Final Evaluation Report

Your Details	
Full Name	Ashok Kumar Ram
Project Title	Strengthening Human elephant coexistence (HECx) in western Terai Landscape of Nepal
Application ID	37197-D
Date of this Report	27 March 2023

1. Indicate the level of achievement of the project's original objectives and include any relevant comments on factors affecting this.

Objective	Not achieved	Partially achieved	Fully achieved	Comments
Objective 1. Strengthening HECx			✓	
Activity 1.1 Printing of HECx booklet in local language			✓	We printed 10000 copies of HECx booklet jointly with NTNC, IEF and Ujyalo Nepal. Our project contributed for 1500 copies from Rufford Small Grant Programme. The printed booklets were distributed throughout the elephant habitat of Nepal for raising landscape level awareness among the villagers.
Activity 1.2 HECx Trainers Training			✓	Two HECx trainings for 3 days were organised at Bardia. In the first meeting 35 participants (ERT members, nature guides, community members and park staffs were participated from Bardia) and another 35 additional ERT members, community member, CFUG members and buffer zone community forest user groups in the second TOT trainings. The second TOT was organised jointly with Ujyalo Nepal and NTNC.
Activity 1.3 Village level HECx awareness classes			✓	Thirty events of HECx village level awareness raising meeting were organised in the buffer zone of Bardia and Shuklaphanta NP.
Activity 1.4 Strengthening local ERTs			✓	Ten events of refresher training to ERT members were organised and trained. 300 people benefitted from this activity. We also distributed 150 spotlights to ERT members for elephant patrol.
Activity 1.5 Radio Program on HECx			✓	Twelve events of "Save the Elephants" radio programme were produced and aired on HEC from Radio Tiger Bhudigaun.
Objective 2. Prediction of habitat connectivity in the Chure Terai Madhesh Landscape			✓	Fieldwork was carried out for assessing bottlenecks, corridors, and connectivity by five persons including PI. Elephant presence absence signs with their

Activity 2.1 Fieldwork for ground-truthing				respective covariates collected from the study area. The collected data were synthesised, entered into Excel format, and data analysis were carried out.
Activity 2.2 Data analysis, reporting, and publishing				Data analysed and report prepared. Manuscript is under preparation and will be sent to journal soon for publication.
Activity 2.3 Stakeholder consultation meetings				The key stakeholders including community leaders and authorities were invited and their perception towards elephant conservation was documented to guide further conservation interventions
Activity 2.4 Sharing workshops				

2. Describe the three most important outcomes of your project.

1). We have strengthened the human elephant coexistence (HECx) by delivering following activities.

Activity 1.1 Printing of HECx booklet in local language

We have prepared a booklet of 30 pages focusing on HECx in the local language and printed 10000 copies with coordination of Ujyalo Nepal, USFWS, NTNC and IEF and distributed throughout the elephant range for giving the same elephant conservation message to all the communities residing in the elephant ranges of Nepal. We have paid for 1500 copies only and used for our project activities.

This booklet gives information about elephant biology, conservation issues, and ways of behaving with elephants when they are in the villages. The booklets were distributed to the participants of village awareness sessions.

Activity 1.2 HECx Trainers Training

We have provided HECx Trainers training for 60 people from the elephant landscape. This TOT was conducted with support of Ujyalo Nepal National Trust for Nature Conservation, Bardiya National Park and buffer zone council of Bardiaya National Park. We have also organised a separate TOT for 30 participants in Bardiya National Park. This training was of 3 days long and very impressive. Participants fully participating in the HECx ToT, and they were used for village HECx awareness raising classes.

Activity 1.3 Village level HECx awareness classes

We organised 30 events of village-level HECx awareness classes in HEC prone areas between June and December 2022. The class was 4 hours long with games and dramas and 30 people in each event took part.

Activity 1.4 Strengthening local ERTs.
We organised 14 events of refresher meeting cum training to the ERT members at the different 10 places of the project area. 150 members of ERT participated and benefitted from this project. We also distributed 150 pieces of the spotlight to the ERT member which were used for handling elephants during patrolling.

Activity 1.5 Radio Program on HECx
We have conducted 12 events of the radio programme from the local Tiger FM Bhudigau Bardia between April 2022 and March 2023. The Save the Elephant Radio programme was very successful and local people enjoyed it a lot. Especially, students and new listeners participated actively during question and answer session. They have requested for continuing the radio programme.

2). Prediction of habitat connectivity in the Chure Terai Madhesh Landscape

2.1. Methods:
We took the whole landscape for predicting habitat connectivity. The details of procedures and results are given below.

2.1.a. Study area
Chure-Terai-Madhesh landscape (CTML) covers the entire elephant distribution range in Nepal. The CTML spreads across 25 districts and covers an area of 42,456 km^2 (Figure 1). CTML comprises five physiographic units: Chure hills (34.4%); Chure narrow gorges (2.2%); Dun/Inner Tarai (8.4%); Bhavar region (14.9%); and Tarai Madhesh (40%). Forty-eight percent of the landscape comprises agriculture and settlement; 47.16% forest, shrub-land, and grassland; and 4.65% river and riverbed

(GoN/PCTMCDB 2017). The study area is also a refuge for several endangered large mammals, including the tiger (*Panthera tigris*), greater one-horned rhinoceros (*Rhinoceros unicornis*), gaur (*Bos gaurus*), and wild buffalo (*Bubalus bubalis arnee*). The annual rainfall ranges from 1,138 - 2,680 mm, with over 80% of the rain occurring during monsoon months (DFRS 2015). The altitudinal range lies between 60-1500 m asl (R. P. Chaudhary, Uprety, and Rimal 2016). CTML is densely populated with an average human density of 392 persons/km^2 (CBS 2014). Large-scale linear infrastructure projects and mining activities are the major drivers of deforestation and habitat fragmentation in the landscape.

