CHAPTER 1

INTRODUCTION

Birds are feathered bipeds. They belong to class Aves and subphylum Vertebrata. The most distinguishing character of birds is the possession of feathers and the forelimbs modified into wings. Birds descended 140 million years ago from the reptilian stock similar to that which produced dinosaurs, a bird-like creature, called *Archaeopteryx*. Nepal is a country endowed with varied floral and faunal resources with unique landscape which extend between 26°27' to 30°27' north latitude and 84°4' to 88°12' east longitude, has long been known as a naturalists' paradise. Nepal has a sharp climatic variation from subtropical to alpine within the short span of less than 200 km (from north to south). The altitude varies from about 60 m above the sea level in the south lowland to 8,848 m above the sea level in the north. The country possesses a high biodiversity considering its size. It has unique geographical location at the junction of two biogeographic regions, Palaearctic to the north and Oriental to the south, has resulted in an extraordinary assemblage of flora and fauna. Nepal has a remarkable diversity of habitats, ranging from bare rock and scrub in the alpine zone to tropical rainforest in the lowlands (Baral and Inskipp 2005). The present study is carried out in Gherabhir, Arghakhanchi district of Lumbini Zone in the mountain belt of Western Development Region of Nepal.

1.1 Nepalese Ornithology

Nepal is renowned for its high diversity of bird species. A total of 867 species have been recorded from Nepal which represent over eight percent of the world's known bird species (BCN 2010). A total of 35 globally threatened species of which six species are listed in ‘critically endangered’, four in ‘endangered’ and 25 in ‘vulnerable’ categories, 19 near threatened species and 15 restricted-range species are recorded in Nepal. Nine species of birds are listed under the protected species by Government of Nepal. As many as 130 breeding and wintering species (15% of Nepal's birds) are now considered nationally threatened. Habitat loss is the major threat to 86% of the birds at risk. Hunting, illegal trade and poisoning are other threats to birds in Nepal (BCN 2010).

1.2 Introduction to the Vulture

Vultures are medium to large sized scavenging birds, feeding mostly on the carcasses of dead animals and are found on every continent except Antarctica and Oceania (Del Hoyo et al 1994). Vultures play important role in maintain clean environment through rapid consumption of animal carcasses and human dead bodies in the form of sky burials within Nepal and Tibet, China. Vultures are the primary consumers of carrion in Asia and Africa, with an individual *Gyps* vulture consuming around 1 kg of tissue every three days (Mundy *et al.* 1992). They do safely disposing off dead animals and help in preventing the spread of zoonotic diseases. The loss of a major scavenger from the ecosystem will affect the balance between populations of other scavenging species and/or result in increase in putrefying carcasses. In the absence of other carcass disposal mechanisms (burial, burning, mechanical processing), the decline in vultures has resulted in an increase in the number of putrefying animal carcasses in rural areas. Populations of feral dogs, the main scavenging species in the absence of vultures, have increased within India (Indian Livestock Census 2003). Both increases in putrefying carcasses and changes in the scavenger populations also have associated disease risks for wildlife, livestock and humans, including the spread of rabies and livestock borne diseases like anthrax, tuberculosis and brucellosis (Prakash *et al*. 2003; Anderson *et al.* 2005).

A particular characteristic of many vultures is bald head and neck. This is because a feathered head would become spattered with blood and other fluids and thus will be difficult to keep clean. Physiologically the bare skin areas in Griffon vultures play an important role in thermo-regulation (Ward *et al.*, 2008).

1.2.2 Status of Vultures in Indian sub-continent

There are nine species of vultures recorded from Indian subcontinent of which five belongs to the genus *Gyps* (Prakash 1999). Four species of vultures in Asia are in grave danger of extinction across the Indian subcontinent (Table 1.1). Population of oriental White-rumped vulture, long-billed vulture and Slender- billed vulture have declined by more than 97% in India (Prakash *et al*. 2003) and Pakistan and annual rates of decline appear to be increasing. Due to these declines, all three species were

listed as critically endangered by IUCN 2000, which is highest category of endangerment. Further to this two more species Red-headed vulture and Egyptian vulture are listed as critically endangered and endangered respectively in 2007. Himalayan Griffon, Lammergeier and Egyptian vulture breed at higher elevation (Inskipp and Inskipp, 1991). White-rumped vultures and Slender-billed vultures are resident breeders of lowland Nepal.

Table 1.1: Status of vultures in Indian Sub-continent

SN	Species	Range Countries	Resident / Migratory	Conservation Status
1.	White-rumped vulture	Nep, Ind, Pak, Ban	Resident breeder	Critically Endangered
2.	Slender-billed vulture	Nep, Ind, Ban	Resident breeder	Critically Endangered
3.	Long-billed vulture	Ind, Pak	Resident breeder	Critically Endangered
4.	Himalayan griffon vulture	Nep, Ind, Pak	Resident breeder	unspecified
5.	Eurasian griffon vulture	Nep, Ind, Pak	Winter visitor	unspecified
6.	Red-headed vulture	Nep, Ind,	Resident breeder	Critically Endangered
7.	Egyptian vulture	Nep, Ind, Pak	Resident breeder	Endangered
8.	Cinerious vulture	Nep, Ind, Pak	Winter visitor	Near Threatened
9.	Lammergeir	Nep, Ind, Pak	Resident breeder	Least Concerned

(Nep = Nepal, Ind = India, Pak = Pakistan, Ban = Bangladesh)

(IUCN, 2000 and DNPWC/MoFSC/GoN, 2009)

1.2.3 Vulture Species in Nepal

Among nine vulture species of Indian sub-continent (Grimmett *et al.* 2000, Ramuseen and Parry 2000), eight species of vultures are found in Nepal that include four species of *Gyps* vulture i.e. White-rumped vulture *Gyps bengalensis*, Slender-billed vulture *Gyps tenuirostris*, Himalayan Griffon *Gyps himalayensis* and Eurasian

Griffon *Gyps fulvus* (BCN 2006). Other vulture species include Lammergeier *Gypaetus barbatus*, Egyptian Vulture *Neophron percnopterus*, Red-headed vulture *Sarcogyps calvus* and Cinerous vulture *Aegypius monachus*. The Cinerous vulture is winter visitor to Nepal. Long-billed *Gyps indicus* vulture is considered endemic to Indian and Pakistan (Rasmussen and Parry 2000) and has not been recorded from Nepal.

