IMPACTS OF THE GORKHA EARTHQUAKE 2015 ON THE CHINESE PANGOLIN (*Manis pentadactyla* Linnaeus, 1758) IN CHAUTARA MUNICIPALITY OF SINDHUPALCHOWK, NEPAL

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Batch: 2070/2071

A thesis submitted in partial fulfillment of the requirements for the Degree of Master of Science in Zoology with special paper Ecology and Environment

Submitted to
Central Department of Zoology
Institute of Science and Technology
Tribhuvan University
Kirtipur, Kathmandu

25 June, 2017

DECLARATION

I hereby declare that the work presented in this thesis has been done by myself, and has not been submitted elsewhere for the award of any degree. All sources of information have been specifically acknowledged by reference to the author(s) or institution(s).

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RECOMMENDATION

This is to inform that the thesis entitled **"Impacts of the Gorkha Earthquake 2015 on the Chinese Pangolin (*Manis pentadactyla* Linnaeus, 1758) in Chautara Municipality of Sindhupalchowk, Nepal"** has been carried out by Ms Sandhya Sharma for the partial fulfillment of the requirements for the Degree of Master of Science in Zoology with special paper in Ecology and Environment. This is her original work and has been carried out under my supervision. To the best of my knowledge, this thesis work has not been submitted to any institutions for other degrees.

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LETTER OF APPROVAL

On the recommendation of supervisor Prof. Dr. Khadga Basnet this thesis submitted by Ms Sandhya Sharma entitled **IMPACT OF THE GORKHA EARTHQUAKE 2015 ON THE CHINESE PANGOLIN (Manis pentadactyla Linnaeus, 1758) IN CHAUTARA MUNICIPALITY OF SINDHUPALCHOWK, NEPAL** is approved for the examination and submitted to the Tribhuvan University in partial fulfillment of the requirements for Master's Degree of Science in Zoology with special paper Ecology and Environment.

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CERTIFICATE OF ACCEPTANCE

This thesis work submitted by Ms Sandhya Sharma entitled **IMPACT OF THE GORKHA EARTHQUAKE 2015 ON THE CHINESE PANGOLIN (*Manis pentadactyla* Linnaeus, 1758) IN CHAUTARA MUNICIPALITY OF SINDHUPALCHOWK, NEPAL** has been accepted for the partial fulfillment of the requirements for the Degree of Master of Science in Zoology specializing in Ecology and Environment

EVALUATION COMMITTEE

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ACKNOWLEDGEMENTS

I would like to express my cordial thanks and sincere gratitude to my supervisor Prof. Dr. Khadga Basnet, Central Department of Zoology, T.U. for his continuous supervision, guidance and encouragement throughout my study. His constructive comments, untiring help and practical suggestion inspired me to accomplish this work successfully.

I am grateful to Prof. Dr. Ranjana Gupta, Head of Central Department of Zoology, T.U., for her kind support and the Central Department of Zoology for providing required research permissions and equipment. I am equally thankful to all teaching and non-teaching staff of the Department for their encouragement.

I am eminently thankful to Mr. Hem Bahadur Katuwal, Former President of Small Mammals Conservation Foundation, for his constructive guidance, support and encouragement throughout the research period and also have helped me in GIS.

I would like to express my sincere gratitude towards all the staff members of District Forest Office (DFO) of Chautara Municipality. My special thanks go to Ms. Rasmi Kunwar for her assistance throughout the survey period. I am also thankful to Binita Pandey and Sapana Khaiju for their help and support.

I wish to thank Chanda Sharma, Nanixhori Shrestha, Chok Bahadur Dulal, Sani Shrestha, Madhav Sapkota, Hari Sapkota, Lekhnath Sapkota and all the local people for their valuable help and support during research.

Last but not the least; I am very much grateful to my family who provided encouragement and inspiration during the difficult part of my study. I appreciate everyone who contributed towards completion of the work.

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ABSTRACT

The Chinese Pangolin is a critically endangered species, enlisted in CITES, and protected by National Parks and Wildlife Conservation Act (1973) of Nepal, However, detail information on its occurrence, distribution and threats is not available. During June and July 2016, this study was conducted to investigate the impact of the Gorkha Earthquake 2015 on occurrence, distribution, and illegal trade of the species in Chautara Municipality. 75 plots of 100m*100m each were used to collect data on occurrence and distribution and interviewed 160 randomly selected respondents to assess the current threat and illegal trade of this species. The data were analyzed using logistic regression model. Data analysis showed the occurrence of the Chinese Pangolin was negatively associated with the mega earthquake ($z= -2.769$, $p<0.05$) and distance to settlement ($z= -3.590$, $p<0.05$) while positively associated with farmland ($z= 2.288$, $p<0.05$) and south facing slope ($z= 2.243$, $p<0.05$). The average density of active burrows was two per hectare with the highest occurrence between the altitudes of 1201m to 1400m having *Schima wallichii* and *Choerospordias axillaris* as major tree species. The earthquake, poaching and illegal trade, and predators were perceived as the major threats by 51%, 23% and 11% of respondents respectively. Rasuwa and Kodari highways were identified as illegal trade routes for selling pangolins and their scales and other products. It was estimated that a total of 24kg-27kg of pangolin scales were sold to China market after the earthquake with an average price of Rs. 35,000 per kilogram. The earthquake impacted pangolins directly by killing them and damaging habitats and indirectly by increasing poaching and illegal trade. Both natural anthropogenic threats should be investigated further in the future while checking poaching through public awareness and strict law enforcement for the long term conservation of the species.

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1. INTRODUCTION

1.1. Background

Earthquakes and earthquake triggered landslides have major impact on the biodiversity worldwide. They threaten plants and animals as well as devastate their habitats leading to mortality of large number of wild species (Zhang *et al*. 2011). Earthquakes very often damage breeding sites of animals (Gurung 2015) and directly affect the behavior and the activity of the species (Fujimoto and Hanamura 2008; Gee *et al*. 2011).

A massive earthquake of Magnitude 7.8 with epicenter in Gorkha hit Nepal on 25 April 2015, the Gorkha earthquake 2015. It was followed by strong aftershocks, including the one of Magnitude 7.3 on 12 May 2015 at the town of Kodari in Dolakha district (Kumar *et al*. 2015). The earthquake had profound effects on human likelihood, causing over 9000 death, more than 23,000 injuries and about 2 million people's displacement (Basnyat *et al*. 2015). The natural environment was also significantly affected. It is estimated that 23,375 ha of forest area was destroyed by the earthquake and subsequent landslides (National Planning Commission 2015) whose effect on the biodiversity has not been monitored.

1.2. Pangolins and their distribution

Pangolins (*Manis* spp.), often called "scaly anteater" are nocturnal, shy, non-aggressive, solitary and burrowing mammals, which have received low scientific attention. The word pangolin is derived from Malaya word, "Penguling", means "something that rolls up" (Sapkota 2016). The generic name of Pangolin in Nepal is "Salak", although it is known by many different local names in particular area. For instance, it is called "Kanyaya" (Newari language), "Kose" (Tamang language), and "Hilemaccha" in hill by virtue of its bronze like overlapping scales (Kaspal 2008). Globally, there are eight different species of pangolins, which are broadly classified as Asian and African pangolin (Hassan *et al*. 2013). The Asian pangolin includes Indian or Thick- tailed pangolin (*Manis crassicaudata*), Chinese or Formosan pangolin (*Manis pentadactyla*), Malayan or Sunda pangolin (*Manis javanica*) and Palawan or Philippine pangolin (*Manis culionensis*) and the African pangolin includes Giant pangolin (*Manis gigantean*), Cape pangolin (*Manis temminckii*), Long- tailed pangolin (*Manis tetradactyla*) and tree pangolin (*Manis tricuspis*).

The Chinese pangolin is found in subtropical and deciduous forests, agricultural lands whereas the Indian pangolin occurs in open grasslands, lightly wooded forests, scrublands. In Nepal, the Chinese pangolin are distributed in Annapurna conservation Area, Makalu Barun National Park and district of Baglung and similarly, Indian pangolins are distributed in Bardia National Park, Chitwan National Park, Shukla Phanta Wildlife Reserve and surrounding districts (Bara, Chitwan and Parsa) (Jnawali *et al*. 2011). The head and body length of Indian Pangolin ranges from 45-75cm and the tail can be 33-45cm having yellow-brown or yellow gray scales Likewise, the body size from head to body of the Chinese Pangolin measures 60cm with an 18cm tail having bronze coloured scales (Raut 2015).

1.3. General Biology

1.3.1. Habitat

The Chinese pangolins are widely distributed in primary and secondary tropical forest (Chakraborty *et al*. 2002), limestone forests, grassland and agricultural fields (Gurung 1996).

1.3.2. Physical characteristics

Pangolins have streamlined body and short legs. The adaptation includes a conical – shaped head, no teeth, a long sticky tongue to lick up the ants or termites and powerful long claws on its legs for digging and breaking apart ant nests or termites mounds (Payne and Francis 1998). Their scales, which are composed of keratin, offer excellent protection not only against potential predators but also from the bites and stings of their ants and termites prey (Payne and Francis 1998). Pangolins are the only species from Nepal that has prehensile tail and can hang by it in tree branches. Their tail is also used to carry infants. The nose is fleshy and has nostrils at the end. They have poor vision but a strong sense of smell by which they locate ant nests and termite mounds.

1.3.3. Behavior

Pangolins are solitary and nocturnal animal. When pangolin is threatened it rolls up into a tight ball to protect their sensitive snout, which is not covered by scales and at the same time, it also emit bad smelling secretion from their anal glands and urine, and this makes the enemies run away from it (Suwal 2011). The Chinese pangolin sleeps in underground burrows during the day. It is shy, non-aggressive and slow moving creature which emerges in the evening to forage for insects (Thapa 2012). They can dig their own burrows by moving their bodies side to side and excavating both sides and roof of the passage (Heath 1992).

1.3.4. Feeding ecology and diet

Pangolins are insectivorous and their feeding habit is stenophagy (only eating several species of ants and termites) and they even feeds upon various invertebrates including bees, worms, flies, earthworm and crickets as supplementary food (Prater 1980) using their long sticky tongue which they lick ants or termites. Pangolins chew using abrasive walls in their stomach and pebbles they have swallowed and drinks water regularly, lapping it up with their tongues in flicking motion (Suwal 2011).

1.3.5. Reproduction Biology

There is very few information regarding reproduction biology of Pangolin. Yang *et al*. (2007) estimate the gestation period of the Chinese pangolin to be 169 + days and fecundity rate to be fairly low. The Chinese pangolin reproduces during April and May. They have very low reproductive rate (usually one cub per litter, one litter per year).

Pangolins have good parental care. They care their babies until five month of age and weaning period is about three months (Payne and Francis 1998). The baby makes short excursion and being alarmed, the mother rolls up around the young, which also rolls up into a light ball (Suwal 2011).

1.3.6. Life span

It is unknown how long Pangolins can live in the wild, though pangolin has reportedly lived as long as twenty years in captivity (www.savePangolins.org). According to the record of central zoo, Jawalakhel, its survival rate from rescue was low in zoo with longest survival of nine months.

1.3.7. Ecological importance

An average Pangolin eat more than 70 million insects individual each year, it means when they were removed from a particular habitat, insects population will increase and upsets the delicate balance of the local ecosystem, so Pangolin have greater role in ecosystem (www.savePangolins.org). Pangolin is a burrowing animal so it provides a shelter for large number of animals. Thereby helps to increase species diversity.

1.3.8. Illegal trade on pangolin

Pangolins are heavily poached for their meat and scales, to supply the illegal food and traditional medicine trade (Challender and Hywood 2012; Zhou *et al*. 2014). The scales are used for different purposes ranging from ornamental to medicinal or trado-medicinal (Soewu and Adekanola 2011) in Asian and African countries where pangolins are found.

