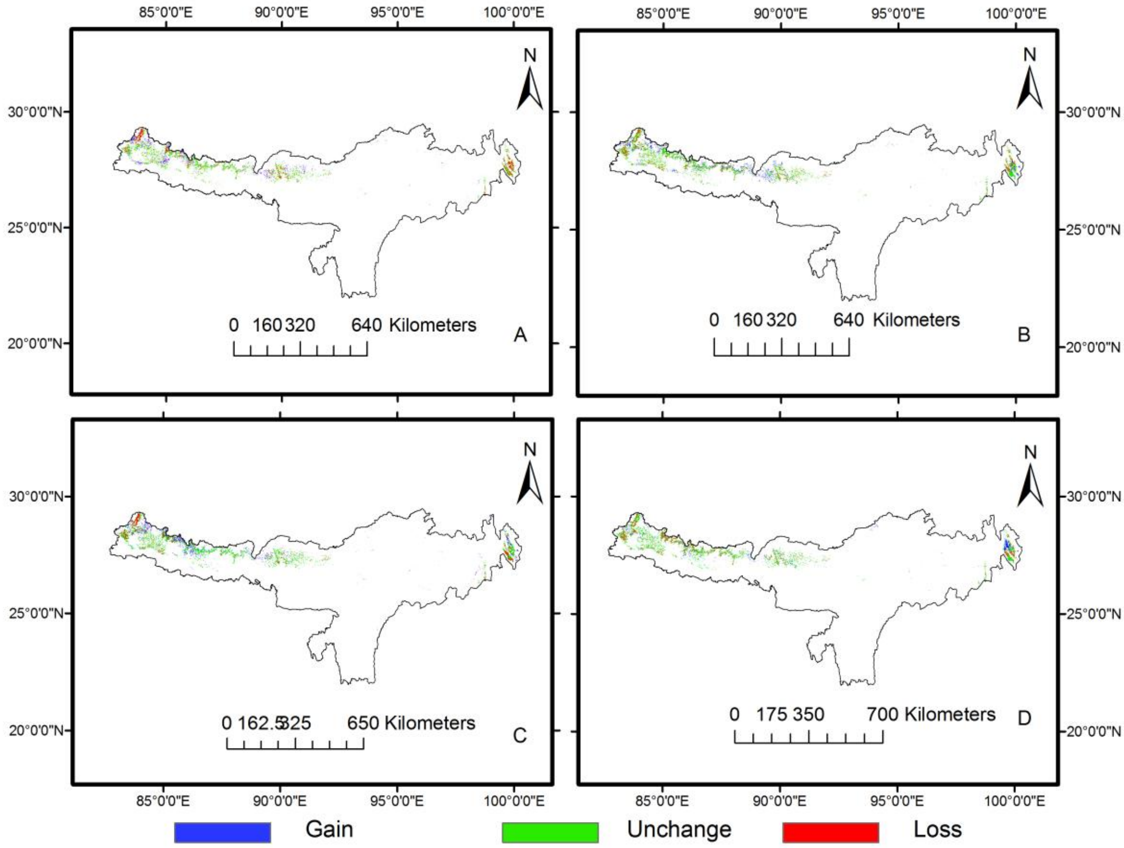


Figure 6.14: Gain and loss in sq. km of suitable habitat of Himalayan Monal in the Eastern Himalayas

Based on RCP-2050 models, the highest predicted gain area is found to be increased by 5825.38 sq. km or 1.11 % of the present suitable area under RCP 6.0 followed by RCP 4.5 (4999.28 sq. km or 0.95%), RCP 2.6 (4683.36 sq. km or 0.89%), and RCP

8.5 (2352.35 sq. km or 0.49%), whereas the highest predicted loss area is found to be decreased by 10752.09 sq. km or 2.05 % under RCP 8.5 followed by RCP 2.6 (8972.88 sq. km or 1.71 %), RCP 4.5 (8460.58 sq. km or 1.61%) and RCP 6.0 (8235.37 sq. km or 1.57%). However, the maximum suitable habitat area of the species, 5503.05 sq. km or 1.01% will remain unchanged in both the present and future climate scenario based on RCP 4.5, followed by RCP 4.5 (5277.85 sq. km or 1.01%), RCP 2.6 (4765.54 sq. km or 0.91%), and RCP 8.5 (2986.33 sq. km or 0.57%). Overall, the maximum total suitable habitat area would be decreased by 8399.74 sq. km or 1.56 % under RCP 8.5 followed by RCP 2.6 (4289.52 sq. km or 0.82 %), RCP 4.5 (3461.30 sq. km or 0.66%), and RCP 6.0 (2409.99 sq. km or 0.46%) [Table 6.2, Figure 6.14].

Table 6.2: Predicting dynamic changes in suitable habitat area for Himalayan Monal in the Eastern Himalayas under different future climate scenario/year combination

Area (sq. km)						**Proportion of area (%)**			
Model	**Future**	**Loss**	**Gain**	**unchanged**	**Total**	**Loss**	**Gain**	**Unchanged**	**Total**
RCP 2.6	18421.78	8972.88	4683.36	4765.54	-4289.52	1.71	0.89	0.91	-0.82
RCP 4.5	18737.71	8460.58	4999.28	5277.85	-3461.30	1.61	0.95	1.01	-0.66
RCP 6.0	19563.81	8235.37	5825.38	5503.05	-2409.99	1.57	1.11	1.05	-0.46
RCP 8.5	16090.78	10752.09	2352.35	2986.33	-8399.74	2.05	0.49	0.57	-1.56

7.1.3.2.3. Impact of future climate change on gain and loss of suitable habitat of the Kalij Pheasant in Eastern the Himalaya

The gain and loss of suitable habitat area of Kalij Pheasant were predicted using Python-based GIS toolkit, SDM tool-box, for the future climatic scenario/year combination RCP-2050. Based on RCP-2050 models, the highest predicted gain area is found to be increased by 3963.99 sq. km or 0.76 % of the present suitable area under RCP 4.5 followed by RCP 6.0 (3921.30 sq. km or 0.75%), RCP 8.5 (3867.93 sq. km or 0.74%),

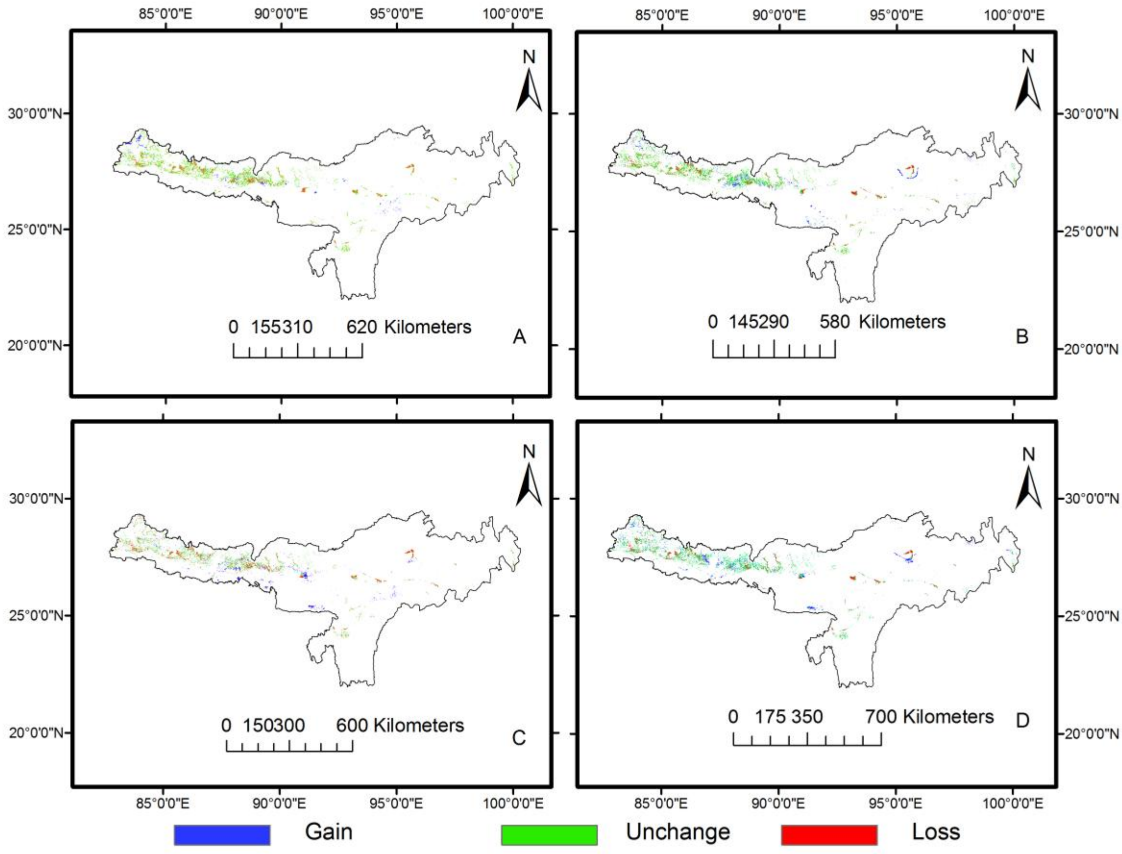


Figure 6.15: Gain and loss in sq. km of suitable habitat of Kalij Pheasant in Eastern Himalaya

and RCP 2.6 (2381.17 sq. km or 0.45%), whereas the highest predicted loss area is found to be decreased by 11988.03 sq. km or 2.29 % under RCP 2.6 followed by RCP 6.0 (10583.45 sq. km or 2.02 %), RCP 8.5 (10500.20 sq. km or 2.00%), and RCP 4.5 (9543.90 sq. km or 1.82 %). However, the maximum suitable habitat area of the species, 4342.89 sq. km or 0.83% will remain unchanged in both the present and future climate scenario based on RCP 4.5 followed by RCP 8.5 (3386.58 sq. km or 0.65%), RCP 6.0 (3303.33 sq. km or 0.63), and RCP 2.6 (1898.75 sq. km or 0.36%). Overall, the maximum total suitable habitat area would be decreased by 9606.86 sq. km or 1.84% under RCP 2.6 followed by RCP 6.0 (6662.15 sq. km or 1.27%) and RCP 8.5 (6632.27 sq. km or 1.26 %), and RCP 4.5 (5579.91 sq. km or 1.06%) [Table 6.3, Figure 6.15].

Table 6.3: Predicting dynamic changes in suitable habitat area for Kalij Pheasant in the Eastern Himalayas under different future climate scenario/year combination

Area (sq. km)						**Proportion of area (%)**			
Model	**Future**	**Loss**	**Gain**	**unchanged**	**Total**	**Loss**	**Gain**	**unchanged**	**Total**
RCP 2.6	16267.95	11988.03	2381.17	1898.75	-9606.86	2.29	0.45	0.36	-1.84
RCP 4.5	17850.77	9543.90	3963.99	4342.89	-5579.91	1.82	0.76	0.83	-1.06
RCP 6.0	17808.08	10583.45	3921.30	3303.33	-6662.15	2.02	0.75	0.63	-1.27
RCP 8.5	17754.72	10500.20	3867.93	3386.58	-6632.27	2.00	0.74	0.65	-1.26

7.1.3.2.4. Impact of future climate change on gain and loss of suitable habitat of the Satyr Tragopan in the Eastern Himalayas

The gain and loss of suitable habitat area of Satyr Tragopan were predicted using Python-based GIS toolkit, SDM tool-box, for the future climatic scenario/ year combination RCP-2050.

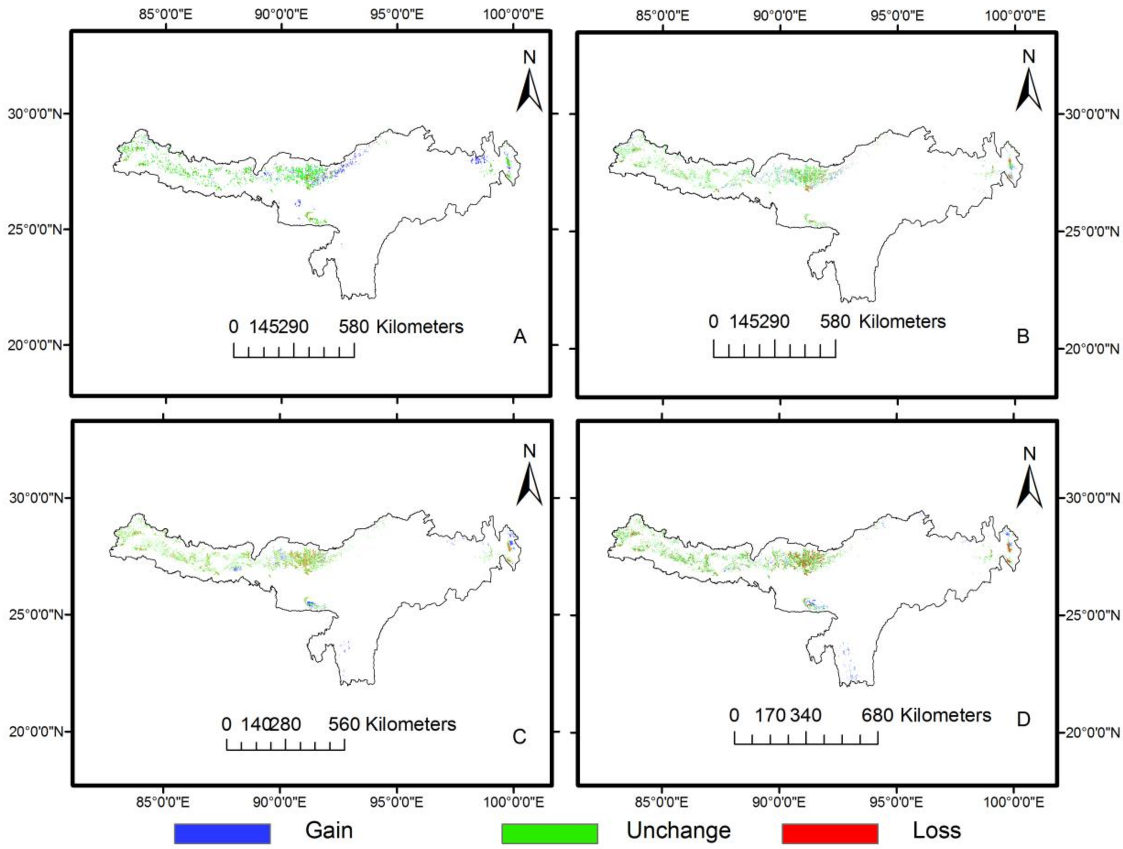


Figure 6.16: Gain and loss in sq. km of suitable habitat of Satyr Tragopan in the Eastern Himalayas.

Based on RCP-2050 models, the highest predicted gain in the area is found to be increased by 5808.11 sq. km, which is 1.11% of the present suitable area under RCP2.5 model followed by RCP 4.5 (3836.98 sq. km or 0.73% of the present suitable habitat area), RCP 6.0 (2975.66 sq. km or 0.57%), and RCP 8.5 (2518.85 sq. km or

0.48%). Whereas, the highest predicted loss in the area cover is found to be decreased by 14120.52 sq. km, i.e. 2.69% of the present suitable area under RCP8.5 model followed by RCP 6.0 (13674.39 sq. km, i.e. 2.61%), RCP 2.6 (9253.75 sq. km or 1.77%), and RCP 4.5 (8073.14 sq. km or 1.54%). However, the maximum cover of suitable habitat area of 6305 sq. km or 1.20% will remain unchanged in both present and future climate scenario based on RCP 4.5 followed by RCP 2.6 (5002.14 sq. km or 0.96%), RCP 6.0 (701.22 sq. km or 13%) and RCP 8.5(258.29 sq.km or 0.05%). Overall, the maximum total suitable habitat area of Satyr Tragopan would have decreased by 11601.67 sq.km or 2.21% under RCP 8.5 followed by RCP 6.0 (10698.73 sq. km or 2.04%), RCP 4.5 (4236.16 sq. km or 0.81%) and RCP 2.6 (3445.64 sq. km or 0.66%)[Table 6.4, Figure 6.16].

