POPULATION STATUS, DISTRIBUTION AND GENERAL BEHAVIOR OF ASSAMESE MONKEY (*Macaca assamensis* McClelland, 1840) IN KALIGANDAKI RIVER BASIN, BAGLUNG AND PARBAT DISTRICTS, NEPAL

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December, 2016

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 source of information have been specifically acknowledged by reference to the author(s) or institution(s).

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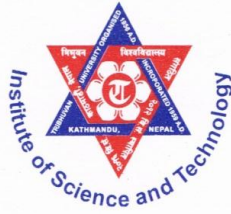   **Pavan Kumar Paudel**

RECOMMENDATION

This is to recommend that the thesis entitled "**POPULATION STATUS, DISTRIBUTION AND GENERAL BEHAVIOR OF ASSAMESE MONKEY (*Macaca assamensis* McClelland, 1840) IN KALIGANDAKI RIVER BASIN, BAGLUNG AND PARBAT DISTRICTS, NEPAL**" has been carried out by **Pavan Kumar Paudel** for the partial fulfillment of master's Degree of Science in Zoology with special paper Ecology. This is his original work and has been carried out under my supervision. To the best of my knowledge, this thesis work has not been submitted for any other degree in any institutions.

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LETTER OF APPROVAL

On the recommendation of supervisor "Associate Prof. Dr. Mukesh Kumar Chalise" this thesis submitted by Pavan Kumar Paudel entitled **"POPULATION STATUS, DISTRIBUTION AND GENERAL BEHAVIOR OF ASSAMESE MONKEY (*Macaca assamensis* McClelland, 1840) IN KALIGANDAKI RIVER BASIN, BAGLUNG AND PARBAT DISTRICTS, 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.

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This thesis work submitted by Pavan Kumar Paudel entitled **"POPULATION STATUS, DISTRIBUTION AND GENERAL BEHAVIOR OF ASSAMESE MONKEY (*Macaca assamensis* McClelland, 1840) IN KALIGANDAKI RIVER BASIN, BAGLUNG AND PARBAT DISTRICTS, NEPAL"** has been accepted as a partial fulfillment for the requirements of Master's Degree of Science in Zoology with special paper Ecology.

EVALUATION COMMITTEE

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LIST OF ABBREVIATIONS / ACRONYMS

Abbreviated form	Details of abbreviations
asl	Above sea level
CAMP	Conservation Assessment and Management plan
CITES	Convention on International Trade in Endangered Species of Wild Flora and Fauna
cm	Centimeter
d.f.	Degrees of Freedom
GIS	Geographic Information System
GPS	Global Positioning System
IUCN	International Union for the Conservation of nature and Natural Resources
Kg	Kilogram
Km^2	Square kilometer
LNP	Langtang National Park
m	Meter
MBCA	Makalu Barun Conservation Area
mm	Millimeter
NG/RDHM	Nepal Government/ Regional Depart of Hydrology and Meteorology
SNNP	Shivapuri Nagarjun National Park
T/HB	Tail to Head Body Ratio
VDCs	Village Development Committees
Yrs	Years
VDCs	Village Development Committees

ABSTRACT

This study is focused on Assamese Macaques population, distribution, general behavior and vegetation associated with their habitats in Kaligandaki River Basin especially in Baglung and Parbat Districts, Nepal. The field survey was conducted mainly from "9 November, 2015" to "28 June, 2016" to explore the population dynamics of Assamese Macaque. The total area of 104.70 km^2 was surveyed; data were collected by total count method, questionnaire survey, and vegetation analysis by random sampling method and behavioral data were collected by scan sampling method to a particular troop.

The total population of Assamese Macaques during the study period was 47 individuals in four different troops. The group density was found to be 0.038 groups/km^2 with a population density of 0.44 individuals/km^2 and a mean group size of 11.75 (range 3-16) individuals. Age-sex composition of macaque comprised 23.40% adult males, 19.14% adult females followed by 17.02% sub adult male, 19.14% young adult female, 14.8% juveniles and 6.38% infants. Adult sex ratio was observed 1:0.81 i.e. 122 males per 100 females and the recruitment rate was found 0.33. i.e. 33 infants per 100 females. The distribution pattern of Assamese Macaques among four different study blocks was found clumped distribution in the habitat. There was significant difference in distribution of Assamese Macaques among four different blocks (χ^2 = 6.2996, d.f.= 3, p = 0.09791, p>0.05). Total of 1640 scan samples were recorded from the focal Aduwabari Troop during the study period. The focal troop revealed that foraging was 47%, moving 28%, resting 14% and grooming 11%. By Quadrate sampling, 58 plant species with 716 number were recorded. this study revealed that Sal (*Sorea robusta*) is the dominant plant species with relative density 31.42% and relative frequency 8.376% followed by Tiju *(Diospyros malabarica)* relative density 10.93% and relative frequency 8.376%. Among the crop raided by Assamese Macaques, maize cubs were found to be highly prefered and was 46.95%, followed by 15.91% paddy, 15.11% potato, 10.84% millet, 6.88% wheat, 2.05% pulses, 1.59% fruits and 0.66% vegetables. The most commonly used crop protection strategy was guarding the field 50% followed by scarecrows 25%, using dogs 20% and 5% tin box and catapult.

Key words: Age-sex composition, Behavior, Macaque, Vegetation, Questionnaire.

1. INTRODUCTION

1.1 Background

A population is defined as any group of organism of the same species occupying a particular space at a particular time (Krebs, 1994) and functioning as a part of a biotic community (Odum and Barret, 2005). The ultimate constituents of the population are individual organisms that can potentially interbreed (Krebs, 1994). The population becomes an important study level when a species is nearing extinction. In order to maintain or re-establish the species; one need to know what space, shelter and food the population requires. To know and understand the interactions of the endangered animals with other species is also important for a successful conservation program (Fleming, 1973). To the wildlife biologist, precious knowledge of population composition with regard to age and sex structure and animal behavior is a basic necessity for intelligent conservation and management (Benton and Werner, 1966).

Species distribution is the manner in which a species is spatially arranged. It has been observed that Extinct and Threatened species are more likely to be clumped in their distribution (Purvis *et al*., 2000). The reasoning behind this is that they share traits that increase vulnerability to extinction because related taxa are often located within the same broad geographical or habitat type where human induced threats are concentrated. Using recently developed complete phylogenies for mammalian carnivore and primates it has been shown that the majority of instance threatened species are far more from randomly distributed among taxa and phylogenetic clades and display clumped distribution. The study of distribution pattern also contributory for the conservation of wild animal species (Purvis *et al*., 2000).

Behavior is the response of both the physical as well as habitat condition of animals (Sarkar, 2000). It varies from habitat to habitat depending upon the resource distribution. In Primate, food, mates, drink and roosting trees are the most important resources, which control activities. Among these resources, food seems to be the most crucial primary factor which regulates day-to-day activity profiles (Sarkar *et al.,* 2012). The study of animal behavior is of great practical importance for the conservation of wild animals in their natural habitats (Manning and Dawkins, 1998).

1.1.1 Primates

All mammals that belong to an order Primate, which include the monkeys, apes, human and other similar forms typically having dexterous hands and feet, binocular vision and a well-developed brain (Tattersall, 1993). They are commonly called monkeys, excluding only the tree shrews; the lemur-like forms, the apes and humans and therefore embody tremendous evolutionary and adaptive arrangements of animals (Tattersall, 1993). Of all the primates, monkeys next to human have adapted best to widely diverse environmental conditions which are found in tropical forest, dry savannas, mountains, village, temples and even in large cities (Van Hoff, 1990). Macaques are ecologically extremely adaptive primates which are distributed more widely than any other non-human primate genus. After a split off from the Baboons, Mandrills, and Mangabeys, they moved out of Africa

and today only the Barbary Macaque (*Macaca sylvanus*) is still found in Africa. All other extant *Macaca* species occur in Asia, ranging from Pakistan, India, Nepal and Tibet of Chaina in the west to the Northeastern tip of Japan and just south of the Wallace line in the Southeast (Thierry *et al*., 2004). Primates today are found throughout the tropical zones of South America, Africa and Asia. Within those continental areas where they do occur, primates occupy all type of habitat, from climax rain forest and moorland, on high mountain ranges to open Savana and desert habitat (Dunbar, 1998). In broader sense, Primates now days are confirmed between 40^0N to 40^0S of equator in the moderate habitat (Chalise, 1999). Macaques are found in tropical rain forests across Asia but may live at high altitudes in the Himalayas and other temperate regions with long snowy winters (Schukle *et al*., 2011; Chalise, 2013b).

The larger Primates are widely hunted, many of the smaller ones are prized for commerce and the pet trade, and all suffer from habitat loss. Even where their forest remain, substance and commercial hunting in west and central Africa and southeast Asia are resulting in vast areas of silent and empty forest. The 2000 IUCN Red list of threatened species classifies Primate Species and 224 species and sub species as threatened (Rylands, 2001).

According to the geographical distribution monkeys are categorized into two types, New World Monkeys and Old World Monkeys. The New World Monkeys lack cheeks pouches and nostrils open two sides rather than down. Area between the nostrils is wide and flat. Most have long prehensile tail and non-have callous pads on the buttocks, e.g. Spider Monkeys, Capuchins etc. The Old World Monkeys have protruded muzzle and well developed check pouches, nostril set close together facing forward and downward(Walker, 1968). The tail is never prehensile and some species are tail less. Both the hands and feet are adapted for grasping callous pads on the buttocks are often bright and in case of females swollen during estrus period (Walker, 1968).

In Nepal, only three species of non-human Primates (Hanuman Langur, Rhesus and Assamese Monkeys) are recorded (Chalise *et al.,* 2005). The Rhesus Monkeys (*Macaca mulatta* Zimmermann, 1780) are found freely ranging in wild as well as in urban religious places. The Langurs (*Semnopithecus entellus* Dufresne, 1797) are found freely ranging in wild forest and its marginal areas of Nepal (Southwick *et al.,* 1982). The other species Assamese Monkey (*Macaca assamensis* McClelland, 1840) reported from mid-hills and high montana forest of Nepal, whose ecological and behavioral details are still largely unknown (Chalise, 2006).

1.1.2 Assamese Macaques

Assamese Macaques are not well researched non-human primates of Nepal (Chalise, 2000a). The local vernacular name of this monkey is Pahare Bandar, Pupa, Timnyau and Kala Ganda (Chalise, 2000b). Distribution of *Macaca assamensis* is restricted to the Himalayan foothill region of Nepal. It occurs from central Nepal East through the Himalaya to Southern most China, North and Central South-East Asia (Fooden, 1982a). It has never had intensive field study anywhere in South- East Asia, or Barley, in South Asia (Mitra, 2002; Mitra, 2003), so remains little known for such as a widespread monkey (Fooden, 1982b). A survey in Bhutan found Assamese Macaques down to 600 m

(Kawamoto *et al.,* 2006). Choudhury (2008) referred to occurrence as low as 100 m, but detail information neither dealt nor discussed the finding. In Nepal it is recorded beyond churia hills along river basin (Chalise 2016).

Because of their distribution pattern, Assamese Macaque population would have been more influenced by forest habitat deterioration compared with Rhesus Macaque populations (Wada, 2005). The fragmented distribution of the Assamese Macaque seems inadequate for maintaining a viable population in Nepal. There has been few studies to estimate the minimal viable population size necessary for the conservation of not only Assamese Macaques, but *macaca* in general (Wada, 2005). Species viability can be measured by evaluating population dynamics and environmental effects (Fa and Lind, 1996).

Of equal concern is the fact that these animals are considered pest as a frequent crop raiding behavior in Nepal and, as such conflict between local people and the macaque are on the rise, with an additional threat to the survival of present macaque population (Chalise, 2001a). In Nepal, crop damage is very common along the immediate periphery of national parks and protected area systems. Nevertheless, crop damage is not limited around of conservation area but also along the different habitat outside it (Chalise, 2000a: Chalise, 2001a and Paudel, P.K. 2016a).

1.1.3 Status of Primate and Phylogeny

There are 633 identified species of primates and of those 54% of them are threatened, endangered, and critically endangered (IUCN/SSC, 2012) among them 25 primates species considered to be the most endangered species worldwide (Schweitzer *et al.,* 2015). Primates are grouped into-Strepsirhines, The New World Monkeys or Ceboides, Platerhines - Old World Monkeys and Man or Hominoids (Chalise *et al.,* 2005). All apes are offshoot of Old World Monkeys. Among the Great Apes Orangutans, Gorilla, Chimpanzees resembles with other close relatives human being in many capacities - social structure, taste mental and emotional development and physiology (Jolly, 1985). The little known Pigmy Chimpanzee, that resembles more than 98% with human, shows much more similarities in locomotion, communication and sexual behavior (Jolly, 1985). However only three species (Hanuman Langur, Rhesus and Assamese Monkey) are recorded so far in Nepal with their sub species through densities as a whole are unavailable (Chalise *et al.,* 2005).

The taxon is categorized as threatened due to its limited distribution of less than 22,000 km^2, an expected area of occurrence of about 914 sq. km. with ongoing decline in area, lessening population and narrowing quality of habitat. As stated of its restriction of occurrence, rising threats to the individual and its habitat, and decreasing number in fragmented patches, the Nepal Assamese population is categorized as Endangered. As well as the National parks and wild life conservation Act of 1973 lists the Assamese Macaque as a protected species of Nepal and kept appendix II of CITES (Chalise *et al.,* 2005).

Human and monkeys share the same root of evolution. The lively inquiring minds, the structure of the hand, the social system and mother infant relationship and manipulative skills of the monkeys certainly makes us ponder about what W. S. Gilbert had said about

man: "Man however well-behaved at best is only a monkey shaved". In anatomy and behavior monkeys are our closest relatives. They may hold the key to our origins and the roots of what we considered the human characteristics of friendship, love, aggression, language and tool use (Subba, 1998).