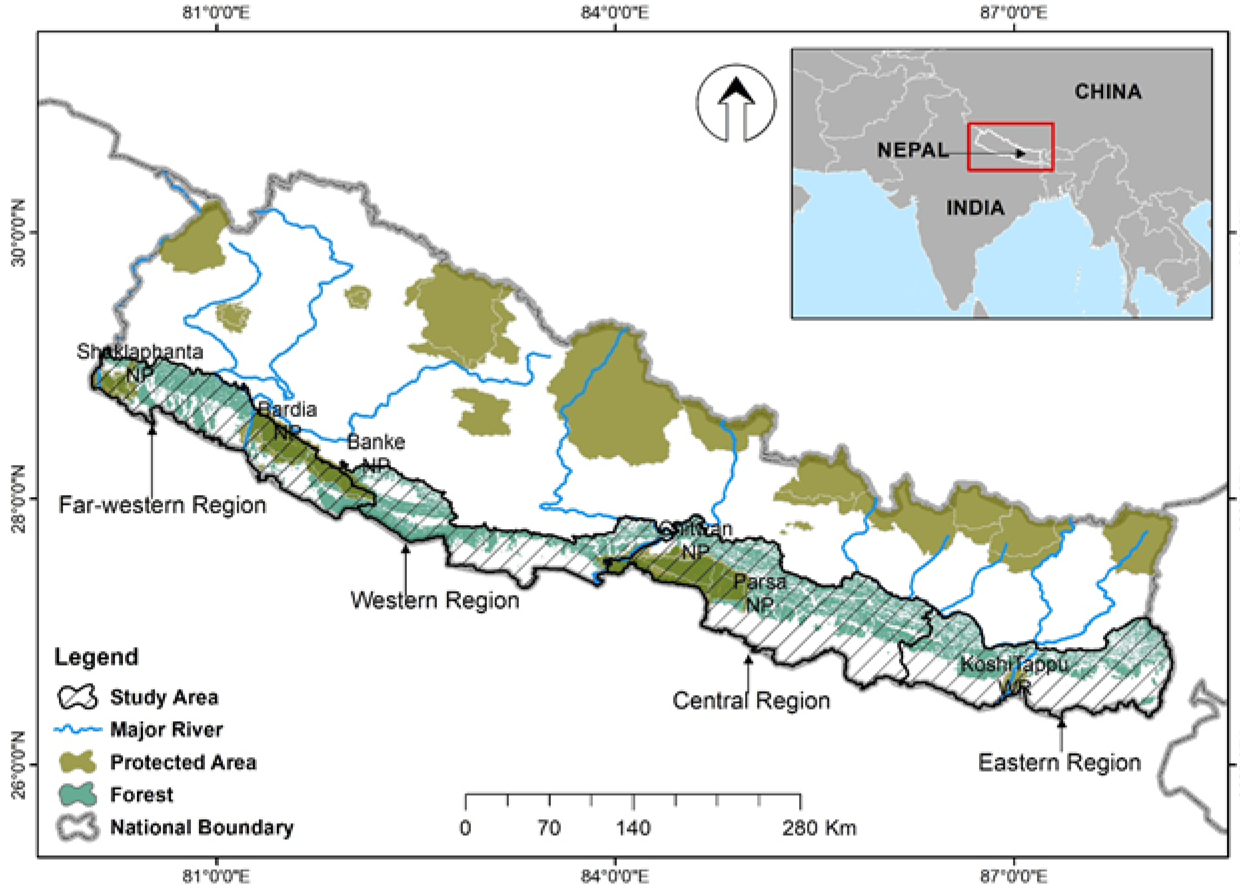

Figure 1: Study area four elephant regions with the six Terai protected areas of CTML.

2.1.b. Elephant occurrence data:

We collected elephant occurrence points through systematic occupancy survey in 2022. We overlaid grid cells of 15x15 km^2 across the CTML (Goswami et al. 2014) and surveyed 45 km transects along rivers, forest roads, foot trails and animal trails. Elephant presence (footprints, dung, tree breaches, body rubbing mark) or absence, land use type (forests, shrubs, grassland, settlement, croplands, waterholes, rivers and others), terrain and human disturbance. The field survey was carried out by authors, the trained naturalists and student volunteers. To reduce spatial bias caused by unequal sampling effort, we carried out spatial filtering at the scale of 5x5 km^2 following Brown (2014) procedure using Spatial Rarefy Tool in the SDM ToolBox v2.2 under ArcGIS 10.6 (Kramer-Schadt et al. 2013).