Table 6.4: Predicting dynamic changes in suitable habitat area for Satyr Tragopan in the Eastern Himalayas under different future climate scenario/year combination

Area (sq. km)						**Proportion of area (%)**			
Model	**Future**	**Loss**	**Gain**	**Unchand**	**Total**	**Loss**	**Gain**	**Unchand**	**Total**
RCP 2.6	20064.01	9253.75	5808.11	5002.14	-3445.64	1.77	1.11	0.96	-0.66
RCP 4.5	18215.79	8073.14	3836.98	6305.67	-4236.16	1.54	0.73	1.20	-0.81
RCP 6.0	17351.27	13674.39	2975.66	701.22	-10698.73	2.61	0.57	0.13	-2.04
RCP 8.5	16897.67	14120.52	2518.85	258.29	-11601.67	2.69	0.48	0.05	-2.21

7.1.3.2.5. Impact of future climate change on gain and loss of suitable habitat of the Blood Pheasant in Sikkim Himalayas

The gain and loss of suitable habitat area of the Blood Pheasant were predicted using Python-based GIS toolkit, SDM tool-box, for the future climatic scenario/year combination RCP-2050 in Sikkim Himalaya.

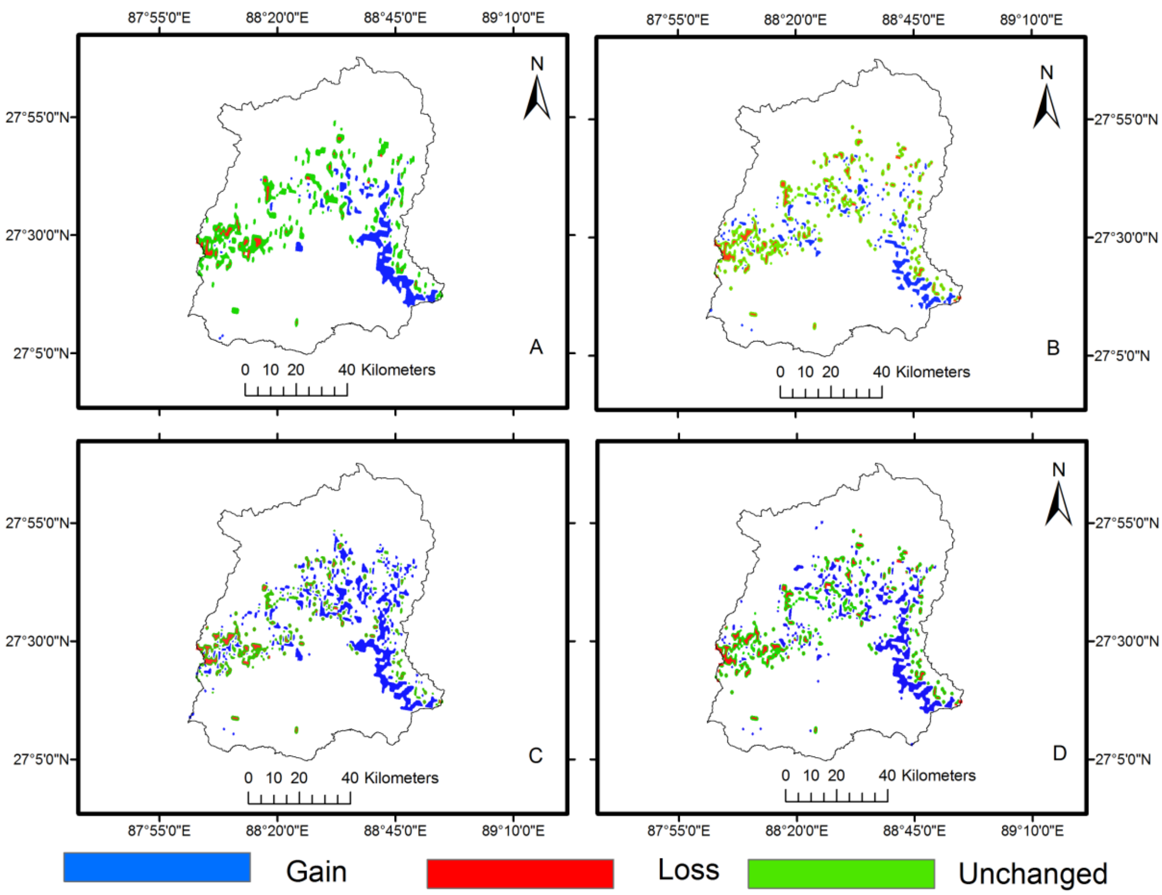


Figure 6.17: Gain and loss in sq. km of suitable Habitat of Blood Pheasant in the Sikkim Himalayas.

Based on RCP-2050 models, the highest predicted gain in the geographic area is found to be increased by 747.2942 sq. km or 10.5312 % of the present suitable area under RCP 6.0 followed by RCP 8.5 (556.1872 sq. km or 7.838038%), RCP 2.6

(379.3522 sq. km or 5.219169 %), and RCP 4.5 (336.0847 sq. km or 4.736256 %). Whereas, the highest predicted loss area is found to be decreased by 336.0847 sq. km or 4.736256 %, under RCP 4.5 followed by RCP 8.5 (329.4948 sq. km or 4.643388 %), RCP 6.0 (204.2868 sq. km or 2.878901 %), and RCP 2.6 (102.8024 sq. km or 1.448737 %).

Table 6.5: Predicting dynamic changes in suitable habitat area for Blood Pheasant in the Sikkim Himalayas under different future climate scenario/year combination

Area (sq. km)						Proportion of area (%)			
Model	**Future**	**Loss**	**Gain**	**unchanged**	**Total**	**Loss**	**Gain**	**unchanged**	**Total**
RCP 2.6	1062.291	102.8024	370.3522	589.1367	267.55	1.44	5.22	6.49	3.77
RCP 4.5	798.6954	336.0847	336.0847	126.526	0	4.73	4.74	1.39	0
RCP 6.0	1209.905	204.2868	747.2942	258.3239	543.007	2.88	10.53	2.84	7.65
RCP 8.5	1018.798	329.4948	556.1872	133.1159	226.692	4.64	7.83	1.46	3.19

The maximum suitable habitat area of the species, 589.1367 sq. km or 6.491149 % will remain unchanged in both the present and future climate scenario based on RCP 2.6 followed by RCP 6.0 (258.3239 sq. km or 2.846231%), RCP 8.5 (133.1159 sq. km or 1.46668 %), and RCP 4.5 (336.084 sq. km or 1.394072 %). Overall, the maximum total suitable habitat area would be increased by 543.007 sq. km or 7.652297 % under RCP 6.0 followed by RCP 2.6 (267.55 sq. km or 3.770434 %), and RCP 8.5 (226.692

sq. km or 3.194645 %), and under RCP 4.5 overall suitable habitat area would not be either increased and decreased (Table 6.5, Figure 6.17).

7.1.3.2.6. Impact of future climate change on gain and loss of suitable habitat of the Himalayan Monal in Sikkim Himalayas

The gain and loss of suitable habitat area of Himalayan Monal were predicted using Python-based GIS toolkit, SDM tool-box, for the future climatic scenario/year combination RCP-2050 in Sikkim Himalaya.

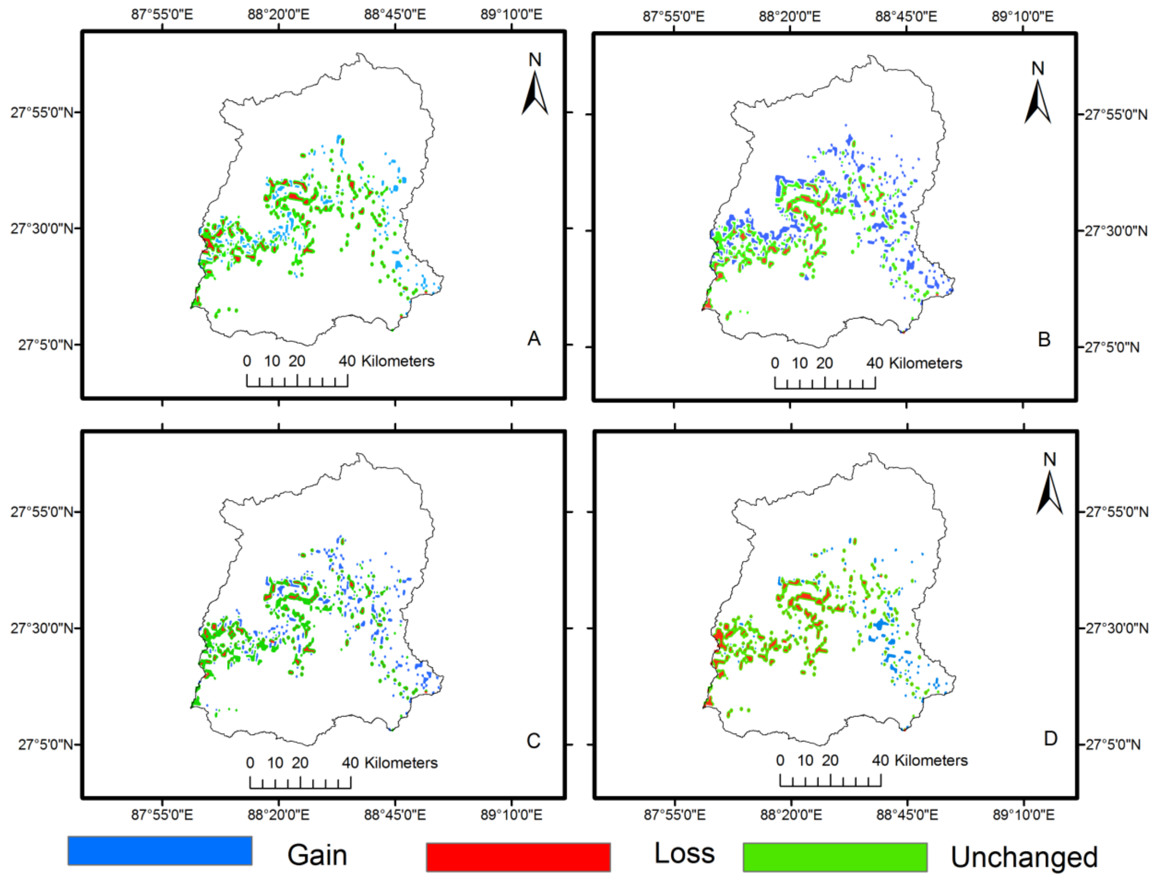


Figure 6.18: Gain and loss in sq. km of suitable habitat of Himalayan Monal in the Sikkim Himalayas

Based on RCP-2050 models, the predicted gain area is found to be increased by 554.9503 sq. km or 7.820607 % of the present suitable area under RCP 4.5 followed by RCP 6.0 (369.5285 sq. km or 5.207561%), RCP 2.6 (284.0504 sq. km or 4.002965), and RCP 8.5 (189.3669 sq. km or 2.668643 %). Whereas, the highest predicted loss area is found to be decreased by 399.7746 sq. km or 5.633802 %, under RCP 8.5 followed by RCP 2.6 (337.9674 sq. km or 4.762787 %), RCP 4.5 (324.8169 sq. km or 4.577465%), and RCP 6.0 (220.9281 sq. km or 3.113417 %). However, the maximum suitable habitat area of the species, 326.1319 sq. km or 4.595996 % will remain unchanged in both the present and future climate scenario based on RCP 6.0 followed by RCP 4.5 (222.2431 sq. km or 3.131949 %), RCP 2.6 (209.0927sq. km or 2.946628%), and RCP 8.5 (147.2854 sq. km or 2.075612%). Overall, the total suitable habitat area would have increased by 230.133 sq. km or 3.24314% under RCP 4.5 and RCP 6.0 by 148.6 sq. km or 2.09414%, and the total suitable habitat area

Table 6.6: Predicting dynamic changes in suitable habitat area for Himalayan Monal in the Sikkim Himalayas under different future climate scenario/year combination

Area (sq. km)						Proportion of area (%)			
Model	**Future**	**Loss**	**Gain**	**unchanged**	**Total**	**Loss**	**Gain**	**unchanged**	**Total**
RCP 2.6	831.1105	337.9674	284.0504	209.0927	-53.917	4.76	4.00	2.94	-0.76
RCP 4.5	1102.01	324.8169	554.9503	222.2431	230.133	4.58	7.82	3.13	3.24
RCP 6.0	916.5885	220.9281	369.5285	326.1319	148.6	3.11	5.20	4.59	2.09
RCP 8.5	736.4269	399.7746	189.3669	147.2854	-210.41	5.63	2.67	2.07	-2.97

would have decreased by 210.4077 sq. km or 2.965159 %, and RCP 2.6 by 53.917 sq. km or 0.759822 % (Table 6.6, Figure 6.18).

7.1.3.2.7. Impact of future climate change on gain and loss of suitable habitat of the Kalij Pheasant in Sikkim Himalaya

The gain and loss of suitable habitat area of Kalij Pheasant were predicted using Python-based GIS toolkit, SDM tool-box, for the future climatic scenario/year combination RCP-2050 in Sikkim Himalaya. Based on RCP-2050 models, the predicted gain area is found to be increased by 626.2335 sq. km or 8.825162 % of the present suitable area under RCP 4.5 followed by RCP 8.5 (413.5504 sq. km or 5.827937 %), RCP 6.0 (307.2089 sq. km or 4.329325 %), and RCP 2.6 (236.3145 sq. km or 3.330249%).

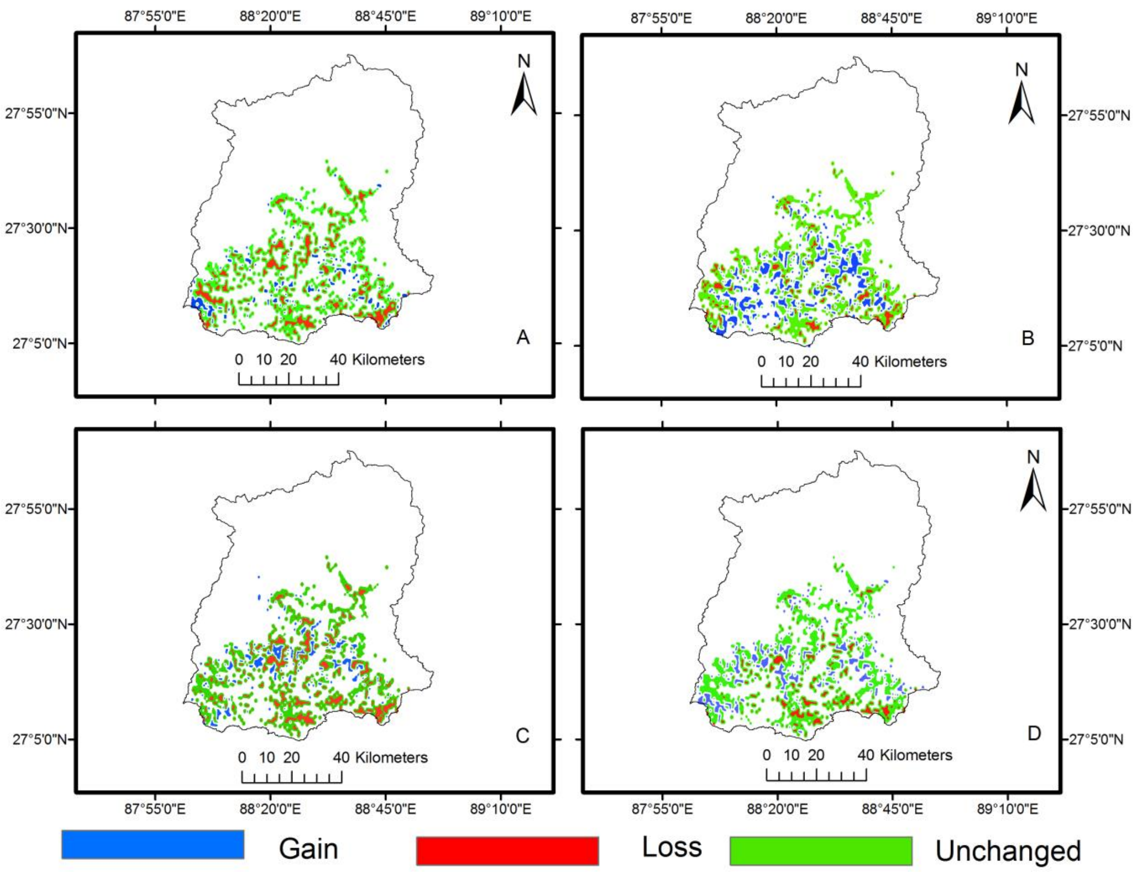


Figure 6.19: Gain and loss in sq. km of suitable habitat of Kalij Pheasant in the Sikkim Himalayas

Whereas, the highest predicted loss area is found to be decreased by 783.7765 sq. km or 11.04533%, under RCP 2.6 followed by RCP 6.0 (712.8821 sq. km or 10.04625 %), RCP 8.5 (405.6733 sq. km or 5.716929%), and RCP 4.5 (355.7846 sq. km or 5.013875 %). The maximum suitable habitat area of the species, 891.4309 sq. km or 12.56244 % will remain unchanged in both the present and future climate scenario based on RCP 4.5 followed by RCP 8.5 (841.5423 sq. km or 11.85939 %), RCP 6.0 (534.3334 sq. km or 7.530065 %), and RCP 2.6 (463.439 sq. km or 6.530989). Overall, the total suitable habitat area would have increased by 270.449 sq. km or 3.81129 % under RCP 4.5 and RCP 8.5 by 7.8771 sq. km or 0.11101%, and the total suitable habitat area would be decreased by 547.462 sq. km or 7.715079 % under RCP 2.6 and RCP 6.0 by 405.6732 sq. km or 5.716928% (Table 6.7, Figure 6.19).