1.3.1 Cause of the Sudden Decline in Vultures Population

There has been catastrophic decline in the populations of three *Gyps* species of vultures in the Asia due to contamination of carcass with the veterinary drug Diclofenac, a non-steroidal anti-inflammatory drug, NSAIDs (Oaks *et al*. 2004, Cuthbert *et al*. 2006). Diclofenac is used for a variety of painful and inflammatory conditions in both veterinary and human medicine. Vultures that consume sufficient tissue from treated carcasses die from the effects of Diclofenac induced kidney failure, with clinical signs of visceral gout (Oaks et al. 2004, Swan et al. 2006a). These are exposed to Diclofenac when they feed on carcasses of livestock that have died within a few days of treatment and contain toxic residues of the drug (Oaks et al. 2004).

While Diclofenac is the main cause of vulture population decline, the other causes to some extent may be the habitat loss and scarcity of food. The Community Forest (CF) operational plans generally prescribe to remove old (selection felling), dying and diseased trees thereby opening the area for new regeneration. This might have some level of impact on the habitat of vulture. Similarly, people now a days, prefer to rear improved breed of livestock in limited number. These livestock are preferred to bury upon death. These changes in traditional behavior of people might have led to the scarcity of food on the other hand. Other sources of mortality include poisoning through feeding on deliberately poisoned carcasses that are placed out to kill other animals (e.g. dogs), felling of nesting trees, disturbance and destruction of nests to prevent vultures nesting above agricultural land and dwellings, exclusion from feeding sites through disturbance or alternative carcass disposal methods (burial), and direct persecution and hunting of vultures either for medicinal purposes. (DNPWC/MoFSC/GoN 2009).

1.3.2 Conservation Practices

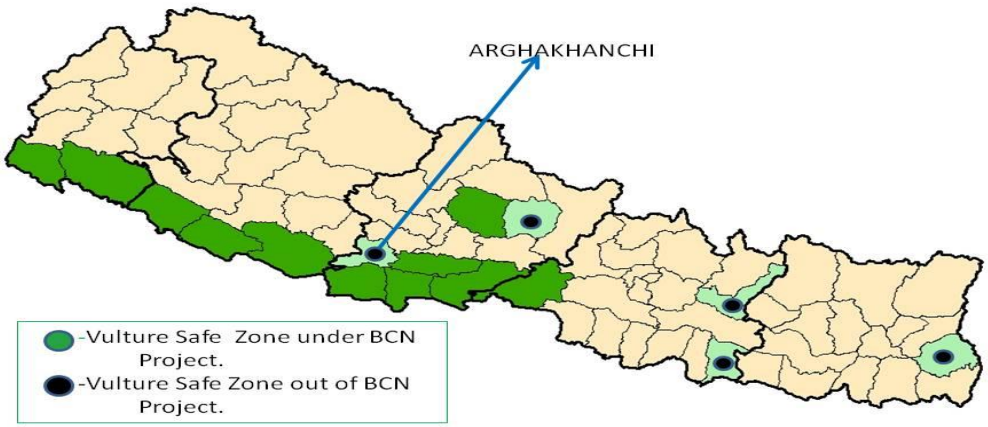
Ban on veterinary Diclofenac, exchange of Diclofenac with Meloxicam, establishment of captive breeding center, Safe Feeding Sites (Jatayu/Vulture restaurant), Vulture Safe Zones (VSZ), monitoring of vulture colonies and raising conservation awareness are some strategies to save the Critically Endangered vultures from the brink of imminent extinction. For the conservation of vulture in long term, India has prepared the 'Action plan for vulture conservation in India 2006' and in Nepal 'Vulture conservation action plan for Nepal 2009-2013' has been endorsed with main objectives to prevent the extinction of vulture species by ensuring re-introduction, safe food supply, maintenance of suitable habitat and better understanding of the ecological importance of these birds in Nepal (DNPWC/MoFSC/GoN 2009).

1.3.2.1 In-situ Conservation

In-situ conservation and availability of safe food, in combination with conservation advocacy and awareness programs, plays an important role to help ensure that at least some of the small remaining vulture populations remain extant. Two in-situ measures have been adopted to reduce mortality in the wild: **a**) the exchange of Diclofenac with alternative safe drug the Meloxicam in areas surrounding natural breeding colonies and **b**) provision of safe food near the breeding colony areas (DNPWC/MoFSC/GoN 2009)

Nepal is leading in-situ conservation in South Asia through innovative approaches such as community based 'Vulture / Jatayu Restaurants and the declaration of 'Vulture Safe Zone' (Fig 1). The VSZ approach primarily targets to create a safe environment for Vultures, free from the veterinary drug Diclofenac, supported by intensive awareness, advocacy, scientific research and nest site conservation. The Government of Nepal has banned the manufacture and import of veterinary Diclofenac in June 2006 and promoted Meloxicam as a vulture-safe alternative. The safe feeding site (Jatayu Restaurant) has now been implemented successfully in 6 sites in Nepal such as i) Pithauli and Kawasoti VDC of Nawalparasi, ii) Gaidahwa Lake, Lumbini, Rupandehi, iii) Lalmatiya VDC of Dang, iv) Bijauri

VDC of Dang,v) Samaiji Community Forest of Beli VDC Kailali and vi) Ghachok VDC of Kaski (BCN 2010).



(Source:- Bird Conservation Nepal)

Fig 1. Vulture Safe Zone area of Nepal.

1.3.2.2 Ex-situ Conservation

Realizing the rapid decline (25-48% per annum) of wild populations (Green et al. 2004) and urgent need to establish breeding centers, Vulture Conservation Breeding Centers (VCBC) were established by the Bombay Natural History Society (BNHS) and Haryana Forest Department at Pinjore, Haryana State, India. Two additional centers have been established at Raja Bhat Khawa (Buxa Tiger Reserve), West Bengal, in 2006, and Rani Forest in Assam State in 2007. These three centers currently hold 226 Vultures of critically endangered species. Actions to establish a VCBC have also been initiated in Pakistan and this centre currently holds around 11 birds. The Department of National Parks and Wildlife Conservation (DNPWC), Nepal, in collaboration with National Trust for Nature Conservation (NTNC), Bird Conservation Nepal (BCN), Royal Society for the Protection of Birds (RSPB) and Zoological Society London (ZSL) has established a VCBC at Kasara, Chitwan National Park. The centre currently has two holding aviaries and a breeding aviary that hold 59 individuals of critically endangered white-rumped Vultures (Ananda Chaudhary Pers.Comm, 2011).

1.4 ECOLOGY

1.4.1 Ecology of Himalayan Griffon

Adult Himalayan Griffons are 103–110cm (41-43inches) long, have a wingspan of 260–289cm (102-114inches) across the wings and weigh 8–12 kg (18-26.4 lbs). They are the second largest Old World Vulture, behind only the Cinereous Vulture in size (BirdLife International 2004). It is a huge pale colored Vulture. It is heaviest breeding vulture in Nepal which resembles Eurasian Griffon but more pale white to sandy buff, larger and wider with yellowish beak. Young bird dark and streaked differs from other young Griffons by large size, higher altitude and associated adults. It produces grunts, screeches gooses, like clamor and hisses sounds (Shrestha 2001).