1.1.4 Taxonomy
Kingdom: Animalia
Phylum: Chordata
Class: Mammalia
Order: Primates
Family: Cercopithecidae
Genus: *Macaca*
Species: *assamensis*

The Assamese Macaque belongs to the family Cercopithecidae and the order Primates. Three sub species of Assamese Macaque have been reported until now and they Eastern Assamese Macaque (*Macaca assamensis assamensis)*. Western Assamese Macaque (*Macaca assamensis pelops*) and Assamese Macaque 'Nepal population'. The Assamese Monkey of Nepal are considered 'Nepal population' and categorized as "Endangered" by CAMP Workshop 2003 due to taxonomic confusion and shrinking population in their typical natural habitat (Molur *et al.,* 2003). This population is different from the Assamese Monkeys described up to now from South-East Asia in respect to the head-body length, tail length, T/HB ratio and weight. The body fur and facial coloration also differ in males and females then so far described population of this species and So, Nepali Assamese Macaque should consider a new sub species however; need further taxonomic investigation (Chalise, 2003; Chalise, 2005a; Chalise, 2005b).

1.1.5 Morphology
The Assamese Macaque is also known as the Himalayan Macaque or the Hill Monkey (Chalise and Ghimire, 1998; Chalise, 2000a). The Assamese Macaque's pelt is dark to yellowish brown in color. The adult macaque has red skin. The Assamese Macaques has hairless face cheek pouches to store food in while foraging. The macaque's body length measures from 50 to 73 centimeters (20 to 29 inches). The Assamese Macaque's short tail is between 19 and 38 centimeters (7.5 to 15 inches) long, Himalayan form has longer tail then Indian one. The average body weight of the adult male Assamese Macaque is between 10 and 14.5 kilograms (22 to 32 pounds). The females weight between 8 and 12 kilogram (17 to 26 pounds) (Flannery, 2004).

Assamese Monkeys are shy, timid and less aggressive to human beings in comparison to rhesus monkey. They are arboreal, terrestrial and omnivorous animals with multi male and multi female social troops (Chalise, 2011). The Assamese Monkey can be confused with the rhesus by general outlook and size but there is clear difference between them morphologically too. The orange red hue on the loins and rump is absent in this species while it also differs by general body coloration. It has darker fur in exposed area while whitish blonde-haired to ashy white in abdominal in inner parts. It has purple (eggplant color) snout particularly around the nose while crimsoned red to pinkish red skin around

the eyes and chick (Chalise, 1999). Local saying finely reflects the fur color difference with in a group as this species called 'Misssel' means mixed group. The palm sole and nails are dirty brown in color. The ischial callosities in male are conspicuous from a distance and distinct in darker individuals. In higher elevation, the animals are with darker fur in back and whitish in abdominal parts resembling to Tibetan Monkey. General Assamese Monkey consists of nearly 2 feet in head and body length while tail is one-third of it. It is heavier and larger then rhesus weighing more than 12 kg weight. Himalayan form has longer tail then Indian one (Chalise, 2003; Chalise, 2011; Chalise et al., 2005).

1.1.6 Distribution
Assamese Monkey inhabit in the mountains and hills along the Himalayas. It is recorded from Nepal, India (Assam), Upper Burma, South China, Northen Myanmar, Northern Thailand (ranging 610 m to 1,830 m asl.) (Fooden, 1982a; Chalise and Ghimire, 1998; Chalise, 1999) and Yunnan, Southern china (Chalise, 1999). In Nepal, Chalise, (2013b) recorded it from 380 m in Mulghat Tamor to 2,350 m asl in Langtang. Mostly found in mid hills (warm temperate monsoon; cool temperate monsoon, 1000-3000m asl.) however they are recorded from lower elevation of 300m asl. in Gorkha, Abukhaireni to Rimiche Langtang nearly 2,500 m asl (Chalise, 2013a).

They are found in the Basin of Arun River around Apsuwa confluence, Bhumlingtar, Haluwabeshi, Tamor River, Bagmati, Trishuli, Sunkoshi, Gandaki and Karnali River basin at higher elevation but warmer valleys. Thus, Nepal population can be located in sub-tropical hill sal forests area to mixed deciduous forest, temperate broad leaved forest with rocky out crops and along the riverside steep sloppy forest of above altitude. The species confirmed from Kimni Acham, Dadeldhura, Ramdi palpa, Langtang National Park and Helambu area, Makalu Barun NP and Bhumlingtar, Hariharpur, Nagarjun forest of Kathmandu and Kaligandaki river basin Baglung (Paudel, P.K. and Chalise M.K., 2016). The population is recorded in Nepal during first decade of 2000 from different sites shows altogether 282 mature individuals while total population with different age and sex comprises up to 525 (Chalise, 2004a, 2004b; Chalise, 2005a). Later on Assamese census was conducted in different occasion revealed that 1099 individual in 51 troops were recorded from East Makalu to West Api area of Nepal (Chalise, 2013a).

1.2 Statement of the Problem
Human beings and monkey share the same root of evolution. Human monkey association is as old as human˙s own existence. Monkey and human being are in the sense that a particular of monkey is popularly considered the remote ancestor of present day human (Sinha et al., 2004). However, with the rapid increment in human population in an around the monkey˙s habitat, the relationship between these Primates has turned in to enmity. It is frequently argued those human beings are sole blame of destructing habitat of monkey. The macaque inhabiting forest were markedly disturbed by the over utilization of forests by humans who cultivate crop in fields, cut tree branches as food for domestic animals and collect firewood. It is because monkeys are very often causing of nuisance to local people leading to the seeds of accord between these two creatures. Human population growth and activities like deforestation agriculture and urbanization lead to an ever

increasing encroachment on wildlife habitats. The interface of wildlife habitat and human use dominated landscape has become grounds for a wide range of human wildlife conflict (Sinha *et al.,* 2004).

In Kaligandaki River Basin area, including Baglung and Parbat VDC's there is no study in case of population status, distribution and habitat utilized by Assamese Monkey. It is essential to explore the present population status, distribution and habitat used by this monkey along the periphery of a Kaligandaki River Basin, Baglung and Parbat area.

1.3 Objectives of the Study
1.3.1 General Objectives
The main objective of the study was to investigate the population status, distribution and general behavior of the Assamese Monkey in Kaligandaki river basin at Baglung and Parbat, Districts, Nepal.

1.3.2 Specific Objectives
The specific objectives of the present study were:
- To determine the total troops and population distribution pattern of Assamese Monkey in Kaligandaki river basin along Baglung and Parbat.
- To investigate the age/sex composition of Assamese Monkey in Kaligandaki river basin at Baglung and Parbat.
- To explore the habitat characteristics utilized by the species along the river basin.
- To document the general behavior of Assamese Macaque in Kaligandaki river basin at Baglung and Parbat.
- To estimate the crop raiding by monkey and crop protection strategies used by local people along this river basin.

1.4 Rationale of the Study
Non-human Primates are not studied thoroughly in Nepal. Few research works had been done on population status and distribution of Primate (Chalise and Ghimire, 1998; Chalise, 2006). In case of Assamese Monkeys of different ecological zone of Nepal such as Lakuwa of Sankhuwasabha, Mulghat, Tapkedanda of Makwanpur, Halambu of Langtang, Gottekhola, Ramechhap, Phulchowki, Dhading, Phisling, and Ramdi have already done the research work (Chalise, 2008) though, no research has been conducted along the Kaligandaki river basin of Baglung and Parbat. This area is habitat of protected species Assamese Monkey that lies outside of the protected area system of Nepal. The obtained data of population, its composition, distribution pattern will be contributory for the management and conservation programs of Assamese Monkeys in Kaligandaki river basin, Baglung and Parbat which in turn can help to contribute the management of protected species outside the protected area system.

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1.5 Limitation of the Study

Present study is meant for Master Level Dissertation and following limitations were felt during the study period.

- River basin steep sloppy forest and rocky outcrops of the study area created difficulties to follow the animal continuously for long period.
- In some places, monkeys were persecuted by local people so very much scared and made it difficult to observe for longer period made it difficult to see and follow the group regularly.
- Sophisticated scientific equipment and finance were the prime limitation for the continuous field work.

2. LITERATURE REVIEW

2.1 National Context

Non-human primates are not studied thoroughly in Nepal. Few researches have been carried out on population status, distribution, behavior and habitat used by primates in different topographical region of Nepal. Among four primate species recorded in Nepal, Assamese Macaque is least studied.

Subba (1998) studied the ecology and habitat of *Macaca assamensis* in Makalu Barun Conservation Area, Nepal. She found that trees with lesser height are not suitable for the night halt and dynamic resting for the Assamese Monkeys. She also reported the Kaulo and *Schima wallachi* are the most exploited tree species and Bilaune was the most common plant among the ground vegetation of the macaque's habitat. She concluded that the way in which Primate use time and organize activity pattern is an important aspect of behavioral ecology.

Chalise (1999) studied the behavior of Assamese Monkey of Makalu Barun Area, Nepal and find out that macaque spent 44% of time in foraging, 25% in moving, 13% in grooming and 18% time in resting furthermore he proposed for the detail investigation including molecular analysis of this species that could expose the hidden truth and provide firmed ground of its taxonomic status.

Bhattarai (2002) studied the general behavior and habitat use of Assamese Macaque in Syafrubensi Area of LNP. He found that *Macaca assamensis* used broad- leaved conifer mixed forest and grassland with scattered trees of Urticaceae family abundantly. He recorded the time spent on sitting as highest as 33.3% on followed by 29.6% on feeding, 28.25% on walking, 6.4% on grooming and 1.1% on mating.

Khatiwada *et al.,* (2007) studied the population status of Assamese Macaque in Kathmandu, Rasuwa and Dhading districts. They found that the macaques are patchily distributed in the fragmented forests in these areas where macaques are having been continuously facing the problem of habitat encroachment by the local people.

Regmi (2008) studied the status of Assamese Macaque in Langtang National Park. He reported that a total of 213 Assamese Macaques were encountered in 9 groups of 113 km^2 in which the group density is found to be 0.0791 groups / km^2 with a population density of 1.8691 individuals / km^2 and a mean group size of 23.66 individuals within the total area surveyed of 113 km^2 at Langtang National Park. In addition composition of Age-sex of macaque comprised 31% adult females, 16% adult males, 18% young, 16% juveniles and 19% were infants in the study area.

Chalise (2010) studied on Assamese Monkey in Sebrubeshi of Langtang National Park, Nepal. The botanical quadrates data in their habitat revealed that the composition of forest was with 18 species trees and 12 species shrub and herbs. According to this study, the monkeys spent time in forest (35), rocky slope (30%), bari land (27%), riverbed (4%) and lowland (4%) during their activities. Whereas the average troop composition was 14% adult male, 18% adult female, 24% sub-adult male, 20% young adult female, 10% juvenile and 14% infants.

Chalise *et al.,* (2013) studied the ecology and behavior of Assamese Monkey in Shivapuri Nagargun National Park. They reported that foraging/eating covered 46% of total observed time while resting 19%, locomotion 16%, sleeping 12%, grooming 6%, and playing 1%. Some other behavior noticed such as aggression, copulation, stone licking, coughing and sniffing for short duration. Young and tender leaves as well as burgeoning twigs were primary sources of food (38.24 %) for winter followed by seeds (35.29%, moss and epiphytes (14.71%), insects (5.88%) and others 5.88% while water drinking was never observed. All troops in Shivapuri forest were found residing on the steep cliffs along with river bank while Nagarjun forest troops used cliff as well as tall trees.

Regmi and Kandel (2013) estimated the group density of Assamese Macaque in Lower Kanchenjungha area, during which 35 observations of Assamese Macaque were made. They found that macaque group encounter rate was 0.19521groups/km in the study area and estimated macaque group density 1.2253 groups/km^2 with the expected group size 26.714. Similarly, the estimated population density and total number of macaques in the area were 32.733 and 1015.0 respectively.

Adhikari and Chalise (2014) studied the general behavior of Assamese Macaque (*Macaca assamensis*) from "April 2012" to "March 2013" at upper Marsyangdi River in Taghring of Annapurna Conservation Area and a total of 53 Assamese Macaques were counted in three different troops. A total of 2640 scan samples were recorded during the study period covering all four distinct seasons. The studied group spent more than one third (45%) of their total time for foraging purpose, followed by 25% on locomotion, 20% on resting and 10% on grooming. A distinct seasonal variation in activities has been recorded.

Pandey and Chalise (2015) studied the general ecology and time budgeting for Assamese Monkey (*Macaca assamensis*) in Shivapuri Nagarjung National Park, Nepal. They reported that the general ecology and daily time budget of Assamese Monkey (*Macaca assamensis*) is accessed in Shivapuri Nagarjun National Park (SNNP) following Sikre Khola troop. They found Assamese Monkeys has allocate 40% time in foraging/feeding, 21% time in locomotion, 16% time in grooming while 15% time inactive. Play and sleeping claimed 6% and 1% time simultaneously. Thus the total time for personal activities is 78% and 22 % in social activities.

2.2 Global Context

Cooper and Berstein (2002) studied social grooming in Assamese Macaque (*Macaca assamensis)* living on the Tukeshowari temple ground in Assam, India. Their study has shown in accordance with social grooming, females as long term inhabitance of this matrifocal group, groomed each other and juveniles more groomed one another or juvenile. In additional, males groomed female more often and for longer duration that female groomed males, but both male and female groomed juvenile more often than juveniles groomed them, juveniles groomed their elders for longer duration. Grooming was concluded that, function to establish and maintain affinitive social bonds rather than as a specific mechanism to obtain mating.

Cooper *et al.,* (2005) studied the reconciliation and relationship quality of Assamese Macaque's group living near the Turkeshwari temple near Golpara, Assam, India. Their study stated that animal reconcile are likely to have strong social bonds. In which females

reconciled more often with female with which they had stronger grooming and aiding relationship, which was significant for support to the aggressor and the victim, whereas these couldn't found in males. Their study provides evidence that females reconcile most often with valuable and compatible socials partners.