Asian pangolins are traded widely, being highly valued for their meat, which is considered a delicacy in China and Vietnam. Their scales which are used for traditional medicine by a number of Asian communities, and their thick skins, which are exported to international markets in Europe for many years to be made into belts, bags and shoes (Ellis 2005). In Africa, the pangolin are used as a complementary protein source (Wright and Priston 2010); traditional medicinal preparation and as ornaments (Soewu 2013b Pangolin populations are increasingly under threat throughout their range of habitat due to domestic and international demands for live pangolins, their skin, scales and meat (Mohapatra and Panda 2013). It is a chain of work where people of one village take pangolin and its scales to other village and finally making it to China border (Katuwal *et al*. 2015).

1.3.9. Conservation status

Both the Chinese and Indian pangolins are listed on CITES Appendix II (CITES 2000) but have been proposed to transfer from Appendix II to Appendix I under the CITES (National Daily Newspaper "Kathmandu Post" on July 17, 2016) to stop its trade. Global Conservation Status of the Indian pangolin is Endangered (Baillie et al. 2014) whereas the Chinese pangolin is Critically Endangered (Challender et al. 2014a). Both species are protected in Nepal by Department of National Parks and Wildlife Conservation Act 1973, and hunting of both the species is prohibited in Nepal. In this Act, there is provision of fine of Rs.40,000 to Rs.75,000 or jail from one year to ten years or both upon the illegal killing of these protected mammals.

1.4. Objectives

General objective

- To determine the impact of the Gorkha Earthquake 2015 on occurrence, distribution and illegal trade of pangolins.

Specific objectives:

- Investigate the distribution of pangolins
- Examine the conditions of their habitats
- Identify the current threats to pangolins, and
- Identify trade routes and estimate the trade volume

1.5. Justification of study

Pangolins have not been studied well in Nepal. The regional decline of most of the species has occurred largely within the last 50 years, because of hunting under a weak law enforcement situation (Corlett 2007). The Indian pangolin has recently been listed as "Endangered", but this change in conservation status has not deterred the massive illegal killings of the species. Since they are shy and relatively small nocturnal animals, they have not been documented well. According to many local and national newspapers reporting about it, illegal trade of this species has been increasing rapidly in Kathmandu. Pangolins are one of the most and widely traded taxa in the Southeast Asian illegal wildlife trade (Newton 2007).

Wildlife in general is threatened due to poaching and habitat loss brought about by deforestation, grazing and logging. Beside this, earthquake and earthquake triggered landslide also played an equal role in species extinction. Research on impacts of earthquakes on pangolins and their occurrence, distribution, and illegal trade has not been done in Nepal like in other countries (e.g., Gee *et al*. 2011; Zhang *et al*. 2011). Since the catastrophic earthquake of 2015 hit the study area, most of the habitats, illegal trade routes, and socio-economy of the local people were suspected have been affected. This study investigated these issues that are necessary in making strategies, policies and programs for pangolin conservation.

1.6. Limitations

- People hesitate to disclose the route of trade flow and price of scales of pangolins due to security reasons.
- Being nocturnal and shy nature of pangolins, it is difficult to search them and find out about their actual status.
- Only representative areas of Sindhupalchowk have been explored due to the earthquake triggered landslides, logistics and time constraint.

2. LITERATURE REVIEW

2.1. Effects of earthquakes on biodiversity.

Earthquakes affect diversity of plant and animal species. The Wenchuan earthquake 2008 increased the habitat patches and also destroyed the huge tract of bamboo forest, leading to severe food shortage of giant panda (Xu *et al*. 2009).

Several studies have been done to assess the impact of earthquake following tsunami on coral reef (Castilla *et al*. 2010; Foster *et al*. 2006) which includes widespread damages, uplifted reefs, shattered beds of corals, overturned coral colonies and caused the mortality of adult coral.

The earthquake also injured or stressed wildlife. Out of total 16 Active Roost sites of barn owl, four were completely damaged with five partially damaged and seven remaining unaffected. Similarly, among 11 Occupied Breeding Sites, two were completely damaged, one partially damaged and remaining were unaffected though no barn owls were found dead during the post- earthquake survey and the rate of stressed barn owls was almost double the number that was before the earthquake (Gurung 2015).

2.2. Distribution of pangolin in Nepal

Suwal (2011) found altogether 152 burrows in the Balthali, Kavre covering 19.5 hectare, showing the fresh burrow density of 8 burrows per hectare whereas Bhandari and Chalise (2014) found 235 burrows of the Chinese pangolin in Nagarjun forest of Shivapuri Nagarjun National Park and fresh burrows density were calculated to be 0.8333 burrows per hectare. Recent national survey of pangolins in Nepal (Basnet et al. 2016) has recorded pangolins from 44 districts. With the preparation of `Pangolins Monitoring Protocol, Nepal' (Basnet et al. 2017), pangolins will be surveyed and monitored all over the country particularly focusing on possible habitats.

The burrows of the Chinese pangolin were distributed in a non-uniform clumped distribution (Dhakal 2016 and Karki 2015) with maximum number of burrows in forest having canopy cover 0-25% (Raut 2015).

Pangolins prepare its burrow in the soil having PH value more or less neutral, 10-25% moisture content. The color of the soil varied from blackish to reddish with the major vegetation like *Symplocos pteridophytes, Colebrookea oppositifolia, Myrsine* spp., *Eurya acuminate, Schima wallichii* (Sapkota 2016).

The Chinese pangolin burrows were mainly found in canopy cover between 0-25% with brown soil and in northwest aspect in the elevation range between 1520m to 1620m (Khadgi 2016).

Acharya (2016) studied the habitat of the Chinese pangolin in Balthali, Kavre and found indirect sign like burrows (including 74 news and 184 old), footprints and trace of trails with preferred habitat in red soil, forest land, ground and crown cover of 0-50% with the elevation of 1300m to 1600m and west facing slope.

2.3. Distribution of pangolins in other countries

Mahmood *et al*. (2012) studied Habitat preference of the Indian pangolin (*Manis crassicaudata*) in District Chakwal of Potohar plateau, Pakistan and found that they were evenly distributed due to some ecological features and they were mostly found in soft and semi-sandy area as these soil were suitable for digging burrows and more abundantly found in areas were ants and termites colonies were abundant.

Mahmood *et al*. (2013) studied plant species association, burrow characteristics of the Indian pangolin, *Manis crassicaudata*, in the Potohar plateau, Pakistan and found that preference of the animal species is associated with *Capparies deciduas* and *Salvadora oleoides* trees and found that the number of feeding and living burrows of pangolin differed significantly.

Pangolins show a patchy distribution in Margalla Hills National Park Islamabad, Pakistan with low population density (0.36/km^2) and major vegetation of *Dalbergia sissoo, Acacia modestaand, Pinu sroxburghii* as a dominant trees, *Dodonaea viscose* and *Lantana camara* as dominant shrubs and *Cynodon dactylon* as dominant herb species were recorded (Mahmood *et al*. 2015).

2.4. Illegal trade on Pangolins

Pangolins were hunted both for subsistence and medicinal and the price of selling sub-adult or adult pangolin cost approximately US $ 4 in village and US $ 8 in city village and the organ such as skin, heart, intestine and head are used for medicinal purposes to treat asthma, cardiovascular and dermatologic diseases (Akpona *et al*. 2008).

Illegal trade of pangolins in Nepal was mainly for food/ meat, various medicinal purposes such as –treatment of asthma, uterine organ to avoid abortion, and -scales to prevent from evils besides making various items belts, buttons, and necklaces (Kaspal 2010).

Pangolins play a significant role in the food web by feeding upon termites, which a serious insect pest of agricultural crop (Mahmood *et al*. 2012) but they are hunted for flesh, skin and scales

Katuwal *et al*. (2013) studied pangolin trade, ethnic importance in eastern Nepal and found the average minimum price of pangolins (Rs 500-1000/kg) at local hunter and the prices rises to (40,000-50,000/kg or even more) as it reaches to china by high ranked poachers. Its medicinal value includes cure of gastro-intestinal diseases, skin diseases, cardiac problem, and painkiller during pregnancy and during back pain.

Pangolins are mostly traded in China and Vietnam, where pangolin meat is consumed as food and scales in traditional medicine. They are sourced from southeast and south Asia, and increasingly from Africa (Challender and Hywood 2012; Mohapatra *et al*. 2015).

Pangolins are traded for the sake of money and the retail price of whole skin was reported at RMB 2000 (USD 326), RMB 3000 (USD 489) for a kg of scales, and RMB 11500 (USD 1875) for a whole pangolin (that is RMB 10,000 for the meat and RMB 1500 for

0.5 kg of scales) for the trade in, from and to Myanmar whereas its price in China are considerably higher (Zhou et al. 2014; Challender *et al*. 2015).

The Kathmandu valley is a major center of illegal trade of pangolin in Nepal. A total of 26 cases were registered from the fiscal year 2067/68 to 2073/74 B.S against 61 individuals from 13 districts in the valley and illegal trade on pangolin scales has been increasing for the last six years (K.C. 2016).

During the period from October 2010 until the end of June 2015 a total of 65 pangolin seizures reported in Zimbabwe of which 58 involved live pangolins and nine involved dead pangolins including one seizures of skin and scales and a total of 89 suspects were arrested and out of these suspects 34 were either fined or received jail term and the length of jail terms has increased significantly through time (Shepherd *et al*.2016).

3. MATERIALS AND METHODS

3.1. Study area

3.1.1. Physical setting

The study area was situated in Chautara Municipality of Sindhupalchowk district which is surrounded by four Rural Municipality – Pipaldada, Kubende, Sanosirubari, and Chautara. It lies between 27°46′0″ latitude and 85°42′0″ longitude. The municipality stands at the elevation of approximately 1600m above the sea level.

The soil of the study site was dominated by red soil with fine texture favorable for pangolins. The geological condition of the municipality was high hills. This municipality was rocky in some areas. After the earthquake 2015 the study site was more prone of landslide.

The study site was also rich in water system. The major river was Kubendekhola which was Permanent River where water level slightly decreases in winter season. Beside this, there were numerous steams but after the earthquake water flown had been stopped in most of the streams.