2.1.c. Derivation of environmental variables

We acquired the vector data for elevation, slope, aspect, river, road from the Department of Survey, Nepal. Elevation data was obtained from the Digital Elevation Model (DEM) at the 30 m spatial resolution SRTM (Shuttle Radar Topography Mission; http:// www2.jpl.nasa.gov/srtm/). We used the land use land cover (LULC) layer, a composite of 10 classes, derived from 10 m resolution Sentinel-2 imagery available at Esri (2020). We used the 19 bioclimatic variables including 11 temperature and eight precipitation metrics from WorldClim 1.4. at 30 s (~1 km) spatial resolution (WorldClim, 2014) and used in the analysis after resampling in to 30-meter resolution. All spatial data was processed in ArcGIS 10.6.

2.1.d. Modelling landscape connectivity

We modelled the elephant habitat connectivity in three steps; first of all, we prepared resistances surface of the study area, extract core habitats and then quantify spatial connectivity between core areas by using both the least-cost path and circuit theory.

a. Habitat suitability prediction and Extraction of resistance surface

The resistance surface was estimated as a function of local variables at the occurrence locations consisting of geographical characteristics and land use types. The geographic and land use features of each spatial unit along the path were used as predictors for resistance values at occurrence/available locations. The covariate layers were chosen from the potential factors of habitat suitability of Asian elephant, following published literature (Areendran et al. 2011; Puyravaud et al. 2017; Talukdar et al. 2020). The covariates consist of elevation, slope, terrain ruggedness index (Riley, DeGloria, and Elliot 1999), proximity to the water, proximity to road entity, proximity to human habitation, leaf area index (LAI) and land-cover type. The proximity to the nearest grid of each land-cover type was added to alleviate biasness caused by the occurrence point in the edge vicinity between different types of land cover (Thurfjell, Ciuti, and Boyce 2014). Land cover data used in this study was downloaded from Esri 2020. The original land cover types were reclassified into nine types composed of evergreen forest, deciduous forest, secondary forest, plantation, grassland-bareland, agriculture, and other. All of the spatial data analysis was processed in raster format with resolution of 30 m.

We used R statistical package v. 4.0.2 (R Core Team 2020) for data analysis and model building. We used binomial logistic regression by constructing a Generalized Linear Model (GLM) (Zuur, Ieno, and Elphick 2010) to determine the factors associated with habitat suitability. In the GLM, we used binary elephant occurrence data (presence coded as '1' and absence as '0') as a response variable (Clark 2020) and the other 12 landscape predictors as an explanatory variable. We performed z-transformation of the variables to standardise the data and tested multi-collinearity among them, using VIF functions (vifcor function in package 'usdm') in R (Naimi 2017). None of the variables were highly correlated (VIF value >5). Thus, we used all the variables for model building (Chatterjee and Hadi 2012). We performed multivariate logistic regression by constructing the Generalized Linear Model (GLM) (Zuur, Ieno, and Elphick 2010) with the binomial distributions of the response variable to predict the elephant habitat in the CMTL.

For the initial model, we performed Moran's Index test using ArcGIS Spatial Analyst tool and found the z-value (11.992), Moran's Index (0.) and (p-value < 0.01), indicating that there is a less than 1% likelihood that the spatial clustering pattern of the elephant presence was due to random chance (Bivand, Pebesma, and Gómez-Rubio 2013). We also found that the distance threshold between each neighbouring elephant presence site was estimated to be 5,000.5 m. Using the multi-model inference 'MuMIn' package in R version 1.43.17., we constructed all possible models with a combination of predictor variables and ranked them based on the small-sampled AIC (lower AICc value indicates higher model ranking) (Barton and Barton 2020). We obtained the final model by averaging the top candidate models (AICc ≤ 2) (Burnham and Anderson 2001). From the total elephant occurrence (presence – 253, absence--239) data, 80% of samples were randomly selected for model building (training sample) and 20% for validation of the model (test sample). We checked the model's accuracy by comparing the predicted values and the actual value of the test samples. Predicted values of the model with the highest accuracy were reported. Further, we generated the ROC curve and AUC values to predict the reliability of the dominant models using package ROCR in R 4.0.3. We predicted the potential elephant habitat based best performing and highest accuracy models. We used ArcGis 10.6 for preparing predicted habitat suitability map of elephants in the CTML (Ram et al. 2022). We defined the habitat values >0.85 as suitable.

Resistance surface is represented as the difficulties in animal dispersal in the migration routes or in the spatial units. With the increasing value of resistance, higher cost required for the animal movement across the landscape. We calculated the resistance surfaces by reversing the probability response habitat and rescale to be between 0 and 100 (Suksavate, Duengkae, and Chaiyes 2019).

b. Extraction of Cores for least cost path analysis

The suitable elephant habitat was obtained by preparing the habitat prediction map having value ranging 0.0 -0.99. Soon after, we remove the habitat values less than 0.85 and value greater the 0.85 were taken as a suitable habitat. Further, we removed the forest patches area having < 400 ha (S. Liu et al. 2018) and obtained core patches for the least cost analysis. Additionally, each of the protected areas (PAs) were also treated as core patches (Suksawang 2018), as they were elephant bearing PAs and elephant used to disperse 20–40 km for foraging in their habitat (Baskaran et al. 2013 & Cisneros-Araujo et al. 2021).