Table 6.7: Predicting dynamic changes in suitable habitat area for Kalij Pheasant in the Sikkim Himalayas under different future climate scenario/year combination

Area (sq. km)						**Proportion of area (%)**			
Model	**Future**	**Loss**	**Gain**	**unchanged**	**Total**	**Loss**	**Gain**	**unchanged**	**Total**
RCP 2.6	1483.53	783.7765	236.3145	463.439	-547.462	11.04	3.33	6.53	-7.71
RCP 4.5	1873.449	355.7846	626.2335	891.4309	270.449	5.01	8.82	12.56	3.81
RCP 6.0	1554.424	712.8821	307.2089	534.3334	-405.673	10.04	4.32	7.53	-5.72
RCP 8.5	1660.766	405.6733	413.5504	841.5423	7.8771	5.71	5.83	11.86	0.11

7.1.3.2.8. Impact of future climate change on gain and loss of suitable habitat of the Satyr Tragopan in Sikkim Himalayas

The gain and loss of suitable habitat area of Satyr Tragopan were predicted using Python-based GIS toolkit, SDM tool-box, for the future climatic scenario/year combination RCP-2050 in Sikkim Himalaya.

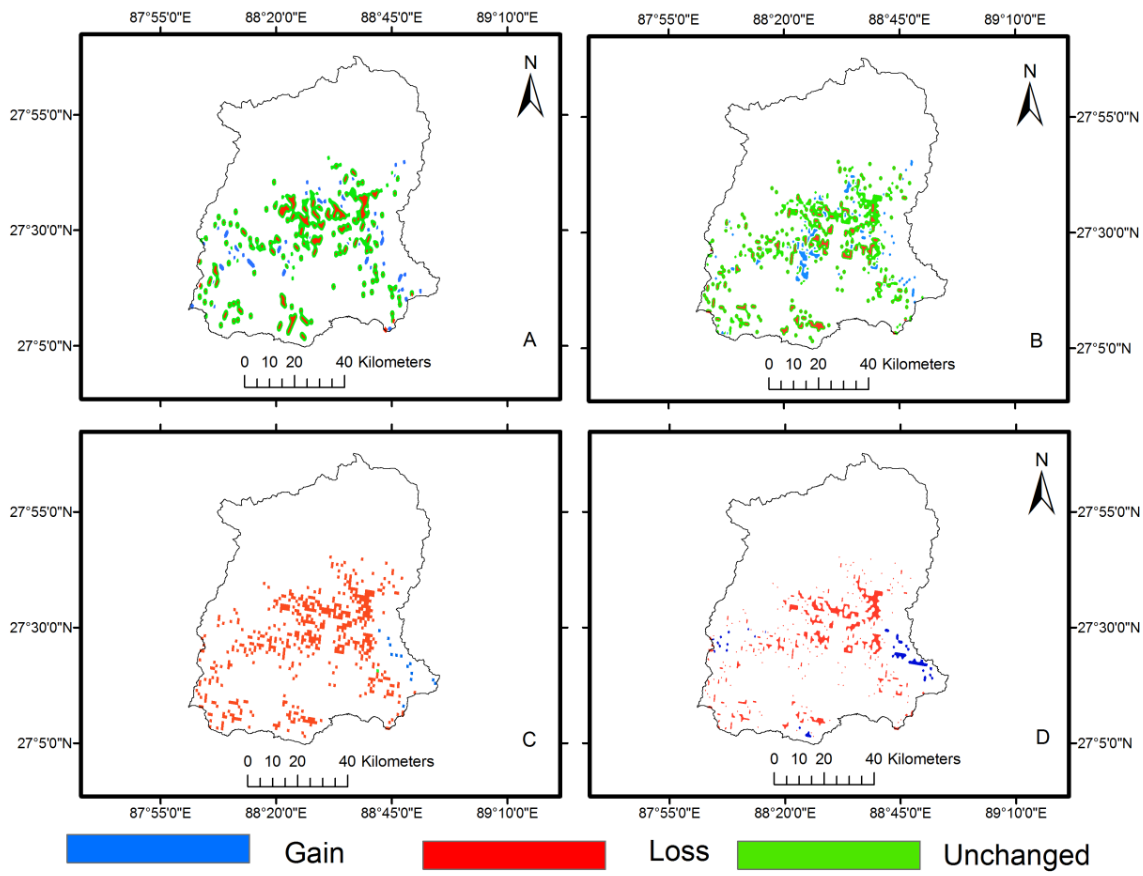


Figure 6.20: Gain and loss in sq. km of suitable habitat of Satyr Tragopan in the Sikkim Himalayas.

Based on RCP-2050 models, the highest predicted gain area is found to be increased by 165.389567 sq. km or 2.33 % of the present suitable area under RCP 4.5 followed by RCP 2.6 (151.6462786 sq. km or 2.13 %), RCP 8.5 (64.31817 sq. km or 0.90%), and RCP 6.0 (17.06716004 sq. km or 0.240518 %), whereas the highest predicted loss area is found to be decreased by 724.56 sq. km or 10.21 % under RCP 8.5 followed by RCP 6.0 (723.385sq. km or 10.19 %), RCP 2.6 (507.2306559 or 7.14%) and RCP 4.5 (413.47391 sq. km or 5.83 %).

Table 6.8: Predicting dynamic changes in suitable habitat area for Satyr Tragopan in the Sikkim Himalayas under different future climate scenario/year combination

Area (sq. km)						Proportion of area (%)			
Model	**Future**	**Loss**	**Gain**	**unchanged**	**Total**	**Loss**	**Gain**	**unchanged**	**Total**
RCP 2.6	836.6691	507.2306559	151.6462786	177.792	-355.584	7.14	2.13	2.50	-5.01
RCP 4.5	889.9534	413.4739179	165.3895671	311.089	-248.084	5.83	2.33	4.38	-3.50
RCP 6.0	741.765	723.385	17.06716004	1.3128	-706.137	10.19	0.24	0.01	-9.95
RCP 8.5	788.882	724.5638	64.31817	0	-660.246	10.21	0.90	0	-9.31

However, the maximum suitable habitat area of the species, 311.0899001 sq. km or 4.384018 % will remain unchanged in both the present and future climate scenario based on RCP 4.5 followed by RCP 2.6 (177.7922 sq. km or 2.505527 %), and RCP 6.0 (1.312858 sq. km or 0.018501) and in RCP 8.5, these will not remain unchanged for the suitable habitat area of the Satyr Tragopan. Overall, the maximum total suitable habitat area would be decreased by 706.1378 sq. km or 9.953746% under RCP 6.0 followed by RCP 8.5 (660.246 sq.km or 9.31%), RCP2.6 (355.5844 sq.km or 5.01%) and RCP 4.5 (244.084 sq.km or 3.50%) [Table 6.8, Figure 6.20].

7.1.3.2.9. Impact of future climate change on gain and loss of suitable habitat of the Blood Pheasant in Khangchendzonga Biosphere Reserve

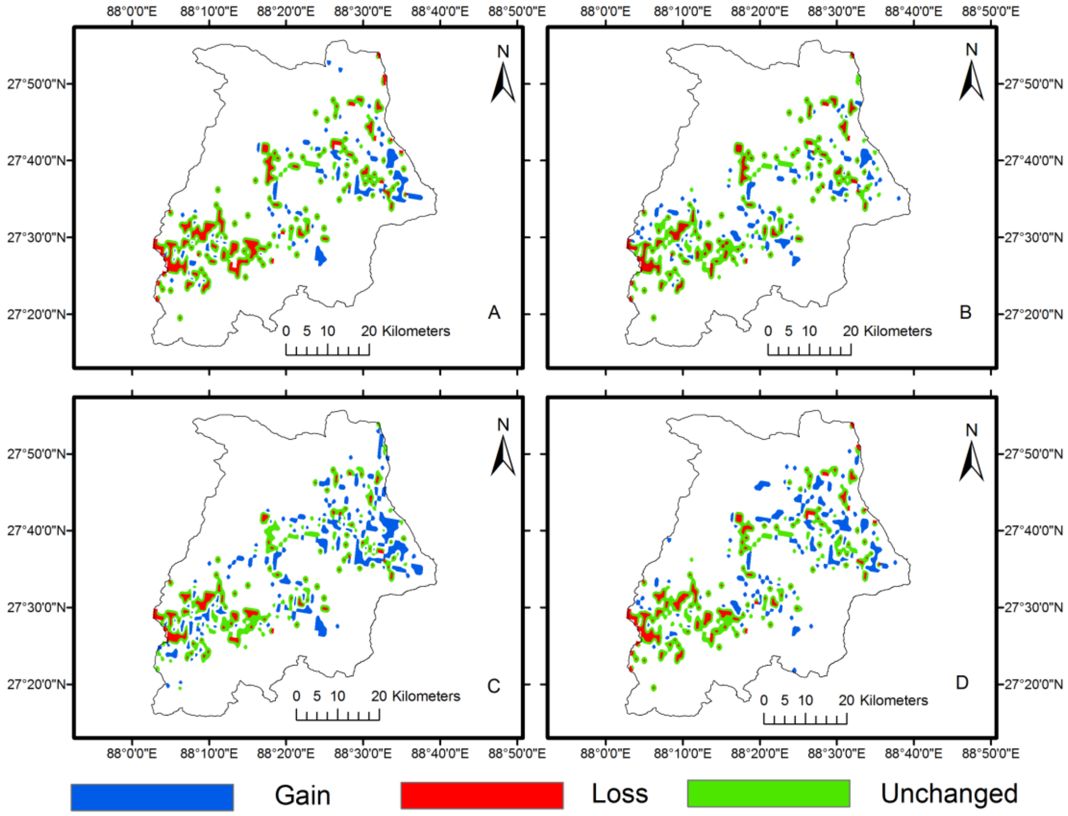


Figure 6.21: Gain and loss in sq. km of suitable habitat of Blood Pheasant in the Khangchendzonga Biosphere Reserve

In the Khangchendzonga Biosphere Reserve, the gain and loss of suitable habitat area of Blood Pheasant were predicted using Python-based GIS toolkit, SDM tool-box, for the future climatic scenario/year combination RCP-2050. Based on RCP-2050 models, the predicted gain area is found to be increased by 272.3708 sq. km or 9.29238 % of the present suitable area under RCP 6.0 followed by RCP 8.5 (190.3177sq. km or 6.493003 %), RCP 2.6 (135.6156 sq. km or 4.62675 %), and RCP 4.5 (131.8379 sq. km or 4.497868 %); whereas the highest predicted loss area is found to be decreased by 243.8801 sq. km or 8.320372 % under RCP 2.6 followed by RCP

4.5 (188.6646 sq. km or 6.436604 %), RCP 8.5 (184.6195 sq. km or 6.298599%), and RCP 6.0 (137.8948 sq. km or 4.704509 %).

Table 6.9: Predicting dynamic changes in suitable habitat area for Blood Pheasant in the Khangchendzonga Biosphere Reserve under different future climate scenario/year combination

Area (sq. km)						Proportion of area (%)			
Model	**Future**	**Loss**	**Gain**	**unchanged**	**Total**	**Loss**	**Gain**	**Unchanged**	**Total**
RCP 2.6	422.8015	243.8801	135.6156	43.30582	-108.265	8.32	4.62	1.47	-3.69
RCP 4.5	418.2444	188.6646	131.8379	97.74188	-56.827	6.43	4.49	3.33	-1.93
RCP 6.0	559.5567	137.8948	272.3708	149.2911	134.476	4.70	9.29	5.09	4.59
RCP 8.5	477.5036	184.6195	190.3177	102.5664	5.698	6.29	6.49	3.49	0.19

However, the maximum suitable habitat area of the species, 149.2911 sq. km or 5.093312 % will be remaining unchanged in both the present and future climate scenario based on RCP 6.0 followed by RCP 8.5 (102.5664 sq. km or 3.499222 %), RCP 4.5 (97.74188 sq. km or 3.334626 %), and RCP 2.6 (43.30582 sq. km or 1.47745 %). Overall, the total suitable habitat area would have increased by 134.476 sq. km or 4.587871% under RCP 6.0 and in RCP 8.5 by 5.6982 sq. km or 0.194404%, whereas, the total suitable habitat area would have decreased by 108.2645 sq. km or 3.693622 % under RCP 2.6 and in RCP 4.5 by 56.8267 sq. km or 1.938737% (Table 6.9, Figure 6.21).

7.1.3.4. Impact of future climate change on gain and loss of suitable habitat of the Himalaya Monal in Khangchendzonga Biosphere Reserve

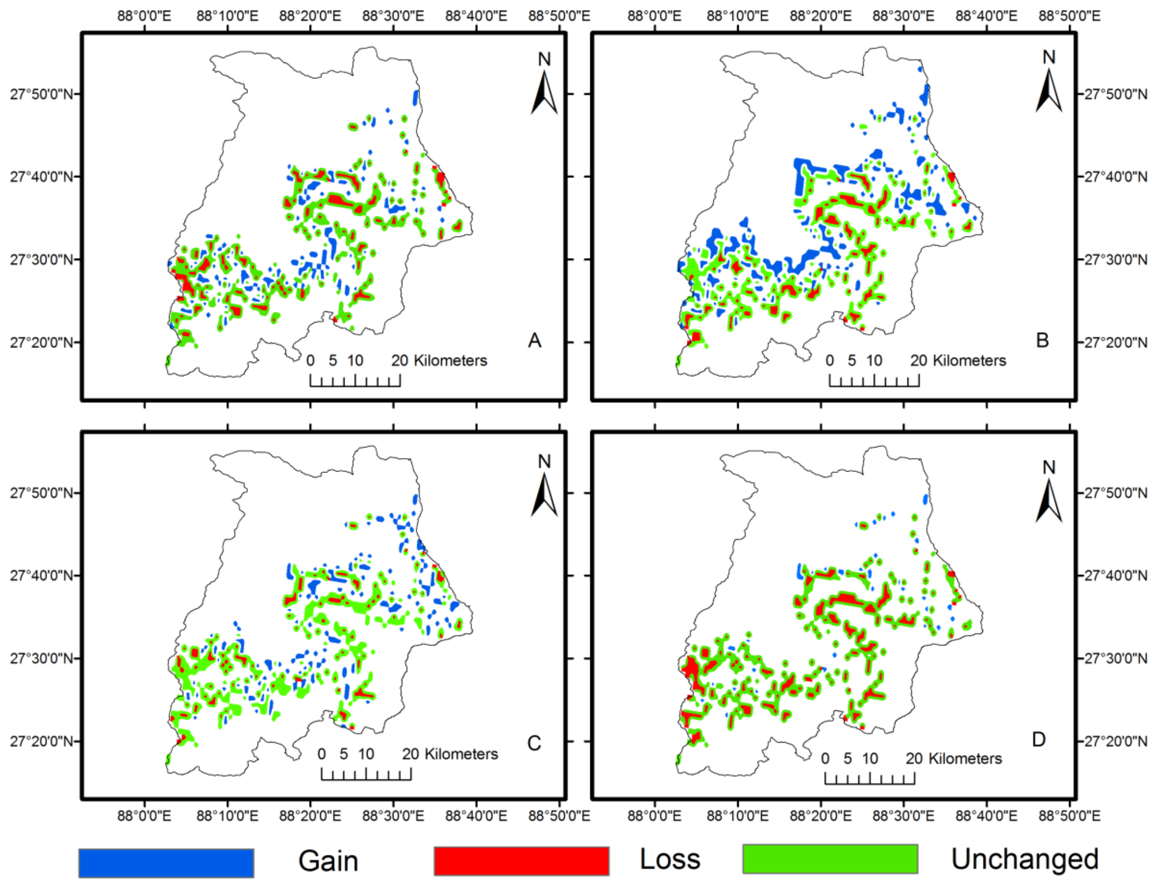


Figure 6.22: Gain and loss in sq. km of suitable habitat of Himalayan Monal in the Khangchendzonga Biosphere Reserve

Using python-based GIS toolkit, SDM tool-box, the gain and loss of suitable habitat area of Himalayan Monal were predicted for the future climatic scenario/year combination RCP-2050 in the Khangchendzonga Biosphere Reserve.