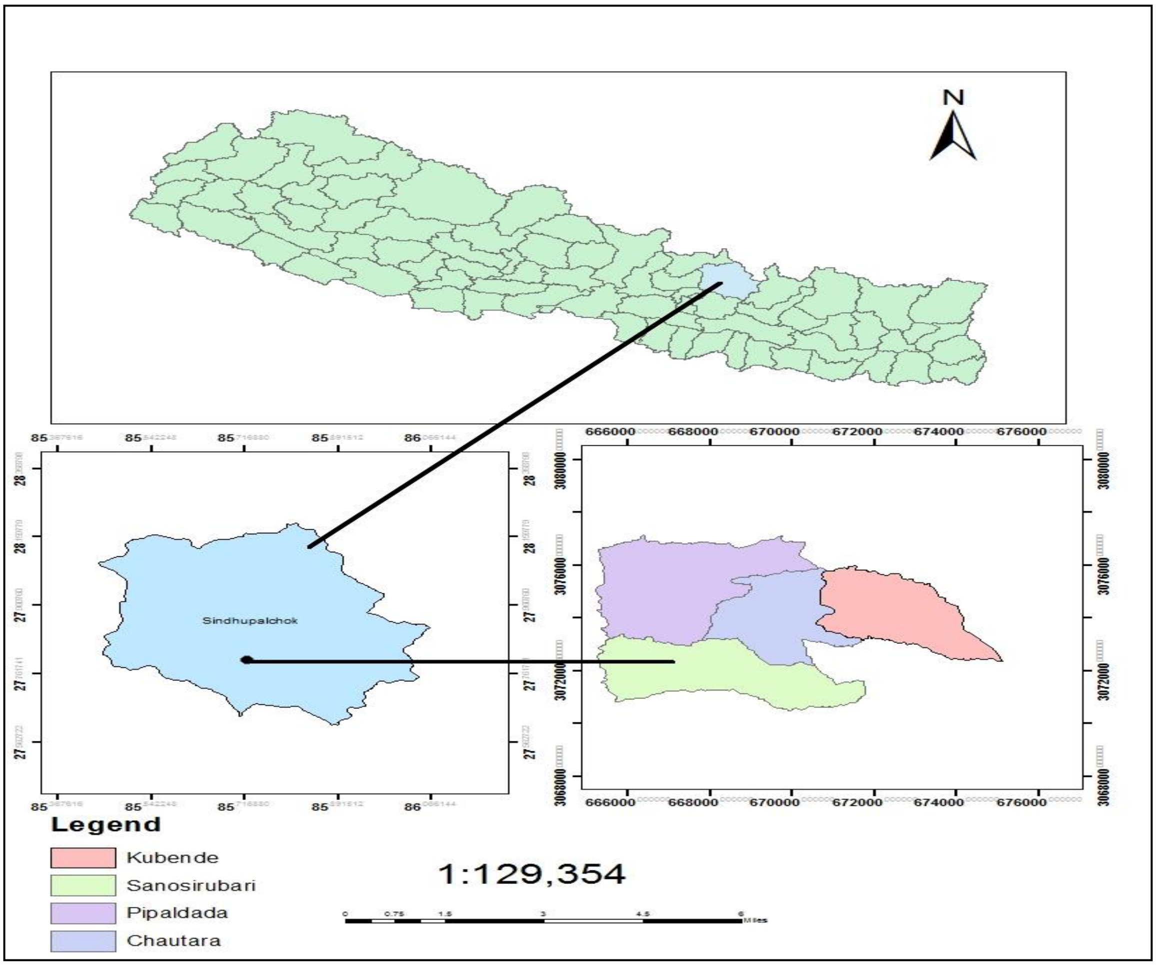


Figure 1. Map of the study area

3.1.2. Climate

The climate is warm and temperate in Chautara. In Chautara the average temperature is 17.8°C. The rainfall has averages 2244mm. The driest month is November with 10mm of rainfall. The greatest amount of precipitation occurs in July, with an average of 606mm. The warmest month is June with an average temperature of 22.6°C. The lowest average temperature in the year occurs in January when it is around 10.3°C.

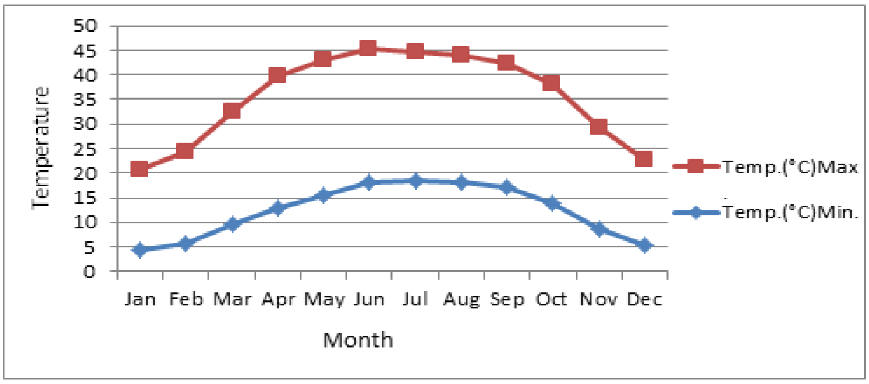


Figure 2. Monthly Minimum Temperature (°C) of Chautara Municipality

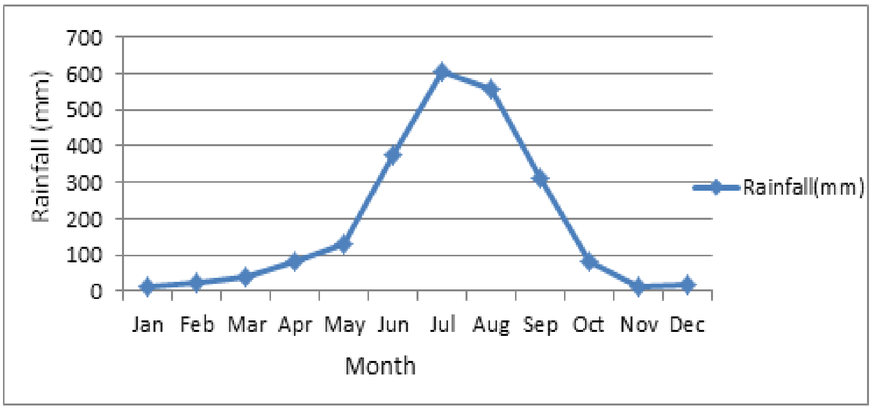


Figure 3. Monthly Rainfall (mm) of Chautara Municipality

Source: Climate-data.org 2015.

3.1.3. Biological Component

Most of the land of Chautara Municipality was covered by Farmland while few lands were covered by private and community forests as well as land for grazing animals. The major vegetation found in Farmland was Chilaune (*Schima wallichii*) and in community forest by pine (*Pinus wallichianna*) followed by Uttis (*Alnus nepalensis*), Lapsi (*Choerospondias axillaris*), Siris (*Albizia species*), Khapal (*Myrica esculenta*) etc.

The municipality is also rich in faunal diversity. These includes the Chinese pangolin (*Manis pentadactyla*), Porcupine (*Hystric* spp.), Common leopard (*Panthera pardus*), Mongoose (*Herpestes auropunctatus*), Yellow – throated Marten (*Martes flavigula*), Common Langur (*Presbytis entellus*), Squirrel (*Funcambulus* spp.) etc. Major wild birds are Sparrow (*Passer domesticus*), Crow (*Corvus spenders*), Rock Pigeon (*Columbia* *livia*), Common Myna (*Acridotheres tristis*) etc. Similarly the reptiles are found in this municipality are different types of Snakes and Lizards.

3.1.4. Socio – Economy

This municipality is mainly the inhabitants of farmer, teacher and government employ. People mainly depend upon agriculture. The main food crops are rice, maize, millet and green vegetables. The main castes of this municipality are Sherpa, Newar, Brahmin, Chhetri, Gurung, Magar, Tamang etc. The major languages spoken are Nepali, Newari and Tamang.

3.2. Methods

3.2.1. Reconnaissance survey

Preliminary survey was conducted from May 22 to June 2, 2016 to identify the major study sites and understanding the people's perception about the pangolin distribution and its illegal trade. I visited Chautara Municipality and discussed with the experts, District Forest Officer (DFO) authorities about the study and identified study site which includes forest, cultivated land and grassland. Different burrows and biophysical parameters were observed during this survey. Relevant literature, reports, journals, books and internet were thoroughly studied to collect the secondary data on pangolin.

3.2.2. Research design

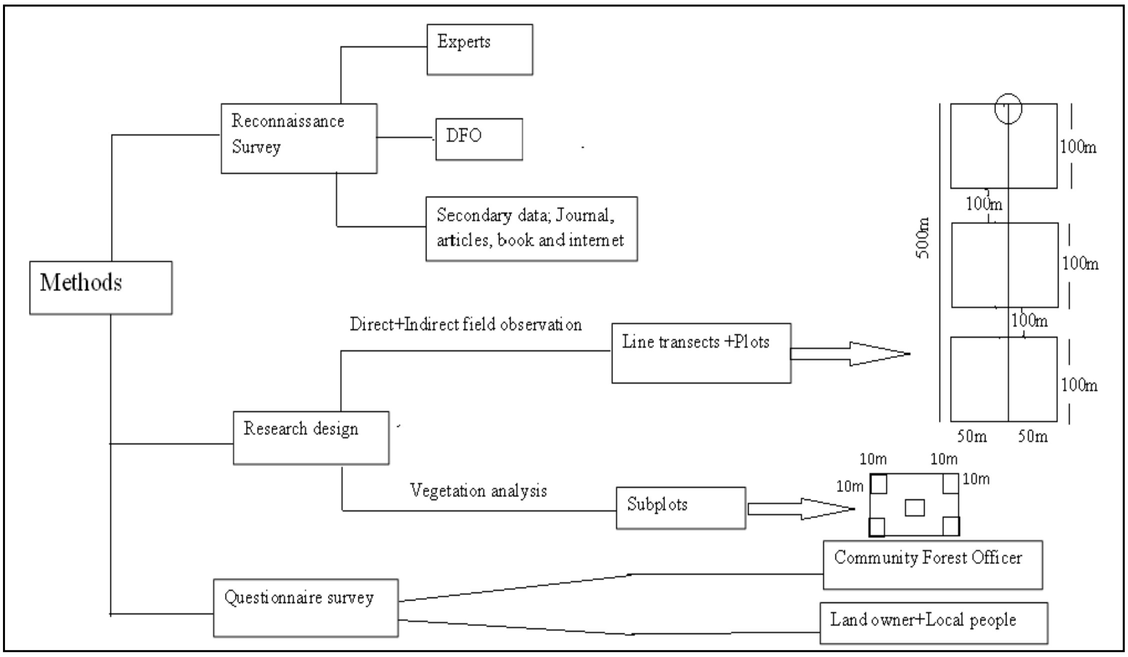


Figure 4. Diagrammatic representation of research design

3.2.2.1. Field study design

Potential sites based on the reconnaissance survey were selected. After one burrow was found, taking that burrow as a reference point, a line transect of 500m were laid out.

Three plots of each (100*100) m were made in each line transect. Each plot was drawn at equidistance of 100m.

Slope, aspects, threats, distance from settlement area, road, water resources, ant nests/ termites mound, litter condition, ground cover, canopy cover of each plot were observed and recorded. GPS coordinates, elevation, depth and diameter of each burrows present within the blocks were measured.

3.2.2.2. Indirect Field Observation

Indirect field observation included burrows, pugmarks, pellets, scales, traces of tail were also recorded from each plot. GPS coordinates were recorded to produce distribution map using GIS Software. Depth and diameter of each burrow were measured using measuring tape. The burrows were categorized into active and inactive ones as:

If the burrows contained less compact and loose soil, recent digging, footprints and pellets at the entrance of burrow it was classified as active (new) burrows. If the burrows contained compact soil, burrows mostly covered with dried vegetation, spider nets and the burrows without scratch sign at the burrow's opening it was classified as Inactive (old) burrows (Suwal 2011). As Nepal is affected by the catastrophic Gorkha earthquake 2015 inactive burrows were further sub- classified as:

Inactive (old) burrows before the earthquake: Burrows one year before earthquake.

Inactive (old) burrow after the earthquake: Burrows one year after earthquake.

The total number of burrows in each plot was randomly counted and densities of burrows were calculated by dividing total number of active burrows by total area;

$$\text{Burrow density} = \frac{\text{Total number of active burrows}}{\text{Total area}}$$

3.2.3. Vegetation Analysis

Three plots were laid out in each line transects. In each plot, 5sub-plots were made for vegetation analysis of tree species. For the tree species (10*10)m plot were laid out in four corners and one in the middle of each plot. DBH greater than 10cm were taken into account. DBH of all trees were measured with the help of measuring tape. Density, Relative density, Frequency, Relative frequency, Dominance and Relative dominance were used to estimate the Important Value Index (IVI) as follows:

D- Dominance, RD- Relative Dominance, d- Density, Rd- Relative density, f- Frequency, Rf- Relative Frequency and IVI- Important Value Index = RD + Rd + Rf.

3.3. Questionnaire Survey

One hundred sixty people were randomly sampled and interviewed by using a set of structurally scheduled questionnaires to find the distribution, abundance and also to identify the trade routes and trade volume of pangolin scales after the earthquake. Along with this, landowners or community forest officers belonging to respective plots were also interviewed to get the information on active and inactive burrows before and after earthquake.

3.4. Data Analysis

All the primary and secondary data collected were entered into Microsoft Excel or Notepad and imported into R software. All the charts and tables needed were made in Microsoft Excel.

Chi-square test was used to examine whether there was a significant difference in association of pangolins before and after the earthquake.

T-test was used to see the difference between observation in plots and respondents view after the earthquake for variables (natural calamities, forest fire, grazing, sparse canopy cover, major vegetation (*Schima wallichii*), major soil type, cultivated land and exploitation of natural resources).