Kawamoto *et al.,* (2006) studied the distribution of Assamese Macaques in the Inner Himalayan region of Bhutan and their mtDNA diversity. He recorded no group of Rhesus Macaques (*Macaaca mulata*) in his survey, in contrast with the survey results in the Nepalese Himalayas. He concluded that the macaques of the inner Hamalaya regions in Bhutan are Assamese Macaques and that they appear to be of a linease distinct from Assamese Macaque in the Indo-Chinese region (sub species *Macaca assamensis assamensis*). He also concluded that on the basis of degree of mtDNA the Assamese Macaque in Bhutan are of a more ancient ancestry then *Macaca assamensis assamensis.* He suggested that the earlier speciation of Assamese Macaques on the basis of greater mtDNA diversity than that of Rhesus Macaques.

Schulke *et al.,* (2011) studied about the ecology of Assamese Macaque at Phu Khieo Wildlife Sanctuary, Thailand. Unlike Zhou *et al.* (2011) they recorded that Assamese Macaque spent large time of feeding on feeding fruit. They concluded that Assamese Macaque spent about 40% of their activity time on the ground and in the lowest stratum of the forest; the canopy was used rarely and they spent a third of their activity time on feeding.

Zhou *et al.,* (2011) studied on diet of Assamese Macaque in limestone seasonal rain forests at Nonggang Nature Reserve, China. They found that Assamese Macaque are highly folivorous, where young leaf were staple food items (74.1% of the diet) and fruit accounted for only 17.4% of the diet.

Sarkar *et al.,* (2012) studied activities profile of free varying forest group of Assamese Macaque, Jokai Reserve Forest (R.F.) Assam India. They stated that the studied groups spend more than one third (40%) of their total annual time for foraging purpose, followed by 25% on locomotion, 13% on resting, 10% on grooming, 9% on monitoring, 1% on playing and 2% in sexual and other activities. The activity of forest group have revel that foraging is the crucial factor responsible for the variation in the activities profile. In forest, as the food was randomly distributed, the group arranged their total time cost effectively and spent more time on foraging, locomotion and resting and less time in grooming, monitoring and play activities. They suggest that from their finding, nature of distribution of food resources is the guiding force for allocating time to various activities in various habitats.

Timmins and Duckworth (2013) studied distribution and habitat of Assamese Macaque in Lao PDR, including its use of low altitude Karsts. They reported that the distribution and ecology of Assamese Macaque remains little studied in South-East Asia. He stated that most records are from hill evergreen forest above 500 m, consistent with standard literature, but the species occurs down to plains level (200 m) on Karsts.

Hessen *et al.,* (2013) investigated the relationship between food resources, feeding competition, energy intake and reproduction in a group of wild female Assamese Macaques in Northeastern Thailand and they found that an increase in food availability had a positive effect on female energy intake and conception rates. In addition, it

appeared that females incurred energetic costs during lactation and that females with a better physical condition during the mating season were more likely to conceive. Neither energy intake rates nor activity budgets were influenced by female dominance rank, even during periods when the levels of contest competition were predicted to be high.

3. MATERIALS AND METHODS

3.1 Materials
Following equipment were used during the field study.

a) Binoculars b) Measuring tape c) Digital Camera d) Data sheet
e) Topographic map of study area f) Stationery g) GPS

3.2 Methods
3.2.1 The Study Area
Baglung and Parbat districts of Dhawalagiri Zone are two of the seventy-five districts of Nepal, lies in the mid-western development region of country Nepal. The district Baglung is a part of Province No. 6, with its district headquarters baglung, cover an area of 1,784 km² and have a population 268,938. Baglung is surrounded by Parbat, Myagdi, Rukum, Ropla, Pyuthan and Gulmi districts. It looks like itself Nepal in shape. It has 59 VDCs and one Municipality. Highest temperature in the lowest altitude of Kharbang Baglung rises up to about 37.5 degrees Celsius in summer and the lowest temperature at Dhorpatan fall up to about-15 degrees Celsius in winter. Altitude of Baglung varies from about 650 meters at Kharbang to about 4,300 meters in Dhorpatan. It extends from 28^0 15' N to 28^0 37' N latitude and 83^0 14" E to 83^0 36" E longitude. Baglung is rich in herbal medicinal plants. Rice, millet, wheat and potato are the major crops of Baglung. It is also rich in wild animals (Source: DDC Baglung 2015).
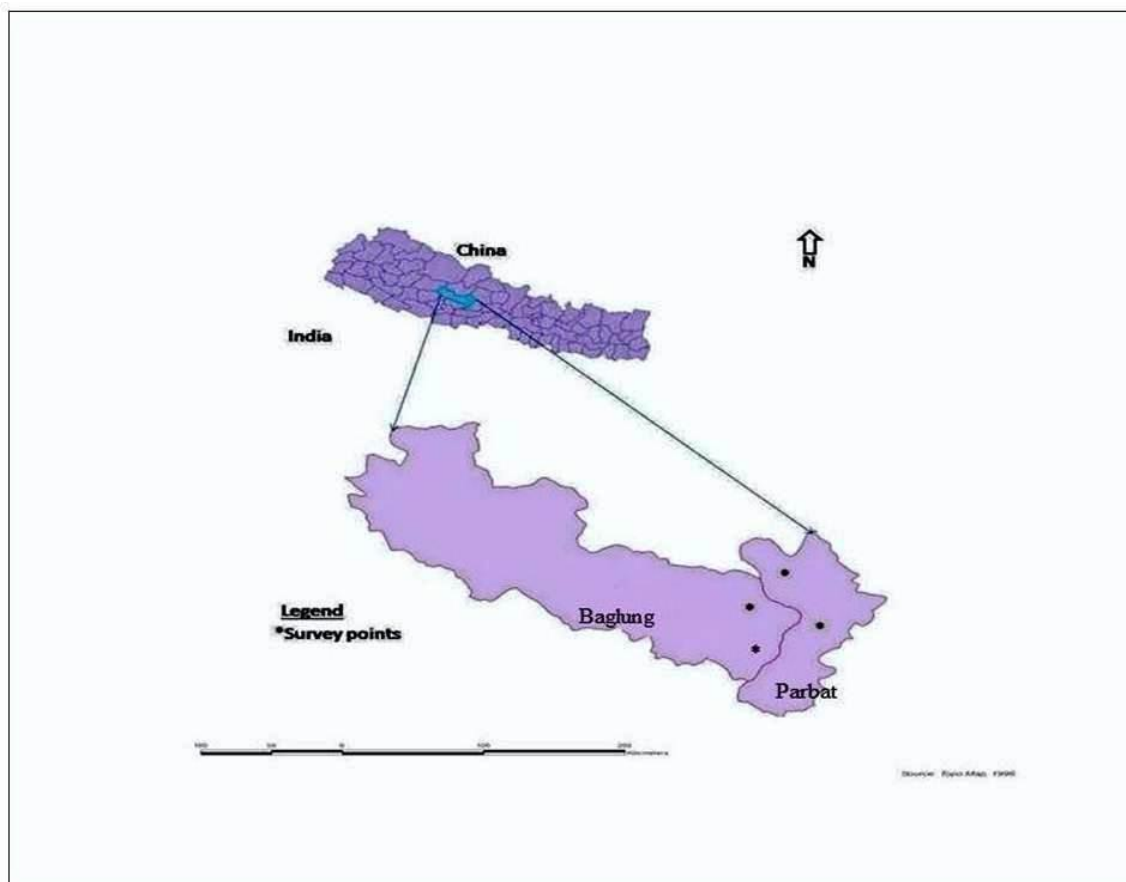
Fig.1: Study area and sites in the map of Nepal.

Parbat district is a hilly area of Nepal. The district Parbat is a part of Province no 4 and one of the seventy-five district of Nepal. The district, with Kusma as their districts headquarter, covers an area of 494 km² and has a population 157,826. It is the fourth smallest district of Nepal with 47 VDCs currently (before Kushma Municipality was formed, total VDCs remained 55). Parbat district is surrounded by Gulmi, Syngja, Kaski, Myagdi and Baglung. Parbat district has diversified geographical features so it is rich in flora and fauna. It extends from 28^0 00' 19" N to 28^0 23' 59" N latitude and 83^0 33' 40" E to 83^0 49' 30" E longitude (Source: DDC Kusma 2015).

3.2.2 Research Site
The study was carried out in Baglung and Parbat at Kaligandaki river basin VDCs, namely Chisti, Jaidi Arjewa, Binamare, Kushmishera, Amalachaur and Narayansthan, All these VDCs are lying one after another from Narayansthan to Chisti at southern part from the District Headquarter Baglung and Dhairing, Nangliwang, Pang and Siwalaya these VDCs lying one after another from Siwalaya to Dhairing at northern part from the District Headquater Parbat (Fig 1).

3.2.3 Geographical Location
Study area is located between $83^0 35' 29.2''$ to 83^0 35'72'' longitude and 28^0 05'24.2'' to 28^0 19' 45'' latitude and elevation ranges between 560 m to 1650 m. Total area of Baglung site VDCs is 71.3452 km ^{2} whether Parbat site VDCs is 33.357 km ^{2}.

3.2.4 Drainage
Study area occupied many small streams, springs falls, and rivers. Kaligandaki River is the main water resource, which continuously flow north south direction. It contributing the back bone of water resources to the biodiversity and enhanced the beauty of this site. Radhi Khola, Chauri Khola, Lauwa Khola, Kalipare Khola, Sumsa Khola, Phalewashi Khola, Theule Khola are also regular source of water at this study site (Source: DDC Baglung, 2015).

3.2.5 Climate
The study area lies in between tropical to temperate belt of Nepal. This study area has a unique geographical feature having both North and South facing topography. The rain-bearing wind from the Bay of Bengal blows from the east towards west of Nepal during the rainy season. The climate of study area and its vicinity is mainly dry and wet (Source: NG/ RDHM Pokhara, 2015).

3.2.5.1 Temperate
The warmest and coldest months of the study area were September (39.3^0c) and January (6^0) respectively. The average maximum temperature was recorded (27.70^0c) and minimum temperature was recorded (15.30^0c) (Fig 2).
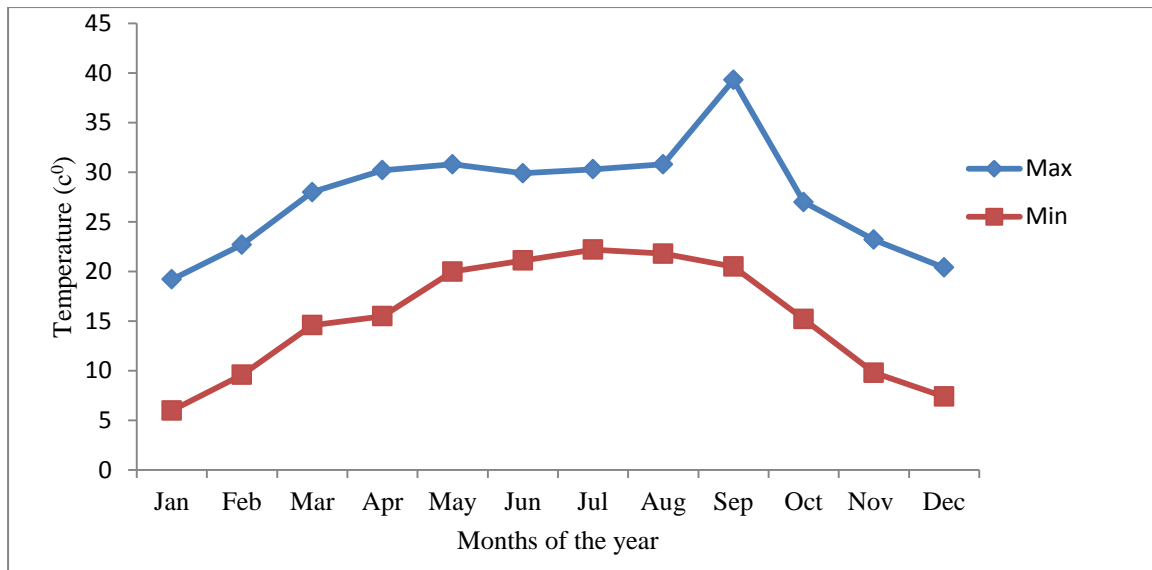
Fig 2: Temperature recorded in 2015 at Baglung Bazar. (Source: NG/ RDHM Pokhara, 2015)

3.2.5.2 Relative Humidity

Relative humidity in the month of August is maximum i.e. (92.8%) and in April is minimum (51.2%). According to the climatic data, average monthly relative humidity (at morning) of the area 77.17% and average monthly relative humidity (at evening) of the area 78.15% (Fig 3).
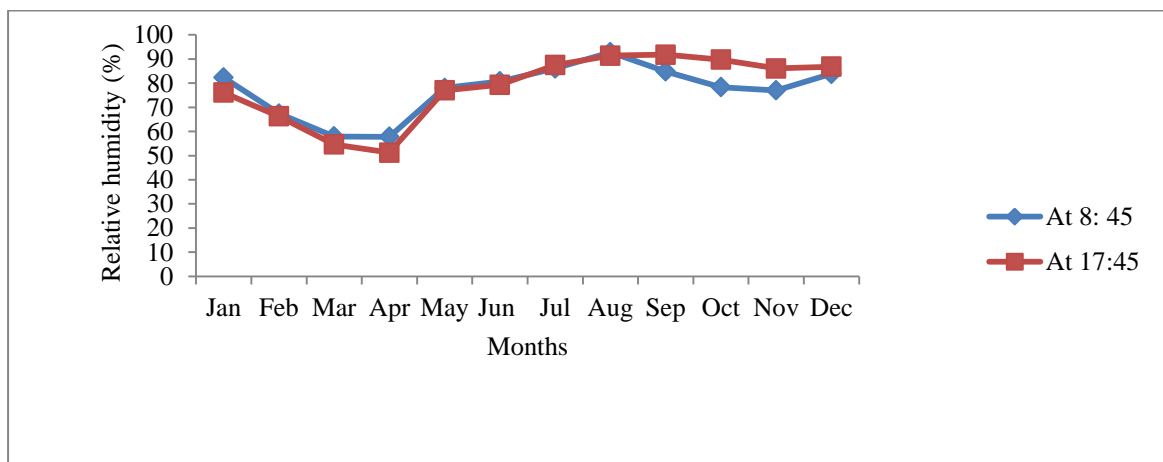
Fig 3: Relative humidity (%) at 8:45 and 17:45 recorded in 2015 at Baglung Bazar. (Source: NG/ RDHM Pokhara, 2015)