This species has an extremely large range, and hence does not approach the thresholds for Vulnerable under the population size criterion (<10,000 mature individuals with a continuing decline estimated to be >10% in ten years or three generations, or with a specified population structure). For these reasons the species is evaluated as 'Least Concern' (Birdlife International, 2009 and IUCN 2010). This species has been recorded from the Indomalayan/Palearctic realms in the high altitude of Central Asian republics and Himalayas from Afghanistan, northern Pakistan, northern India (Assam) through southern Tibet and Nepal to Bhutan, and central China to Singapore. This species occurs mainly in mountainous portions of the Himalayas, although juveniles winter in lowland portions of the Indian subcontinent (Global Raptor Information Network 2010). Distribution is normally between 600 to 2500 m altitudes, foraging up to 4500 m and ever higher (Ali and Ripley 1968).

The breeding season is chiefly January to March or April. Nest is large rough and untidy pad of sticks and rubbish placed on the ledge of a cliff, often inaccessible. Egg is singleton; white, usually unmarked sometimes handsomely blotched with pale reddish to deep reddish brown. Share of the sexes in the nesting chores, and period of incubation is about 50 days (Ali and Ripley 1968).

1.4.2 Ecology of Egyptian vulture

The adult Egyptian vulture measures 47–70 cm (21–28 inches) from the point of the beak to the extremity of the tail feathers and 1.5-1.7 m (5-5.6 ft) between the tips of the wings. It weighs about 2 kilograms (4.4 lbs). The Egyptian Vulture is a small old world vulture, found widely distributed from southwestern Europe and northern Africa to southern Asia (Birdlife international 2009). It is the only living member of the genus *Neophron*. The Egyptian vulture is an opportunist and will feed on a huge range of food that it encounters. Carrion comprises the majority of its diet, including dead birds, small mammals, livestock and large wild animals including mammal faeces especially human beings (Whistler 1994). Due to their small size, they aren't often seen at large carcasses, being unable to fight the larger vultures for the food. Instead they will arrive at a carcass after the larger vultures have left, and will use their smaller beaks to pick the remaining meat from the bones. While other vulture species are seen in large groups, Egyptian vultures tend to be seen either solitary or in pairs. Often a mated pair may remain together outside of the nesting period, a trait unusual for raptors (Birdlife international 2009). The adult plumage is white, with black flight feathers in the wings. The feathers on the neck are long and form a hackle. The facial skin is yellow and crop is unfeathered. Young birds are blackish or chocolate brown with black and white patches.

Their habitat is mainly in the dry plains and nest mainly in arid and rocky hill regions (Photo plate 2 E). Interestingly the successful nesting of Egyptian vulture is also recorded in trees in Nawalparashi district Nepal (Chaudhary *et. al* 2010). The nesting season is February to April and both parents incubate the eggs and feed the chicks until they fledge at the age of 70 to 85 days. Egyptian vultures become sexually mature at four to five years of age and are known to live for up to 37 years in captivity (Grandy *et al* 2009). The number of egg is two and hatch after about 42 days. The second chick may hatch after an interval of 3 to 5 days or more. It sometimes uses stones to break the eggs of birds making it one of the few birds that make use of tools. Birds that breed in the temperate region migrate south in winter while tropical populations are relatively sedentary. Populations of this species have declined in the 20th Century and some isolated island forms are particularly endangered (IUCN 2010).

1.4.3 Ecology of Lammergeier

The adult Lammergeier is 95–125 cm (37–49 in) long with a wingspan of 275–308 cm (108–121 inches) (10 feet), and is quite unlike most other vultures (Photo plate 3 G) in flight due to its large, narrow wings and long, wedge-shaped tail feathers. It weighs 4.5–7.5 kg (9.9–17 lb). It is the only member of the genus Gypaetus. The diet of Lammergeir mainly consists of bone remains from the wild and domestic ungulates (Hiraldo *et al.* 1997, Margalida *et al.* 2007). The bird throws the larger bones from a height on to rocky slopes in order to break them, and immediately descends after them in a characteristic spiral. The bird then eats the bone pieces starting with the bone marrow. The smaller bones are swallowed whole, as the bird's gastric fluids are so strong that they can digest bone easily. Its range in Asia includes the mountains of Afghanistan, Baluchistan, Tibetan Plateau, Mongolia and throughout the Himalayas from the extreme north-west across to Arunachal of India in east (Kaul & Ahmed 1992, Ferguson-Lees & Christie 2001). As such the species is listed as least concern by the IUCN and Birdlife International 2008, although there is some evidence of decline. It is recorded in almost all protected areas of the country's mountains (IUCN Nepal 2008) and it's status there has been described as 'fairly common' to 'common' (Girmmet *et al.* 2000). The adult has a buff-yellow body and head, the latter with the black moustaches which give this species its alternative name. The tail feathers and wings are grey. The juvenile bird is dark all over, and takes five years to reach full maturity.

The habitat is exclusively mountainous terrain (500–4,000 m/1,600–13,000 ft). The Bearded vulture defends huge territories in which the pair feeds and breeds (Photo plate 3 F). The territory size is about 200-400 km^2 and therefore the distribution of the species is rather sparse. The bearded vulture is monogamous. It forms a pair between November and December and eggs are laid between December and February. They usually lay two eggs which hatch between 53 and 58 days, but the 2nd egg, which is smaller, is a form of biological insurance and the chick is usually killed by its older sibling in the first weeks after hatching (WWF bearded vulture-2010). After hatching the young spend 106 to 130 days in the nest before fledging. Typically, the Lammergeier nests in caves and on ledges and rock outcrops.

1.5 Statement of the Problem

Nepal contains several mountain cliffs along Mahabharat range and is suitable habitat for Himalayan Griffon, Egyptian vulture, Lammergeier and Red-headed vulture. Gherabhir Arghakhanchi is habitat of vultures still have not been recorded in Nepal. So, there is necessity to assess by the regular survey in these areas and record them. Unless a comprehensive study of the population status and existing threats is conducted, no reasonable management recommendation and conservation action plan can be established. There is necessity of regular monitoring to save these majestic scavenging birds from extinction.

1.6 Objectives

The primary objective of this study was to collect the information about vultures in Gherabhir which is newly discovered habitat in Nepal.

The major objectives of study were:

1. To Estimate the Population Size of Himalayan Griffon, Egyptian vulture and Lammergeir in Gherabhir of Arghakhanchi, Nepal.
2. To study the breeding success of Himalayan Griffon, Egyptian vulture and Lammergeier.
3. To survey NSAIDs, current trend on their use and prevailing stocks in the Agro-vet shops of Arghakhanchi district.
4. To asses public awareness for vulture conservation in the study area.