c. Predicting landscape connectivity

We used least-cost path (LCP) (B. H. McRae et al. 2012), and circuit theory (Littlefield et al. 2017) approaches to quantify the connectivity between habitats along with the expected frequency of potential elephant movement throughout the landscape. Further, we used Linkage Mapper, Centrality Mapper, and Pinchpoint Mapper to assess connectivity by modelling current flow and locating pinch points and barriers (B. McRae et al. 2016). The pinch points are defined as areas within corridors where movement is constricted. Pinchpoint Mapper identifies pinch points along mapped corridors and highlights sites critical for connectivity. Barrier Mapper identifies barriers along the corridor network that significantly influence the quality and location of respective corridors (Kwon, Kim, and Ra 2021). Barriers could be strongly contrasting land use types surrounding core-habitat patches, thereby reducing the dispersal ability of the focal species (i.e., forest core surrounded by agricultural monocrops such as sugarcane or maize).

We used core habitat and resistance layers as inputs for Linkage, PinchPoint and Barrier Mapper. We chose network adjacency method for Linkage Mapper, which was set to cost-weighted and Euclidean (cost-weighted used for further analyses), to identify cores, construct core network, calculate cost-weighted and Euclidian distance, refine network and calculate and normalize corridors.

The cost-weighted distance cut-off was set to 30 km in PinchPoint Mapper analysis to know how long corridors should be in cost-weighted distance. We calculated Raster centrality using Circuitscape, where centrality analysis treats each core patch as a node and generates a centrality score for each core based on the resistance values for surrounding least-cost corridors (B. H. McRae et al. 2012)

The linkage mapper was used to identify adjacent core areas as well as to create a least-cost path between core areas based on calculated cost-weighted distance (CWD). The least-cost corridor was determined by the optimal pathway which provides the minimum cost-weighted distance between pairs of defined networks (Van de Perre et al. 2014). The user-specified cutoff of corridor's width was set at 500 cost weighted kilometres, to estimate least cost-path corridor for the further simulation. This allows us to explore the least-cost corridor of different width that was expected to affect the volume of linkage zone and to accommodate the uncertainty underlying error from spatial data and process of resistance surface modelling (Washington Wildlife Habitat Connectivity Working Group (WWHCWG) 2010). Two ratio matrices were calculated for each core area pairs to quantify the characteristics of least-cost paths i.e. a) the length of Euclidean distance to the length of least-cost path (Eu:Lc) and it was used to determine the dispersive difficulty between core areas relative to the proximity, b) the cost-weighted distance to the length of least cost path corridor (Cw:Lc), which provides the resistance per length unit cost along least-cost path corridors between habitat core areas (Dutta et al. 2016).

3). Results

3.1. Occurrence points:

We surveyed 165 grids and covered 7425 km for elephant occupancy survey. We collected elephant occurrence points at every kilometre and got 3,635 elephant presence signs and 3,539 absence point during transect survey. To reduce the spatial bias, we did spatial filtering by rarefying all the occurrence points on 5x5 km^2 and obtained a total 253 elephant occurrence points and 239 true absence locations and these points were utilised for analysis.

3.2. Least-cost Path Analysis

3.2.1. Habitat suitability

The model having highest accuracy were used for preparing the predicted potential elephant habitat. We used ArcGis 10.6 for preparing predicted habitat suitability map of elephants in the CTML (Ram et al. 2022) by giving the value 0-0.99. We got

19059 km^2 area out of 42,000 km^2 land mass of CTML, as a suitable habitat for elephants (Figure2.)

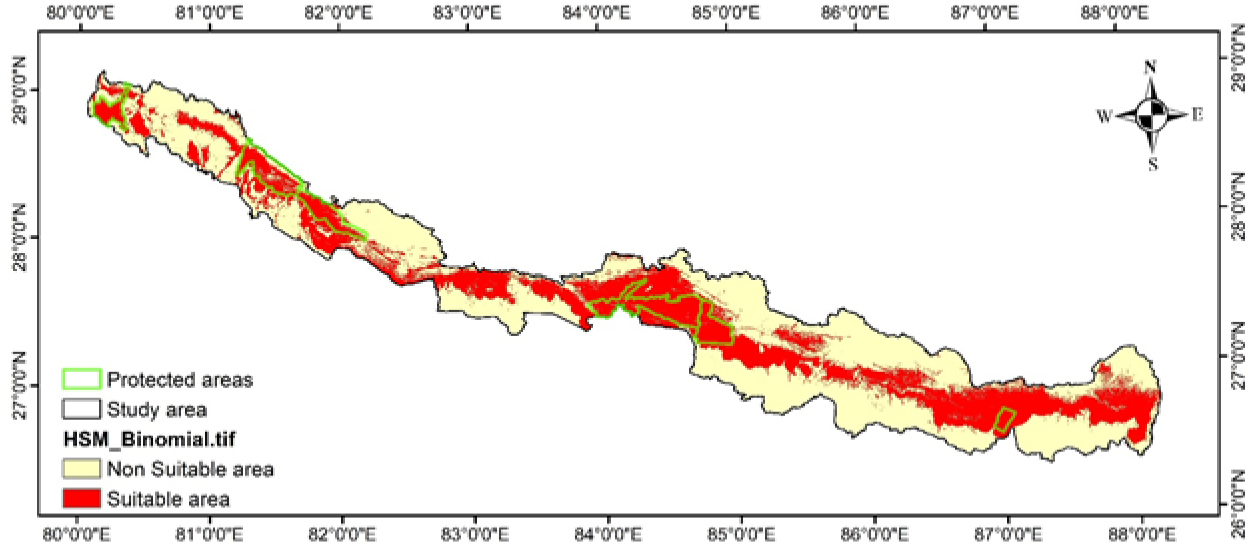

Figure 2: Suitable and non-suitable habitat for elephants.