3.2.5.3 Precipitation

The precipitation of Baglung Bazar data shows that main rainy days were in the month of July and August. The highest precipitation was recorded (553.6 mm) in the month of July

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during the study period, while there were not recorded of precipitation in the month of November and December (Fig 4).
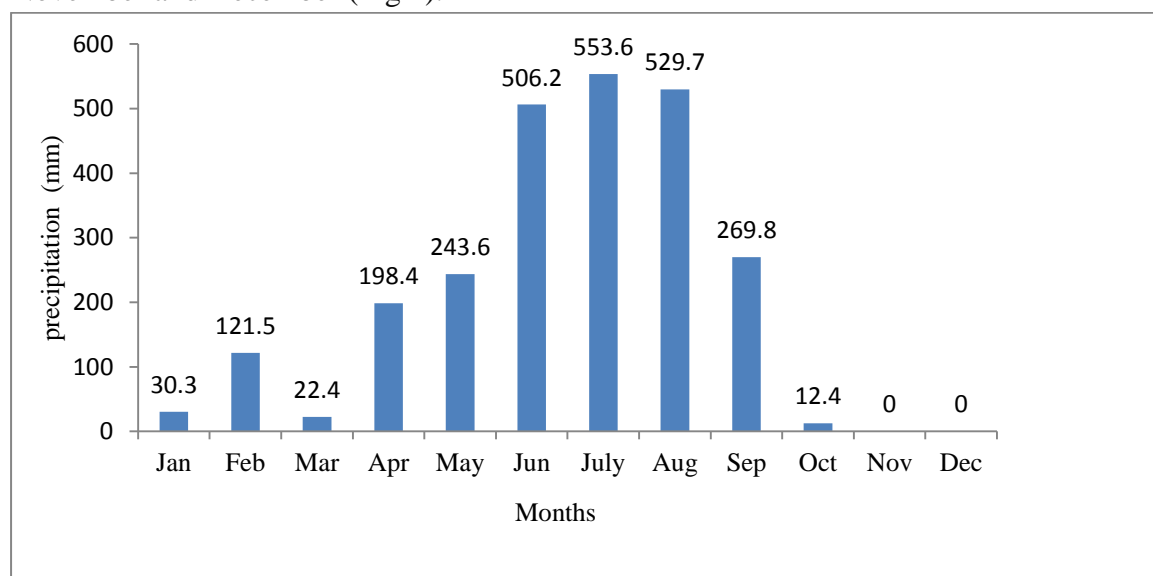
Fig 4: Monthly precipitation recorded in 2015 at Baglung Bazar. (Source: NG/ RDHM Pokhara, 2015)

3.2.6 Biodiversity
The study area is rich in biodiversity. The reason for this may be due to presence of alluvial soil along the basin of this large Kaligandaki River (Chalise, 2013c).

3.2.6.1 Flora
Study area falls in *Sorea-Diospyros* zone (Paudel, P.K. 2016b). Mixed type of forest is found in the study area. Tropical deciduous riverine forest, sub-tropical grassland and sub-tropical evergreen forest are the forest types in the study area (Chalise, 2013c). The dominant tree species of the study area are Sal *(Sorea robusta)*, Tiju *(Diospyros malabarica)* and Chilaune *(Schima wallichi)* (Paudel, P.K. 2016b) etc. similarly, the ground vegetation mainly comprises of Titepati (*Artenusia dubia*), Sisnu (*Girardinia palmate*), Khar *(Typha angustata),* Kalo banmara (*Eupatorium adenophorum*), Seto Banmara (*Eupatorium odoratum*) plants are the bushy type. Trees include Sal *(Schima wallichi)*, Tiju *(Diospyros malabarica),* Chilaune *(Schima wallichiana)*, Simal *(Bombyx ceiba)*, Kafal *(Myrica sculenta),* Nigalo *(Arundinaria cristata),* Dhairo *(Woodfordia fruticosa),* Amala *(Phylleanthus emblica),* Harro *(Terminalia chebula)* and Barro *(Terminalia bellirica)* (Field visit, 2016).

3.2.6.2 Fauna
Forest of the study area harbors a variety of wild animals. Different species of mammals have been recorded in an around the study area. Three species of monkeys Rhesus Monkey *(Macaca mullata),* Assamese Monkey *(Macaca assamensis),* Grey Langur *(Semnopithecus entellus)*, Common Leopard *(Panthera pardus),* Barking Deer *(Muntiacus muntjak)*, Porcupine *(Hystrix indica)*, Jungle Cat *(Felis chaus),* Yellow Throated Marten *(Martes flavigula),* Common Mongoose *(Herpestes edwardsii)*

(Chalise, 2013c). Similarly, Birds include Jungle Crow *(Covus macrorhynchus),* Parrots *(Psittacula spp.),* House Sparrow *(Passer domesticus)*, Owl (*Bubo bubo*), Black kite *(Milvus migrans)*, Kalij Pheasant *(Lophura leucomelana)*, Cuckoo (*Cuculus* sps.), Common Myna *(Acridotheres tristis),* House Crow *(Corvus splendens),* Woodpecker (*Picus* sps.), Hawks, Eagles, Lammergiers (*Gypaetus barbatus*), Babbler (*Pomatorhinus* sps.) and many species of warblers are recorded inside the study area. Reptiles include Snakes, Common Lizards, Yellow Monitor Lizards, Amphibians include Frogs, Toads, *Megophrys parva* is most common among amphibians and *Calotes versicolor* is common among reptiles (Field visit, 2016).

3.3 Data Collection
3.3.1 Preliminary Field Survey
A preliminary field survey was done with Research supervisor from "9 November, 2015" to "15 November, 2015" to understand the geophysical, climatic condition as well as to understand the population status and distribution of Assamese Monkey. Study area was visited on foot. The survey process included mainly field observation and discussion with local villagers of Kaligandaki River Basin VDCs (Photograph No. 4). Information about location and species were gathered by interacting with expert and local people. Primary data were collected using direct observation and secondary data were collected from published and unpublished literature Animals were observed using 10 x 40 mm binoculars and behavioral data collection methods were practiced with experts.

3.3.2 Block Design
To study the Assamese Monkey study area were divide into four blocks namely Block A (Chisti, Jaidi, Arjewa and Binamare VDCs), Block B (Kusmisera, Amalachaur and NarayansthanVDCs), Block C (Siwalaya and Pang VDC) and Block D (Nangliwang and Dhairing VDCs). Blocks are designed on the basis of habitat character (Rijal, 2014). Which were separated by large Kaligandaki river i.e. Block A and B from Baglung district site where as Block C and D from Parbat District site. Field work carried out nine times in different season from "9 November, 2015" to "28 June, 2016" covering 345 hours.

3.3.3 Population Status
3.3.3.1 Population Census
Population surveys throughout the study area (104.70 Km^2) were carried out from all the possible trails, the trails were walked slowly at 0.5 km/ hr., covering the 6 km/day. Observers were placed along trails stopping every 100 meters to search the area for ½ hour by applying both visual and auditory cues simultaneously as described in Altman, (1974) and practiced by Chalise (2003). When the macaques were encountered, the following data were recorded: detection time, duration of observation, locality and its coordinates, activities and age-sex composition of group. Age and sex were categorized properly with the help of Binocular (10 x 40 mm). Counting was repeated four times in an observation session to minimize the bias in distinguishing age and sex of the groups.

3.3.3.2 Population Density

Population density defined as total number of animals per unit area they occupy. It is necessarily a positive number, but may be a whole number or a fraction. The generalized formula to obtain the crude density is:

$$\text{Crude Density (D)} = \frac{\text{Total no. of individuals in an Area (N)}}{\text{Total Area (A)}}$$

$$\text{Group density (G. D.)} = \frac{\text{Total no. of troops}}{\text{Total Area (A)}}$$

Similarly, sex ratio was taken as the number of males in 100 females.

3.3.3.3 Age-sex Composition

Assessing age require study of the age classes used by previous researchers and some practice (Ross and Reeve, 2003). So, the study followed (Chalise, 1997) to distinguish the age and sex of the macaques and practiced with the supervisor in the field (Photograph No 5). Group size and composition was counted and, if groups are stable, then recorded estimation should lead to increasingly accurate counts. However these records may be inaccurate if some classes behave more conspicuously or avoid humans (e.g. mothers with infants) or because the group is widely dispersed and not all animals can be located (Ross and Reeve, 2003). All area was surveyed starting at 06:00 and finishing at 18:00. The following descriptions were used to distinguish individuals among troops (Chalise, 2000c).

Age Classification:

a) **Adults** are those who attained maximum height and body maturity. Adult males were distinguished by descended scrotal sacs, prominent sitting pads, large skull (Photograph No. 2), and a bit flat head and adult females by the presence of dome shaped head, protruded nipple and sexual swelling in estrus period.

b) **Young and sub-adults** are those who attained the height of adulthood, however, not matured enough in body fitness and reproductive activities. They are grown up and independent, without hanging scrotal sac in male and no protruded nipple in female.

c) **Juveniles** are the individuals that are left nipple contact (weaned) and depend on natural foods. They play a lot between the same age groups. Male try to stay far from mother while female follow her mostly.

d) **Infants** are in the stage that still depends on nipple feeding for their main food. The very young infants are always clinging on breast while a little grown up one are frequently clinging to their mothers for movement and security and sometime ride on the back.

3.3.4 Distribution of Assamese Macaque

Assamese Macaque distribution pattern in the study area was determined by calculating the ratio of variance and mean described by (Odum, 1996).

If, $S^2/\overline{X} = 1$ then it means there is a random distribution

If, $S^2/\overline{X} < 1$ i.e. it has a regular distribution

If, $S^2/\overline{X} > 1$ it indicates clumped distribution

Where, S^2 = Variance = $1/n \ \Sigma(X-\overline{X})^2$

       X = Sample value

       $\overline{X}$ = Mean sample

Chi-square (χ^2) contingency test will be used to find significant difference in the distribution of Assamese Macaque in different sample locations.

Chi-square (χ^2) = $\dfrac{\Sigma(X-a)^2}{a}$

Where X = Observed or sampled value

     a = Expected or mean value

3.3.5 General Behavior

The animals were observed daily from 06:00 A.M. to 18.00 P.M. The daily observation schedule was divided into four shifts; early morning shift: 06.00-09.00 hr. late morning shift: 09.00-12.00 hr. afternoon shift: 12.00-15.00 hr. and evening shift 15.00-18.00 hr. Once in a week continuous 12 hourly observations was undertaken with the help of field assistance. Direct ocular observation method was employed for cataloguing the behavior. The ocular observation was aided with 10 x 40 mm binoculars and cameras.

Behavioral data were obtained by the scan sampling method. The behaviors of monkey were recorded for Two minute at interval of 10 minutes (Altman, 1974; Martin and Boteson, 1993; Chalise, 1997) with the help of timer, and aided by binoculars. A total of 1640 scan samples were recorded covering all four distinct time period viz. early morning, late morning, afternoon and evening. Except recording major behavior pattern other events and interesting behaviors of any individual members of the groups were also recorded whenever they were noticed.

Following behaviors were observed including other social activities of Assamese Macaques in the study area. Below mentioned description from Chalise (2003) was used to distinguish the behaviors among troops.

1) Foraging: The behavior activity in which monkey searches for food or wanders in search for food including eating any substance, geophagy, licking stone, drinking water and that may include slight movement in search of food. It is a walk of any kind.

2) Moving: The behavioral phenomenon in which monkey produces motion displacing from one place to another.

3) Resting: The state when Assamese rest with the body supporting upon the buttocks with hind quarters lowered on to a supporting surface.

4) Grooming: The behavioral phenomenon in which monkeys search their own fur or the fur of others for lice, bugs or dirt which include rubbing, licking and scratching.

3.3.6 Questionnaire Survey

To estimate the crop protection strategies (used by the local peoples) and crop damaged by the Assamese Macaque in the study area questionnaire survey was conducted with the local inhabitants in the Kaligandaki River Basin VDCs (Photograph No. 3). Most of the questions were closed type, but some open ended questions were also included to get more explorative approach from the respondents.

Sample size and sample method: Stratified random sampling method was used to select respondent for the questionnaire survey. The main habitats of the Assamese Monkey were along the Kaligandaki River Basin therefore, out of 654 river basin households, 92 respondents were selected as sample size from the study area. Besides this info informal discussion and meetings with locals were frequently done for the study.

3.3.7 Habitat Analysis

Due to presence of mountainous topography that precludes the most of the systemic survey methods impractical (Rose and Reeve, 2003) so the quadrates of 20×20 m sized were used to analyze vegetation of Assamese Monkey habitat (Photograph No. 1). Total 21 quadrates were laid down randomly in the possible habitat of macaques. 11 quadrates were laid down in Baglung site where as 10 quadrate were laid down at Parbat site. Species diversity of trees was calculated. The collected vegetation data were quantitatively analyzed. To understand characteristics and productivity of the habitat, different parameters like density, relative density, frequency, relative frequency and dominance, were determined (Zobel *et al.,* 1987). Local name of the plant was identified by the experienced local persons. Unidentified plants in the field were prepared herbarium and were identified at National Herbarium Center, Godawori, Lalitpur.

$$\text{Density of a species} \ = \frac{\text{Total no. of individuals of a species}}{\text{Total no.of quadrates x Area of a quqdrqte}}$$

$$\text{Relative Density of a species} = \frac{\text{Density of a species}}{\text{Total Density of all species}} \times 100$$

Frequency of a species is the percentage of quadrates in which the particular species occurs. It gives an index on the spatial distribution of a species and is a measure of relative abundance (Krebs, 1978).

$$\text{Frequency of a species} = \frac{\text{No. of quadrate in which of a species occurs}}{\text{Total no.of quadrates}} \times 100$$

$$\text{Relative Frequency of a species} = \frac{\text{Frequency value of species}}{\text{Total frequency value of all species}} \times 100$$

3.3.8 Crop Raiding

The data collected of crop raiding was derived from the questionnaire survey (See Appendix III). The obtained data from the field were quantitatively analyzed by using following formula (Poudel, 2007).

$$X = \frac{XE - XA}{XLC}$$

Where, X = Loss per unit land

XE = Expected yield before crop loss

XA = Actual value after crop depredation

XLC = Total cropping land of the field

XL = XE − XA

Where, XL = Total crop loss

Total economic value = price of crop x total crop loss in the study area.