1.7 Research Hypothesis

There is significant difference in the flock size of vultures in different months at Gherabhir Arghakhanchi.

1.8 Justification

Vultures are nature's most efficient scavengers and are at the end of food chain. Vultures help to maintain the clean sanitation of our village and towns where we live. They help prevent the outbreaks of epidemics and reduce the foul odor by cleaning the carcasses before they putrefy. Therefore it is vital to maintain a healthy population of this ecologically important species of birds.

The population of vulture is declining drastically throughout the world. Within Nepal, India and Pakistan vulture populations have undergone dramatic declines in numbers since the mid 1990s, with declines in excess of 97% for three resident species (white-rumped, slender-billed and long-billed vulture). Monitoring of vultures in Nepal indicates declines of a similar magnitude with a >91% decrease in numbers from 1995 to 2011 (BCN unpublished data).

Hence it is the high time to be conscious about the problem so that we can have timely knowledge to make the suitable environment for the continuity of vulture's race. Most of the researches were done in the protected area system (PAS), but the problem is that most vulture colonies lie outside the PAS. In this context study of Himalayan Griffon, Egyptian vulture and Lammergeir is essential and of utmost importance as indicator of Mountain ecosystem. Gherabhir is newly discovered vulture habitat of Nepal and interestingly utilized by three different species of vultures. This research is important because of the nesting and breeding habits of Himalayan Griffon, Egyptian vulture and Lammergeier will be explored in new site.

1.9 Limitation of the Study

i. The study was started from the January so the pre breeding activities could not be recorded.

ii. Actual cause mortality of dead vulture could not examine.

iii. Steep slope of cliff and environmental complexity like presence of fog in early mornings of winter disturbed the clear visibility of vultures and their nests through binoculars.

iv. A east facing section of the cliff is not accessible to observe thus could not record the possible nest located there.

CHAPTER 2

LITERATURE REVIEW

2.1.1 Himalayan Griffon

Karmacharya (2010) studied the breeding success of Himalayan Griffon in Khodpe Baitadi district and recorded total of 11 occupied nests. Among 4 active nests (having eggs) only 3 nests were productive (fledged chicks). Based on active nests as primary unit the breeding success was 75% while based on occupied nest as primary unit the breeding success was 27%. Altogether 8 nests were unsuccessful. Out of 8 unsuccessful nests, 7 (i.e. 88%) failed during egg laying and 1 (i.e. 12%) during incubation period.

Acharya et al. (2009) studied population trends of Himalayan Griffon in the mountainous region of Upper Mustang, Nepal, which is an important breeding area for the species. Vultures were surveyed in 2002, 2004 and 2005 along 188 km of transects, and observing numbers of birds at breeding colonies. The number of birds recorded per day and per kilometer of transect declined by 67% and 70% respectively over the period of study. The numbers of active nests were declined by 84% from 2002 to 2005.

Li and Kasorndorkbua (2008) reported the Himalayan Griffon, a large scavenging raptor previously known to be resident to the Sino-Himalayas and Central Asia, is increasingly being recorded throughout South-East Asia. It now been recorded in six South-East Asian countries and is represented by a total of over 30 documented records, mostly of immature birds. The causes for the increase in sightings are unknown, but has been speculated that climate change, deforestation and hunting, coupled with natural patterns of post-fledging dispersal and navigational inexperience may be contributing to this change.

Virani et al. (2008) conducted the Himalayan Vultures (*G. himalayensis*) survey in Nepal between 2001and 2006. They found no evidence that their populations are facing the same magnitude of decline or threat as those of the other three species of lowland *Gyps* Vultures. They suggested that Himalayan Vultures may not be experiencing the same degree of Diclofenac poisoning for a number of reasons,

including possibly different foraging behaviors by Himalayan Vultures compares to the other *Gyps* Vultures, and/or relative lower use of Diclofenac in the highland regions.

Katzner *et al*. (2004) conducted observations with 10x40 binoculars on 4 August 2002, from several points from the cliff and recorded adjacent nesting by Lammergeier *Gypaetus barbatus* and Himalayan Griffon *Gyps himalayensis* on the Tibetan Plateau, China.

2.1.2 Egyptian Vulture

Prakash et al., 2003 carried out the counts of Egyptian and red-headed vultures in 13 Indian protected areas between 1991 and 1993 were repeated in 2000 and revealed a significant decline of around 48% for red-headed vulture and a non-significant decrease of 22% for Egyptian vulture.

Cuthbert *et al*., 2000, 2002 and 2003 studied the rapid population decline of Egyptian and Red-headed vulture in India. The Egyptian vulture population was estimated to decline by 35% per year (95% CL 24–44%) whereas that of the red-headed vulture declined by 41% per year (95% CL 26–53%).

Hernández M. *and* Margalida A.(2009) studied the poison-related mortality effects in the endangered Egyptian vulture population in Spain. A total of 211 poisoning incidents registered over the period 1990–2007 and affecting 294 Egyptian vultures were studied. Poison-related mortality mainly affected the birds on an individual level, with low numbers of individuals being found in each incident (mean 1.39) with 94.9% being adults. Deaths were largely recorded (81.8%) during the breeding season, with mortality peaking during May and June (52.1%). In contrast with other raptor species, a high proportion of adult individuals (74.2%) were found in the nest or its surroundings. The illegal use of poison to control predators was the main cause of mortality (93.8%), and particularly in small hunting reserves (74.9%).

Gautam and Baral, 2009 studied the Population Status and Breeding Success of Three Endangered vulture Species in the Pokhara Valley, Kaski, Nepal. The observed maximum number of Egyptian vultures increases from 52 to 75 in a year. Of seven nests of Egyptian vultures, only three nests had chicks this year. The breeding success of Egyptian vultures was calculated as 42.85% in the breeding season 2009.

2.1.3 Lammergeier

Donazar *et.al* (1983) studied the factors that influence the selection of nesting sites breeding density and breeding success of Lammergeier in Pyrenees North Spain by means of statistical model of environmental factors measured on 1:50,000 maps. The nest site selection model obtained indicated that the Lammergeier select cliff in rugged areas at an average altitude, far from other breeding pairs and far from village.

Margalida *et.al* (1999) studied the nest use and interspecific relationships in the Bearded vulture for nest location in the eastern Pyrenees (NE Spain) and their influence on breeding success. A total of 40% (n = 70) of Bearded Vulture nests were usurped (expulsions) by other species, the Griffon Vulture being the species which occupied most nests (81%). The frequency of nest changes, the distance between nests and the productivities obtained do not differ significantly between territories with expulsions (60%) and those which still have all their nests available (40%).