3.2.2. Resistance Value, Resistance Surface and Cores calculation

We got the resistance layer by reversing the probability response and rescale it to 3.5 and 260 (Suksavate, Duengkae, and Chaiyes 2019). The highest resistance value 260 was found to be at settlements and the hilly terrains which were inaccessible for elephants and also far from the protected areas. The low resistance values 3.5 was found cantered in the protected areas, and inside the forest patches. However, tea gardens, sugarcane fields and man-made mango gardens which behaves as man-made corridors for elephants also have significantly lower resistance values, though they were located far beyond the forest boundary (Figure3). After analysis of resistance surface and resistance value, we also extracted cores which was treated as nodes for least cost path analysis. There were 47 extracted green cores from resistance map (Figure 3) having the total core green areas 3886.82km^2. The largest core green area was of 410.30 km^2, which is inside the Chitwan National Park and the detail of corridor is given in Supplementary material appendix II.

3.2.3. Least-Cost Distance, Least-Cost Path and Corridor Analysis

There was a total of 103 pairs of neighbours found to be adjacent, 102 were adjacent according to Euclidean allocation (eucAdj) and 79 were found to be adjacent using cost allocation (cwdAdj) reflecting the resistance surface. The Linkage mapper calculates the cost distances and least-cost paths (Figure 4). There are 103 least cost paths linked with 47 core green areas analysed from the linkage mapper. The cost weighted distance was found increased while encountered with bigger settlements, business areas (markets) in the dispersing routes.

Out of 103 least cost paths, 18 were traversing through the settlements. Out of these 18 paths, 12 paths were not used anymore by elephant during their dispersal. The least cost path, which were used by elephants before 1930 are now totally blocked i.e., Naya padampur to Debghat, Devghat to Chormara-Daunne, Daunne-Butwal-

Sainamaina and Sainamaina-Gorusinge to Guagauli (western boundary of Kapilbastu).

The least-cost number 19 bears the highest cost weighted distance, which connects the core ID# 9 and 11, with a total cost weighted distance 10,293 km and the actual length of the route is approximately 138.2 km. The average resistance was 92km, attributed to the absence of residential areas as well as agricultural areas and most of the routes with a cost weighted distance of >70 km were penetrating through the settlements of this landscape, while the least-cost path passing inside the protected areas and forest was low.

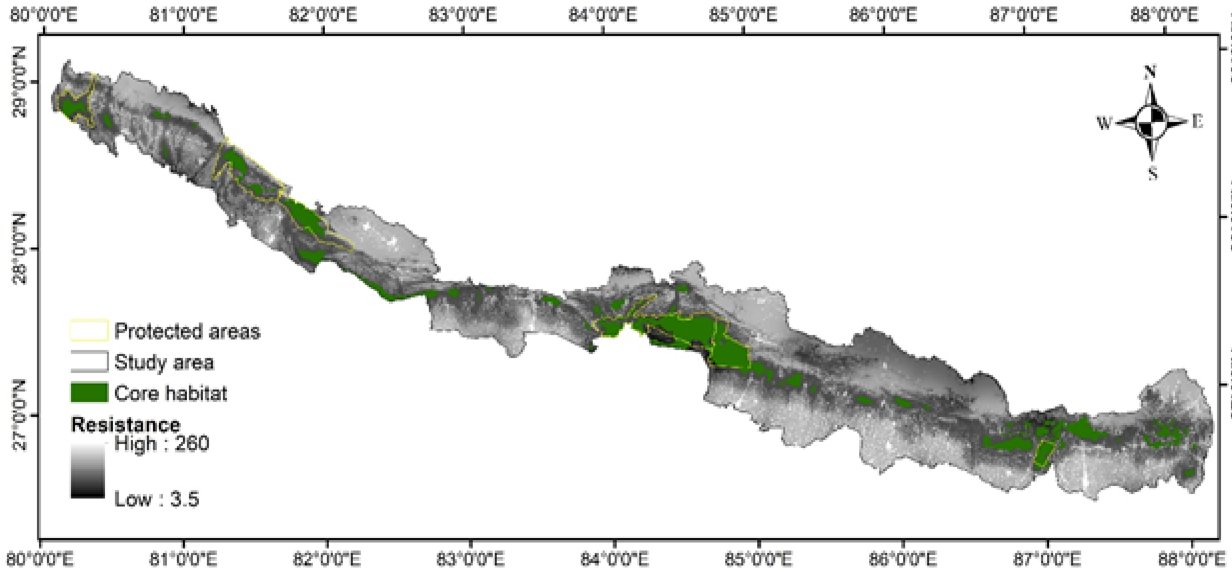

Figure 3: Core habitats (#47 cores with total area 3886.82 km²)