Binomial Logistic Regression Model was used to test the significant between the distribution of pangolins burrows in different plots for natural calamities (NC0 = absence/NC1 = low/ NC2 = medium/ NC3 = high), distance to settlement (DS) (m), aspects (Aspect1 = north/Aspect 2 = south/ Aspect3 = east/ Aspect4 = west) and habitat types (HT1 = forest/ HT2 = grassland/ HT3 = farmland) as an independent variables and distribution (presence/absence) as a dependent variable were analyzed using R-studio.

3.5. Distribution pattern

Data on pangolins location such as number of burrows, recorded in each plot were used to determine distribution pattern. The distribution pattern of pangolins was calculated by variance to mean ratio (Odum 1971) in poisson distribution, the variance (s^2) is equal to the mean ($\bar{x}$). If $s^2/\bar{x} < 1$, distribution is uniform

If $s^2/\bar{x} = 1$, distribution is random

If $s^2/\bar{x} > 1$, distribution is clumped

4. RESULTS

4.1. Occurrence and distribution of the Chinese pangolin

4.1.1. Occurrence and distribution of Pangolins in plot

Among the 75 plots laid out, 47 plots (63%) had indirect evidences of Pangolin and the rest (37%) did not show any presence (Figure 6).

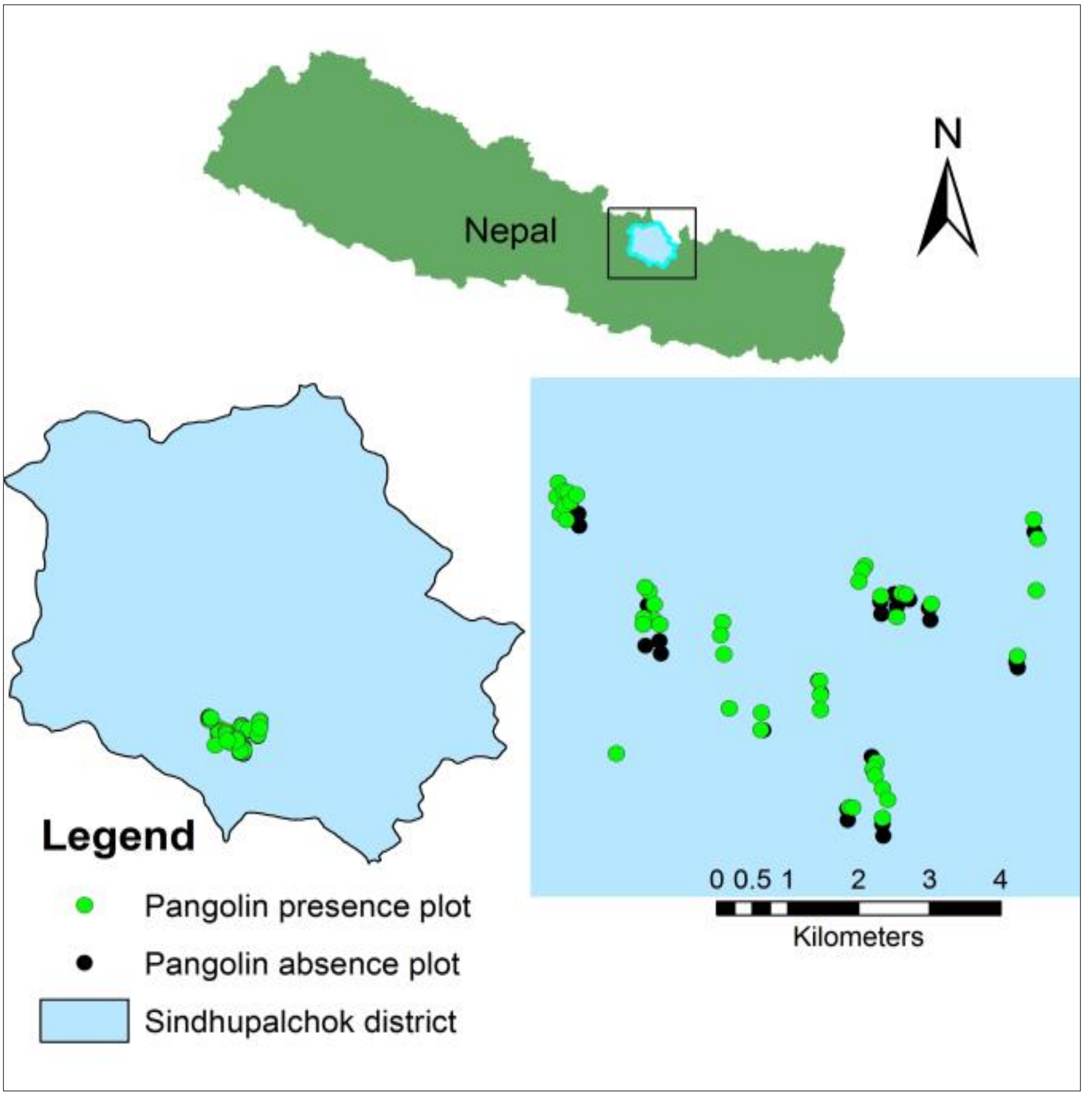


Figure 5. Distribution pangolins in a plot

Within the total plots there were altogether 307 burrows of which 121 burrows (almost 40%) were before the earthquake, 96 burrows (31%) were new while 90 burrows (29%) were after the earthquake. A burrow density of active burrows was two burrows per hectare.

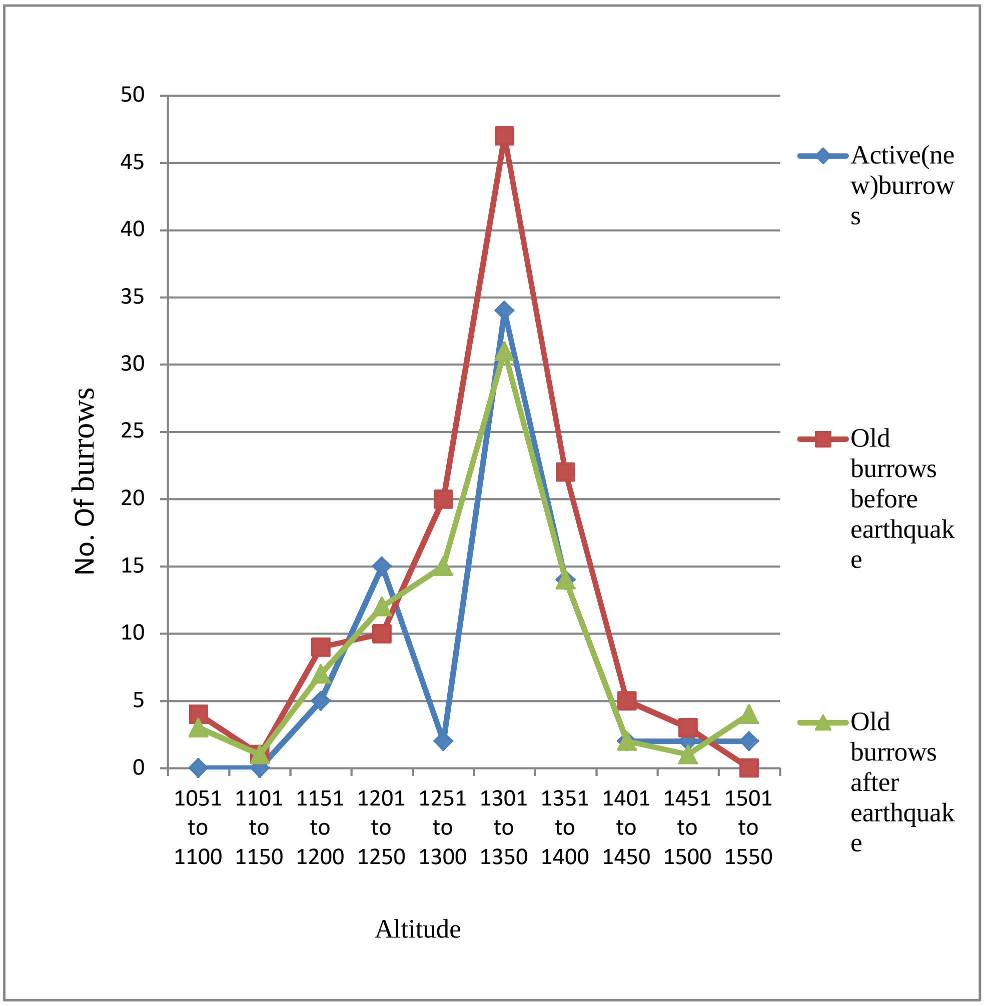


Figure 6. Altitudinal distribution of burrows

All the types of burrows (active burrows, old burrows before the earthquake and old burrows after the earthquake) were highly distributed between the altitudes of 1201m to 1400m. The number of Active burrows between the altitudinal ranges of 1251m to 1300 m declined to almost zero (Figure 6) in the study area.

Table 1. Binomial Logistic regression model for the occurrence and distribution of Chinese pangolin (*Manis pentadactyla*). Model parameters were natural calamities (absence/ low/ medium/ high), aspect (north/ south/ east/ west), distance to settlements (m) and habitat types (forest / grassland / farmland) at 95% confidence limits (CL) (R Development Core Team 2016).

Variables	Estimate	Std. Error	Z value	Pr(>|z|)
Intercept	3.157e+00	1.64e+00	1.944	0.05189.
NC1	-1.939e+00	1.365e+00	-1.421	0.15542
NC2	-1.185e+00	1.615e+00	-0.734	0.46318
NC3	-4.643e+00	1.677e+00	-2.769	0.00562 **
Aspect2	2.089e+00	9.313e-01	2.243	0.02490 *
Aspect3	1.271e+00	1.213e+00	1.048	0.29470
Aspect4	-1.456e+01	1.639e+03	-0.009	0.99291
DS	-1.235e-02	3.441e-03	-3.590	0.00033 ***
HT2	3.873e+00	2.861e+00	1.354	0.17578
HT3	2.064e+00	9.021e-01	2.288	0.02213 *
Signif. Codes: 0 '***' 0.001 '**'0.01 '*' 0.05 '.' 0.1 ' ' 1				

Presence of pangolins in each plot was affected by south facing slope, distance to the settlements, highly impacted natural calamities and farmland (Table 1). The distribution pattern of pangolins in Chautara Municipality showed clumped distribution ($s^2/\overline{x} = 8.95$). The variance/mean ratio was found to be significantly greater than 1 suggesting an uneven distribution of pangolins in the study area.

4.1.2. People's perception about occurrence and distribution

Data analysis showed that 83% of the respondents had not seen live pangolins but all of them had seen indirect signs and evidence of pangolins either in the form of burrows, scratches, scales or pugmarks. Among the respondents, 72% of them had seen their burrows and remaining 28% of them had seen pugmarks, scales and scratches (Table 2). According to the age group,the highest almost 43% of the people were between age of 36 to 50, over 32% were between the age of 26 to 35, over 19% were above the age of 51 and almost 6% were below the age of 25. Among them, over 53% were male and almost

48% were female. Simiarly, around 88% of the respondents were farmers, almost 6% were in the category of service, over 2% were business men and almost 4% were students.

Table 2. Opinion of local people about distribution and occurrence of Pangolin

S.N	Main Points	Opinions of the respondents			
1	Sighting of live pangolins	Yes	No		
		17%	83%		
2	Sighting of live pangolins	Day	Night	Early morning	Not seen
		3%	9%	5%	83%
3	Seen the evidence of pangolins	Burrows	Scratches	Scales	Pugmarks
		72%	8%	14%	6%

Almost 45% of the respondents said that new burrows of pangolins were decreased after the earthquake but 21% of the respondents claimed that new burrows were increased (Figure 7).