Bertran *et.al* (2002) studied territorial behaviour during the breeding season in four Bearded vulture pairs in the eastern Pyrenees of northeastern Spain. A total of 121 attacks on Griffon Vultures were recorded, 98 of which (80.9%) occurred at a distance of less than 300 m from a Bearded Vulture nest. A total of 115 (95%) of all attacks consisted of an aerial chase without physical contact, and in six (5%) there was physical aggression including blows from the talons.

Margalida et.al (2008) studied the Sources of variation in mortality of the Bearded vulture Gypaetus barbatus in Europe. They analyze the causes of mortality for the Bearded vulture in Europe. Shooting (31%), intentional poisoning (26%), collision (18%) and unintentional poisoning (12%) were the most important causes of mortality. No differences were found between sexes or age classes (non adults and adults) for any of the causes of death.

Acharya *et.al* (2010) studied the status of Lammergeier in Upper Muatang, Nepal and recorded total of 67, 49, 21 and 13 in the years 2002, 2004, 2005 and 2008 respectively. A statistically significant decline was observed for the total numbers of birds along on all four transects combined, with an estimated multiplicative decline rate of 25.0% a year.

2.2 NSAIDs

Swarup et al. (2007) tested the safety of the NSAID Meloxicam on the oriental white-rumped vulture, long-billed Vulture and a range of other scavenging birds in India (Egyptian vulture, cattle egret, house crow, large-billed crow and common mynah). All 31 *Gyps* vultures and the 20 other scavenging birds given Meloxicam were survived. Feeding behaviour remained normal and there were no significant differences between the treated and control groups in body mass, or the blood haematology and biochemistry parameters monitored, including those known to be affected by Diclofenac.

Cuthbert et al. (2007) conducted the surveys of veterinarians' and zoos' documents about the treatment of over 870 scavenging birds from 79 species. As well as Diclofenac, Carprofen and Flunixin were associated with mortality, with deaths observed in 13 and 30% of cases, respectively. Mortality was also found following treatment with Ibuprofen and Phenylbutazone. In contrast, there were no reported mortalities for the NSAID Meloxicam. The relative safety of Meloxicam supports other studies indicating the suitability of this NSAID to replace Diclofenac in Asia.

Prakash et al. (2005) gave the evidence to support that Diclofenac caused catastrophic vulture population decline using the result of the recent papers along with the pioneering work in Pakistan, conclusively showed that Diclofenac was responsible for the catastrophic mortality amongst vultures throughout the Indian subcontinent.

Green et al. (2004) studied the Diclofenac poisoning as a cause of vulture population decline across the Indian subcontinent. Surveys indicate annual rate of decline of 22-50% for WRV, SBV during 2000-2003 by collection of dead vulture carcasses, post mortem examinations and Diclofenac analysis.

Oaks et al. (2004) studied Diclofenac residues as the cause of Vulture population decline in Pakistan. Between 2000 to 2003 high annual adult and sub-adult mortality (5-86%) and resulting population declines (34-95%) were associated with renal failure and visceral gout in 16 WRV colonies in Pakistan.

Shultz et al. (2004) showed that a high proportion of *Gyps bengalensis* and *G. indicus* found dead or dying in a much larger area of India and Nepal also have residues of Diclofenac and visceral gout, a post-mortem finding that is strongly associated with Diclofenac contamination in both species.

CHAPTER 3

STUDY AREA

3.1 Physical Description

Arghakhanchi lies in the western region of Nepal and is the smallest district of Lumbini Zone. The district covers a total of 1,193 km² area with the elevation ranging 305-2515 masl. Geographically the district is situated between 27˚45' North to 28˚6 North latitude and 80˚45" East to 83˚23" East longitude. It is surrounded by six districts; Palpa towards east, Pyuthan and Dang towards west, Gulmi towards north and Kapilbastu and Rupandehi towards south (Fig. 2). Its about 68% of the total area lies in the Mahabharat Range, and the remaining lies in the Siwalik Region, while 54.37% of its total area is covered by forest. The land use pattern of the district is cultivated land 24,244 hectare, not cultivated land 15,702 hectare, pasture land 9,742 hectare, forest 73,134 hectare and other land 4,550 hectare. Total population of the district is 2,08,1391 and population density per square kilometer is 175 (2001 census).

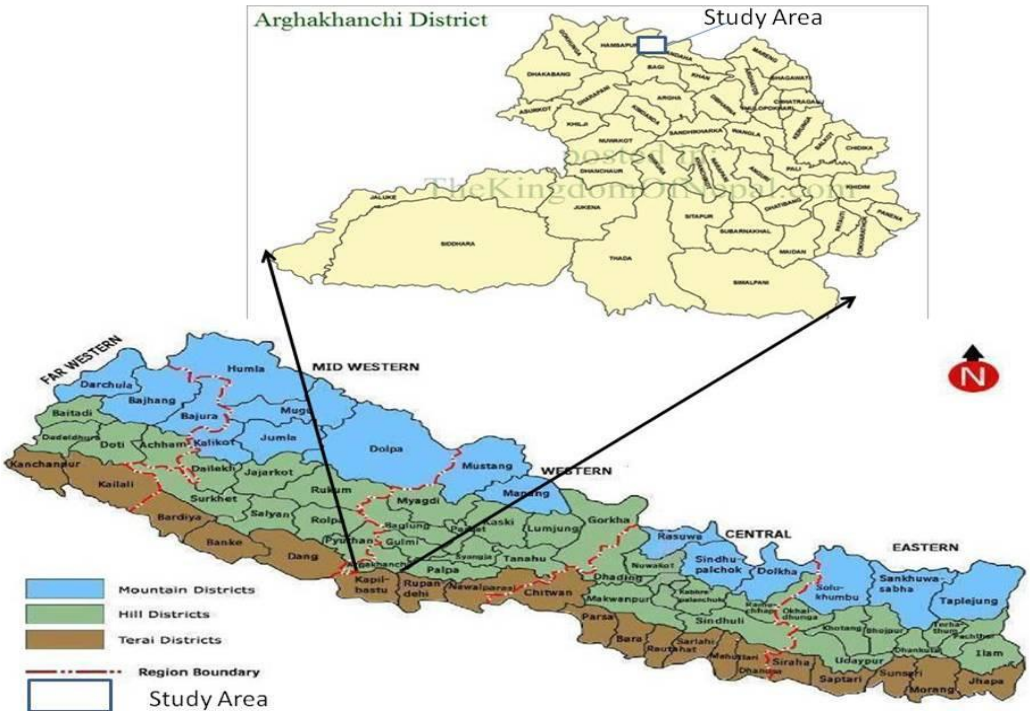


Fig: 2. Map of Nepal Showing Arghakhanchi District and Study Area.