Table 6.10: Predicting dynamic changes in suitable habitat area for Himalayan Monal in the Khangchendzonga Biosphere Reserve under different future climate scenario/year combination

Area (sq. km)						Proportion of area (%)			
Model	**Future**	**Loss**	**Gain**	**unchanged**	**Total**	**Loss**	**Gain**	**Unchanged**	**Total**
RCP 2.6	541.9164	218.1299	162.4613	161.3252	-55.6686	7.44	5.54	5.50	-1.89
RCP 4.5	672.5671	213.5855	293.112	165.8696	79.5265	7.28	10.00	5.65	2.71
RCP 6.0	566.9104	145.4199	187.4553	234.0352	42.0354	4.96	6.39	7.98	1.43
RCP 8.5	423.7627	282.8872	44.30763	96.56791	238.5796	9.65	1.51	3.29	-8.13

Based on RCP-2050 models, the predicted gain area is found to be increased by 293.112 sq. km or 10.00% of the present suitable area under RCP 4.5 followed by RCP 6.0 (187.4553 sq. km or 6.395347 %), RCP 2.6 (162.4613 sq. km or 5.542636%), and RCP 8.5 (44.30763 sq. km or 1.511628 %); whereas the highest predicted loss area is found to be decreased by 282.8872 sq. km or 9.651164 % under RCP 8.5 followed by RCP 2.6 (218.1299 sq. km or 7.441862 %), RCP 4.5 (213.5855 sq. km or 7.286822 %), and RCP 6.0 (145.4199 sq. km or 4.96124 %). The maximum suitable habitat area of the species, 234.0352 sq. km or 7.984497 % will be remaining unchanged in both the present and future climate scenario based on RCP 6.0 followed by RCP 4.5 (165.8696 sq. km or 5.658915 %), RCP 2.6 (161.3252 sq. km or 5.503876%), and RCP 8.5 (96.56791 sq. km or 3.294574 %).

Overall, the total suitable habitat area would have increased by 79.5265 sq. km or 2.71318 % under RCP 4.5 and in RCP 6.0 by 42.0354 sq. km or 1.43411 %, whereas, the total suitable habitat area would be decreased by 238.5796 sq. km or 8.139536 % under RCP 8.5 and in RCP 2.6 by 55.6686 sq. km or 1.899226% (Table 6.10, Figure 6.22).

7.1.3.11. Impact of future climate change on gain and loss of suitable habitat of the Kalij Pheasant in Khangchendzonga Biosphere Reserve

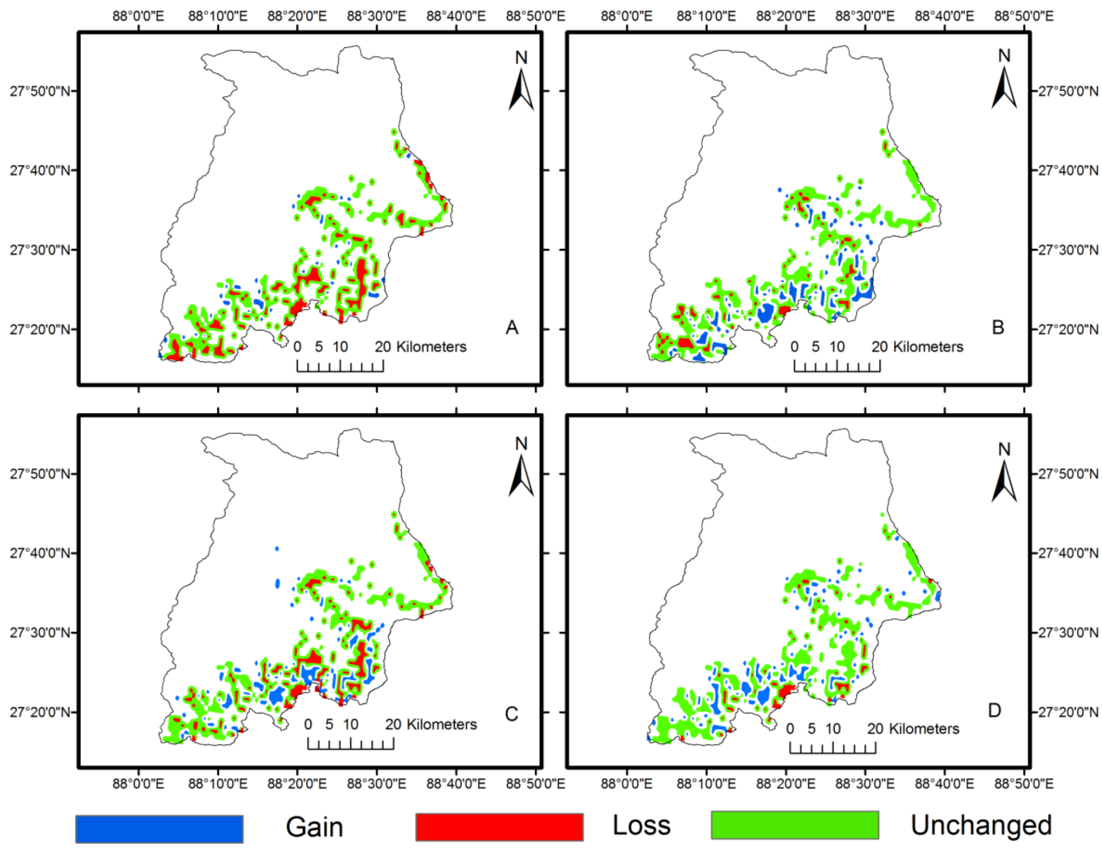


Figure 6.23: Gain and loss in sq. km of suitable habitat of Kalij Pheasant in the Khangchendzonga Biosphere Reserve

In the Khangchendzonga Biosphere Reserve, the gain and loss of suitable habitat area of Kalij Pheasant were predicted using Python-based GIS toolkit, SDM tool-box, for the future climatic scenario/year combination RCP-2050. Based on RCP-2050 models, the predicted gain area is found to be increased by 141.6274 sq. km or 4.831853 % of the present suitable area under RCP 4.5 followed by RCP 8.5 (133.9033 sq. km or 4.568332 %), RCP 6.0 (130.2972 sq. km or 4.445304 %), and RCP 2.6 (45.32076 sq. km or 1.546193 %); whereas the highest predicted loss area is found to be decreased by 230.0028 sq. km or 7.846925% under RCP 2.6 followed by RCP 6.0 (198.2783 sq. km or 6.764592 %), RCP 4.5 (100.8387 sq. km or 3.440279%), and RCP 8.5 (79.43415 sq. km or 2.710027 %).

Table 6.11: Predicting dynamic changes in suitable habitat area for Kalij Pheasant in the Khangchendzonga Biosphere Reserve under different future climate scenario/year combination

Area (sq. km)						Proportion of area (%)			
Model	**Future**	**Loss**	**Gain**	**unchanged**	**Total**	**Loss**	**Gain**	**unchanged**	**Total**
RCP 2.6	440.7444	230.0028	45.32076	165.4208	-184.68	7.85	1.54	5.64	-6.30
RCP 4.5	537.051	100.8387	141.6274	294.5849	40.7887	3.44	4.83	10.05	1.39
RCP 6.0	525.7208	198.2783	130.2972	197.1453	-67.981	6.76	4.4	6.72	-2.31
RCP 8.5	525.4002	79.43415	133.9033	312.0627	54.469	2.71	4.57	10.64	1.85

The maximum suitable habitat area of the species, 312.0627 sq. km or 10.64653% will remain unchanged in both the present and future climate scenario based on RCP 8.5 followed by RCP 4.5 (294.5849 sq. km or 10.05025%), RCP 6.0 (197.1453 sq. km or 6.725938%), and RCP 2.6 (165.4208 sq. km or 5.643604 %). Overall, the total suitable habitat area would have increased by 54.4692 sq. km or 1.85831 % under RCP 8.5 and in RCP 4.5 by 40.7887 sq. km or 1.39157 %, whereas, the total suitable habitat area be decreased by 184.682 sq. km or 6.300733 % under RCP 2.6 and in RCP 6.0 by 67.9811 sq. km or 2.319288% (Table 6.11, Figure 6.23).

7.1.3.12. Impact of future climate change on gain and loss of suitable habitat of Satyr Tragopan in the Khangchendzonga Biosphere Reserve

The gain and loss of suitable habitat area of Satyr Tragopan were predicted using Python-based GIS toolkit, SDM tool-box, for the future climatic scenario/year combination RCP-2050 in the Khangchendzonga Biosphere Reserve. Based on RCP-2050 models, the predicted gain area is found to be increased by 86.07617 sq. km or 2.936631 % of the present suitable area under RCP 4.5 followed by RCP 2.6 (68.3776 sq. km or 2.332815%), RCP 8.5 (12.45839sq. km or 0.425039%), but in RCP 6.0 there was no predicted gain; whereas the highest predicted loss area is found to be decreased by 319.3879 sq. km or 10.89645% under both RCP 6.0 and RCP 8.5 followed by RCP 2.6 (239.3216 sq. km or 8.164852%), and RCP 4.5 (172.1523 sq. km or 5.87326 %). The maximum suitable habitat area of the species, 147.2355 sq. km or 5.023182 % will remain unchanged in both the present and future climate scenario based on RCP 4.5 and in RCP 2.6 by 100.2872 sq. km or 3.421463 %), whereas, both RCP 6.0 and RCP 8.5 will be totally remain changed.

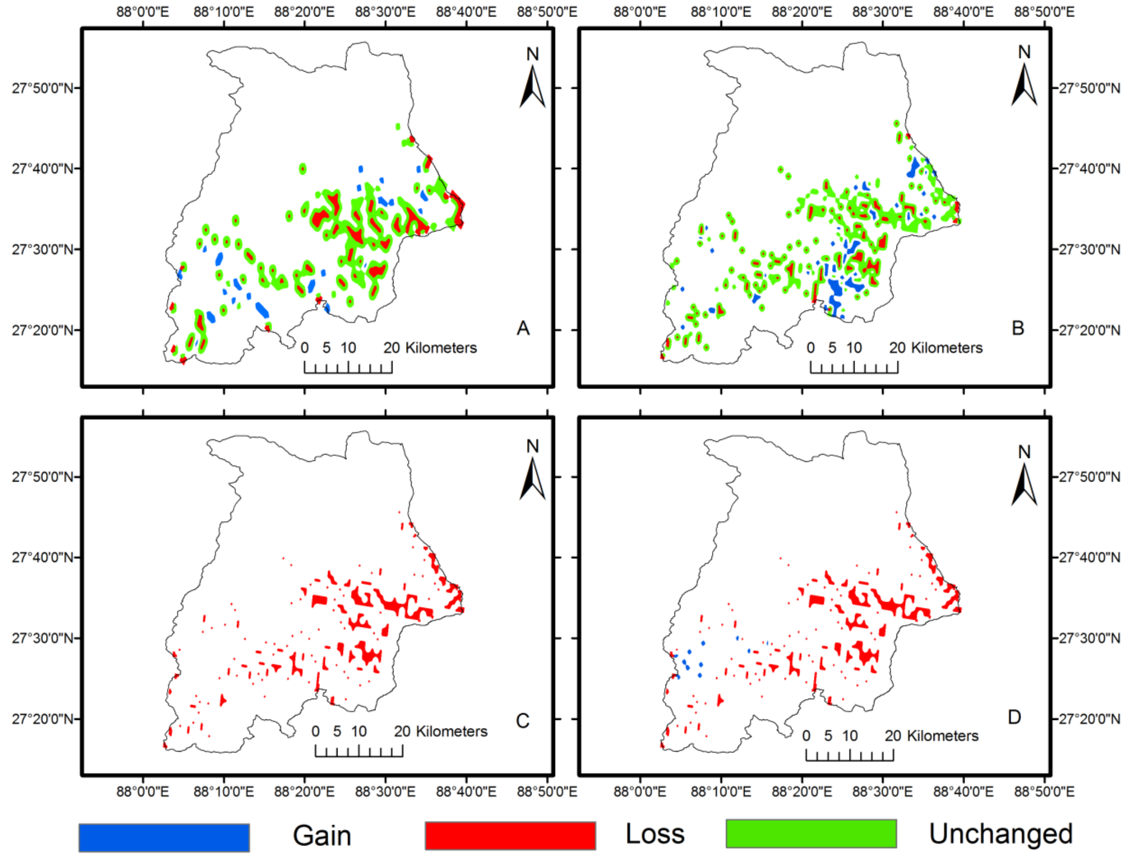


Figure 6.24: Gain and loss in sq. km of suitable habitat of Satyr Tragopan in the Khangchendzonga Biosphere Reserve

Overall, the total suitable habitat area would have decreased by 319.387 sq.km or 10.89 % under RCP 6.0 followed by RCP 8.5 (306.9295 sq. km or 10.47141%), RCP 2.6 (170.944 sq. km or 5.832037 %), and RCP 4.5 (86.07613 sq. km or 2.936629%), whereas in RCP 6.0, the future suitable habitat area of the Satyr Tragopan will be lost (Table 6.12, Figure 6.24).

Table 6.12: Predicting dynamic changes in suitable habitat area for Satyr Tragopan in the Khangchendzonga Biosphere Reserve under different future climate scenario/year combination

Area (sq. km)						Proportion of area (%)			
Model	**Future**	**Loss**	**Gain**	**unchanged**	**Total**	**Loss**	**Gain**	**unchanged**	**Total**
RCP 2.6	407.9864	239.3216	68.3776	100.2872	-170.94	8.16	2.33	3.42	-5.83
RCP 4.5	405.464	172.1523	86.07617	147.2355	-86.076	5.87	2.93	5.023	-2.94
RCP 6.0	319.3879	319.3879	nil	nil	-319.38	10.89	0	nil	-10.89
RCP 8.5	331.8463	319.3879	12.45839	nil	-306.93	10.89	0.42	nil	-10.47

7.1.3.3. Distributional shifts in the core zone

7.1.3.3.1. Centroid Change of the Blood Pheasant in Eastern Himalaya

The core distribution shift of the suitable habitat area for the Blood Pheasant was quantified in the Eastern Himalayas. The centroid of the present distribution of the suitable habitat of the Blood Pheasant was located at the geo-referenced position of 91.228E in the longitude and 27.771 N in the latitude of the part of Bhutan in the Eastern Himalayas. Under future climatic scenario RCP 2.6, the centroid of suitable habitat of the Blood Pheasant would be shifted towards the west of Bhutan at the geo-referenced position of 89.812 E in the longitude and 27.779 N in the latitude.

Similarly, in RCP 4.5, the present centroid of the suitable habitat of the Blood Pheasant would be shifted towards the western part of Bhutan at the geo-referenced position of 90.646 E in longitude, and 27.754 N in longitude. In RCP 6.0, the present centroid of the suitable habitat of the Blood Pheasant would be shifted towards the south-west of Bhutan at the geo-referenced point of 91.125 E in longitude, and 27.651 N in latitude. Whereas, under RCP 8.5, the present centroid of the suitable habitat of the Blood Pheasant would be shifted towards the eastern part of Bhutan at the geo-referenced point 91.728 E in longitude, and 27.701 in latitude (Figure 6.25).