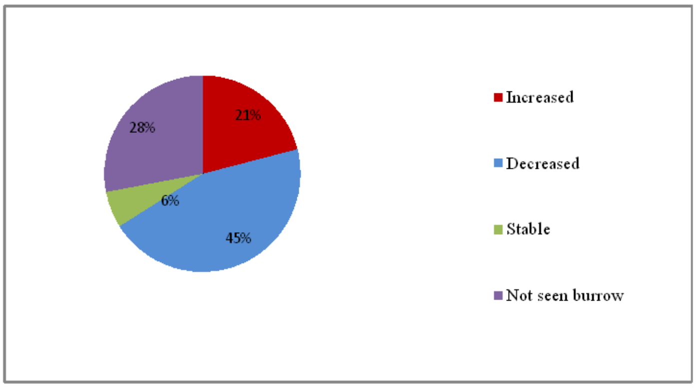


Figure 7. Status of Pangolin

From the result of 160 respondents, almost 59% of the respondents had seen the burrows near house before the Earthquake, whereas nearly 56% of the respondents had seen burrows away from house after the earthquake (Table 3).

Table 3. Sighting of burrows before and after the earthquake

	Before earthquake	After earthquake
Sighting of burrows near houses	95	17
Sighting of burrows away from house	21	89

There was a significant differences in sighting of burrows near and away from house before and after the earthquake (χ^2 =93.486, df =1, p-value <2.2e-16).

4.2. Habitat conditions

Altogether 26 tree species were recorded from 75 plots. The IVI was the highest for *Schima wallichii* (10701.35) followed by *Choerospondias axillaris* (4057.52) and the lowest for *Colocasia esculenta* (15.31) (Table 4). Beside this, only 47 plots had pangolin occurrence, among the pangolin present plots 46 plots were present in canopy cover between 0-25% while one plot between canopy cover 25-50%. Likewise, 37 plots were found in red soil and only 10 plots in brown soil amongst the pangolins present plots. The average depth and diameter of active burrows were 228cm and 26cm; burrows before the earthquake were 102cm and 14cm; and burrows after the earthquake were 165cm and 20cm respectively.

Table 4. Important Value Index for tree species

S. N	Common Name	Scientific Name	IVI	S. N	Common Name	Scientific Name	IVI
1	Lapsi	*Choerospondias axillaris*	4057.52	14	Bilouni	*Maesa chisia*	36.72
2	Utis	*Alnus nepalensis*	1223	15	Mahua	*Madhuka latifolia*	70.06
3	Gobre salla	*Pinus wallichinna*	2032.27	16	Satisal	*Dalbergia latifolia*	76.58
4	Koiralo	*Bauhinia variegate*	111.63	17	Badahar	*Artocarpus lakoocha*	531.79
5	Simal	*Bombax ceiba*	78.66	18	Bhogate	*Maesa macrophylla*	17.54
6	Kutmero	*Litsea monopetala*	1071.61	19	Musure Katus	*Castanopsis tribuloides*	693.52
7	Chilaune	*Schima wallichii*	10701.4	20	Jamun	*Syzgium cumini*	23.59
8	Chiniya naspati	*Malus baccata*	34.14	21	Kaaphal	*Myrica esculenta*	598.39
9	Taro	*Colocasia esculenta*	15.31	22	Dabdabe	*Garuga pinnata*	210.72
10	Sal	*Shorea robusta*	24.41	23	Ankhataruwa	*Trichilia connaroides*	51.37
11	Saj	*Terminalia alata*	28.43	24	Khari	*Celtis australis*	331.35
12	Amala	*Phyllanthus emblica*	12.15	25	Aanp	*Mangifera indica*	218.95

13	Siris	*Albizia* sps.	91.02	26	Harro	*Terminalia chebula*	38.97

Observations in plots and respondents view for each variable were used to describe the conditions of habitat of Chinese pangolins after the earthquake.

Table 5. Condition of habitat after the earthquake

S.N	Variables	Observation	Respondents
1	Natural calamities	66	82
2	Forest fire	9	12
3	Grazing	5	13
4	Sparse canopy cover	73	97
5	Major vegetation Chilaune (*Schima wallichii*)	44	64
6	Major soil type red	56	95
7	Cultivated land	53	72
8	Exploitation of natural resources	51	11

There was no significant differences (t = -0.69499, df = 12.112, p –value = 0.5002) between the observation in a plot people claim about the habitat of pangolins after the earthquake. About 63% of the respondents thought that the number of pangolins was lowered due to the lack of awareness followed by lack of information (24%) and research (13%) respectively were the reasons for its extinction in the near future.

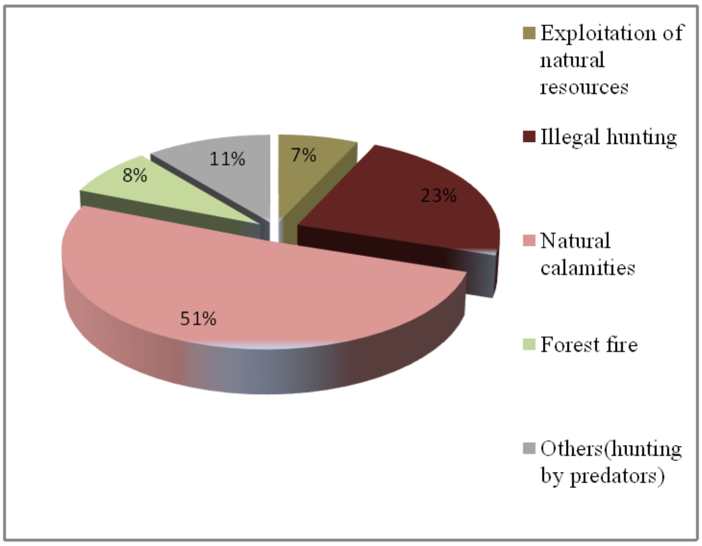


Figure 8. Current threats to Pangolins

From the data analysis, 51% of the respondents indicated that the current threats to pangolin was due to natural calamities followed by exploitation of natural resources (7%), illegal hunting (23%) and remaining 19% of them by other causes including forest fire and others (hunting by predators) (Figure 8).

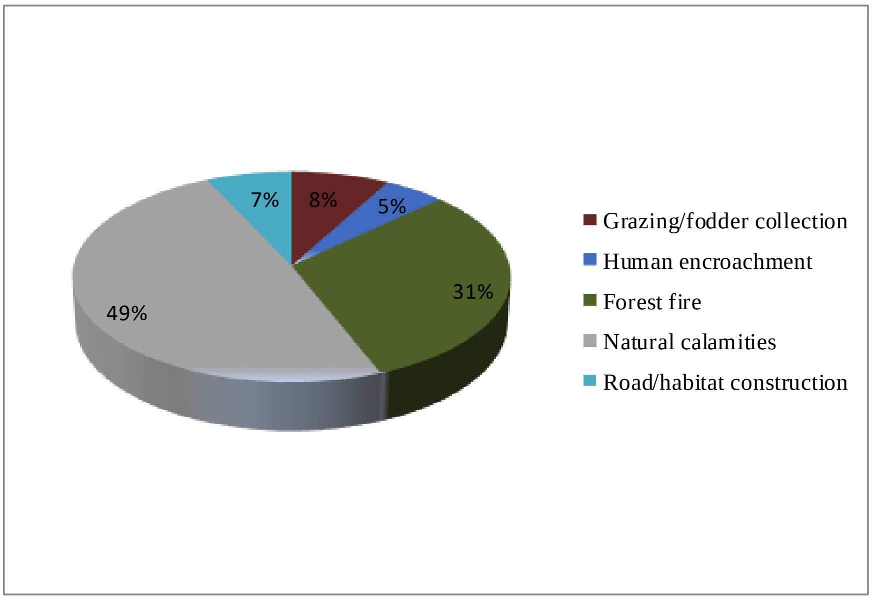


Figure 9. Causes of habitat disturbance of Pangolin

Almost 49% of the respondents focused on natural calamities as the cause of habitat disturbance followed by almost 31% on forest fires, 8% on Grazing/fodder collection and remaining 12% indicated Road/habitat construction and human encroachment as a cause of habitat disturbance of pangolins (Figure 9).

4.3. Illegal trade

Survey data showed that there was no significant difference between responses of increasing trade (37%) and decreasing trade (34%) after the earthquake. But there were a quite high percentage of people (28%) who were unknown about its trade (Figure 10).

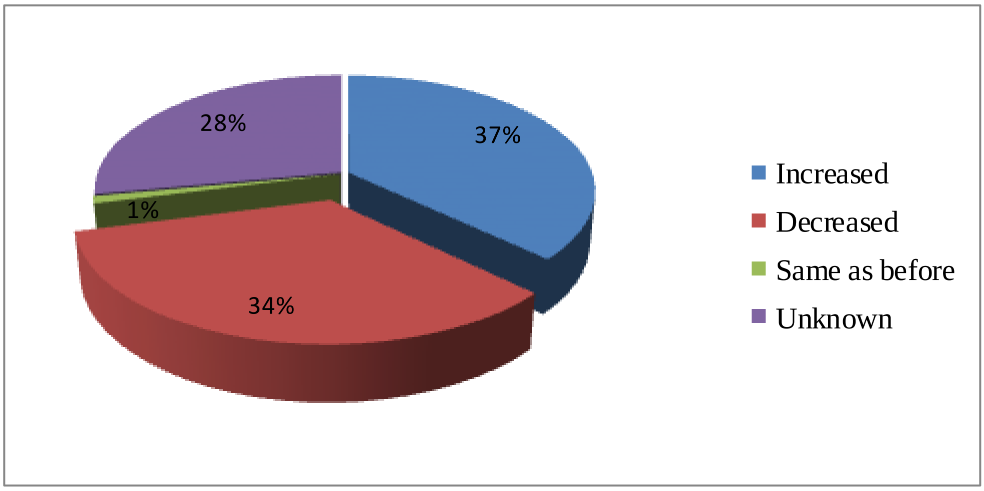
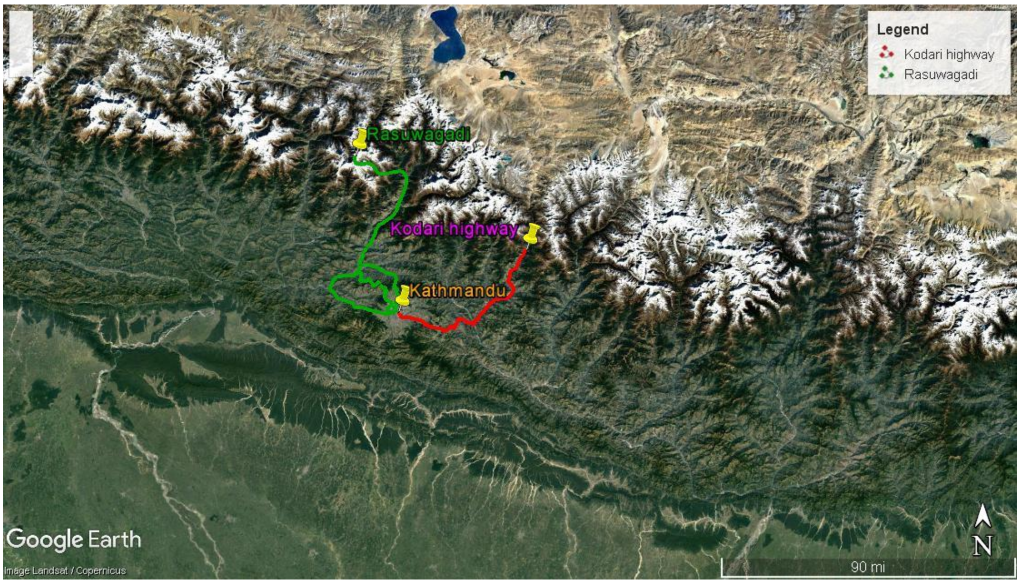


Figure 10. Illegal trade after the earthquake

4.3.1. Illegal trade route

About 52% of the respondents thought the illegal trade route for selling pangolins and pangolin products might have changed because of the earthquake in contrast to almost 11% of the respondents who thought trade routes were the same as before, and over 37% of the respondents did not know about the illegal trade route after the earthquake

Over 36% of the respondents indicated that illegal trade route for selling pangolin product might have changed through Rasuwa, almost 11% of them thought through Kodari highway, and over 16% of them thought through both Rasuwa and Kodari highway and remaining 37% did not know about the illegal trade route after the earthquake (Figure 11-14).