3.3.9 Data Analysis and Presentation

The collected data was analyzed with the use of MS EXCEL 2007, R-Software (R-Console version 3.3.1) and Arc GIS 10.1 was also used to map out the distribution of Assamese Macaque in the study area (Figure 1). The collected data was edited, coded and tabulated. The editing was done thoroughly for analysis and interpretation. Both descriptive statistics (Percentages Frequencies) and inferential statistics were used to analyze the data. Charts, Table, graphs and bar diagrams were used to present the data in must simplified and understandable form.

4. RESULTS

4.1 Population Status of Assamese Monkey

4.1.1 Total Population

A total of 47 individuals of Assamese Macaques (*Macaca assamensis*) were counted in four different troops during the field study dated on "9 November, 2015" to "28 June, 2016". The minimum of Assamese Macaques were reported from the Balewa Troop of Amalachaur VDC whereas maximum numbers of Assamese Macaques were reported in Aduwabari Troop of Chisti VDC.

Table 1: Population of Assamese Macaques in different blocks in the Kaliganaki River Basin Baglung and Parbat districts Nepal at 2016.

Block	Altitude (m)	Troop Size
A (Aduwabari) N $28^0$05'05.02'' E $83^0$35'18.59''	687	16
B (Balewa) N $28^0$11'47.5'' E $83^0$39'083''	750	3
C (Pang) N $28^0$14'45.8'' S $83^0$38'30''	925	15
D (Dhairing) N $28^0$19' 45'' E $83^0$35'72''	1096	13
Total		**47**

4.1.2 Population and Group Density

The total population counted was 47 which were existing in four troops and total area of study area was 104.70 km^2, therefore the crude density in the study area was calculated to be 0.44 individuals /km^2. However, the groups found are four so the group density of the Assamese Macaques population in the study area was calculated to be 0.038 groups /km^2. The mean group size of Assamese Macaques in the study area was found to be 11.75 (Range 3-16) individuals.

4.1.3 Age-Sex Structure

Out of 47 individuals adult males were showed the highest percentage 23.40% followed by adult female 19.14%, sub-adult male 17.02 %, young-adult female 19.14%, juveniles (4 male and 3 female) 14.8% and infants (1 male and 2 female) 6.38%.

4.1.3.1 Sex Ratio

The adult sex ratio (male to female) observed during the entire study area was 1.22 (122 male per 100 females) i.e. 1:0.81. Among four different blocks the adult sex ratio was 1.33 (133 male per 100 females) i.e. 1:0.75 in Block A and in Block C. However, 1 (100 male per 100 females) i.e. 1:1 in Block B and in Block D.

Among sub adults, out of 17 individuals male to female ratio was obtained to be 0.88 (88 sub adult males to 100 young adult females) i.e. 1: 0.88.

Among the juveniles, out of 7 individuals male to female ratio was obtained to be 1.33 (133 juvenile males to 100 juvenile female) i.e. 1:0.75.

Among 2 infants, the sex ratio was computed at 1:1 that indicate the 100 male infants to 100 female infants.
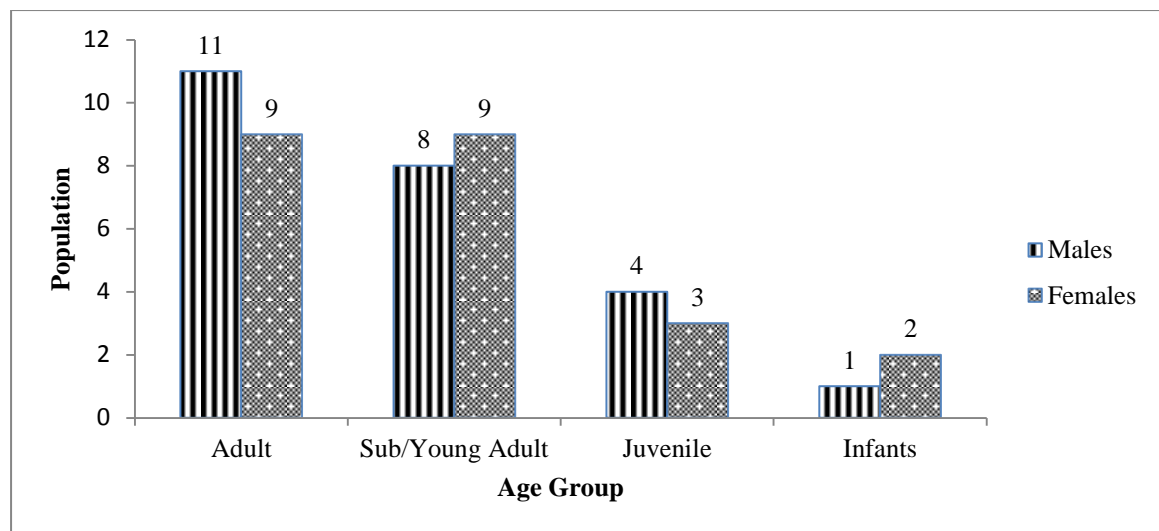
Fig 5: Age-sex structure of Assamese Monkey in the Kaliganaki River Basin Baglung and Parbat districts Nepal at 2016.

4.1.4 Recruitment Rate (Birth Rate)

Recruitment rate (Female to infant ratio) observed during the entire study area 0.33 (33 infant per 100 female).The recruitment rate was 0.33 (33 Infants per 100 female) in block A and in block C,0.5(50 infants per 100 female)in block D and 0 in Block B.

4.2 Distribution of Assamese Macaques in Different Blocks.

Assamese Macaques were recorded from all the four blocks of study area.The study area Baglung and Parbat District river basin VDCs, were divided into four different study blocks according to habitat character then the below mentioned result were obtained.
One troop with 16 individuals were recorded in Block A,where 4 adult males and 3 adult females with three sub adult male, 3 young adult female, 2 juveniles and 1 infant were

found in Aduwabari of chisti VDC baglung having less human interference and moderate of food and water sources.

In Block B, One troop with 3 individuals were found in Blovk B, where 1 adult male, 1 adult female, with 1 juvenile were found near the takuri at Amalachaur VDC baglung having more human interferance and the habitat was fragmented by newly born Kaligandaki corridor.

One troop with 15 individuals of Assamese were observed in Block C,where 4 adult male, 3 adult female, 2 sub-adult male, 3 young-adult female, 2 juvenile and 1 infant were found in Kushma municipality, 4, salghari pang parbat at the edgg of pang tari village with south facing rocky out crop.

One troop with 13 individuals were recorded in Block D, where 2 adult male, 2 adult female , 3 sub-adult male, 3 Young-adult female, 2 juvenile and 1 infant were found in Dhairing VDC parbat at the edge of salyan village.
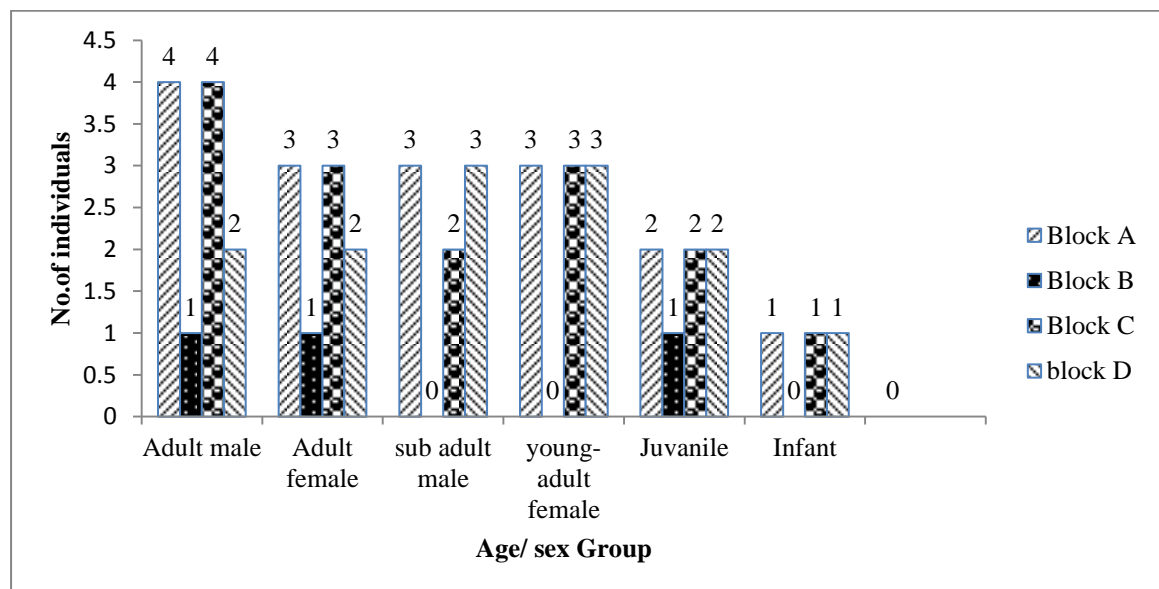
Fig 6: Distribution of Assamese Macaques in different blocks in the Kaliganaki River Basin Baglung and Parbat districts Nepal at 2016.

The varience to mean ratio was used to determine the distribution pattern of Assamese Macaques among four different study Blocks.The calculated value of varience to mean ratio was found to be 1.51. Since, the value of $(S^2/\bar{X}) > 1$, The result has shown clumped distribution of Assamese Macaque in study Area.

Chi-square significance test Showed that there was no significant difference in distribution of Assamese Macaques Among four different blocks. (χ^2 =6.2996, d.f.= 3, p = 0.09791, p>0.05).

4.3 Vegetation Analysis

By quadrate sampling, 58 plant species with 716 number were recorded. this study revealed that Sal (*Sorea robusta*) is the dominant plant species with relative density 31.42% and relative frequency 8.376% which is followed by Tiju *(Diospyros malabarica)* relative density 10.93% and relative frequency 8.376%. The detail list of vegetation is given in (Appendix-I).

4.4 General Behavior and Daily Activity Pattern

4.4.1 General Behavior

The Assamese group of size of 16 individuals of Aduwabari troop of Baglung were selected for the scan sampling to measure the general behavior of Assamese Macaque. Field work was carried out from March to June, 2016. Total jungle time was of 345 hours and animal contact time was 185 hours. Four major behaviors (foraging, moving, resting and grooming) were recorded during the study period. Behavioral data were obtained by the scan sampling method. Total of 1640 scan samples were recorded from the focal Aduwabari Troop.

The animals were observed daily from 06:00 A.M. to 18.00 P.M. The daily observation schedule was divided into four shifts; early morning shift: 06.00-09.00 hr. late morning shift: 09.00-12.00 hr. afternoon shift: 12.00-15.00 hr. and evening shift 15.00-18.00 hr. Once in a week continuous 12 hourly observations was undertaken with the help of field assistance. Direct ocular observation method was employed for cataloguing the behavior. The ocular observation was aided with 10 x 40 mm binoculars. The focal group revealed that foraging was 47.25%, moving 27.25%, resting 14%, grooming 11.5% (Fig 7).
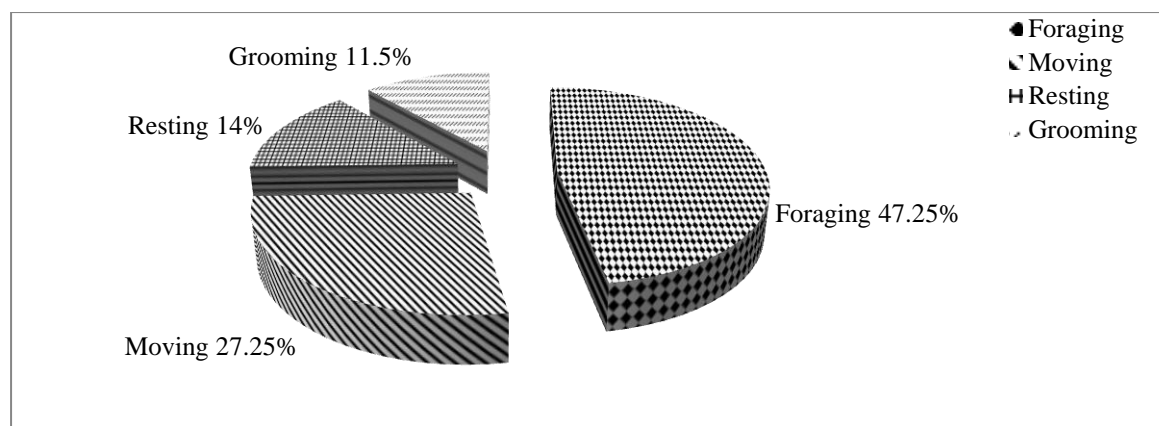
Fig 7: General behavior of Assamese Macaque in Baglung, Chisti VDC Aduwabari at 2016.