Gherabhir is rocky mountain (Photo plate 1 A) elevated about 1,732 m to 2,200 m from sea level and lies in the junction of Hansapur VDC-4 and Khanadaha VDC-6 (Fig 3). South facing cliff slope of Gherabhir is popularly known as the vulture habitats since historic time. Geographically the cliff is situated between 28°03'35.6" North to 28°03'50.9" North latitude and 83°05'18.4" East to 83°05'59.6" East longitude. The climatic condition ranges from sub tropical to temperate, the south slope vulture nesting site is dry and touch with direct sun light.

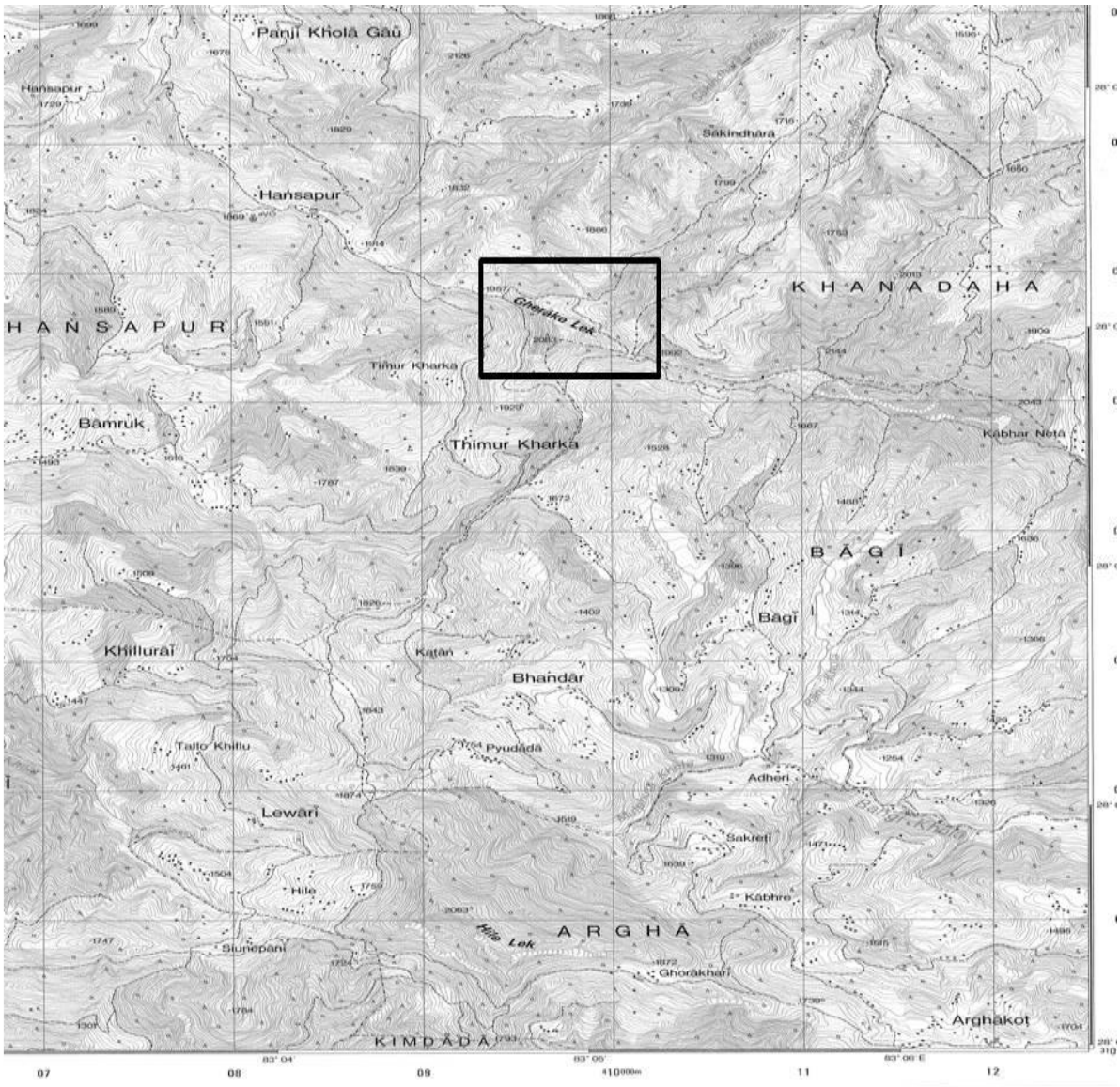


Fig: 3. Topographic Map of Study Area.

3.2 Climate:- The climatic condition of district is ranges from sub-tropical to temperate. The maximum temperature of district is 32°C and minimum temperature is 6.5°C. The yearly average rainfall of district is 2200 mm and relative humidity is 74%. In summer days are quite hot and in winter are relatively so cold. The climatic condition recording station is Khanchikot lies at elevation 1760 m. The mean maximum temperature is 21.64° C with maximum temperature 25.2° C recorded in April 2009. The mean minimum temperature of district is 13.3 with the minimum temperature 7 ° C recorded in December 2009 (Fig 4).

The monsoon starts from May and reaches peak in August and continues to late October. The mean annual precipitation was estimated to be 115.19 mm during 2009. The maximum rain fall was recorded to be 526.8 mm in August and the no precipitation was recorded in January 2009 (Fig. 5).

The relative humidity of district is moderate. The mean relative humidity during morning is 66.79% and that of during evening is 71.93%. Its maximum value in the morning was found to be 94.1% in August and in the evening was found to be 92.8% in August 2009 (Fig. 6).