Source: Google Earth 2016

Figure 11. Illegal trade route for selling Pangolin products

Through Kodari highway:

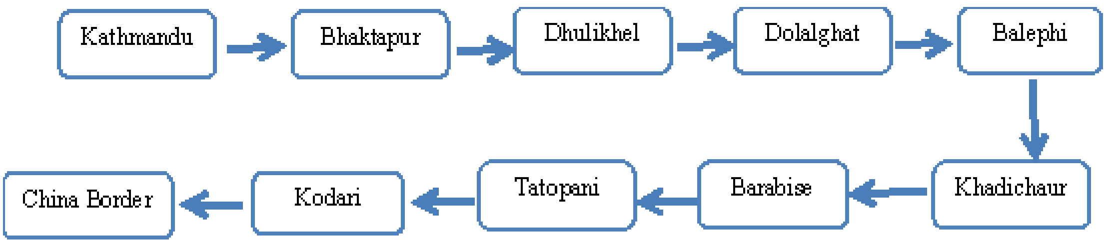


Figure 12. Flow chart showing the illegal trade route through Kodari highway

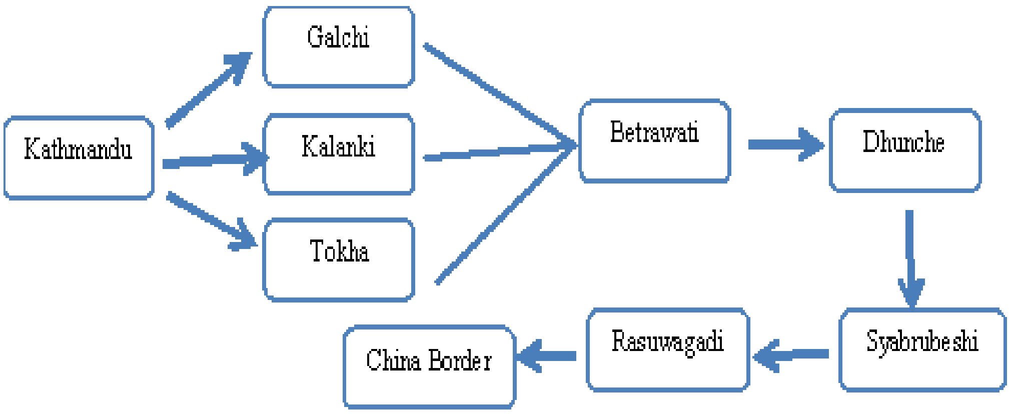


Figure 13. Flow chart showing the illegal trade route through Rasuwa

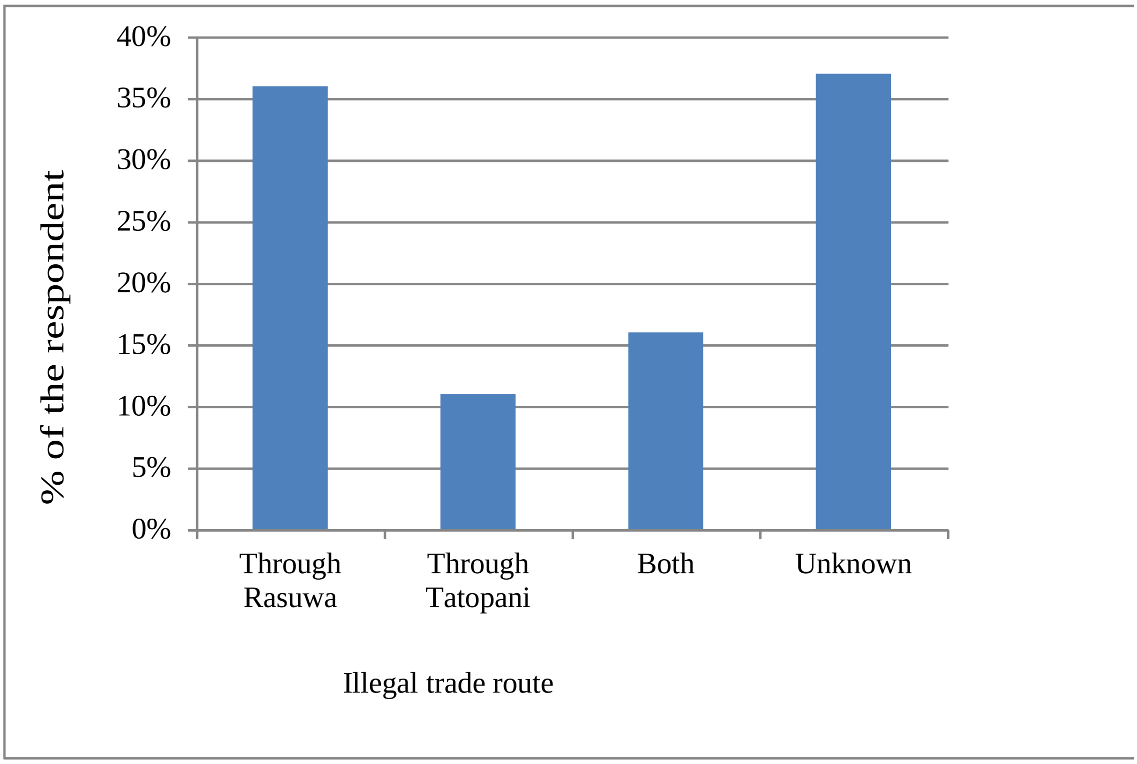


Figure 14. Identification of illegal trade route for selling Pangolin products

4.3.2. Trade volume and the cost

Only 21% of respondents were known about the trade volume and estimated that total of over24kg- 27kg of pangolin scale were sold to china market after the earthquake. Over 52% of the respondents indicated that the cost trend of pangolin's scales after the earthquake had increased (Figure 15).

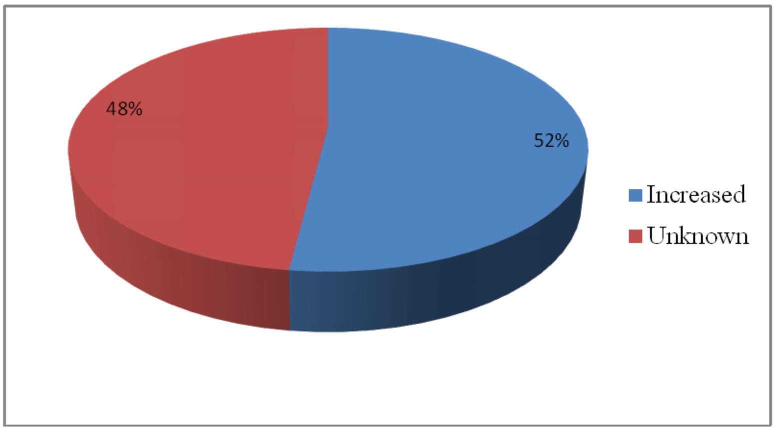


Figure 15. Cost of scales after the earthquake

4.3.3. Price dynamics

About 14% of the respondents knew about the price/cost of the Chinese pangolin in that area. The survey showed the price of scales was increasing steadily during the last five years (Figure 16).

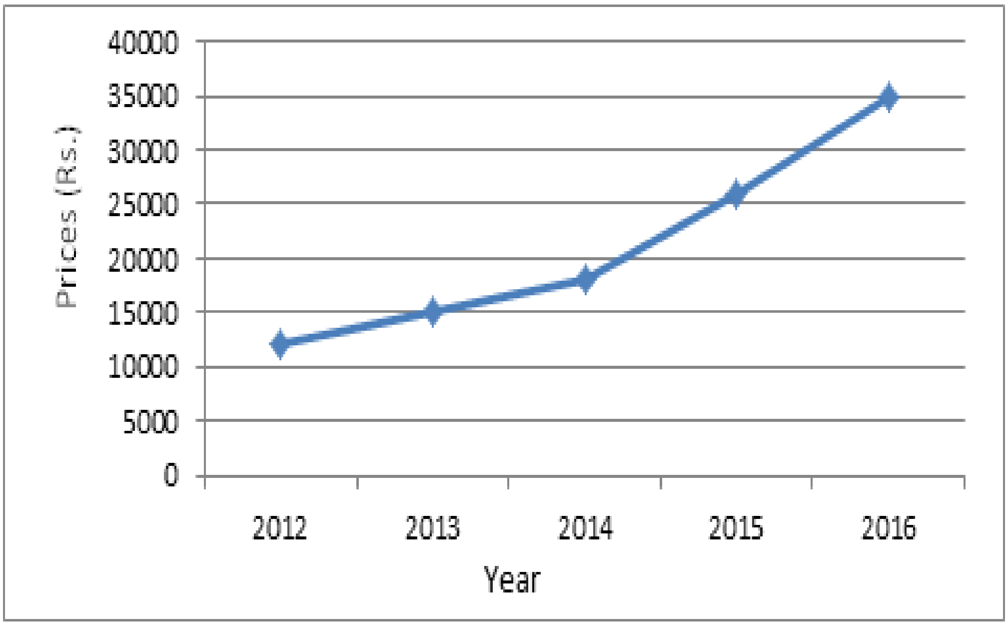


Figure 16. Price of scales of Pangolin within five years

The price of scales at the beginning of 2016 was very high i.e. Rs.35, 000 per kg on average. However, the actual price was not known because it varied locally and from one person to another. The cost was Rs.35, 000 per kg at the local market but after reaching to China border its rate went up.

5. DISCUSSION

5.1. Distribution and occurrence of pangolins in plots

The distribution of pangolins was significant and favorable in farmland at the south facing slope with major vegetation Chilaune (*Schima wallichii*) in between the canopy cover (0-25%) with red soil. This finding indicated that pangolin preferred south aspect in the canopy cover 0-25% in red soil. Gurung (1996) and Acharya (2001) also stated that pangolins preferred south facing slope with maximum number of burrows in red soil in Nagarjun whereas Bhandari and Chalise (2014) indicated that pangolins preferred northwest aspect in the canopy cover between 25-50% in brown soil. The reason might be lower human disturbances and less earthquake triggered landslides in the south facing slope in compared to other aspects. However, Suwal (2011) recorded more burrows in the east facing slope with brown soil. Preference to the certain areas might be influenced by climatic condition, availability of food, human settlements and also due to the intensity of natural calamities.

The depth and diameter of burrows before the earthquake were very less compared to the active burrows and burrows after the earthquake which indicated that burrows before the earthquake were highly affected by natural calamities (earthquake and its consequences). Pangolin makes active burrows > 2m depth with 21~23cm in diameter Acharya (2001).

The maximum numbers of burrow during my study were found at the altitudinal range of 1201 to 1400 but between the altitudes of 1251 to 1300 the number of active (new) burrows declined to almost zero this might be probably because of landslides, as consequences of the earthquake. The distribution of burrows was higher at the altitude range of 1450m to 1550m (Bhandari and Chalise 2014) and Heath (1992) and Wu *et al*. (2003) indicated the animal preference up to 1550m while Chao (2001) and Chakraborty *et al*. (2002) recorded up to 2000m.

The fresh burrow density was almost 2 burrows per hectare. The total burrow density recorded by Kaspal (2008) was $10.2/km^2$ and burrow density recorded by Suwal (2011) was 8 burrows per hectare. Low burrows density as compared to those in other sites; was due to the earthquake and earthquake triggered landslides, which might have killed pangolins and affected their habitats.

The distribution pattern of pangolins was uneven or clumped as per the distribution of resources such as food, water and shelter, human settlement and natural calamities. Bhandari and Chalise (2014) and Karki (2015) observed similar pattern in their study. Clumped pattern of distribution is common in nature, almost the rule when individuals are considered (Odum 1971).

Due to the earthquake and its consequences, burrows before the earthquake were damaged and local villagers thought that some pangolins might have been killed inside the burrows. As a result the number of old and active burrows declined after the earthquake. Similarly, before the earthquake almost 60% respondents had seen burrows near human settlements but after the earthquake over 65% burrows must have been damaged or buried under the damaged houses and the pangolins must have been killed or moved to safer places thus shifting their habitats away from human settlements.