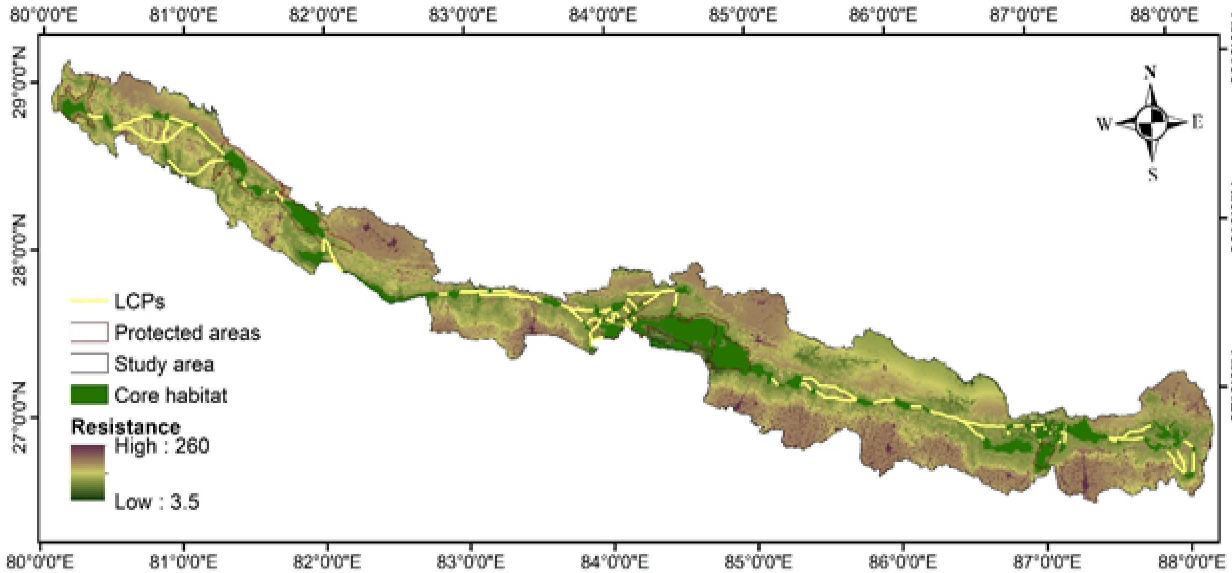

Figure 4: Least cost paths were derived from the study area.

3.1.d Centrality
Further, we also analysed the centrality and pinch point to distinguish the relatively high-importance areas and dispersal routes, bottlenecks and connectivity breaches but not included here in this report. We will publish the details in the peer reviewed journals.

4). Discussions

Landscape connectivity provides a linkage between two or more than two core habitats. Chure Terai Madhesh Landscape (CTML) is a last remnant habitat for Asian elephants in Nepal where ~250 elephants are surviving in the fragments. The resistance surface and connectivity map were created by using elephant presence data collected during the occupancy grid survey from Chure Terai Madhesh Landscape (CTML). However, the detailed information on animal dispersal viz. telemetry, camera trapping data were preferred in the estimation of landscape resistance (Suksavate, Duengkae, and Chaiyes 2019). Our study results indicate that there were many factors associated with the resistance to dispersal of the elephant.

Elephants are dispersing east west through the Chure foothills, which is mostly occupied by settlements and agriculture; however, CTML is also a biological hotspot providing habitats for many flagship species viz. tiger, one-horned rhinoceros, gaur, water buffaloes and many other endangered flora and fauna. The elephant movement was depending upon availability of resources, migratory route and available corridors. The dispersal behaviour increased risk of human-elephant conflicts (HEC) in these areas which were human-wildlife interface zone because elephants' habitat extended for foraging to the fringe of crop fields where food and water resources were abundant (Wanghongsa et al., 2007 (Li et al., 2018; Vinitpornsawan et al., 2016).

Usually, elephants are interacting severely while dispersing through this landscape, resulting large number of human loss and huge amount of crop, property damage. Sometimes, they were also killed in retaliation. These serious human elephant interactions were happened due to breached in the corridor and connectivity in the landscape level and densely populated area in their migratory routes, bottlenecks.

Elephants are distributed in the four isolated population, however, they are more often used to disperse from one population to another, though landscape connectivity is severely breached. The large herds rarely migrated east west, however the solitary bulls and a small sub adult male group having 8-13 individuals frequently dispersed east west. The eastern transboundary migratory herds from West Bengal (~130 individuals) visited each year to Mechi river and majority of large herds revert back to West Bengal (India), however, small clans (13-23 elephants with calves) migrated up to Chulachuli area of Ilam and they were reverted back. Some of the loners and sub adult bull groups are migrating towards the west and visited up to Koshi Tappu Wildlife Reserve (KTWR), Sunsari. They were staying up to 6 months in the Koshitappu and surroundings and further moved toward west up to Sindhuli through Chure foothills of Saptari, Siraha, Udapupur. During their dispersal, they have interacted with humans causes severe human elephant conflicts (HECs) in Kanchanrup, Fatepur, Agnisair, Sambhoonath, Sripur, Kamalpur area of Saptari and Lahan. Golbazar, Mirchaiya, Bandipur area of Siraha district, which are HEC hotspots. Similarly, Chisapani, Godar, Mithila area of Dhanusa district; Ranibas, Bhiman, Kamalamai areas of Sindhuli district; Bardibas, Tuteswor areas are another conflict hotspots in Mahotari district. Furhter, elephant entered into Sarlahi, they stayed up to 3 months in this area and moved towards the west visiting form Patharkot, Kalinjor, Isworpur to Murtiya and then crossed the Bagmati river connecting to the CharkosheJhadi of Rautahat. Beyond this, elephants directly moved to Tangya settlement through the Jungle saiya and Kanakpur and entered into Chitwan Parsa complex. We followed, a small clan from Chitwan Parsa complex and found migrated east ward up to Siraha and another sub adult male group from Koshitappu, wihich was found dispersed from the Jhapa to Chitwan-Parsa Complex.