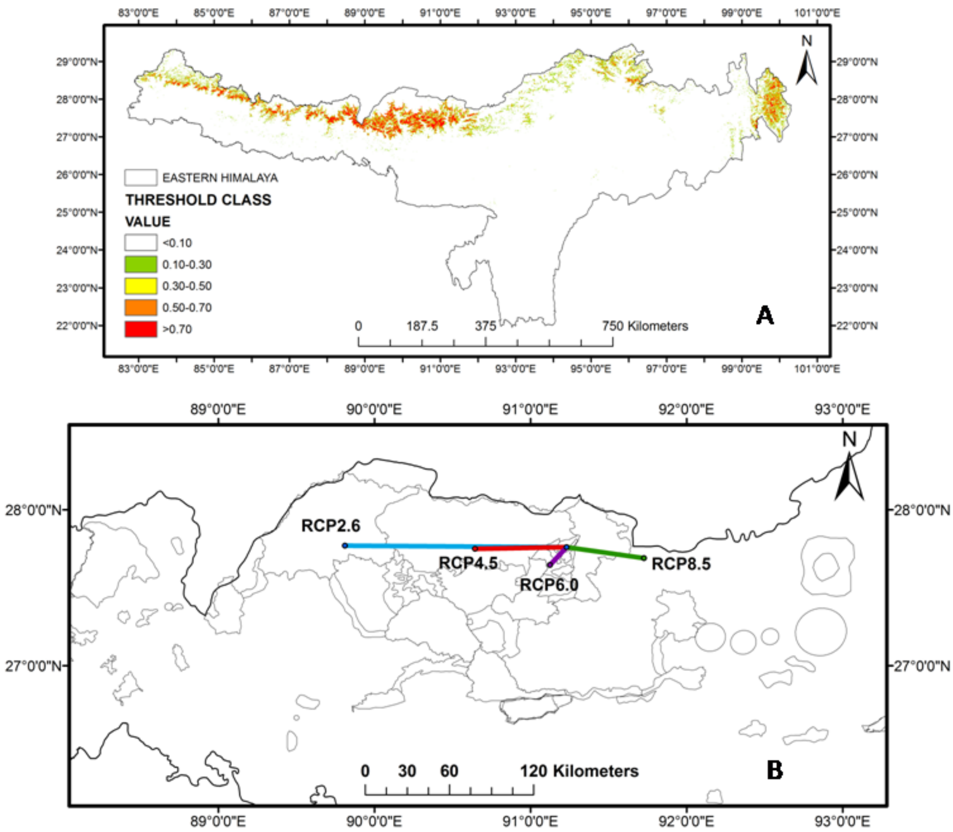


Figure 6.25: Centroid change of Blood Pheasant in the Eastern Himalayas (grey lines depict protected areas).

7.1.3.3.2. Centroid Change of the Himalayan Monal in Eastern Himalaya

The core distribution shift of the suitable habitat area for the Himalayan Monal was quantified in the Eastern Himalayas. The centroid of the present distribution for the suitable habitat of the Himalayan Monal was located at the geo-referenced position of 88.531 E in longitude and 27.887 N in latitude of part of Sikkim Himalaya. The present centroid of the suitable habitat of the Himalayan Monal under RCP 2.6 would be shifted towards the western part of the Sikkim Himalayas at the geo-referenced of 86.614 E in the longitude and 27.974 N in latitude.

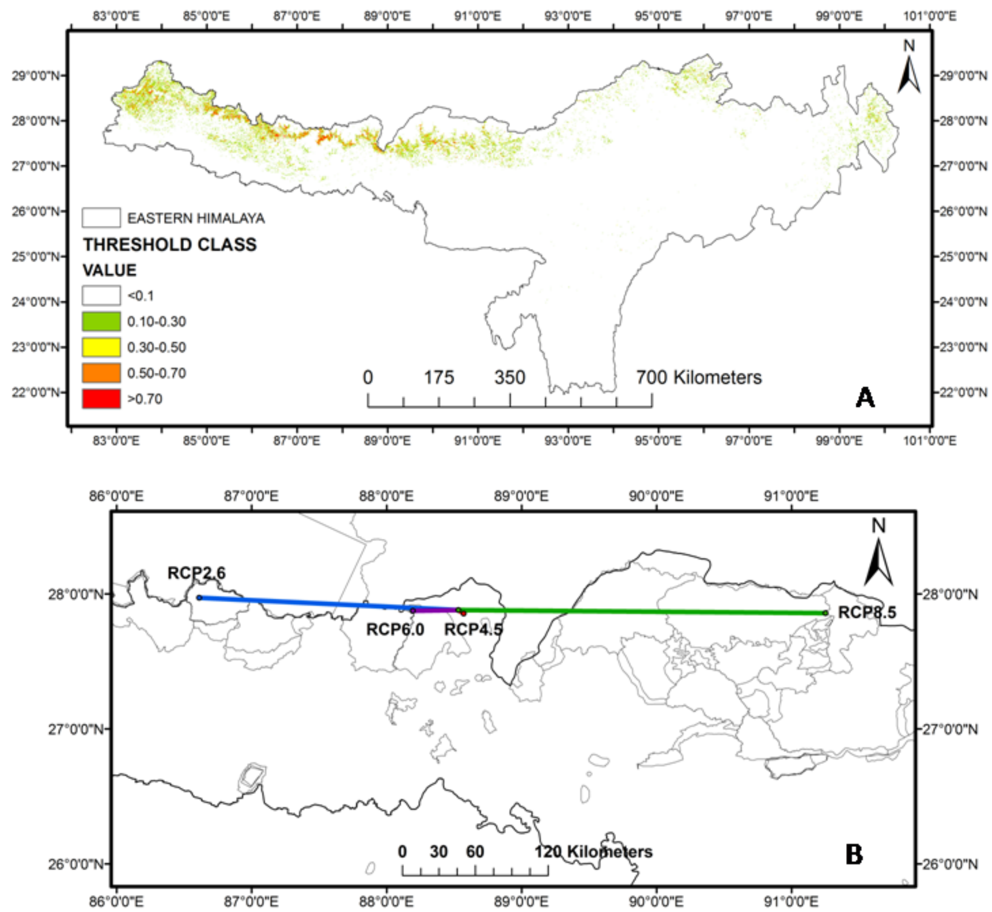


Figure 6.26: Centroid change of Himalayan Monal in the Eastern Himalayas (grey lines depict protected areas).

Under RCP 4.5 the present centroid of the suitable habitat of the Himalayan Monal would not much be affected and shifted around the present centroid at the geo-referenced position of 88.573 E in longitude and 27.974 N in latitude in the Sikkim Himalayas. Whereas, in RCP 6.0 the present centroid of the suitable habitat of the Himalayan Monal would be shifted towards the western part of Nepal at the geo-referenced of 88.188 E in the longitude and 27.878 N in latitude. In RCP 8.5 the centroid of the suitable habitat of the Himalayan Monal would be shifted towards the extreme north-east part of India at the geo-referenced position of the 91.252 E in longitude and 27.861 in latitude (Figure 6.26).

7.1.3.3.3. Centroid Change of the Kalij Pheasant in Eastern Himalaya

The core distribution shift of the suitable habitat area for the Kalij Pheasant was quantified in the Eastern Himalayas. The centroid of the present distribution for the suitable habitat of the Kalij Pheasant was located at the geo-referenced position of 88.065 E in Longitude, and 27.478 N in latitude of part of Sikkim. The present centroid of the suitable habitat of the Khalij Pheasant under RCP 2.6 would be shifted towards north-west part of Sikkim at the geo-referenced position of 88.065 E in the longitude and 27.478 N in latitude. Under RCP 4.5 the present centroid of the suitable habitat of the Kalij Pheasant would be shifted towards the eastern part of Sikkim at the geo-referenced position of 88.563E in longitude and 27.335 N in latitude in the Sikkim Himalayas. Whereas, in RCP 6.0 the present centroid of the suitable habitat of the Kalij Pheasant would be shifted towards eastern part of Sikkim at the geo-referenced position of 88.717 E in the longitude and 27.063 N in latitude. In RCP 8.5 the centroid of the suitable habitat of the Kalij Pheasant would be shifted towards the south -east part of Darjeeling (West Bengal) of India at the geo-referenced position of the 88.563 E in the longitude and 27.347 N in latitude (Figure 6.27).

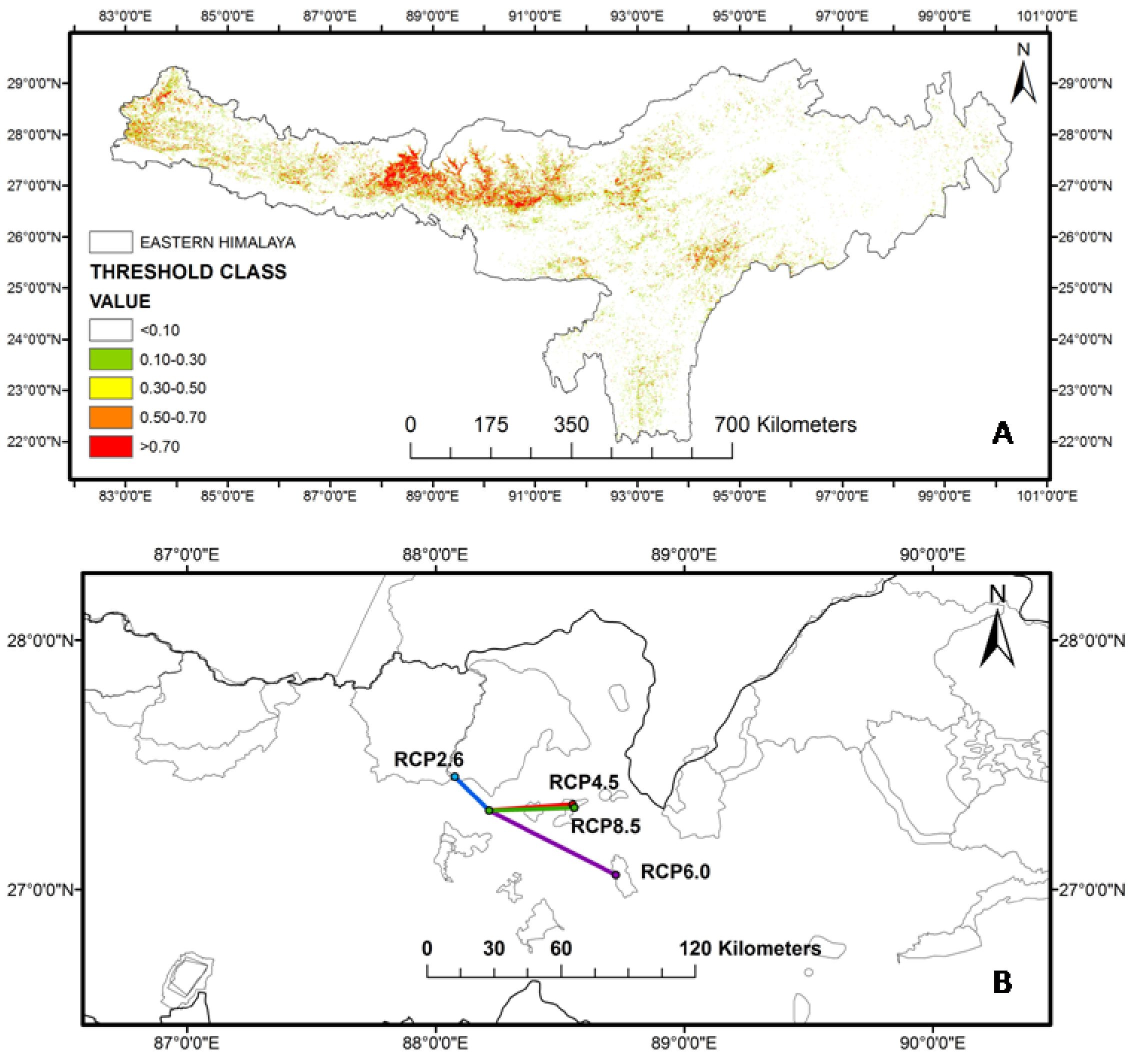


Figure 6.27: Centroid change of Kalij Pheasant in the Eastern Himalayas (grey lines depict protected areas).

7.1.3.3.4. Centroid Change of the Satyr Tragopan in Eastern Himalaya

The core distribution shift of the suitable habitat area for the Satyr Tragopan was quantified in the Eastern Himalayas. The centroid of the present distribution for the suitable habitat of the Satyr Tragopan was located at the geo-referenced position of 89.511E in longitude and 27.454 N in latitude of part of Bhutan. The present centroid of the suitable habitat of the Satyr Tragopan under RCP 2.6 would be shifted towards the eastern part of Bhutan at geo-referenced position of 91.561 E in longitude and 27.561 N in latitude.

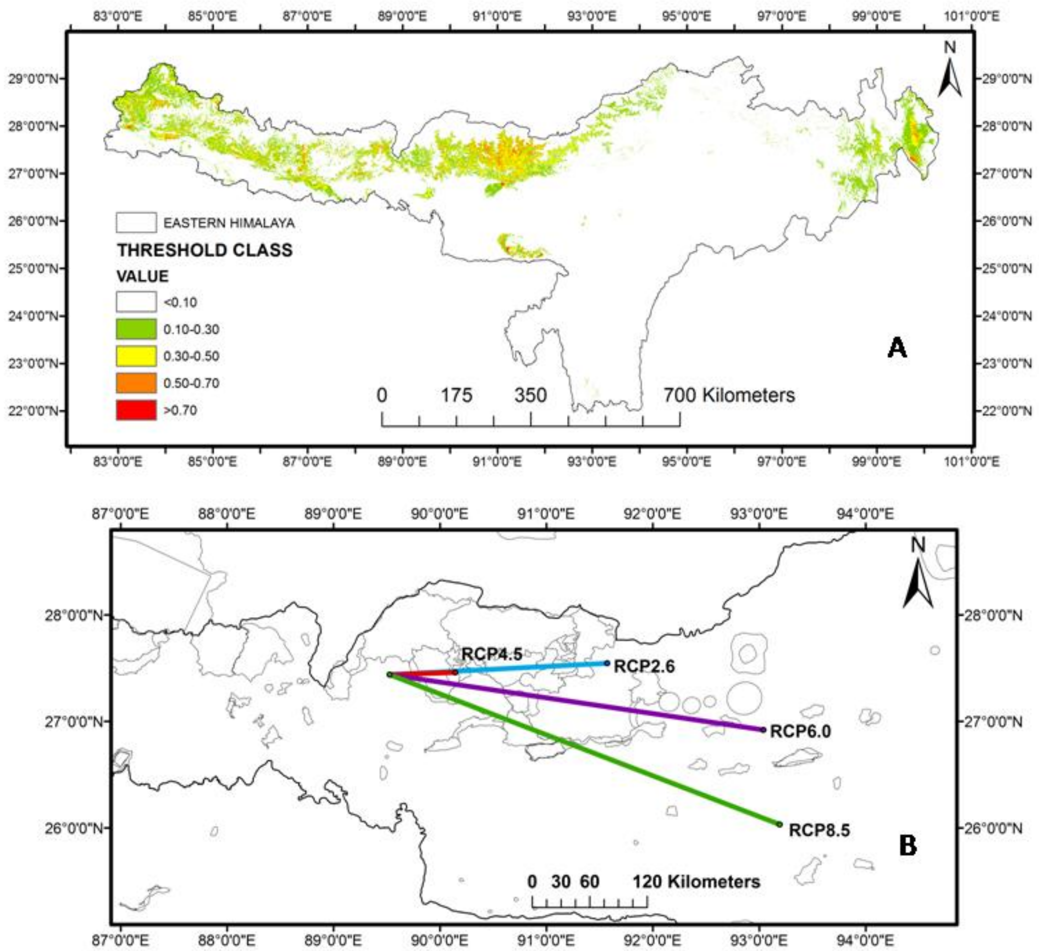


Figure 6.28: Centroid change of Satyr Tragopan in the Eastern Himalayas (grey lines depict protected areas).

Under RCP 4.5 the present centroid of the suitable habitat of the Satyr Tragopan would not much be affected and shifted towards the eastern part of Bhutan at the geo-referenced position of 93.03 E in the longitude and 26.956 N in latitude in the Sikkim Himalayas. Whereas, in RCP 6.0 the present centroid of the suitable habitat of the Satyr Tragopan would be shifted towards the north-east part of India at the geo-referenced position of 90.127 E in longitude and 27.489 N in latitude. Again, in RCP 8.5 the centroid of the suitable habitat of the Satyr Tragopan would be shifted towards the extreme north-east part of India at the geo-referenced position of 93.196E in the longitude and 26.044 N in latitude (Figure 6.28).