4.4.2 Diurnal Activity Pattern

Foraging time of the Assamese monkey was found to be highest 54% in 15:00 to 18:00 observational phase followed by 50% in the morning from 06:00 to 09:00 observational phase, 43% in 09:00 to 12.00 observational phase and 40% in the observational phase of 12.00 to 15.00 hours. Moving time of the Assamese Monkey was found to be highest 33% in 12.00 to 15.00 observational phase followed by 30% in 09:00 to 12:00

observational phase, 24% in 06:00 to 09:00 observational phase and 22% in 15:00 to 18:00 observational phase. Resting time of Assamese Monkey was found to be highest 15% in 09:00 to 12:00 hours followed by 14% in 06:00 to 09:00 and 12.00 to 15.00 hours, 13% in 15:00 to 18:00 observational phase. Assamese Monkey were seen mostly grooming 13% in 12.00 to 15.00 hours, 12% in 09:00 to 12:00 observational phase, 11% in 09:00 to 12:00 observational phase, and10% in 15:00 to 18:00 observational phase (Fig 8).
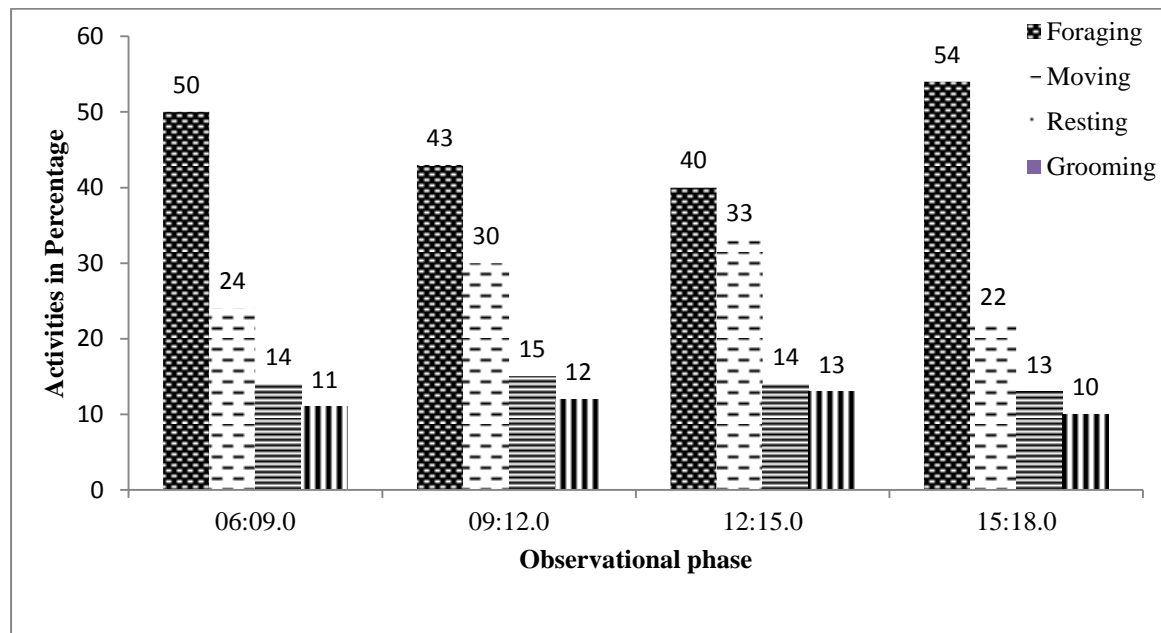
fig 8: Diurnal Activity pattern of Assamese Macaque in Baglung, Chisti VDC Aduwabari at 2016.

4.5 Conflict Due to Monkey

4.5.1 Crop Raiding

Crop raiding was found to be the major problem caused by the monkey. Major crops raided by monkeys included maize, potato, millet, wheat, paddy, pulses, vegetables, (pumpkin, bean, cauliflower, cabbage etc.), and fruits (pear, peach, cucumber,etc.). In which maize was the highest raided crop. From the total 92 respondents, total loss noted was 46.95% of maize, followed by 15.91% paddy, 15.11% potato,10.84% millet,6.88% wheat,2.05% pulses, 1.59% fruits and 0.66% vegetables. Most of the respondents had very limited crop land to grow their crops. Out of this respondents, 50% respondents were facing more trouble from the crop raiding problems and 5% respondents had already left some land fallow due to severe crop raiding problem.
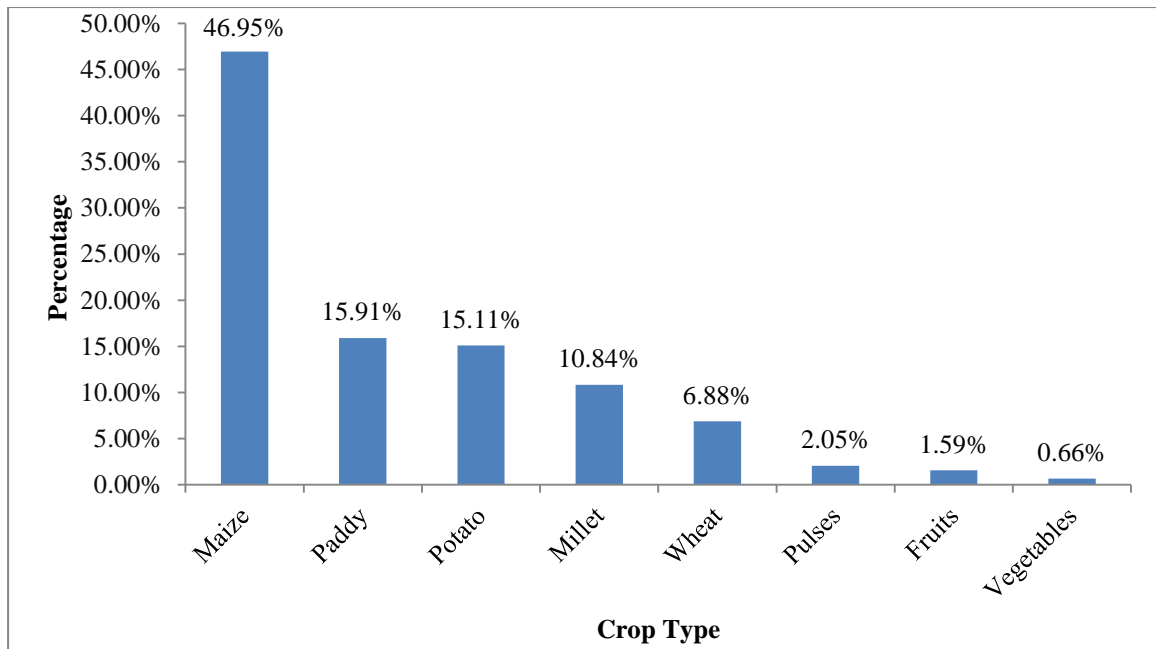
Fig 9: Crop damage (%) by Assamese Macaques in the Kaliganaki River Basin Baglung and Parbat districts Nepal at 2016.

Out of the total 92 respondents, a total of 61.18 hectare of land was utilized for the cultivation of crops. In that land area, total yield of crop was expected to be 688.29 quintals but 567.74 quintals was observed yield during the study time. It indicated that 120.55 quintals of crops was lost by the Macaques, on the basis of average monetary value was accumulated from Baglung Bazar (Appendix – IV). Among the various raided crops, maize was found highly raided that worth the loss Rs.226400. Altogether, the loss of raided crops worth Rs. 558926 from questionnaire surveyed area the result showed that 14.98 quintals of crops was raided in each hectare of land (Appendix – V).

4.5.1   Crop Protection Strategies and Management

To protect crop fields and orchards from wildlife including Assamese Macaque, farmers used many methods. These methods include patrolling and guarding the fields by farmers including their children, Scarecrow, Tin-box, throwing stone with "Catapult", keeping Dogs, fencing with thorny twigs etc. The most used crop protection strategy in guarding their field by constant vigilance. This method was used by 50% of the farmers in the study area. 25% of field owners use "Scarecrows"(a device to scare the animals from the field). Few farmers about 20% used dogs for crop protection to chase the macaques away, while the remaining 5% farmers used tin- box and catapult (a device made with rubber to hit the distant objects) to chase the macaques from the crop fields.
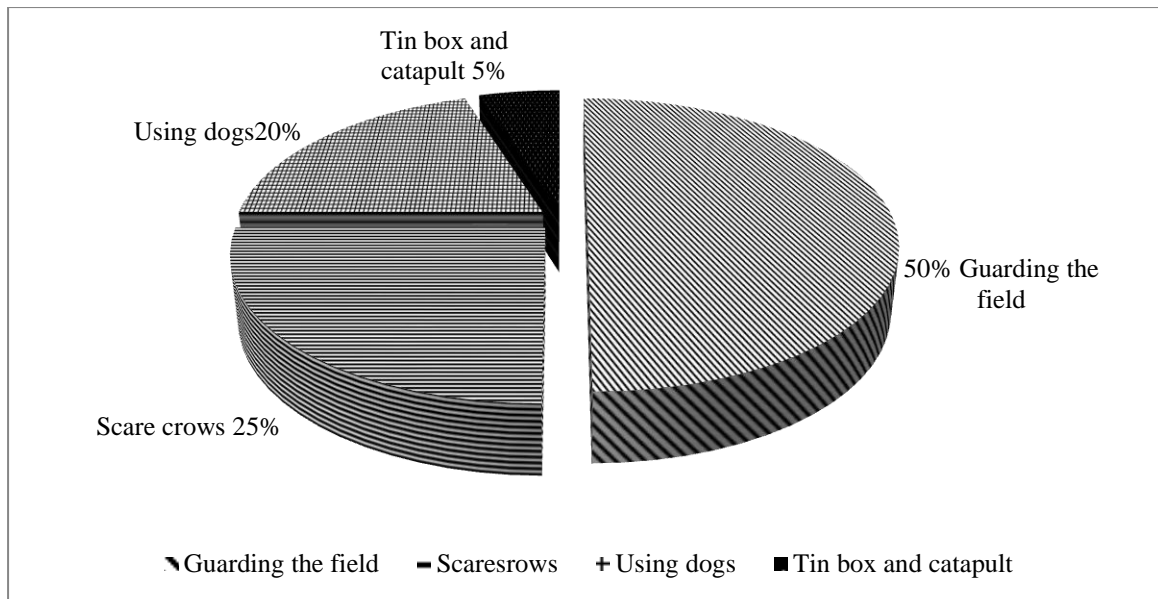
Fig 10: Different crop protection strategies used by farmers in the Kaliganaki River Basin Baglung and Parbat districts Nepal at 2016.

Along with above methods all the farmers commonly fence their farms using thorny twigs and branches of different trees and shrubs as protective measures. Despite all these measure of crop protection, macaques do manage to invade the crops.

5. DISCUSSION

5.1 Population Status and Distribution

During this study Assamese Macaques in Baglung and Parbat, Kaligandaki River Basin VDCs was found to be distributed in four different Blocks. A total of 47 individuals in 4 different troops were recorded in which 16, 3, 15 and 13 from Aduwari, Balewa, Pang and Dhairing respectively however, Adhikari (2013) also recorded the similar result where three troops of Assamese Macaques having total 53 individuals from three different blocks in which 13, 15 and 25 in number from Paune, Jagat and Chipla respectively, may be due to presence of similar type of geology in between these study site similar type of result were obtained during this study compared to Adhikari (2013). Chalise *et al.* (2013) had recorded the similar result where three troops of Assamese Macaque having total 83 individuals in Nagarjun forest of SNNP; troop size recorded was 35 from Fulbari, 32 from Simpani area and 17 from Sanagaun-Mudkhu.

Rose and Reeve (2003) reported that population of a wild Primate typically involves a considerable investment of resource and time i.e. equipment money and labors. But only investing these resources may not be sufficient for the survey of Primates in such mountainous topography that precludes the most of the survey methods impractical.

Chalise (2000a) reported seven troops of Assamese Macaques in Makalu-Barun area in 1997 and estimated group size of 7-50 and the ratio of adult males to the adult females were 1:2.03 and again, in 1998 from the same study area, he reported 1:1.9 adult sex-ratios from group size in range of 13-27 of 4 troops. Southwick *et al.* (1964) reported two troops of Assamese Monkeys in Darjeeling and estimated group size of 10-25 and the ratio of adult male to the adult female were 1:1.7 Regmi (2008) recorded 9 Assamese Macaques troops in LNP and observed troop size ranges from 13-23 individuals and the ratio of adult males to the adult females were 1:1.92. Recently, Adhikari (2013) reported three troops of Assamese Macaques in Lamjung and estimated group size 13-25 and the ratio of adult males to the adult female were 1:2.14. Whereas the present study recorded 4 Assamese Macaques troops and observed troop size varies from 3-16 individuals in Baglung and Parbat, Kaligandaki River Basin VDCs. The adult sex ratio of Assamese Macaques troop observed in this study i.e. 1:0.81 is a apparently not similar to that of the above stated in the study of chalise (2000a) i.e. 1:2.03 in 1997, 1:19 in 1998, Regmi (2008) i.e. 1:1.7 and Adhikari (2013) i.e. 1:1.92 i.e. Macaque live in multi - male, Female - kin bonded groups and the ratio of male to females ranges from 1:2.2 *Macaca radiate* to 1:9 *Macaca nemestriana* (Feeroz, 1996). This finding do not supports that the *Macaca assamensis* also live in multi-male and female-kin, bonded groups like as other macaques. Hanya *et al.* (2003) estimated the group density of Japanese Macaques as 1.43 and 0.737 group /km^2 in disturbed and undisturbed area by the method of combining point census and group fallow within a census area of 7 Km^2 in the western area of Yakusima, an island in South Japan. Regmi (2008) reported the group density of Assamese Macaques as 0.0790 groups/ Km^2 in LNP where as in the present study the group density of Assamese Macaques was found to be 0.016 group/km^2 by applying a total population count within a census of 183 Km^2. Moreover, Hanya *et al.* (2003) in the same study area, Population was

calculated to be 22.9 and 11.8 individuals/Km^2 in the distributed and undistributed area respectively with the main group size of 16. Regmi (2008) also estimated the population density of Assamese Macaque was found to be 1.8691 individuals /km^2 with the mean group size of 23.66 and Adhikari (2013) reported the population density of Assamese Macaques 0.28 individuals/ Km^2 with the mean group size of 17.66 in Lamjung whereas in the present study, the population density of Assamese Macaque was found to be 0.44 individuals/ Km^2 with mean group size 11.75 the reason behind this difference in density is due to comparatively large area of present study and the population also from outside of the protected area where there is no any rules and regulation effectively implemented by the government to protect this fragmented population from being vanish.