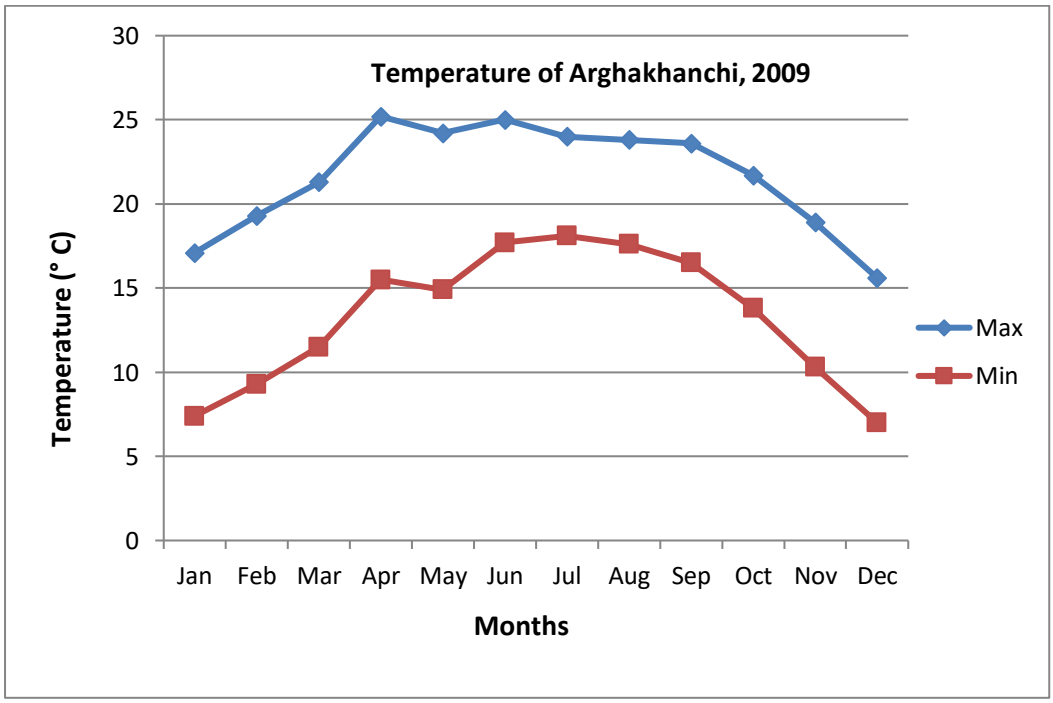


Fig. 4. Monthly maximum and minimum temperature of Arghakhanchi in 2009.

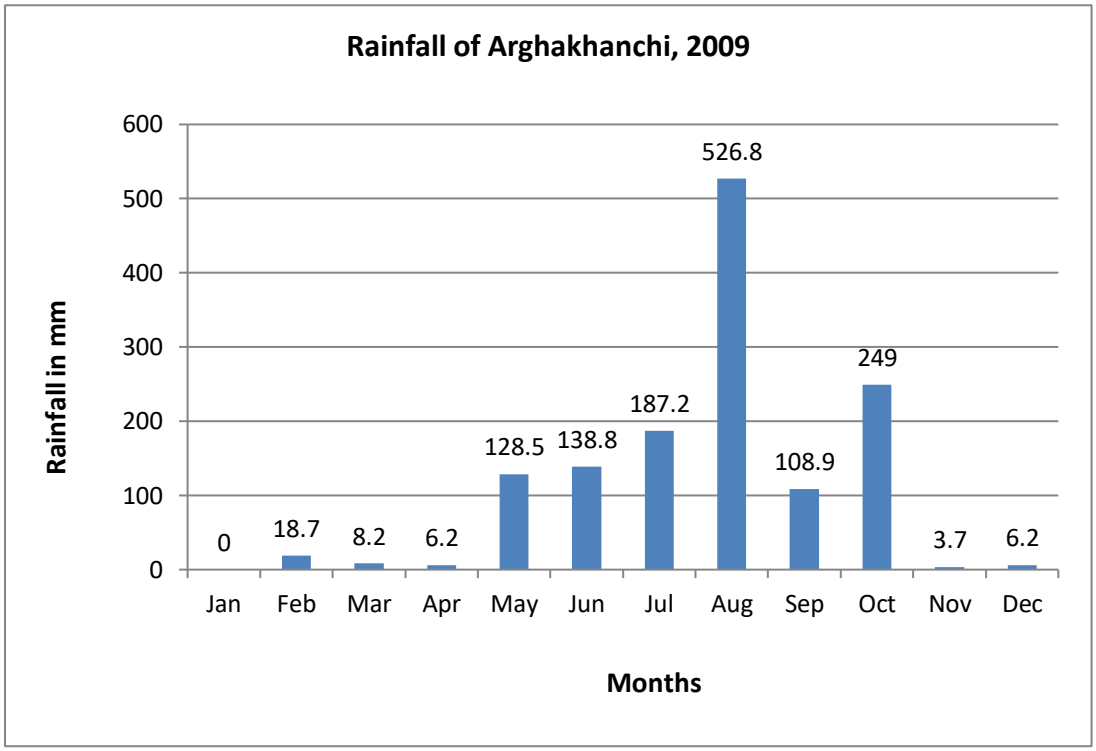


Fig. 5. Monthly rainfall of Arghakhanchi in 2009.

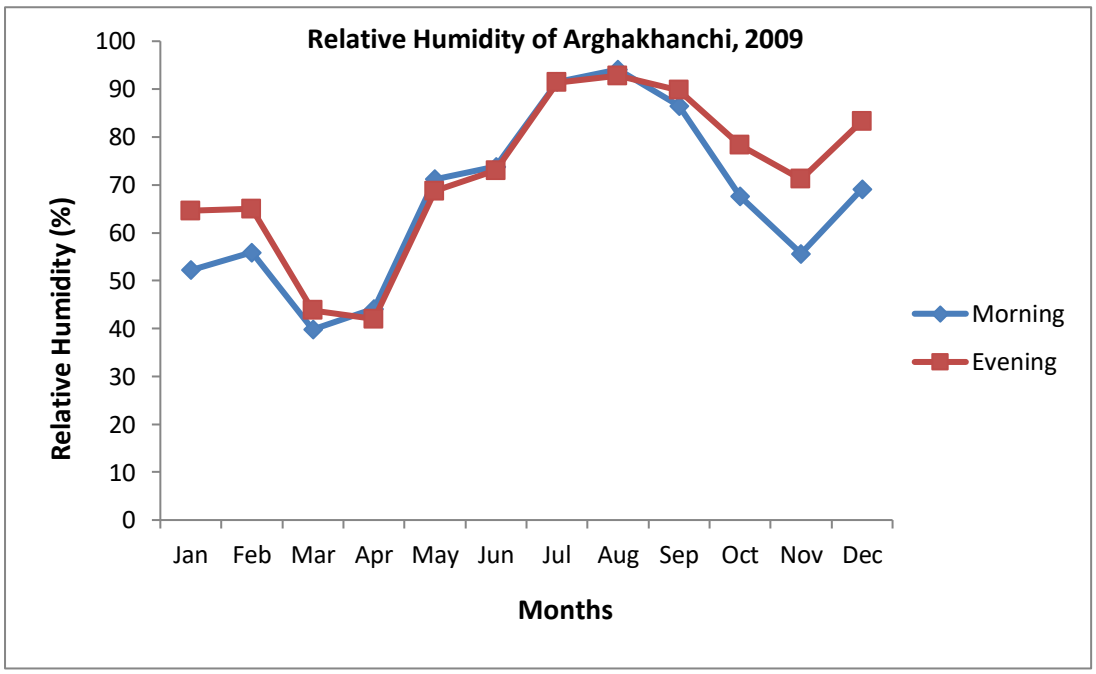


Fig. 6. Monthly relative humidity of Arghakhanchi in 2009.

(Source: Department of Hydrology and Meteorology, GON, 2011).