5.2. Conservation Threats

There are direct and indirect factors affecting the population of pangolins. Hunting and trade are the direct factors whereas natural calamities, habitat fragmentation, forest fires, exploitation of natural resources are the indirect factors affecting their distribution.

I found the earthquake and its consequences as a basic current threat for pangolins as it destroyed a large number of burrows and pangolins. Moderate to large earthquakes like the 1989 Loma Prieta earthquake (M = 6.9) caused liquefaction (Pease and Orourke 1997) and that must have triggered destruction of burrows.

The Luschan earthquake and Wenchaun earthquake on April 20, 2013 and May 12, 2008 respectively causes injury or death of giant pandas and also damages conservation facilities for pands which results in further fragmentation and degradation of pandas habitat (Zhang et al. 2014 and Cheng et al. 2009).

ASEAN countries are parties to Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) and are committed to stop the international trade in pangolins, their parts and derivatives. However, the illegal trade of pangolins and their body parts is widespread (Shepherd 2009). The study indicated that there was a lack of information, awareness and research on pangolin and associated policies.

5.3. Illegal trade route, trade volume and the price

As a result of the earthquake, illegal trade might have been increased because the people lost their houses and property with alleviated poverty. In order to survive and recover their damaged houses, some people resorted illegal trade. Thus the wildlife became more vulnerable to poaching after the earthquake. Hunting and commercial trade at local level flourished due to food insecurity (Ministry of Science, Technology and Environment 2015). Kathmandu police arrested two persons of Sindhupalchowk for their alleged involvement in smuggling of a pangolin hide with scales from Gothatar (The Kantipur Daily on July 15, 2016). It showed that people of Sindhupalchowk were involved in trade of pangolins due to the earthquake triggered poverty. The Nepal government report revealed the Gorkha earthquake 2015 pushed one million people below the poverty line (The Himalayan Times on June 14, 2015).

Illegal trade route through Tatopani was blocked because of the earthquake followed by several landslides so most smuggling occurred through Rasuwagadi route. Rashuwagadi was the alternative trade route after Tatopani to China border (The Kathmandu Post on April 17, 2015). On June 16, 2016, one kilogram skin of the Red panda was seized by Police Officer of Rasuwa (District Police Office 2016). Trade volume of pangolin scales after the earthquake was estimated to be over 24kg-27kg.

Trade price for pangolin scales per kg was increased and it was about 35,000/kg on average at the local market. Data analysis showed that it was due to poverty triggered by the earthquake. In China and Vietnam the price of pangolin scale was much higher compared with my result. It was USD 759.15/kg in China and USD 484.91/kg in Vietnam in 2013 (Challender *et al*. 2015).

6. CONCLUSIONS AND RECOMMENDATIONS

6.1. Conclusions

Chinese Pangolins were distributed in all the VDCs of Chautara Municipality, Sindhupalchowk. At least 17% of the respondents had seen the live pangolins mostly during the night time and mostly in the cultivated land. Altogether 307 burrows were found (121 burrows before the earthquake, 96 active (new) burrows and 90 burrows after the earthquake).

The burrows were distributed from 1051m to 1550m altitude with the most occurrences at 1201m to 1400m but between 1251m to 1300m number of active (new) burrows declined to almost zero. Pangolins preferred the south aspect in farmland the most. The IVI was the highest for *Schima wallichii* (10701.35) followed by *Choerospondias axillaris* (4057.52) and the lowest for *Colocasia esculenta* (15.31). Pangolins presence in each plot was affected by south facing slope with major vegetation chilaune *(Schima wallichii*) and pangolin was largely determined by natural calamities (earthquake and earthquake triggered landslides) and distance to settlements.

Although local people did not clearly responded whether poaching and illegal trade was increasing or decreasing, circumstantial evidence (e.g. acute poverty, food insecurity and police report showed that the illegal trade was increasing. Almost 21% of the respondent estimates total of over 24kg - 27kg of pangolin scale was sold to China border after the earthquake.

The Illegal trade routes of selling pangolins product were identified either through Tatopani or Rasuwa. Tatopani trade route was highly affected by the earthquake so the illegal trade occurred through Rasuwa. Cost of scales of pangolins after the earthquake was increasing. Scales were the most valuable parts with the price of Rs.35,000 per kg with variation as high as 7 - 8 hundred thousand rupees for a kilogram in China border.

The study concluded both the natural and anthropogenic factors were responsible for affecting the species occurrence and distribution.

6.2. Recommendations

For the survival of Pangolins, protection and maintenance of habitat is necessary. The following recommendations have been put forward from this study.

- Protection of pangolin habitats from forest fires, deforestation, overgrazing, and encroachment is essential for the protection of pangolins
- Research on causes and consequences of declining populations of pangolins, their distribution and distribution range, and awareness programs must be the priorities of government and non-government organizations.
- Strict law enforcement particularly in and around trans-border areas and identified trade routes always help to stop or minimize illegal trade of the species.

7. REFERENCES

Acharya, P.M. 2001. Distribution and status of pangolin in Nagarjun Forest in Central Nepal and its conservation measures. Proceedings of workshop on Asian pangolin, Taipei, Taiwan.

Acharya, S. 2016. Assessment of conservation threats and habitat management of Chinese pangolin (*Manis pentadactyla* Linnaeus, 1758) in Balthali VDC of Kavre, Nepal. B.Sc. Thesis. Institute of Forest, Hetauda.

Akpona, H.A., Djagoun, C.A.M.S. and Sinsin, B. 2008. Ecology and ethnobiology of the three-cusped pangolin *Manis tricuspis* (Mammalia: Pholidata) in the Lama Forest Reserve. Benin. Mammalia, **72**: 198-202.

Basnet, K., Shah, K.B, Suwal, T.L, Thapa, S., Gurung,S., Koirala, S., Aryal, P.C., and Thapa, A. 2016. National pangolin Survey 2016. Final report submitted to WWF/Hariyo Ban Program, Baluwatar, Nepal.

Basnet, K., Shah, K.B, Suwal, T.L, Thapa, S., Gurung, S., Koirala, S., Aryal, P.C., and Thapa, A. 2017. Pangolins Monitoring Protocol, Nepal' Draft submitted to Government of Nepal and Harioban/WWF Nepal.

Basnyat, B., Tabin, C., Nutt, C. and Farmer, P. 2015. Post-earthquake Nepal: the way forward. The Lancet Global Health, **3**(12): 731-732.

Baillie, J., Challender, D., Kaspal, P., Khatiwada, A., Mohapatra, R., Nash, H. 2014. *Manis crassicaudata*. IUCN Red List of Threatened Species.www.iucnredlist.org assessed on 05 September 2016.

Bhandari, N. and Chalise, M.K. 2014. Habitat and distribution of Chinese pangolin (*Manis pentadactyla* Linnaeus, 1758) in Nagarjun Forest of Shivapuri National Park, Nepal. Nepalese Journal of Zoology, **2**(1): 18.

Castilla, J.C., Manriquez, P.H. and Camano, A. 2010. Effects of rocky shore coseismic uplift and the 2010 Chilean mega-earthquake on intertidal biomarker species. Marine Ecology Progress Series, 418: 17-23.

Chakraborty, S., Ramakrishna, S. and Chakraborty, R. 2002. Pangolins (Mammalia: Pholiodata) of India. Zoological Society of India. ENVIS Newsletter, **9**: 5-9.

Challender , D., Baillie, J., Ades, G., Kaspal, P., Chan, B., Khatiwada, A. *et al*. 2014a. *Manis petadactyla*. IUCN Red List of Threatened Species. www.iucnredlist.org. assessed on 05 September 2016).

Challender, D.W.S., Harrop, S.R. and MacMillan, D.C. 2015. Understanding markets to conserve trade. Threatened Species in CITIES. Biological Conservation, **187**: 249-259.

Challender, D.W.S. and Hywood, L. 2012. African pangolin under increased pressure from poaching and international trade. TRAFFIC Bull, **24**(24): 53-55.

Chao, J.T. 2001. General status of Formosan pangolin *Manis pentadactyla pentadactyla*. (Abs) Workshop on Asian Pangolin, Taipei, Taiwan.

Cheng, S., Kong, J. and Song, H. 2009. Wenchuan 512 earthquake and giant panda habitat in Wolong China: A review of strong earthquake effects. Frontiers of Forestry in China, **4**(4): 388-393.

CITES. 2000. Prop. 11.13. *Manis crassicaudata, Manis pentadactyla*, *Manis javanica*. Transfer from Appendix II to Appendix I (India, Nepal, Sri Lanka, United States).
Corlett, R.T. 2007. The impact of hunting on the mammalian fauna of Tropical Asian Forests. Biotropica, **39**(3): 292–303.

Corlett, R.T. 2007. The impact of hunting on the mammalian fauna of tropical Asian forest. Biotropica, **39**(3): 292-303.

Dhakal, S. 2016. Distribution and conservation of Chinese pangolin (*Manis pentadactyla* Linnaeus, 1758) in Palungtar municipality of Gorkha district, Western Nepal. B.Sc. Thesis. Kathmandu Forestry College, Kathmandu.

Ellis, R. 2005. Tiger bone and rhino horn-the destruction of wildlife for traditional Chinese medicine. Island Press, London.

Foster, R., Hagen, A., Perera, N., Gunawan, C.A., Silaban, I., Yaha, Y. *et al*. 2006. Tsunami and earthquake damage to coral reefs pf Aceh, Indonesia, Reef Check Foundation, Pacific Palisades, California, USA. 32 pp.

Fujimoto, M. and Hanamura, S. 2008. Response of wild chimpanzees (*Pan troglodytes schweinfurthii*) toward seismic aftershocks in Mahale Mountains National Park, Tanzania primate. **49**: 73-76.

Gee, B.M., Guan, T.P., Powell, D., McShea, W.J. and Song, Y.L. 2011. Effects of an earthquake on wildlife behavior: a case study of Takin (*Budorcas taxicolor*) in Tangjahe National Nature Reserve, China. **26**(1): 217-223.

Gurung, J.B. 1996. A pangolin survey in Royal Nagarjun Forest in Kathmandu, Nepal. Tigerpaper, **23**(2): 29-32.

Gurung, S. 2015. Effects of landuse and land cover on occurrence of Barn owl (*Tyto albascopoli*). The M.Sc. Thesis. Central Department of Zoology, Kirtipur, Kathmandu, Nepal.

Hassan, M., Sulaiman, M.H. and Lian, C.J. 2013. The prevalence and intensity of *Amblyomma javanense* infestation on Malayan pangolin (*Manis javanica*) from Peninsular Malaysia. Actatropica1**, 26**(2013): 142-145.

Heath, M. 1992. *Manis pentadactyla*, Mammalian Species, **414**: 1-6.

Jnawali, S.R., Baral, H.S., Lee, S., Acharaya, K.P., Upadhyay, G.P., Pandey, M. *et al*. 2011. The status of Nepal mammals: The National Red List series, Department of National Parks and Wildlife Conservation, Kathmandu, Nepal.

Karki, N. 2015. Distribution and conservation status of Chinese pangolin (*Manis pentadactyla* Linnaeus, 1758) in Rani Community Forest, Makwanpur, Central Nepal.

Kaspal, P. 2010. Saving the pangolin: ethnozoology and pangolin conservation awareness in human dominated landscape of Nepal. In Shrestha, A., Shrestha, S., Dahal, S., Kafle, R., Thapa, A., Suwal, T.L. *et al*. (Eds.), Proceedings of first one day National seminar on Small Mammals issue (44-58). Lalitpur, Nepal.

Katuwal, H.B., Neupane, K.R., Adhikari, D., Sharma, M., Thapa, S. 2015. Pangolins in eastern Nepal: trade and ethno-medical importance. Journal of Threatened Taxa, **7**(9): 7563-7567.

K.C., R. 2016. Trend analysis on illegal trade of Pangolins in Kathmandu Valley, Nepal. B.Sc Thesis, Institute of Forestry, Pokhara.