The variance to mean ratio of Assamese Macaques from different study blocks was found to be more than one. The result showed clump distribution which is the most common type of distribution and also called as cluster or contagious and aggregated. It may be due to the response of seasonal weather, environmental changes and social behavior as well as it may tend to concentrate around a geographical feature that provides nutrients or shelter and when the occurrence of small sized groups (including blanks) and large sized groups is more frequent and the occurrence of middle sized group less frequent then expected in those studied blocks. This finding supports the idea of (Smith, 1996; Odum, 1996).

Ale (2010) estimated the population density of Highland langurs in LNP using line transect method covering the area of 32km^2 was found to be 4.65 langurs/km^2. Wangchuk (1995) calculated the population density of golden langurs using the same method covering the area of 58.5 km^2 was found to be 2.1 langurs/ km^2, but I observed population study of Assamese Macaque in my study site was found to be 0.44 individuals/km^2. Severel study shows that environmental constrains and human interference might affect group composition and group size of the macaques (Machairas *et al.,* 2003). Actually, this study area bears high human population as well as very high crop food and newly constructed Kaligandaki corridor road way due to which the Assamese Macaques are distributed in very limited space of the study area where as small group size three observed in Block B (Amalachaur troop). Due to presence of high human pressure and less resource of food the group size may affect itself when such effect is probably found by the patchiness of resource distribution.

Vegetation analysis was done by quadrate sampling, quadrates of 20m x 20m size were laid down in the main habitat of Assamese Macaque. By quadrate sampling, 58 plant species with 716 number were recorded. This study revealed that Sal (*Sorea robusta*) is the dominant plant species with relative density 31.42% and relative frequency 8.376% which is followed by Tiju *(Diospyros malabarica)* relative density 10.93% and relative frequency 8.376% where as Aryal (2013) reported from Arkhele and Nayagaun gulmi area by 8 quadrate of size 25m×25m quadrate sampling, 23 plant species with 191 number were recorded according to his study Khote Salla (*Pinus ruxberghii)* was the dominant plant species with relative density 30.89% and relative frequency 13.043% which is followed by Chilaune (*Schima wallichi*) with relative density 8.34 and relative frequency 10.87 due to difference in altitude range between these two study sites two different types of dominnt vegetation were found. Rijal (2014) also laid down 8 quadrates of size 25m×25m at Nagarjun forest of SNNP by quadrate sampling, 27 plant species

with 196 numbers were recorded from his study Chilaune (*Schima wallichi*) was the dominant plant species with relative density 30.89% followed by Jhankrikath (*Machilus duthiei*) with relative density 8.98 and Masure katus (*Castanopsis tribuloides*) with relative frequency 10.87 this result also supports th findings of this study altitudional variation causes the change in vegetation pattern.

5.2 General Behavior and Diurnal Activities

Sarkar (2000) behavior is the response of both the physical as well as habitat condition of animals. It varies from habitat to habitat depending upon the resource distribution. In primate, food, mates, drink and roosting trees are the most important resources, which control activities. Among these resources, food seems to be the most crucial primary factor which regulates day-to-day activity profiles (Sarkar *et al.,* 2012). During this study period, four troops of Assamese Macaques were recorded in predesigned four blocks of Baglung and Parbat district, kaligandaki River Basin VDCs. Among those the troop of Aduwabari of troop size 16 was selected for exploring the general behavior of the Assamese Macaques from the study area in "9 November, 2015" / "28 June, 2016". Four major behaviors were recorded in different field visiting time during the study period in which general behavior were recorded as foraging 47.25%, moving 27.25%, resting 14%, and grooming 11.5% whereas Bhattarai (2002) recorded eating 29.20%, sitting 33%, walking 28.20%, grooming 6.40%, mating 1.1%, aggregation 0.71% and play 0.40% in LNP, Chalise *et al.* (2005) recorded foraging 43.4%, moving 31.7%, sitting 18.5%, grooming 3.4% and stone licking 1.7% in the same LNP, Regmi (2008) recorded foraging 49%, moving 26%, resting 16% and grooming 9% in LNP, Chalise (2013a) recorded foraging/eating 56%, resting 19%, locomotion 16%, sleeping 12%, grooming 6% and playing 1% in SNNP, Adhikari and Chalise (2014) recorded foraging 45%, locomotion 25%, resting 20%, and Grooming 10% and Pandey and Chalise (2015) recorded 40% time in foraging/feeding, 21% time in locomotion, 16% time in grooming while 40% time inactive, 6% playing, and 1% sleeping in SNNP. The different in general behavior may be due to different season, food resources availability and day length as well.

The amount of time spent on locomotion is determined primarily by the distribution of food and food plant species in the habitat and by the nature of food items (Sarkar, 2000). Therefore, the Assamese Macaque had to allot 28% time to locomotion similar result were recorded by Sarkar *et al.* (2012) in forest group of Assamese Macaque in Jokai reserved forest (RF) of Assam as 25% time (range 23-26) for locomotion. Similarly, Chalise (2000b) recorded four major behaviors during the study in the both expeditions (1997/98) in Makalu-Barun National Park taking geophagy into separate account and found 3 to 4% difference in case of feeding in his study (1997/98) invested 29/25%. The present study showed that the Assamese Macaques spent 47% of their total time on feeding while Sarkar *et al.* (2012) showed that the forest group spend 40% of their total annual time (range 38-45) on feeding. Chalise (2000a) found 47/44% which is 3 to 4% difference in case of feeding in his study (1997 to 1998) in Makalu Barun National Park. Adhikari and Chalise (2014) recorded that the seasonal activity budget of Assamese Macaques in different four season as, 47% feeding in winter, 45% in Pre monsoon, 44%

in monsoon and 43% in post monsoon. They found 43/47% which is 4% difference in deeding on different four seasons.

Higher time spent in locomotion, costs higher expenditure of energy. The Assamese Macaque which spent more time on locomotion had to spend more time in resting in order to make a balance of energy demand and supply. Hence the *Macaca assamensis* spent 14% of their total time in resting where different time spent was recorded by Sarkar *et al.* (2012) in resting for 13% (range 7-20). Simillarly Adhikari and Chalise (2014) recorded that 21% time for resting in Lamjung where as Pandey and Chalise (2015) reported that 14.95% resting in SNNP.

Food resources are randomly distributed in the study area, individual of Primate do not able to monopolize the resources. So, social tension due to Aggregation is comparatively less in the forest group as compared to provision or temple group (Sarkar, 2000). Grooming behavior in long term serves the function of reducing "Social Tension" (Schino *et al.,* 1988) and establishes a social bonding among the individual within the group (Kurland, 1977), so the Assamese Macaque spent only 10% of their total time on grooming in the present study. Whereas Chopra *et al*. (1992) showed 14% in grooming by Rhesus Macaque, Bhattarai (2002) recorded grooming 29/25%, Chalise *et al.* (2005) recorded grooming 3-4%, Regmi (2008) recorded grooming 9%, Chalise (2013a) recorded 6% grooming, Adhikari and Chalise (2014) found 10% grooming and Pandey and Chalise (2015) reported that 16% in grooming. Hence, lacks of extra social tension in the Assamese Macaque due to its less size reduce the time spend on grooming.

Diurnal activities were recorded during March to June, 2016. A total of 16 individuals representing different age groups of focal aduwari troop of both the sexes were observed. The most common activity was feeding/foraging which was highest during 15pm to 18pm among the four periods i.e.54% and lowest is during 12am to 15pm. Time spent on moving was found to be highest at 12am to 15pm i.e. 33% and lowest 22% at 15pm to18pm. Time spent on resting was found highest 15% during 9am to 12am and lowest 13% at 15pm to 18pm. Grooming was observed highest 13% at 12am to 15pm and lowest 10% at 15pm to 18pm where as Koirala and Chalise (2014) reported from SNNP area time spent on feeding and foraging behavior was highest during 12 noon to 15 pm among the four periods i.e. 46% and lowest was during 15pm to 18pm i.e. 33%. Time spent on moving was too highest during 12 pm -15 pm i.e. 29% and lowest percentage of time spent on moving was during 9am – 12noon i.e. 15%. During 12 noon – 15 pm macaques spent greater percentage of time on feeding and moving behavior so the time spent in resting and social behavior was lowest than other period i.e. 19% and 6% respectively the higher percentage of feeding during my study period was may be due to lack of sufficient food on habitat. Due to newly born Kaligandaki corridor habitats of macaques are divided into several fragmented so the macaques also spent more time for searching their own food.

5.3 Threats to Monkeys (Crop - Raiding and its Consequences)

Crop raiding was found as a major cause of conflict though physical hurt and harassment, taking and grabbing of food materials were also reported as the problems caused by monkeys. Among the respondents crop raiding was reported by 80% but the extent of crop raiding was found to be different areas. Crop raiding was found to be highest at Block A Aduwabari village of Chhisti VDC Baglung (78%) followed by the Block D Dhairing, at the edge of Salyan village with rocky out crop of Dhairing VDC Parbat least

to the crop raiding (61%). Higher extent of crop raiding in former two is due to the settlement and crop field very near to the forest. Khatri (2006) found that 76% of respondents of Vijayapur Area of Dharan reported the crop raiding as a major problem. Similar in the study of Patty McCourt (2005) 92% respondents of Hetauda were found to suffer from crop damage from monkeys, Adhikari (2013) 78% of respondents of Lamjung area reported crop raiding as a major problem.

Chalise (2000a) collected the information of crop raiding by the interviews in Lakuwa village of MBCA and reported that Rhesus and Assamese Macaques was the most crop raider and langurs visited the least and the villagers blamed that among the two species, Assamese Monkey were the terrible then rhesus. This study couldn't similar with this present study where the villagers blamed that among the two species, Rhesus Monkey were the terrible then the Assamese, and he stated that monkey raid heavily to the maize field 29% then followed potatoes 23% (tubers also), rice 13%, fruits 12%, and millets 12%. The tubers and fruits comet to 35% of the total loss and the entire cereals combine made 65% loss in Lakuwa village but here this crop raiding ratio of fruit and cereals crop is similar to this present study.

Regmi (2008) reported crop raiding in LNP by 62% for maize, 23% for potato, 7% for millet, 6% for buckwheat and 2% for other, which result is similar to this study. Khatri (2006) also supports that maize is the prominently vulnerable crops for raiding by primates. Adhikari (2013) found crop raiding by Assamese Monkey in Lamjung area, 44% maize followed by 27% potato, 13% millest, 7% wheat, 4% paddy, 3% fruits and 2% vegetables this finding also supports the present study may be due to the similar type of geology in between these two study sites.

Different preventive measures were applied to deter monkey, though chasing of monkey by shouting and guarding was found to be most effective and widely used measure. Local peoples usually protect their crop and chased monkey by shouting and guarding. Small hut locally called "Chhapro" were made to guard the field. Use of dog use of catapult and stone to chase monkeys, hitting tin boxes as well as other method like planting alternative crops were also found. Khattri (2006) in Vijayapur found the use of catapult to frighten the monkeys to be the most effective which is similar with present study.

Bagale (2003) found guarding overnights as an effective crop protection technique in Lumbini area in order to protect their crops from Nilgai (*Boselaphus tragocamelus*) a nocturnal crop raider. In this present study guarding field as most employed crop protection technique in this large river basin from Assamese Macaque, a diurnal crop raider. Though the guarding/chasing is the most effective method of deterrent in which mainly the woman and children engage, it is time expensive and keeps people away from other activities (Bell, 1984; Hill, 2000; King and lee, 1987; Knight, 1999; Pirta *et al*., 1997; Sekhar, 1998; Southwick and Lindburg, 1986; South wick and Siddiqi, 1977) especially consumes the time of educational activities of children in such remote areas which further move the poor people backward through long lasting impacts. So the loss is invaluable in comparison with time rather than economy.

Chhangani and Mohnot (2004) in a study in and around Aravallis of India, Calculated the percentage of crop protection methods by farmers as 60% guarding fields, 20% throwing stones, 15% using dogs and 5% others including dangerous method like single shot gun,

potash bomb and high voltage electric current in which animals are usually killed or seriously injured but the farmers of this study areas were not used cruel type of crop protection strategies but in this study Guarding the field 50%, scare crows 25%, Using dog 20%, Tin box and Catapult 5% because like that of gun and potash bomb are prohibited by his majesties of government for the use to public.

McCurt (2005) in Hetauda found stone throw catapult 40%, followed by chasing 20%, threaten 18% and stick wave 2%. Adhikari (2013) reported that Guarding and shouting 68%, stone and catapult 16% and hitting tin box and using dogs 12% from Lamjung Area but in this study Guarding the field 50%, scare crows 25%, Using dog 20%, Tin box and Catapult 5% the difference between 68% guarding and shouting and guarding 50% may be due to the children of this study area are engaged in school for their study.

6. CONCLUSION AND RECOMMENDATIONS

Conclusion

Total population of Assamese Macaque was recorded 47 from four troops in Kligandaki River Basin, Baglung and Parbat Districts during the study period of "9 November, 2015" to "28 June, 2016". Maximum number was reported from Block A (Aduwabari Troop) and minimum number was recorded in Block B (Balewa Troop). Distribution of Assamese in four blocks of study area was found to be clumped type of distribution. The sex ratio of Assamese Macaques was found to be 1:0.81 i.e. 122 males per 100 females. There were more males than females, which did not depart significantly from 1:1 sex ratio. Average group size was found 11.74 individual in the study area.

The study shows the general behavior of Assamese Macaques in different field visiting time in which the feeding activity has been found the major activity profile and minimum was grooming. Maize crops were highly preferred by the Assamese Macaque as a major crop raiding which is followed by paddy and guarding the field and Scare crow was the most effective crop protection strategies adopting by the farmers.

Recommendations

On the basis to the finding of this study, following recommendations can be made for the protection of this Assamese Monkey population in this large river basin.