CHAPTER 07(I)

OBJECTIVE 04

DISCUSSION

7.1.4. Discussion

The results of climate change distribution model also demonstrated that the future global climate change will have a significant impact on the availability and distribution of Himalayan pheasants in the Eastern Himalayas, Sikkim Himalayas, and Khangchendzonga Biosphere Reserve; that will be an indication of future climate change impact on avian distribution in the Himalayas. Some of the species are restricted to a particular habitat, which is very difficult for them to cope up with altered habitat. Additionally, the population loss and along with altering distribution and abundance of many species are driven by climate change threatening both species diversity and the delivery of critical ecosystem services (Wang et al., 2014; Hu et al., 2015). Most of the climate change researches and forecasts have focused the shifts in climatic means around the world. According to IPCC, 2013 AR5 report the Greenhouse gases contributed a global mean surface warming in the range of 0.5°C to 1.3°C over the period 1951 to 2010 (Stocker et al., 2013). The Himalayas are experiencing a rapid process of climate change, wherein the temperature is increasing (Sharma et al., 2009) and the rainfall is uncertain (Goswami et al., 2006). Furthermore, Himalaya is considered as a data deficient region, the main reasons for this data deficit are the limited number of long-term research stations and systematic data collection; in addition there are uncertainties about the consequences of various drivers of change due to a lack of long-term data (Chettri et al., 2015; Chhetri et al., 2017). Based on IPCC, 2013 AR5 report the Greenhouse gases have contributed to a global mean surface warming in the range of 0.5°C to 1.3°C over the period 1951 to

2010 (Stocker et al., 2013). In the study, the three models (GCMs) were an ensemble, based on their means to reduce the bias among the models for predicting the impacts of future climate change on the distribution of the Himalayan Pheasants in the Himalayas. The results indicate that various forms of temperature and precipitation have an important role in shaping the distribution range of the Himalayan Pheasants in the future climate scenario RCP-2050. The present study predicts that under different concentrations of greenhouse gas emission scenario RCP 2.6-2050, RCP 4.5-2050, RCP 6.0-2050 and RCP 8.5-2050, most of the suitable habitat range will be shrinking in the Khangchendzonga Biosphere Reserve, Sikkim Himalayas, and Eastern Himalayas, until a genuine policy change to reduce greenhouse gas emission is in place and implemented effectively. Based on the result of loss and gain of suitable habitats of the Himalayan Pheasants under different future scenario RCP-2050 in the Eastern Himalayas, Sikkim Himalayas, and Khangchendzonga Biosphere Reserve, on assessing separately, the models reveal that the majority of suitable habitats of the Himalayan Pheasants will be shifting towards higher altitude and latitude in the Himalayan landscape. Although, the estimates of anthropogenic based climate change impacts on biodiversity rely on the projection of different climate models but the uncertainties in those have been a limiting factor, in particular at local scales, a new generation of more complex scenarios' climate change models, perhaps naively, expected to provide more certain projections (Knutti & Sedláček, 2013). Sometime robustness of new generation models can be weaker in consistency than simpler models for accuracy. Even theoretical process understanding and some experimental observations provide strong support for the argument that climate change will probably exceed in the twenty-first century compared to the past century

(Solomon et al., 2007) but the RCP 2.6 scenario, in which global greenhouse-gas emission is reduced by about 90% in 2100, is compared with the present status (Knutti & Sedláček, 2013). However, most of the suitable habitat of the Himalayan Pheasants would be lost in low altitude and latitude landscapes under the different future climate scenario. In general, the present study reveals that the trend of habitat shift to the higher altitude and higher latitude would gradually become more prominent and significant with climate warming. However, the protected areas are considered be have a vital role to play in achieving the global biodiversity targets (Rodriguez et al., 2007; Dunn et al., 2016); additionally, this type of climate change model will help to identify very sensitive areas or habitats of species besides protected areas (PAs). Such type of areas ideally is placed under biodiversity conservation management where the level of biodiversity is under risk or climatic impacts with very high threatening factors (Ricketts et al., 2005). Based on Dunn et al. (2016), the study has strongly challenged the conservation policy for management of protected areas of the Himalayas because the existing protected area network was significantly worse than their optimal zonation result and not up to both Aichi Target 11 and CBD targets for Himalayan Pheasants conservation viewpoint. Within protected areas effective reinforcement is needed to prevent pheasant species extinctions, whereas, from South –East Asia, it is reported that the protected areas have not prevented habitat loss of species (Clark et al., 2013). Furthermore, biodiversity threats have reported that the hunting of Himalayan Pheasants is prevalent across the Himalayas for food and features (Kaul et al., 2004; Hilaluddin & Ghose 2005; Baral, 2005), especially Himalayan Pheasants (Inskipp et al., 2016), wherein even their population is declining (IUCN, 2016). The study suggests the presently protected area networks in the Eastern Himalayas do not cover adequately the distribution of suitable habitat area of the Himalayan Pheasants, thus questioning conservation potential of the same. Although, the species distributions may depend on climate change (Root et al., 2003; Hu et al., 2015; Wang et al., 2014), there may be possibilities in future, that many PAs in the Eastern Himalayas may offer better habitat opportunities for the species (Hannah et al., 2007). However, the Himalayan region comes under the influence of anthropogenic threats due to overexploitation of biodiversity by the people for their survival and largely for commercial purposes (Badola & Aitken, 2010). Moreover, the sustainable use of native biodiversity and improved area management is equally important. Or else, overexploitation of natural resources may result in an alternation of the habitat of certain faunal diversity including Himalayan Pheasants and birds, which is highly threatened for its great sensitivity towards habitat degradation. Hitherto, Himalayan Pheasants are largely ignored for their conservation management and researches, as most of them are found in high elevation habitats, it is often very difficult to monitor them in sloppy and undulating terrains. More sophisticated modelling under climate scenario is needed to attain a goal and vision for the conservation management programmes. The present study further suggests the following management strategies for the Himalayas in response to future climate change, especially in the context of Himalayan Pheasants:

A) Conserve the threatened or climate sensitive species by making suitable conservation policy or programme to introduce/translocate the same in the new projected area(s) at present and in future; B) Implement long-term monitoring of the Himalayan Pheasants in highly sensitive zones, where there are potential threats, which may cause habitat loss of the Himalayan Pheasants under the future climate change scenario; C) Promote and support establishing and extending more PAs within newly projected highly suitable habitat areas in the trans-boundary landscapes, at present and in future climatic conditions, to protect sensitive or endemic species, before they plunge to extinction by poor human management and ignorance.

CHAPTER07(II)

OBJECTIVE 04

To study the climate change impact on the distribution of pheasants and their associated elements, including using perception tools.

Climate change impact on Himalayan Pheasants based on local perception (II).

CHAPTER 07 (II)

OBJECTIVE 04

BACKGROUND

Objective 04(II)

7.2: Climate change impact on Himalayan Pheasants based on local perception

7.2.1. Background

Conceptual frameworks of the impact of climate change on biodiversity have given more emphasis to the understanding linkage between indigenous people and their environment. Indigenous and traditional ecological knowledge plays a crucial role to develop as baseline long-term data sets assembled over centuries of trial and error (Turner, 2009), which can be utilized by scientists, and policy-makers to develop an action plan of the landscape for future perceptive. Indigenous people are closely related to the natural rhythms and processes of their ecosystem (Vogt et al., 2002). Therefore, their perception of changing in their ecosystem with the time is crucial for understanding the ongoing biodiversity process and pattern, and climate change trends of the landscape. With diminishing of such cultures, their indigenous and traditional ecological knowledge system is also vanished, for example taking with it the repository of long- term phenological data (see Barnard & Thuiller, 2008) and range shift data of species that we desperately need. Similarly, in many developed countries, loss of traditional culture and Indigenous knowledge has led to a gap between people and nature. Nowadays, this loss also accelerated by modernization, new technology, and anthropogenic pressure for the betterment of our lifestyle. In Polar regions, hunting and fishing strategies depend on stable ice for Arctic people; yet, the temperature in the Arctic is predicted to rise by as much as 8˚C in the 21st century under present century (Pachauri et al., 2014). In the alpine region, climate warming is critically viewed in response to the loss of alpine biodiversity. Upward movement of plant species, predicted to be displaced off the top of mountains, off their “sky islands” (Gottfriedetal, 1999). Increases in mean annual temperature are not uniform across the globe. Instead, some of the highest average temperature increases are experienced in the high-mountain ecosystem of the Himalayas (Pachauri et al., 2014). Rural people already have in-depth knowledge of local climate variability and these changes as part of their traditional ecological knowledge which evolving by adaptive processes and handed down through generation by cultural transmission (Berkes et al., 1995, 2000). Therefore, ‘local perceptions’ refer to the way how local people identify and interpret their long- term observation and concepts (Byg & Salick, 2009; Vignola et al., 2010). Most studies on the perceptions of climate deal with temperature and rainfall (Deressa et al., 2009; Fisher et al., 2010), even meteorological data are often used to confirm villagers’ assessments (Orlove et al., 2000; Vedwan & Rhoades, 2001; Deressa et al., 2009; Fisher et al., 2010), and perception of risks and threats related to climate variability (Adger et al., 2009; McCarthy, 2011; Saroar & Routray, 2012). Furthermore, the collaboration between indigenous and scientific knowledge to address more precise time frames of climate change and its impact on biodiversity could be explored. Using this strategy the first time attempt was made to assess the impact of climate change on Himalayan Pheasants and their resilience in the Sikkim Himalayas based on perception tool.

CHAPTER 07 (II)

OBJECTIVE 04

MATERIALS & METHODS

7.2.2. Materials and Methods

The perception-based survey was carried out in and around villages of the Khangchendzonga Biosphere Reserve in Sikkim especially focusing it's in the northern region and western region. The perception-based information was gathered by interviewing those who are directly or indirectly associated with the KBR such as forester, *Himal Rakshak,* guides, porters and pack owners. The semi-structured questionnaire was used followed by a snowball technique to collect the data from the 46 respondents. The interviews consisted of a series of questionnaires based on, 1) present availability of the Himalayan Pheasants, 2) status of the temperature in the locality, 3) Changes of availability of the Himalayan Pheasants compared to the last 10-20 years back, 4) present status of Poaching & Hunting of the Himalayan Pheasants, 5) experience of climate change in your locality, 6) Maximum poaching and hunting of the Himalayan Pheasants by forefathers, 7) range shift of the Himalayan Pheasants, 8) factor of range shift of the Himalayan Pheasants, 9) food habit of the Himalayan Pheasants, 9) predator of the Himalayan Pheasants, and 10) uses of Himalayan Pheasants.

7.2.2.1. Analytical analysis

From the procured data, the percentages of the responses and Priority Index was quantified by using formula,

Percentage of the response= no. of respondents respond the question /Total no. respondent*100

Priority Index= no. of a score of respondent given for a particular question/total score *100

The maximum possible score for each question was 10.

7.2.2.2. Statistical analysis

After gathering the data (Range shift, factor of range shift, and phenology shift of the Himalayan pheasants) various descriptive statistics were used. For establishing reliability constructs of the questionnaire Cronbach's alpha value was used (followed by a similar approach of Gliem & Gliem, 2003). Factor analysis was used to establish the scale dimensionality. Subsequently, to ensure the use of Principal Component Analysis, the Barlett Test of Sphericity (BTS) and Kaiser-Meyer-Olkin (KMO) test of appropriateness were used (followed by a similar approach of Olawale & Garwe, 2010). KMO (Kaiser-Meyer-Olkin) test was used to measure sample size adequacy (Norusis, 1985). A value the KMO test falls between one and zero if the value above 0.60 suggests that a factor analysis of the variables is appropriate (followed by a similar approach of Crane et al., 1991; Olawale & Garwe, 2010). In addition to this, a multiple regression analysis was used to find the degree of relationship between two explanatory variables (Factors of range shift of Himalayan pheasant and shift of phenology of Himalayan pheasant) and one dependent variable (Range shift of Himalayan pheasant). Collected the data of range shift, factor of range shift (climate change), and phenology shift of Himalayan Pheasants from the respondents was frame into 3 point scale for statistical analysis.

CHAPTER(II) 07

OBJECTIVE 04

RESULTS

7.2.3. Results

7.2.3.1. Analytical analysis

A total of 46 local persons, directly associated with the Khangchendzonga Biosphere Reserve, were interviewed. The respondents totally agreed to the fact that within the KBR, the four Himalayan Pheasants are found. They are Blood Pheasant, Himalayan Monal, Satyr Tragopan and Kalij Pheasant. Information gathered through interaction and semi-structured questionnaires revealed that the majority of the Himalayan Pheasants are found in the high-altitude region of the KBR except for the Kalij Pheasant, confined to the subtropical forest to the temperate forest of the region. This information was also validated by the current field surveys.

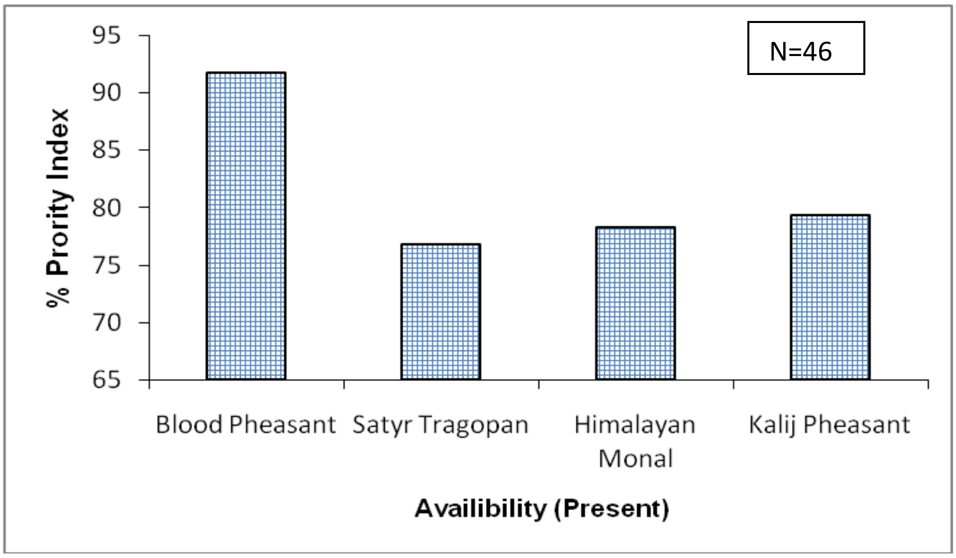


Figure 6.29: The present status of availability of the Himalayan Pheasants in the KBR based on perception of the local people

Using respondents' knowledge, the present status of availability of the Himalayan Pheasants was quantified and it seemed that the availability of Blood Pheasant population in the KBR was highest followed by Kalij Pheasant, Himalayan Monal, and Satyr Tragopan (Figure 6.29). The changes in the availability of the Himalayan Pheasants compared to the last 10-20 years back was also quantified from the respondents' perception and knowledge (Figure 6.30). Respondents revealed that the availability of the Himalayan Pheasants is moderate compared to the last decade; they did not see drastically changes. A few respondents also agreed that the populations of most of the Himalayan Pheasants of KBR are decreasing, except that of Blood Pheasant, which is increasing in the biosphere reserve.

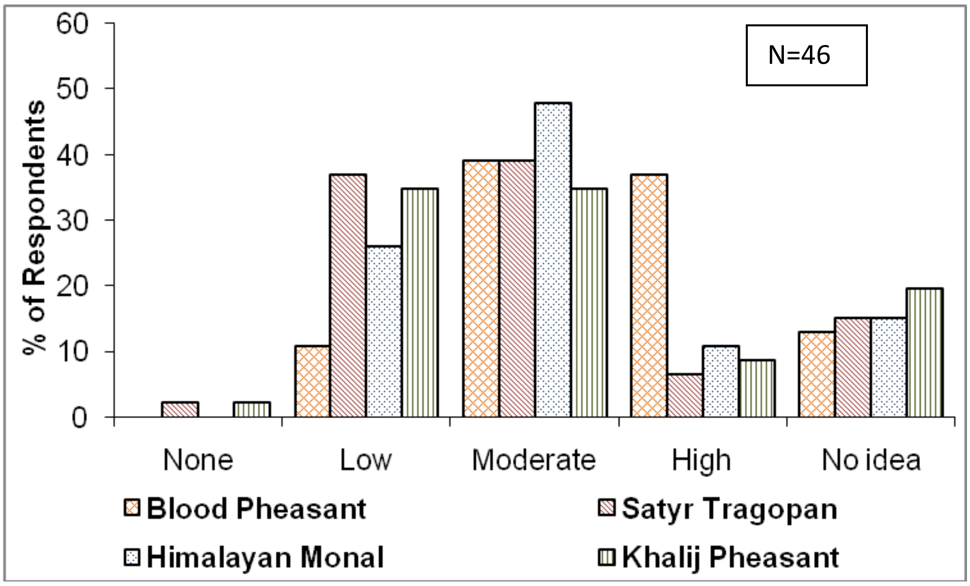


Figure 6.30: Availability of the Himalayan Pheasants compared to the 10-20 years back based on perception of the local people.

The respondents were also asked about the poaching or hunting of the Himalayan Pheasants in the Khangchendzonga Biosphere Reserve. Most of the respondents did not accept that they saw or encountered any poaching /hunting of the Himalayan Pheasants in the KBR except for a few numbers of respondents (Figure 6.31). The respondents were also asked for the maximum poaching/ hunting pressure of the Himalayan Pheasants in the Khangchendzonga Biosphere Reserve compared to the last decades, it was revealed that the maximum hunting pressure was on Kalij Pheasant followed by Satyr Tragopan, Blood Pheasant, and Himalayan Monal (Figure 6.32).