The central clans (eight individuals: three female, three calves, two males) started moving from Chitwan Parsa complex during November 2019 and reached up to Bandipur area of Siraha district in January 2020 and then they have reverted back to Chitwan Parsa complex in February. However, the male sub adult group of Kosdhi complex dispersed westward and reached to Chitwan Parsa complex in 4 months. They have started dispersing in June from jhapa reached to Koshitapu and dispersed to Chitwan Parsa complex within four months. They have usually dispersed during nights and stay in the small forests or private gardens during the days.

During their movement they have faced lots of difficulties; shouting and hitting by people, gunfire and bullets by lots of people, firecrackers and also chased by tractors as well by the excavator also with loud sounds. They were so much irritated and resulting human losses as well as elephant losses also. We found nine elephants were killed in retaliation (electrocution), five were shot, and three tusks were stolen between 2018-2020.

In comparison to central and western elephant population, large herds were found dispersing which were severely using both the transborder habitat of Nepal and India. The large herd from Uttarakhand (i.e., Pilibhit, Dudhuwa) are sharing both the habitat of Suklaphanta National Park and Bardiya National Park using the transborder territory of western Terai Arc Landscape. The large herd are dispersing each year from Duduwa, Pilibhita and Katarniaghat to Badiya National Park (BNP) during mid of June and stayed for four months and second groups arrived at BNP in October and November each year, stayed for 3 months and reverted to India. Only, some loners and sub adult bulls are staying year-round in BNP except Babai Population.

Some of the loners and subadults (8-10) dispersed towards east up to Banke National Park (BaNP) and dispersed to Sohelba wildlife sanctuary of India through Kamdi corridor (Dang) and reached to Gugauli area of western boundary of Kapilbastu district. Beyond Gugauli, we didn't find any further elephant dispersal signs up to the Narayani River in Nawalparasi.

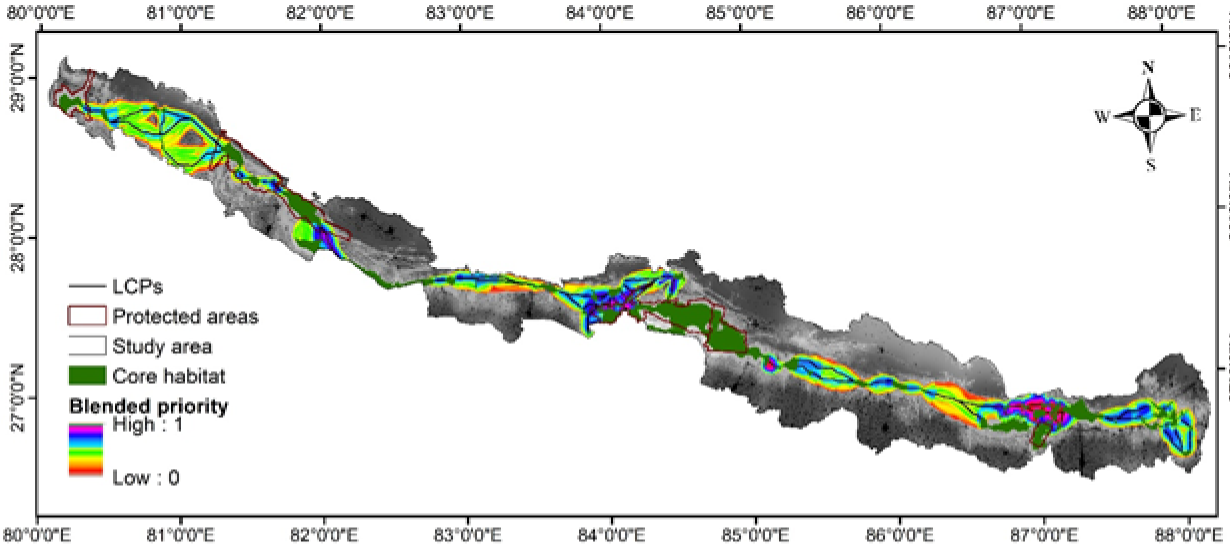

Figure 5: Predicted corridor.

The most significant achievement of this project is to identify the corridor and connectivity and pinch points which help protected area managers to prepare a strategic plan for the corridor and connectivity restoration for the better conservation of elephants outside the protected areas.

3. Explain any unforeseen difficulties that arose during the project and how these were tackled.

We accomplished our project "Strengthening Human elephant coexistence (HECx) in western Terai Landscape of Nepal" with the support of local community, park professionals, provincial and local government offices. Conserving elephants in these human-dominated landscapes require community cooperation and tolerance, which we got fully from the local community. They have actively participated in each of the events, either village level meetings or HECx trainers' trainings.