1. To protect this fragmented monkey population, forestation of fruiting and flowering plant should be carried out which also minimize their raid in crop field.
2. Need more researches on the ecology and behavior of Assamese Monkey should be carried out through Universities, research agencies and wildlife experts.
3. Balewa Amalachaur troop having three individual is important to know genetically whether that is a newly split troop or it is the troop going to vanish.
4. Newly Constructed Kaligandaki corridor making many fragmentations on Assamese Monkey habitat along the river basin which directly affect this monkey population so, to save these populations need more research and conservation implementation plan.

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PHOTO PLATE 1

1. Collecting information of vegetation
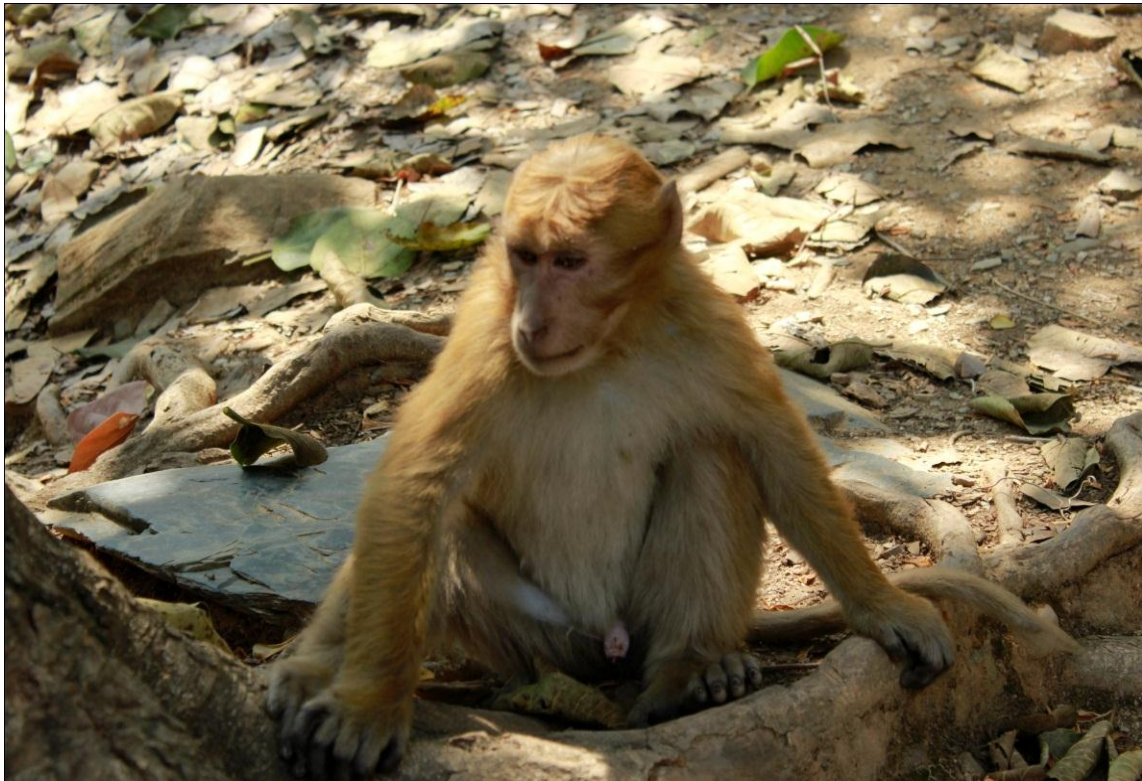
2. Adult male of Assamese macaque

3. Questionnaire with local people

4. Interacting with local people

5. Photograph with supervisor watching macaque

6. Crop damaged by Assamese Macaque

Appendix – I: Climatic parameters recorded at Baglung Bazar in the year 2015.

Months	Temperature (^{o}C)		Humidity (%)		Rainfall (mm)
	Maximum	**Minimum**	**8:45**	**17:45**	
January	19.9	6	82.3	76.1	6
February	22.7	9.6	67.4	66.3	9.6
March	28	14.6	57.9	54.6	14.6
April	30.2	15.5	57.8	51.2	15.5
May	30.8	20	78.0	77.0	20
June	29.9	21.1	80.7	79.3	21.1
July	30.3	22.2	86.1	87.5	553.6
August	30.8	21.8	92.8	91.4	529.7
September	39.3	20.5	84.8	91.8	269.8
October	27	15.2	78.3	89.7	12.4
November	23.2	9.8	77.0	86.1	0.0
December	20.4	7.4	83.8	86.8	0.0

(Source: NG/RDHM, 2015)

Appendix- II: Value of different parameters for tree species in study area.

S.N.	Common Name	Scientific Name	Total	D.	R. D	F.	R. F
1	Sal	*Sorea robusta*	208	0.0204	31.42	85.71	8.376
2	Chilaune	*Schima wallichii*	56	0.0055	8.47	66.66	6.514
3	Aap	*Mangifera indica*	14	0.0013	2.002	28.27	2.762
4	Ghokre		10	0.0009	1.386	23.80	2.325
5	Kutmiro	*Litsea monopelata*	3	0.0002	0.308	9.52	0.930
6	Khanyo	*Ficus semicordata*	41	0.0040	6.162	33.33	3.257
7	Jamun	*syzigium cumini*	14	0.0013	2.002	38.09	3.722
8	Aamala	*Phyllanthus emblica*	5	0.0004	0.616	9.52	0.930
9	Tiju	*Diospyros malabarica*	73	0.0071	10.93	85.71	8.376
10	Kaligede		13	0.0009	1.386	23.80	2.325
11	Tuni	*Toona ciliata*	11	0.0010	1.540	47.61	4.652
12	Pakhuri	*Ficus spp.*	3	0.0002	0.308	9.52	0.930
13	Mahuwa	*Engelhardia spicata*	29	0.0028	4.467	42.85	4.187
14	Belauti	*Psidium guajava*	29	0.0028	4.467	14.28	1.395
15	Saj	*Terminalia alata*	6	0.0005	0.770	19.04	1.860
16	Bhorla	*Bauhiniaa vahlii*	8	0.0007	1.078	19.04	1.860
17	Thulo gabajo		4	0.0003	0.462	19.04	1.860
18	Mel	*Pyrus pashia*	1	0.00009	0.138	4.76	0.465
19	Sindure	Bixa orelana	1	0.00009	0.138	4.76	0.465
20	Pipal		1	0.00009	0.138	4.76	0465
21	Dhairo	*Woodfordia fruticosa*	22	0.002	3.081	38.09	3.722
22	Aakhitare		6	0.0005	0.770	14.28	1.395
23	Pakhuri	*Ficus glaberrima*	3	0.0002	0.308	4.76	0.465
24	Bas	*Bambusa spp.*	6	0.0005	0.770	23.80	2.325
25	Dabdabe	*Garuga pinnata*	10	0.0009	0.386	9.52	0.930
26	Sajiwan	*Jatropha curcas*	8	0.0007	0.078	9.52	0.930
27	Kavro	*Ficus infectoria*	2	0.0001	0.154	14.28	1.395
28	Gijari	*Premna spp.*	2	0.0001	0.145	9.52	0.930
29	Aasuro	*Adhatoda vasica*	4	0.0003	0.462	9.52	0.930
30	Simal	*Bombax ceiba*	10	0.0009	0.386	23.80	2.325
31	Katus	*Catanopsis indica*	1.	0.00009	0.138	4.76	0.465
32	Jai		2	0.0001	0.154	9.52	0.930

	Chilauni						
33	Chiuri	*Aesandra butyracea*	4	0.0003	0.462	9.52	0.930
34	Bad dhairo	*Lagerstroemia parviflorus*	1	0.00009	0.138	4.76	0.465
35	Dhursu	*Colobrokia spp*	11	0.0010	0.540	14.28	1.395
36	Khirro	*Sapium insigne*	13	0.0012	0.848	19.04	1.860
37	Bar	*Ficus bengalensis*	4	0.0003	0.462	19.04	1.860
38	Dumri	*Ficus racemosa*	1	0.0009	0.138	4.76	0.465
39	Kemano	*Careya arborea*	7	0.0006	0.924	19.04	1.860
40	Goldarim		2	0.0001	0.154	9.52	0.930
41	Besare		1	0.00009	0.138	14.28	1.395
42	Musure Katus	*Catanopsis indica*	4	0.0003	0.462	4.76	0.465
43	Bhote		1	0.00009	0.138	14.28	1.395
44	Bhogate	*Citrus spp.*	6	0.0005	0.770	4.76	0.465
45	Sano gabajo		1	0.00009	0.138	9.52	0.930
46	Mallato	*Macaranga spp.*	2	0.0001	0.154	9.52	0.930
47	Guyelo		4	0.0003	0.462	14.28	1.395
48	Ratpate		4	0.0003	0.462	14.28	1.395
49	Gayo		5	0.0004	0.616	9.52	0.930
50	Bel	*Aegle marmellos*	1	0.00009	0.138	9.52	0.930
51	Karjo	*Sapium insigne*	4	0.0003	0.462	9.52	0.930
52	Githo	*Discorea spp.*	2	0.0001	0.154	4.76	0.465
53	Niuwa		5	0.0004	0.616	4.76	0.465
54	Teltapre		3	0.0002	0.308	9.52	0.930
55	Raju		3	0.0002	0.308	4.76	0.465
56	Ketuki	*Pandanus odoratissimus*	5	0.0004	0.616	9.52	0.930
57	Aarari Kanda	*Acacia pinnata*	3	0.0002	0.308	4.76	0.465
58	Kaiyeu	*Gravellia robusta*	13	0.0012	0.848	9.52	0.930
Total			**716**	**0.06491**		**1023.2**	

Appendix – III: Pre – structured Questionnaire for crop raiding.

Q.N.:-   Date…………………

Name: …………………………...Age……Sex: M/F   District: ………VDC……

…….Village……….Ward   No………………Occupation:
………………………………….

1. How many members are there in your family? ....

2.   How   much   land   do   you   own?
.......Khet……………..….Bari…………..…Pakho:…………

3. Which crops do you grow in your field?

Name of Crops	Plantation	Harvesting	Name of Crops	Plantation	Harvesting
Maize			Potato		
Paddy			Vegetables		
Wheat			Fruits		
Millet			Others		
Mustard					

4. Do animals or birds damage your crops?

Yes [   ]   No   [   ]

If yes Name:-   Local Name:

5. Does the monkey raid crops?

Yes […...]   No […….]; If yes which monkey species

Name: ……………….   Local Name:

6. Which crop does the monkey raid most?

Crop:

Maize…………………………Pathi/Kg.   Paddy…………………… Pathi/ kg
Wheat…………………………Pathi/Kg   Millet……………………Pathi/Kg

Vegetables……………………..Pathi/Kg   Fruits……………………Pathi/Kg

7. In which year does the monkey raid :…….Last year…….....This Year….…...Never

8. Time of raid: Early morning / Noon / Afternoon / Evening / Night

9. Proximity of damage field to the jungle: 100m/200m/500m/1000m/2000m

10. What is the preferable stage to raid the crops?

Crop	Raiding Stage	Season	Crop	Raiding Stage	Season
Maize	Sprouting	……	Potato	Sprouting	…..
	Young shoot	…….		Young shoot	……
	Milky	…….		Young	…..
	Ripen	…….		Ripen	…..
Millet	Sprouting	…….	Vegetable	Sprouting	…..
	Young shoot	…….		Young shoot	…..
	Milky	…….		Young	…..
	Ripen	……..		Ripen	….
Wheat	Sprouting	…….	Fruits	Sprouting	…..
	Young shoot	…….		Young shoot	……
	Milky	…….		Juicy	…….
	Ripen	…….		Ripen	…….
Paddy	Sprouting	…….			
	Young shoot	…….			
	Milky	……			
	Ripen	……			

11. What is the frequency of monkey interference in crops?

Name of Crops	Frequency / Months	Name of Crops	Frequency / Months
Maize	………………..	Mustard	……………….
Paddy	………………...	Wheat	……………….
Millet	…………………	Vegetables	……………….
Fruits	………………...	Others	……………….

12. Any land left fallow because of the crop raiding of monkey?

Khet …………………..Bari…………………Pakho………………………….

13. Any other kinds of nuisance activities/harassment besides crop raiding?

    If yes, what kinds?
    Biting [   ] Disease transmission [   ] Accidents [   ] others……….

14. What are the preventive methods that you are using to control?

    Guarded by man / woman / young / Children / Dog / Scarecrows / Noising / Fencing /   .   Poison / Fire cracker / Hunting / Others…………………………

15. Have you asked to forest officials for compensation or other solution?

    Yes [   ]   No [   ] Unknown [ ]

16.   What   will   be   the   suggestive   solution? …………………………………………………………..

17. What are the benefits from forest? Fuel wood/ fodder/ timber/cattle grazing/ Employment/ others……………

18. What do you think about the conservation of forest in your area?

    Beneficial [   ]   Harmful [   ] Unknown [   ]

19. What do you think about the wildlife of the forest?

    i) Should be protected   ii) Trans located   iii) Killed

Appendix – IV: Local market price of crops at Baglung Bazar.

S. N.	Crops	NRs Per Quintal (Average monetary value)
1	Maize	4000
2	Potato	5000
3	Millet	3800
4	Wheat	3500
5	Paddy	6500
6	Fruits	4500
7	Pulses	10000
8	Vegetables	6000

Appendix – V: Crop raiding rate of Assamese Macaque in study area.

Crops	Total land (ha)	Expected yield (Quintal)	Observed Yield (Quintal)	Loss (Quintal)	Loss NRs as per market	Loss Quintal / Ha
Maize	15.19	118.12	61.52	56.6	226400	3.72
Paddy	18.54	312.51	293.33	19.18	124670	1.03
Wheat	12.71	104.76	96.46	8.3	29050	0.65
Millet	4.13	64.81	51.74	13.07	49666	3.16
Potato	5.56	43.63	25.41	18.22	91100	3.27
Pulses	2.51	13.32	10.87	2.46	24600	0.98
Fruits	1.23	19.43	17.51	1.92	8640	1.56
Vegetables	1.31	11.71	10.91	0.8	4800	0.61
Total	**61.18**	**688.29**	**567.74**	**120.55**	**558926**	**14.98**