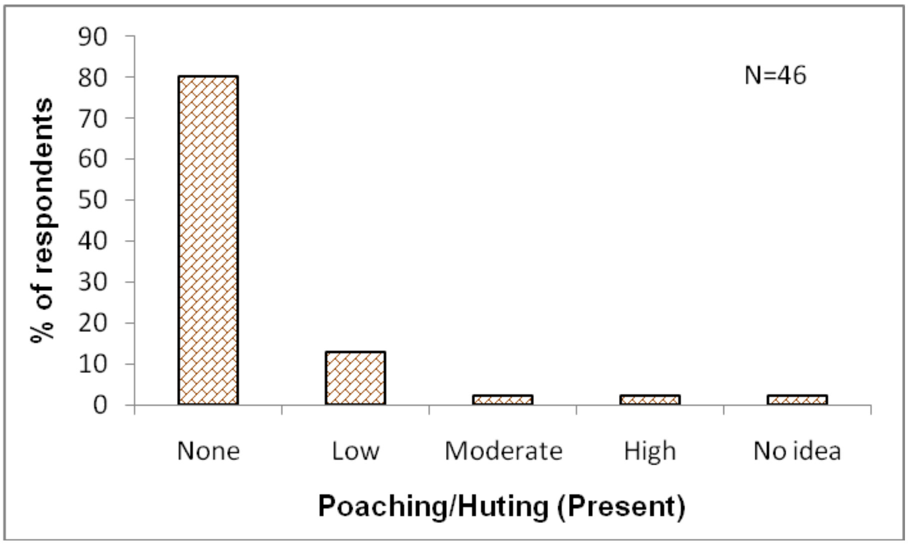


Figure 6.31: Poaching/hunting of the Himalayan Pheasant in present scenario based on perception of the local people.

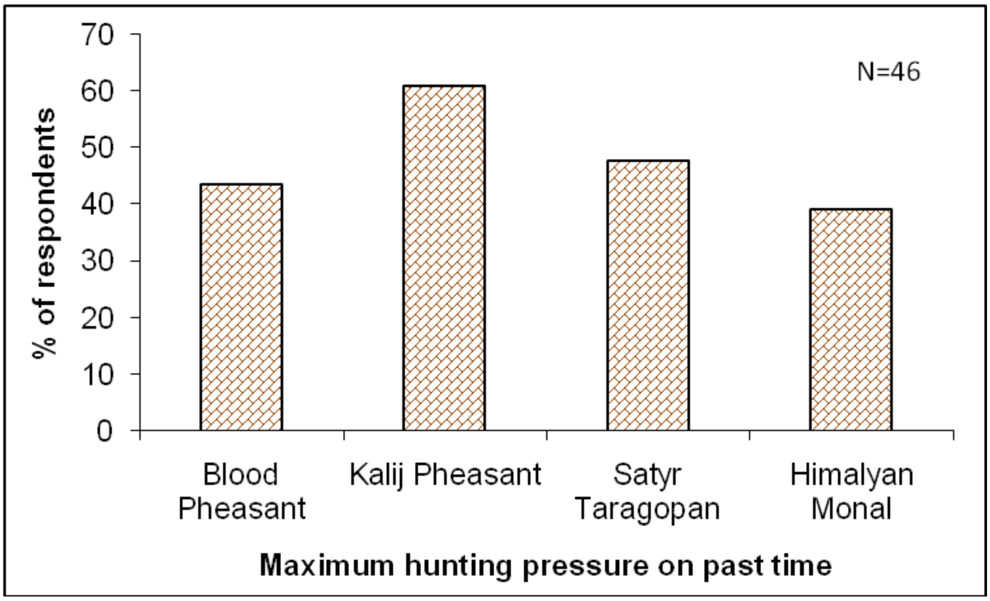


Figure 6.32: Maximum pressure on the Himalayan Pheasant during the last decades based on perception of the local people.

Through respondents, it was understood that the lower altitudinal Pheasants had more poaching/hunting pressure compared to the high altitudinal pheasants because the maximum human settlement is restricted to the lower altitudinal ranges, so it could be the main reason that the lower attitudinal range Pheasants are more threatened; however, such poaching was limited to fewer instances often, as per interaction with stakeholders. The most of the respondents also experienced that the temperature in and around the villages has been increasing compared to the last 10-20 years back (Figure 6.33).

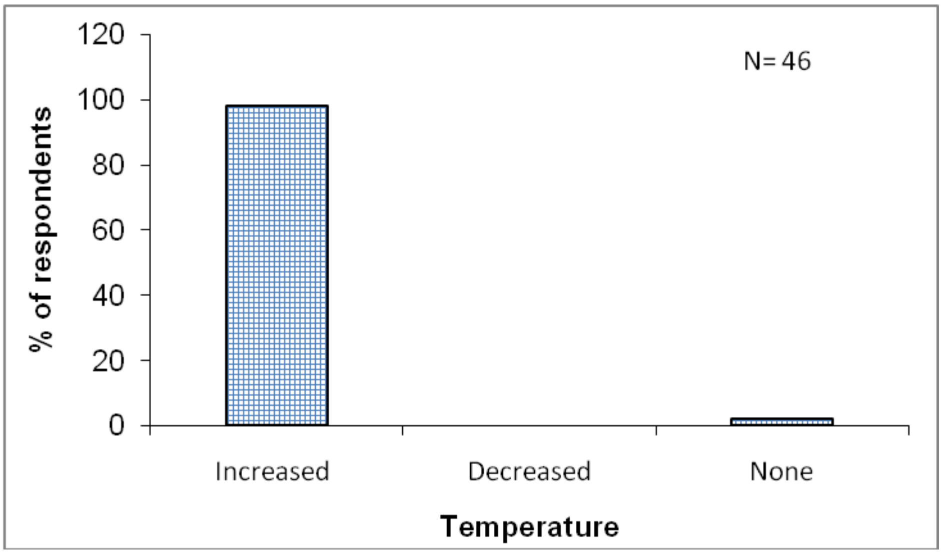


Figure 6.33: Experience of the temperature in the local premise based on perception of the local people.

The respondents were also asked about the experience of climate change in the village; most of the respondents agreed that the climate change in their area is prominent (Figure 6.34). Such as increasing temperature, drying wetland and springs, reducing snow cover, etc.

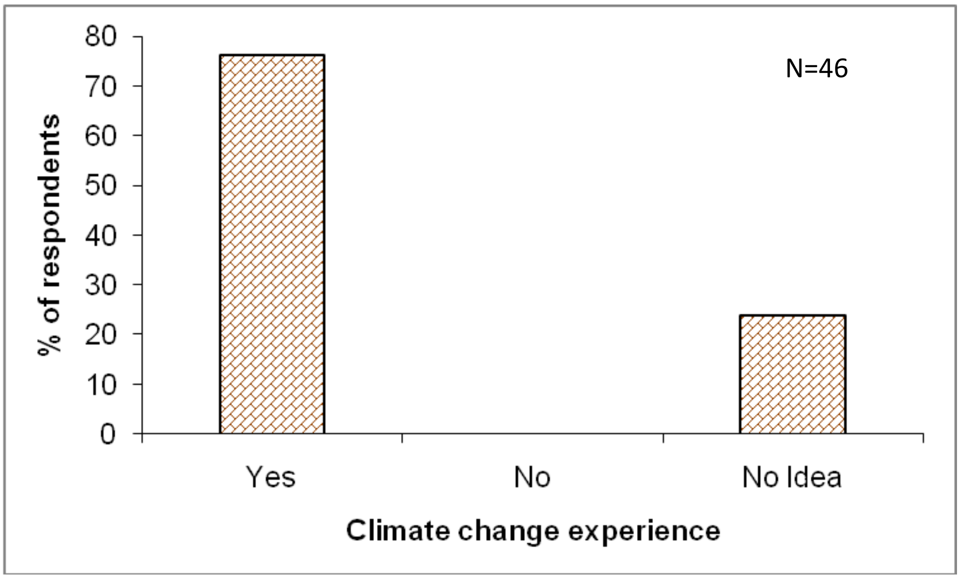


Figure 6.34: Experience of the climate change in the local premise based on perception of the local people.

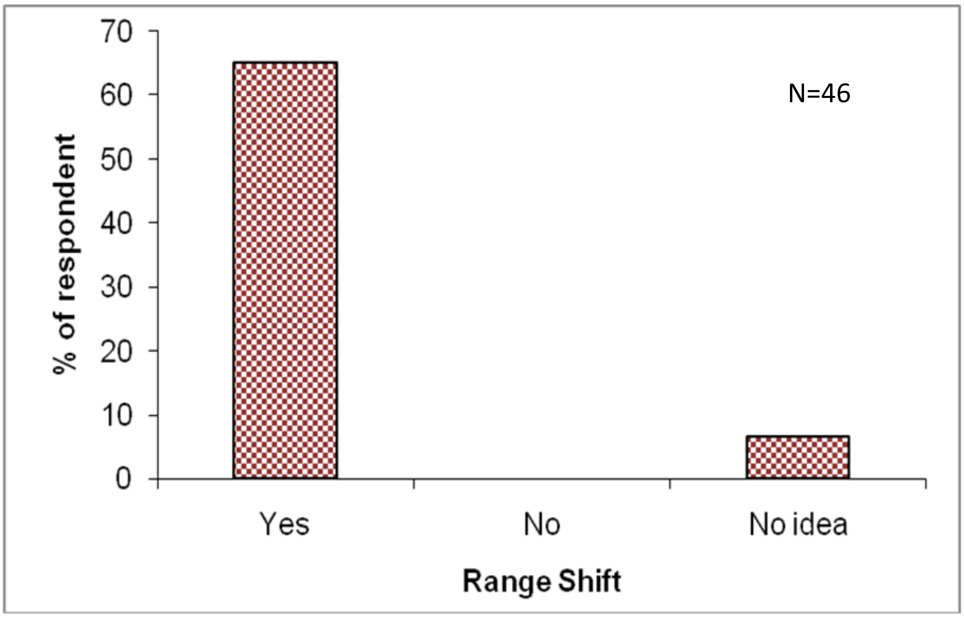


Figure 6.35: Range shift of Himalayan Pheasants based on perception of the local people.

According to respondents, the Himalayan Pheasants are shifting their range compared to the last 10-20 years back (Figure 6.35). Most of the respondents agreed that the Himalayan Pheasants are shifting their habitat range compared to the last decades and gave their views on different factors which could be the reasons for their range shifting.

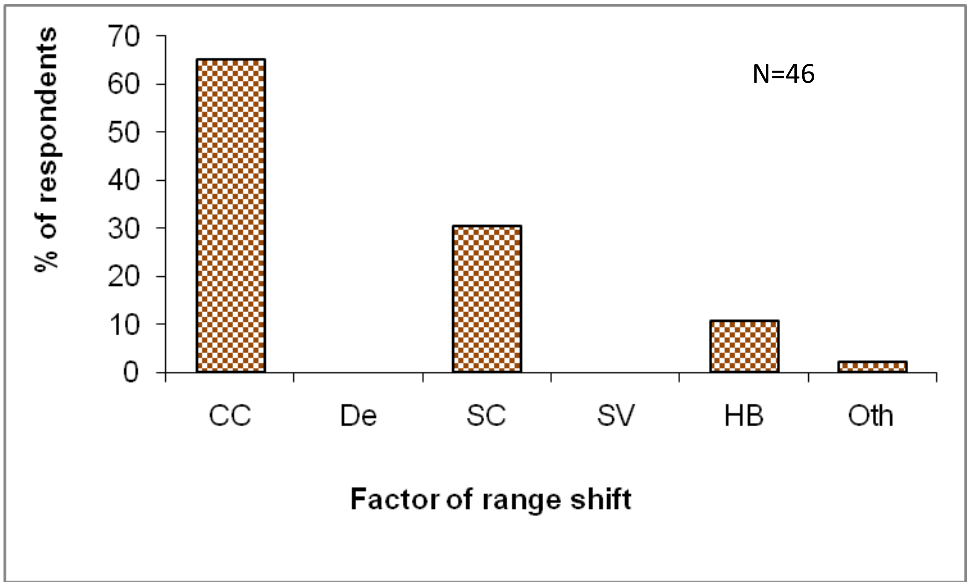


Figure 6.36: Factor of range shift of Himalayan Pheasants in KBR based on the local perception (climate hange,CC; deforestation, De; scarcity of food, SC; shifting vegetation, SV; habitat disturbance, HB; and others,Oth)

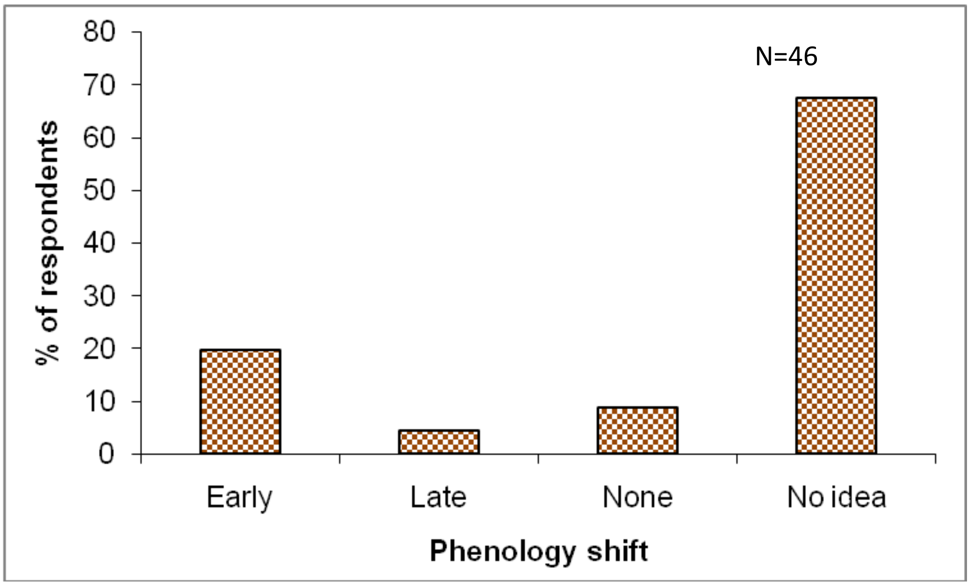


Figure 6.37: Phenology shift of Himalayan Pheasants in KBR based on perception of the local people.

The highlighted factors were climate change (CC), deforestation (De) scarcity of food (SC), shifting vegetation (SV) habitat disturbance (HB) and others (Oth); among them climate change, scarcity of food, and habitat disturbance appeared as the main causes for the Himalayan Pheasants' range shift (Figure 6.36). The people were also asked about any phenology shift of the Himalayan Pheasants, it was understood that the most of the respondents were unknown about it and only a few persons have noticed that the phenology of the Himalayan Pheasants is shifting earlier such as their breeding time compared to the last few decades (Figure 6.37).

The respondents were also asked about the food habits of the Himalayan Pheasants. The perception-based Priority Index (Figure 6.38) suggested that the moss is the most preferred food for the Blood Pheasant, followed by a fungus (*Ophicordceps sinensis*), grass and medicinal plant (*Arisema* spp.). Whereas, the medicinal Plants (*Arisema* spp. and *Aconitum* spp.) and *Ophiocordycep sinesis* are the preferred foods for Himalayan Monal. Similarly, people knew the preferred foods for the Satyr Tragopan are the fern followed by moss, insect, and medicinal plant (*Arisema* spp.). The Kalij Pheasant, however, highly prefers the wild seeds followed by the insect, and medicinal plant, *Arisima* spp. The above people's knowledge many times could be validated during field surveys on pheasants under current study. The study also developed the perception based Priority Index of the predators on the Himalayan Pheasants. Eagle (*Buteo hemilasius*) emerged as the top predator of the Blood Pheasant followed by the fox (*Vulpes ferrilata*), marten (*Martes Flavigula*), mongoose (*Herpestes urva*), and wildcat (*Neofelis nebulosa*). Similarly, the top predator of the Himalayan Monal emerged eagle, followed by mongoose, marten and fox.