Khadgi, B. 2016. Distribution, conservation status and habitat analysis of Chinese pangolin (*Manis pentadactyla* Linnaeus, 1758) in Maimajuwa VDC, Ilam, Eastern Nepal. B.Sc. Thesis. School of Environment Science and Management.

Kumar, A., Singh, M.D. and Roy, L.S. 2015. Field evidence of Gorkha earthquake of 25 April (7.8M) and Kodari earthquake of 12 May 2015 (7.2M) in Nepal. Geomatics, Natural Hazards and Risk. pp. 1-15.

Mahmood, T., Andleebs, S., Anwar. M., Rais.M., Nadeem. M.S., Akrim, F. *et a*l. 2015. Distribution, abundance and vegetation analysis of the scaly ant-eater (*Manis crassicaudata*) in Margalla Hills National Park Islamabad, Pakistan. The Journal of Animal and Plant Science, **25**(5): 1311-1321.

Mahmood, T., Hussain, R., Irshad, N., Akrim, F. and Nadeem, M.S. 2012. Illegal mass killing of Indian pangolin (*Manis crassicaudata*) in Potahar region, Pakistan. Pakistan J. Zoo, **44**: 1457-1461.

Mahmood, T., Jablen. K., Hussain. I. and Kayani, A.R. 2013. Plant species association, burrow characteristics and the diet of the Indian pangolin, *Manis crassicaudata*, in the Potohar plateau, Pakistan. Pakistan J. Zoo, **45**(6): 1533-1539.

Mohapatra, R. K. and Panda, S. 2013. Behavioural sampling technique and activity pattern of Indian pangolin *Manis crassicaudata* (Mammalia: Mandidae) in captivity. Journal of Threatened Taxa, **5**(17): 5247-5255.

Mohapatra, R.K., Panda, S., Acharjyo, L.N., Nair, M.V. and Challender, D.W. 2015. A note on the illegal trade and use of pangolin body parts in India. TRAFFIC Bull, **27**: 33-40.

National Planning Commission. 2015. Nepal earthquake 2015: post disaster need assessment, Vol. A: Key finding. National Planning Commission, Kathmandu, Nepal.

Newton, P. 2007. Potential application of hunters' knowledge for the conservation of pangolins in Vietnam. M.Sc. Thesis, University of East Anglia, Norwich.

Odum, E.P. 1971. Fundamental of ecology. Published by W.B Sanders Company, USA. pp. 205-207.

Pease, J.W. and Orourke, T.D. 1997. Seismic response of liquefaction sites, J. Geotech. Geo environ. Eng, **123**: 37-45.

Prater, S.H. 1980. The book of Indian animals. Bombay: Bombay Natural History Society.

Raut, N. 2015. Indian pangolin (*Manis crassicaudata*) conservation project, Makwanpur District. Report submitted to Rufford Small Grants.

R Development Core Team. 2016. R: A language and environment for statistical computing. R Foundation for Statistical Computing, Vienna, Austria. http://wwwR-project.org/.

Sapkota, R. 2016. Habitat preference and burrowing habits of Chinese pangolin. M.Sc. Thesis. Central Department of Environmental Science, Kirtipur, Kathmandu, Nepal.

Shepherd, C.R. 2009. Overview of pangolin trade in Southeast Asia. Proceedings of the workshop on trade and conservation of pangolins native to South and Southeast Asia. TRAFFIC Southeast Asia.

Shepherd, C.R., Connelly E., Hywood, L. and Cassey, P. 2016. Taking a stand against illegal wildlife trade: the Zimbabwean approach to pangolin conservation.

Soewu, D.A. 2013b. Zootherapy and biodiversity conservation in Nigeria. In animals in tradition folk medicine. Springer Berlin Heidelberg. pp. 347-365.

Soewu, D.A. and Adekanola, T.A. 2011. Traditional-medicinal knowledge and perception of pangolin (*Manis* sps.) among the Awori people, southwestern Nigeria. J. Ethnobiol. Ethnomed, **7**: 25

Suwal, T.L. 2011. Status, distribution, behaviour and conservation of pangolins in private and community Forest of Balthali in Kavre, Nepal. M.Sc. dissertation submitted to Central Department of Zoology, Tribhuvan University of Nepal.

Thapa, P. 2012. An overview of Chinese pangolin (*Manis pentadactyla* Linnaeus, 1758): Its general biology, status, distribution and conservation threats in Nepal. Kathmandu Forestry College.

Wright, J.H. and Priston, N.E. C. 2010. Hunting and trapping in Lebialem Division, Cameroon: bushmeat harvesting practices and human reliance. Endanger. Species. Res, **11**: 1-12.

Xu, W., Dong, R., Wang, X., Ouyang, Z., Li, Z., Xiao, Y. *et al*. 2009. Impact of China's May 12 earthquake on giant panda habitat in Wenchuan country. Journal of Applied Remote Sensing, **3**(1).

Yang, C.W., Chen, S., Chang, C.Y., Lin, M.F., Block, E., Lorentsen R. *et al*. 2007. History and dietary husbandry of pangolins in captivity. Zoo Biology, **26**: 223-230.

Zhang, Z., Yuan, S., Qi, D. and Zhang, M. 2014. The Lushan earthquake and the giant panda: impacts and conservation. Integrated Zoology, **9**(3): 376-378.

Zhang, J., Hull, V., Xu, W., Liv, J., Ouyang, Z., Huang, J. *et al*. 2011. Impact of 2008 Wenchuan earthquake on biodiversity and giant panda habitat in Wolong Nature Reserve, China. Ecol Res, **26**:523-531.

Zhou, Z.M., Zhou, Y., Newman, C. and Macdonald, D. W. 2014. Scaling up pangolin protection in China. Front. Ecol. Environ, **12**: 97-98.

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ANNEXES

Annex-I. Field Survey Form

a) Date of Survey:
b) Transects No:
c) Quadrate No:
d) Location:

Site Information:

a) Aspect:
b) Canopy Cover: less than 25%, less than 50%, less than 75%, less than 100%
c) Ground Cover: less than 25%, less than 50%, less than 75%, less than 100%
d) Soil type:
i) Color: Red/ Brown/ Black/ Others
ii) Texture: Fine/ Medium/ Coarse
e) Habitat type: Farmland/ Grassland/ Forest
f) Distance to settlement:
g) Distance to Road:
h) Distance to Water source
i) Distance to Ant/ Termites Mounds:

Threats

a) Grazing/ Fire/ Logging:
b) Poaching:
c) Exploitation of Natural Resources:

Measurement of burrows

a) Elevation of burrow:
b) Depth of burrow:
c) Diameter of burrow:

Other significant Information

a) Diameter Breast Height (DBH) of tree individual:
b) Number of tree individual in each plot:
c) Name of tree individual:

Annex-II. Questionnaires

Impact of the earthquake on distribution, abundance and illegal trade of pangolins

Name of Respondent: Age: Sex: Village:
Occupation: Education:

A. Abundance and distribution of pangolin

1. (Pangolin photo) Do you know what this is? a. yes b. No What do you think it is?..................................
   What does it eat? .... Where does it live?
2. Have you seen a live pangolin?
   a. Yes b. No a) If yes, when, 1) Year ii) Day/ Night iii) Number
   a) Where (place):
3. Have you seen indirect evidence of pangolins? a. Yes b. No
   If yes, which one e? i) Burrows ii) Scratches iii) Scales iv) Pugmarks
4. How often did you notice/see pangolin new burrows before the earthquake?
   i) No sighting ii) Occasionally iii) frequently
5. How often did you notice/see pangolin new burrows after the earthquake?
   i) No sighting ii) Occasionally iii) frequently
6. Are pangolin new burrows increasing after the earthquake?
   If yes, a) No b) same
   Reason…………………………………………………………..
7. Burrows found before the earthquake? a) Near houses b) Far from houses c)Not seen
8. Burrow found after the earthquake? a) Near houses b) Far from houses c) Not seen
9. Where do you observe the frequent movement of pangolin? a) Forest b) Scrubland c) Grazing/ grasslands d) Agricultural land e) Near water bodies
10. Population of pangolin for the last 5years. a) Increasing b) Decreasing c) Stable d) Not known
    Reasons :……………………………………………………………
11. Current threats to the pangolin? a) Habitat degradation b) Habitat fragmentation c) Illegal hunting d) Exploitation of natural resources e) Natural disaster f) Forest fire g) Others………………
12. Habitat disturbance of pangolin is due to a) Deforestation b) Grazing/ fodder collection c) Human encroachment d) Forest fire e) Road/ habitat construction f) Tower construction g) Rock/ soil mining h) Natural disasters
13. Occurrence of illegal hunting of pangolin a) Regular b) Occasional c) Rare d) none
14. Is pangolin is harmful or beneficial animal? a) harmful b) beneficial
    Reason …………………..

15. Do you feel lack of a) Information b) Awareness c) Research d) Talk program e) Protection
16. How often have you encountered pangolin? a) Frequently b) Occasionally c) Rarely d) Never
17. Have you heard of anyone killing pangolin in the area? a) Yes b) No
18. If yes, why was it killed and when (year) ………………………………………
19. Who is general kills/ hunts pangolin in the area? a) local people/herders b) outside poachers c) predator (specify)……………d) others………………………
20. How many pangolins have been killed in the area during the last ten yes?..................
21. What is the natural predator of pangolin? a) Man b) Leopard c) Dog d) Others
22. Medicinal/ Cultural use of pangolin

S.N	Body part	Use	How it is used	Remarks
1	Scales			
2	Meat			
3	Blood			
4	Bone			
5	Others			

23. Do you know hunting of pangolin is illegal? a) Yes b) No If yes, how did you know……………………………………

24. Do you think pangolin should be protected? a) Strongly agree b) Agree c) No idea d) Disagree e) Strongly disagree

If so, why? ……………………………………………………………….

`24. What is needed to protect pangolin?

a)……………………………….b)…………………………….c)………………………

B. Illegal trade on pangolin

1. Is the illegal trade route for selling pangolin product has been changed because of earthquake?
   a) Yes b) No
2. Illegal trade route for selling its product after earthquake ………………………..
3. Cost for selling pangolin scale during the last 5 years a) 2012: b) 2013: c) 2014: d) 2015: e) 2016:
4. What might be the cost trend of pangolin's scale after earthquake? What's the value?
   a) Increasing b) Decreasing c) Same as before Reason:……………………………………………………………………

5. Is the trade increasing or decreasing after the earthquake
   a) Increasing b) Decreasing c) Same as before
   Reason:……………………………………………………………………………
6. Have you ever seen somebody selling pangolin product in the market after earthquake?
   a) Yes b) No
7. How often pangolin was hunted or trade was seen before earthquake?
   1) No hunting or trade 2) Occasionally 3) Frequently
8. Trade volume after the earthquake?...

C. Others

1. What do you think when you see or kill a pangolin?
   i) Good luck ii) Bad luck iii) Nothing
2. If bad why people kill or poach pangolin? i) For Money ii) Medicine iii) do not know iv) other reasons…….
3. How pangolins are hunted? i) Use of water ii) use of dog iii) excavating burrow iv) other……..
4. Story regarding Good luck/ Bad luck…………………………………………………
   Occurrence of pangolin burrows
   Major vegetation………………………………………………
   Major soil types………………………………………………..
   Canopy cover a) Sparse b) Dense
   Habitat types a) Cultivated land b) Forest c) Grassland

Annex-III: Photo plates

Picture 1. Active (New) burrow

Picture 2. Old burrow after the earthquake

Picture 3. Old burrow before the earthquake

Picture 4. Pugmark of Pangolin inside the burrows

Picture 5. Termites Mound

Picture 6. Earthquake triggered Landslide

Picture 7. Pangolin burrow damaged by Landslide and Fire

Picture 8. Logging in study plot

Picture 9. Local people searching Pangolin burrow

Picture 10. Pangolin burrow damaged by the earthquake

Picture 11. Pangolin burrow damaged by the earthquake triggered landslide

Picture 12. Scales of Chinese pangolin

Picture 13. Measuring Diameter Breast Height (DBH) of tree species

Picture 14. Questionnaire survey and a respondent