Nepal bears ~200 individual elephants, which is distributed in the Chure Terai Madhesh landscape of Nepal. However, our study area has ~120 elephants.

There are seven problematic bulls in this area. The unforeseen difficulties arose during our project was the sudden and untimely arrival of these problem bulls, which damage houses, as well as property and also raiding their crop. We need an additional motivational activity to them because they wanted an immediate relief, which we were unable to provide them at the site.

The people who were participated in the village level HECx meeting, feel difficulties to motivate the victims during the untimely arrival of problem bulls and they have asked for real time-based monitoring of these bulls.

Changing human behaviour is difficult through organising a few events of HECx meetings and required a continuity.

4. Describe the involvement of local communities and how they have benefitted from the project.

Overall, 400 people (70 ERT members, 300 local villagers, community forest user group members, and buffer zone user committee members) were involved directly in the project activities and benefitted from this project and large mass benefitted by sensitising through save the elephant radio programme and by distributing the booklets and pamphlets. Additionally, 15 people including PI was involved in the project field work and official work for analysing corridor and connectivity of elephant habitat.

5. Are there any plans to continue this work?

This is our 2nd Booster Grant, and we need to accomplish the project cycle and we have a plan to finalise our elephant project funded by RSG. So, we will continue our project in the Madhesh province, which is outside the project area and also bears the fragmented habitat where ~45 elephants reside and disperse each year through the Chure foothills. We will continue this project in the elephant corridor.

6. How do you plan to share the results of your work with others?

I am planning to share the project progress in the upcoming "Elephant Conservation and Research Symposium 2023" which will be organised by the International Elephant Foundation (IEF) at Thailand. I have applied for the upcoming symposium and also registered for it. We have also prepared a draft manuscript and will publish in the peer reviewed journals, that international audiences have also access to our project findings. We have continuously published three articles in the high impact factor journal and planned to publish this on the same.

7. Looking ahead, what do you feel are the important next steps?

Asian elephant dispersal is taking place during paddy ripening season and maize harvesting season and they have travelled long distances up to 250 km east to west in eastern Nepal. During their dispersal, large amount of property, crops were damaged and also 20-30 people killed each year on elephant attacks. Not only humans, six elephants also killed in retaliation each year. So, we need to continue elephant conservation awareness activities in their migratory routes. Our study has explored the least cost paths, corridor and connectivity, and highly conflicted zones. This study will also help Nepal Government to prepare an elephant conservation action plan for mitigating human elephant conflict and conserving elephants in this area.

8. Did you use The Rufford Foundation logo in any materials produced in relation to this project? Did the Foundation receive any publicity during the course of your work?

I had used RF logo for preparing conservation awareness material i.e., booklets and posters for disseminating the progress of the project. During my project work, people raise question about logo, and they were satisfied by answering that this project was funded by RF and some of them were interested to apply for Rufford Small Grant. In this way RF had received publicity during my project work.

9. Provide a full list of all the members of your team and their role in the project.

Our team consist of 15 people, five technicians and 10 naturalists. They have been working since 2013, when our first RSG project initiated and accomplished additional three projects (13977-1 and 20338-2 and buster grant 26302-B) including this project.

There are three co-investigators Mr. Nabin Kumar Yadav and **Miss Binita Khanal** and five field assistant **Mr. Sonu Kumar Ram, Sujana** and **Pragya Acharya** (who are BSC forest students) and additionally **Mr. Shankar Luitel, Ram Sahi and Suman Acharya** has involved in this project. **Mr. Hemanta Acharya** and **Ram Sahi** as well as Suman and PI himself has involved in organizing HECx TOT and village level trainings. Elephant sign survey was done by additional 10 naturalist and leaded by PI himself.

Mr. Prabin Shrestha (M.Sc.) has involved in data collection and village level HECx sensitisation meetings.

Mr. Nabin Yadav has completed his M. Tech in Remote sensing and GIS from the Indian Institute of Remote sensing. He is currently a forest officer of GON. He involved in reviewing new approaches for satellite image processing including high resolution optical and SAR images, Satellite image processing related to assigned study/theme and different time-series data processing on weather and climate and spatial-temporal analysis of weather and climate data, Land use/land cover classification using satellite data. He has sound knowledge of handling GIS and remote sensing and habitat analysis work using Arc GIS and R program. He did Remote sensing and GIS work for analysing corridor and connectivity.

Ms. Binita Khanal worked for analysing data.

Similarly, PI worked for designing field plans for conducting fieldwork, whereas, with Ms. Khanal and Mr. Yadav for data entry and analysis, preparing maps, and modelling work. We will furnish our project work within the scheduled time frame.

Additionally, RRT members and students, Eco clubs were used for conducting conservation awareness and conservation Radio programs.

10. Any other comments?

Human elephant conflict (HEC) is one of the major threats for the survival of elephants in Nepal. Majority of conflict is escalated due to human activities and therefore continuous awareness raising campaign is required for this charismatic animal conservation outside the protected areas. We are also planning to continue our project in connectivity of elephant habitat. Thus, we need a continuous support from RSG and other funding institution for the long-term survival of Asian elephant (*Elephas maximus*) in this range.

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