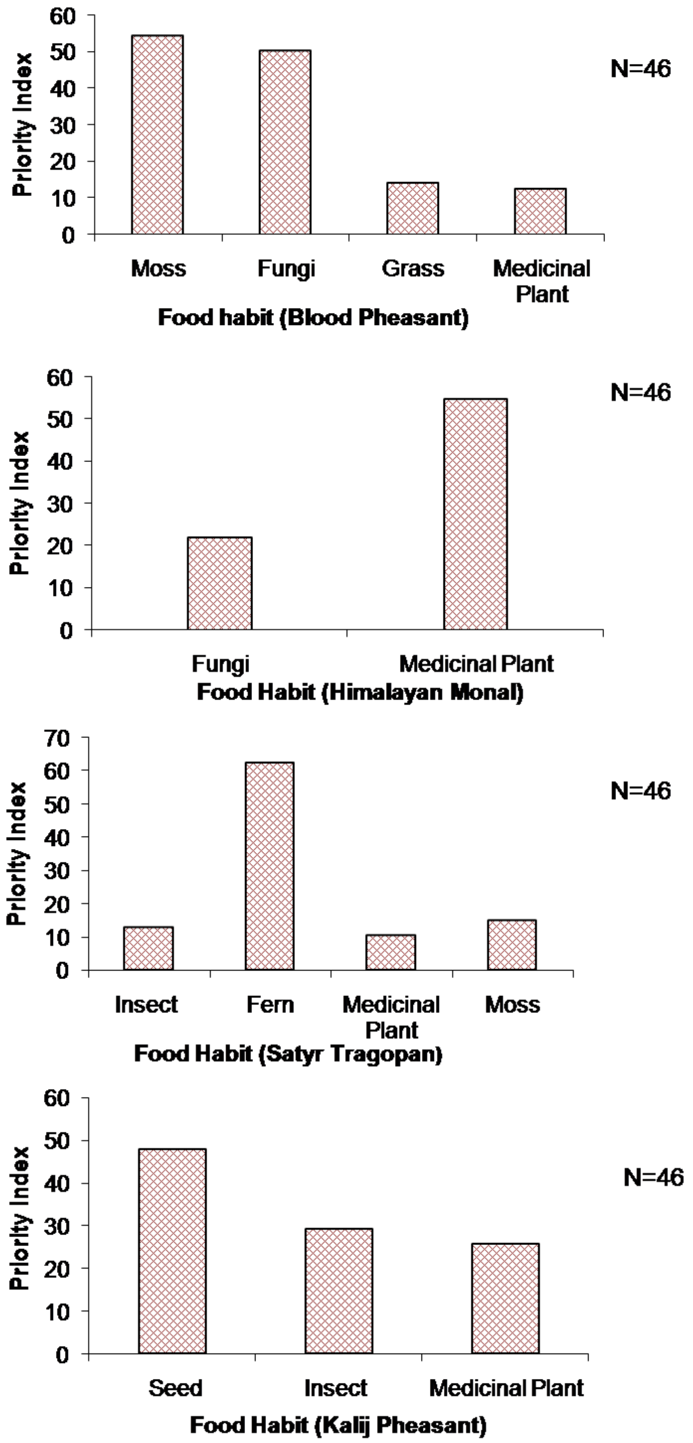
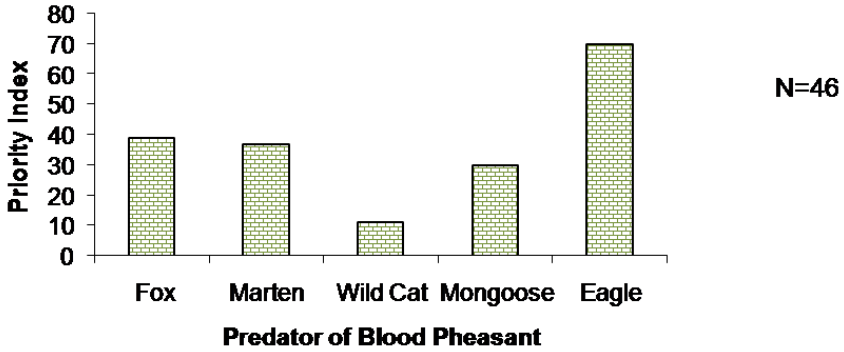
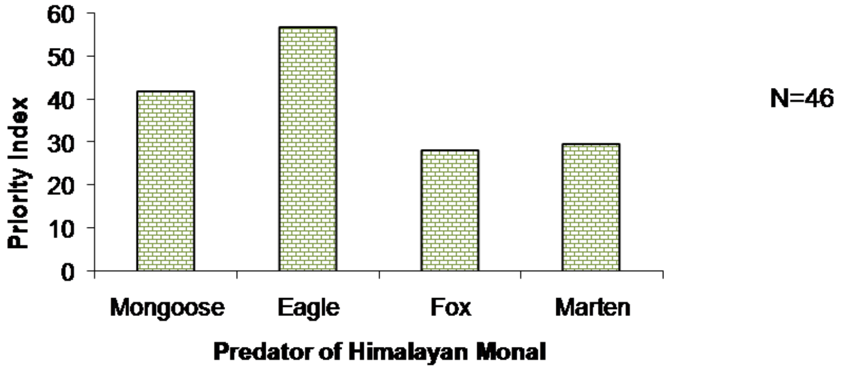
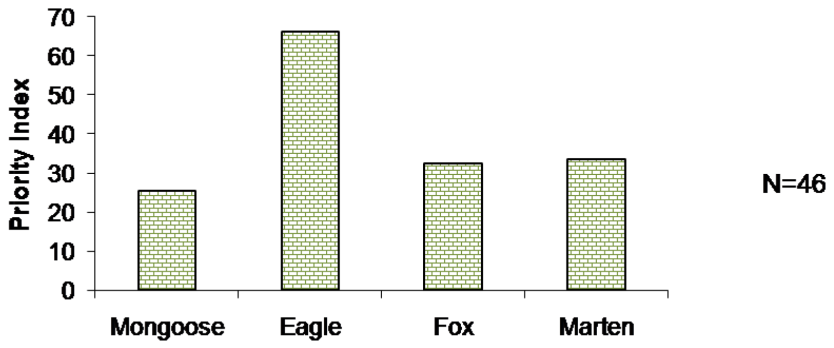


Figure 6.38 : Food habit of the Himalayan Pheasants in KBR, as per respondents' perception.







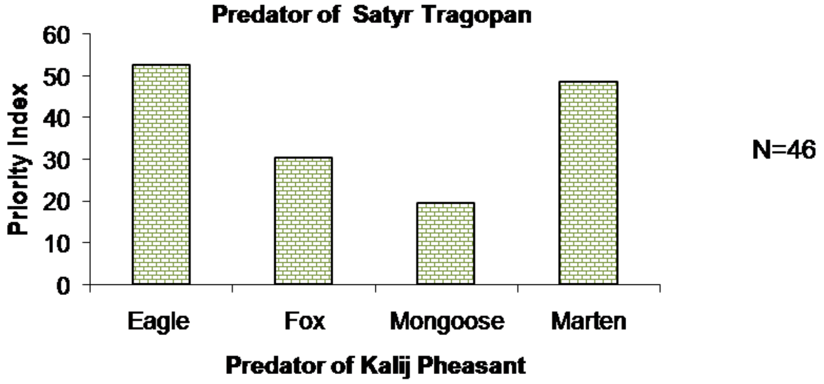


Figure 6.39: Predator of the Himalayan pheasants in KBR, as per respondents' perception.

For both the Satyr Tragopan and Kalij, the eagle emerged as the top perceived predator, followed by marten, fox, and mongoose (Figure 6.39).

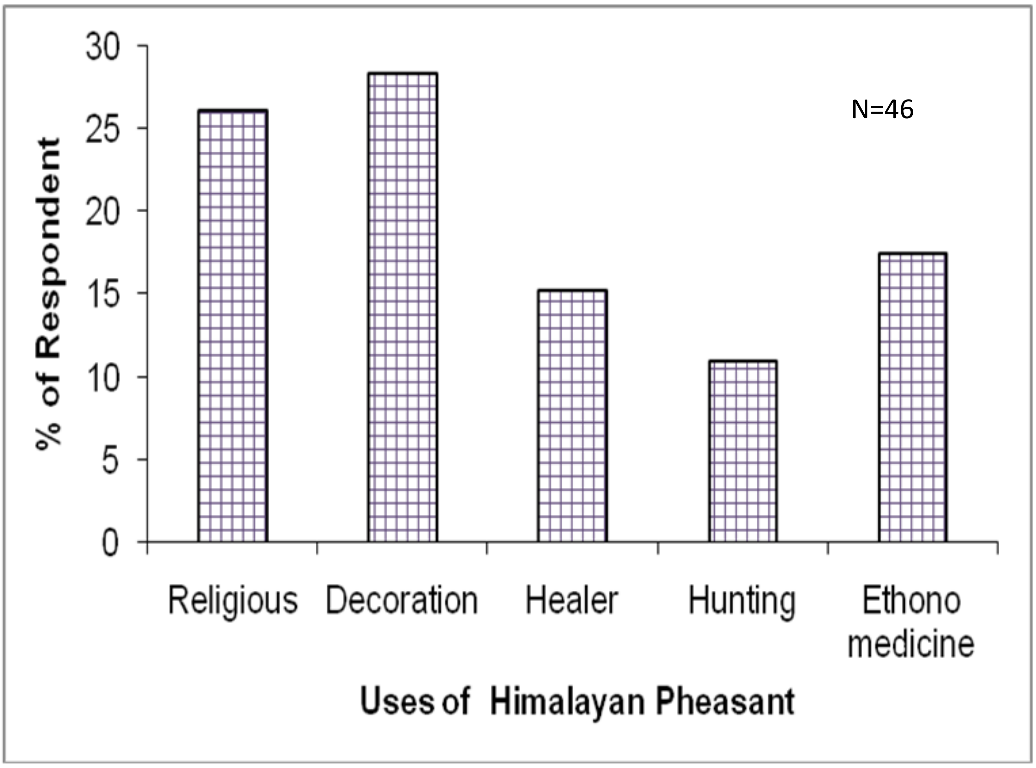


Figure 6.40: Uses of Himalayan Pheasants in past decades, as per respondents' perception.

The respondents were also asked about the uses of the Himalayan Pheasants in the past decades; most of the respondents agreed that the feathers of the Himalayan Pheasants were used in decoration and religious proposes, parts of the Himalayan Pheasant used in ethnomedicine, feathers are used by healers as well as in hunting for making arrows, etc (Figure 6.40).

7.2.3.2. Statistical Results

The descriptive statistics of variables considered in the study was self explanatory and the mean, mode, and median were very close which suggested that the variables not much of departure from the normal distribution. The standard deviation was not very high representing similarity in responses (Table 6.13). The findings of confirmatory factor analysis simply demonstrate that the sample size was adequate enough for the data as denoted by KMO test, the model is well fitted as revealed by the chi-square statistic which was significant beyond $p<.000$ (Table 6.14).

Table 6.13: Descriptive statistic for the explanatory variables of the questionnaire

Descriptive statistic	Range shift	Range shift factor	Phenology Shift
Mean	0.234	0.462	0.182
Median	0.250	0.512	0.144
Mode	0.300	0.600	0.100
Std. Deviation	.092	.180	.128

Bartlett's Test of Sphericity (BTS) result indicated that the data were appropriate for the purpose of Principal Component Analysis (the BTS at 42.814 and the level of significance at P = 0.000).

Table 6.14: KMO and Bartlett's Test for the explanatory variables of the questionnaire

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		.631
Bartlett's Test of Sphericity	Approx. Chi-Square	42.814
	Df	3
	Sig.	.000

Reliability of the questionnaire was denoted by Cronbach's Alpha of which the value was quite high in spite of smaller numbers of items. This signifies that the scale employed in this study demonstrates a high degree of reliability (Table 6.15). Having established the scale reliability and validity, a linear regression analysis is found to be appropriate to judge the pheasant range shift.

Table 6.15: Reliability statistics for the explanatory variables of the questionnaire

Cronbach's Alpha	N of Items
.701	3

Table 6.16 shows only one component with Eigen values greater than one account for 68.813% of the total variance. According to the rules of Principal Component Analysis only factors that have Eigen values greater than one should be retained. The component has an Eigen value of 2.064 and percentage of variance of 68.813 %. The

component consists of three items. These items are range shift, factor of range shift, and phenology shift of Himalayan Pheasant.

Table 6.16: Total variance explained the explanatory variables of the questionnaire

Component	Initial Eigenvalues			Extraction Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	2.064	68.813	68.813	2.064	68.813	68.813
2	0.666	22.191	91.004			
3	0.270	8.996	100.00			

Extraction Method: Principal Component Analysis.

The regressions results are presented in Table-6.17a and Table-6.17b to establish the relationship between the explanatory variables and the dependent variable which indicates the overall Pheasant range shifting. The results of the regression amply demonstrate that the goodness of fit was quite acceptable considering the F value which was significant beyond $p<0.000$. The factors of range shift significantly influence the overall Pheasant range shift as revealed by the data obtained from the respondents. Whereas, the shift of pheasant phenology and range shift of pheasant did not show significant relations. Table 6.17a shows the value of R Square which signifies that 55% of the variance in the dependent variable is explained by the taken independent or explanatory variable

Table 6.17a: Linear regression for the explanatory variables of the questionnaire

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.742[a]	.550	.530	.06339

Table 6.17b: Linear regression for the explanatory variables of the questionnaire

Model	Unstandardized Coefficients		Standardized Coefficients	t	Sig.
	B	Std. Error	Beta		
RS (Dependent Variable)	.109	.020		5.436	.000
FS	.286	.048	.669	5.945	.000
Psh	.105	.081	.146	1.294	.203

CHAPTER(II) 07

OBJECTIVE 04

DISCUSSION

7.2.3.4. Discussion

The local people residing within Khangchendzonga Biosphere Reserve are often great observers of changes in weather phenomena and biotic distribution, presumably related to global climate change. The local perception largely relies on their long-term personal experiences and is much extensive and acute than the science and media dialogue on global climate change (Marin & Berkes, 2013). People's general observations of climate change were consistent with scientific observation (Perez et al., 2010; Marengo et al., 2011). Therefore, nowadays, the traditional knowledge and the perception-based information considered as the baseline data for the modern scientific world because they have had gathered long-term experience about the natural elements in the people's surrounding environments. Unfortunately, most of the traditional knowledge and people's long time experience and observations are rapidly vanishing because of the lack of proper documentation. The mean annual temperature is increasing but not evenly distributed across the globe but some of the largest average temperatures are indicated for high-mountain ecosystems (Pachauri et al., 2014). Similarly, increasing abundance of thermophilic (heat-loving) plants is observed at high elevations (Gottfried et al., 2012; Gaire et al., 2014). The local communities are the witness of changes in natural elements of thier surroundings in targeted areas. This present information can be considered as the baseline data, which should offer vital clues for further research work. Based on the perception of the local people around Khangchendzonga Biosphere Reserve, it appeared that the impact of climate change is more prominent in the Himalayan region which has not only affected the abiotic components (such as increasing temperature, drying springs, and wetlands are drastically reduced, decreasing snow coverage in winter, etc), but also it equally impacted the biotic components (such as range shift of Himalayan Pheasant towards high altitude, upward movement of plant species, phenology change, etc). Further, Dash et al., (2007) observed that the maximum temperature increased over North East India by 1°C during winter and 1.1°C during the post-monsoon months compared to the last century. Most of the respondents highlighted the climate change impacts on the resilience of the Himalayan pheasants such as range shift and phenology change. Climate–driven range shift of the Himalayan Pheasants is correlated with the reduction of snow cover in the region, suggested by most of the respondents. The result also indicates the factors of range shift significantly influence ($P<0.000$) the overall Himalayan Pheasant range shift as revealed by the data obtained from the respondents. Similarly, it was reported that in Himalaya's annual temperature increased by 0.01˚C in the foothills, 0.02˚C in the middle mountains, and 0.04 ˚C in the higher Himalayas which drives biophysical responses like duration of snow cover reduced, snow disappears earlier and less snowfall, therefore, changes in snow-cover dynamics will directly affect biodiversity at high elevations (Tse-ring et al., 2010). From the semi-open structured questionnaire, the respondents also agreed that the Himalayan pheasants are shifting their habitat range to towards high altitudes in the mountain landscape and abandoned their lower altitude ranges. Various studies also suggest that the species are shifting their habitat range due to climate change in the Himalayas (Acharya & Vijayan 2010; Gaire et al., 2014). Therefore, it is important that the long -term monitoring researches should be prioritized on the Himalayan Pheasants especially on their range shift and phenology change before they plunge to extinction.

Plate 09: A glimpse of religious spots of KBR; Coronation Throne of Norbugang Yuksom (A), Tholung Ghumpa/ Monastery (B), Devta Dhunga near Tholung ghumpa/ Monastery (C), and Dubdi ghumpa (D).