3.3 Flora:- Gherabhir consists of diverse vegetation types comprising subtropical and temperate forest. The southern part and northern part of Gherabhir consist of two different forest ecosystems. Southern rocky cliff consists of different types of dry habituated plants like Cactus and most of the part is covered by grasslands. In the months of January and February local people collect grasses for their Livestock. Northern part is covering by bushy shadow loving plants dominated by Rhododendron and Zanthoxylum, Fir, Oak *Quercus* species, Birch *Betula* species (Paiyun, Bhoj patra). In the lower altitudes (1000-1500m) subtropical vegetation dominates the landscape. Forest mainly consists of Montane Sal *Shorea robusta*, Pine *Pinus rouxbergi, Catrius wallichii*, Kafal *Myrica esculenta*, Saj *Terminalia* species and Alder *Alnus nepalensis* (Utis) species.

3.4 Fauna:- The southern unreachable cliff is important habitat for Raptors. Besides three vultures Himalayan Griffon, Egyptian and Lammergeier there are also found other Raptors like Critically endangered Red-headed vulture, Globally threatened Lesser Kestrel (*Falco naumanni*), common Kestrel (*Falco tinnunculus*), Peregrine Falcon (*Falco peregrines*), Laggar Falcon (*Falco jugger*), Bonelli's Eagle (*Hieraaetus fasciatus*), Black Kite (*Milvus migrans*), Crested serpent eagle (*Spilornis cheela*), common buzzard (*Buteo buteo*) etc. The habitat is important for pheasants. Cheer pheasant (*Catreus wallichii*), vulnerable and Nepal Governments protected species (Baral and Inskipp 2004) is also recorded from there. Chukar (*Alectoris Chukar*), Black Francolin (*Francolinus francolinus)*, Kalij pheasant (*Lophura leucomelanos*), Woodpecker, Jungle Crow, Bulbuls, Cuckoo, Asian koel etc. are also recorded from Gherabhir. The area has potential to be listed as Important Bird Area (IBA) of Nepal.

Mammals including Common Langur, Rhesus monkey, Common Mongoose, common Leopard, Jungle cat, fox, Bats, Barking Deer, Golden jackal etc are found in that area. The area is also supported by different species of butterflies, moths, insects, fishes, amphibians and reptiles.

CHAPTER 4

RESEARCH METHODS

4.1 Preliminary Survey

Different reports and journal papers were studied at pre-survey period as references and bird experts were consulted to discuss on data generation methods and issues on Himalayan Griffon, Egyptian vulture and Lammergeier. Libraries were searched on the subject matter along with the internet browsing. Preliminary survey was carried out in Arghakhanchi during November 3rd and 4th, 2009 around the Gherabhir and its vicinity to locate the nesting and roosting sites of vultures. The fieldwork was conducted from dawn to dusk.

After the experiences of preliminary survey, the study was concentrated in the cliff of Gherabhir, Hansapur and Khanadaha VDC, Arghakhanchi from January 2010 to June 2010.

4.2 Absolute Count

Total count of vultures was done in their nesting and roosting sites and maximum number obtained was noted (Annex 1). All the roosting and nesting vultures were monitored in the morning hours (07:00 AM to 10:30 AM, this is the time when they come from their nests for basking under the sunlight and fly in the sky over their nests then they go for searching the food) and in the evening hours (04:00 PM to 06:30 PM, this is the time when they return to their nest and fly in the sky around their nests). Potential nesting and roosting sites were visited during day time when observation in the main sites were omitted. It was already practiced and found suitable for such research.

4.2 Nest Census

In order to study breeding success breeding season of 2010 was taken into account for Himalayan Griffon, Egyptian vulture and Lammergeier. During the period nests were counted and nest occupancies were recorded (Annex 2). The nest were

identified on the basis of the presence of nesting birds or fresh white dropping on the nest rim and nesting ledge, or fresh dropping on the rock cliffs underneath the nesting sites. According to Postupalsky (1974) an active nest is the one in which eggs had been laid, an occupied nest is the one in which eggs have not been laid but some nest building activity must have taken place. A nest from which a chick fledged is termed as 'successful or productive nest'. The geographic position and crude height of nests on cliff were recorded with the help of GPS from nearest accessible point**.** Nests monitoring were made every month to assess the nest status and breeding success.

4.3 Questionnaire Survey

Questionnaire survey was done for the local people to acquire their experiences on the vultures and information were collected from Agro-vet shops (veterinary pharmacies) and veterinary professionals of different VDCs regarding the status of Non-Steroidal Anti-Inflammatory Drugs (NSAIDs) in the market and the effectiveness of Diclofenac replacement by Meloxicam. A form adapted from BCN vulture conservation programme was used for surveying.

4.4 Community Outreach Education Programs

Community outreach and conservation education programs were launched for the local villagers, school children, staffs and veterinary professionals regarding the role of vultures in nature and cause of their decline. Poster, pamphlets and brochures were also distributed to the community people that were printed by BCN displaying the roles of vultures in nature and importance to save them.

4.5 Data Analysis

4.5.1 Population Size

The population size of Himalayan Griffon, Egyptian vulture, Lammergeier, White-rumped vulture and Red-headed vulture was determined using Jacknife technique (Rodgers, 1991). This method assumes that with repeated counts theoretically there is the probability of counting all the animals in the area at one time. This method requires at least five repeated absolute counts and uses the difference between the highest count 'n_{max}' and the second highest count 'n_{max-1}', to calculate population size (N).

The estimated total number,

$$N = 2n_{max} - n_{max-1}$$

(at no immigration or emigration)

4.5.2 Breeding Success

Breeding success of Himalayan Griffon, Egyptian and Lammergeier was determined using following formula

$$\text{Breeding Success} = \frac{\text{productive nest}}{\text{active nest}} \times 100$$

4.5.3 Chi Square($\chi 2$)-test

This test is used to find the significant difference in the flock size of Himalayan Griffon, Egyptian and Lammergeier in different months. It is given by the formula.

$$\chi 2 = \sum (O - E) 2/E$$

Where, O= Observed frequency,

E= Expected frequency.

CHAPTER 5

RESULTS

5.1 Fieldwork Efforts

The preliminary field visit was done in the month November to identify the nesting habitat of vultures. A total of 27 days were spent in the study area starting from November 2009 to June 2010. On average 7 hours were spent in the field per day (Annex 1). Repeated surveys were made to estimate population size. One local field assistant was selected and trained in January 2010 to monitor nests monthly basis when principal investigator is out of field. During the fieldwork local villagers, school children and local veterinarians and para-veterinarians of Hansapur and Khanadaha were also mobilized.

5.2 Population Status

Using Jacknife technique estimated the population size of vultures in study area was found to be 77 individuals for 2010 field season. Among them Himalayan Griffons were estimated to be 58, Egyptian vultures were 11 and Lammergeier were 6 in number. The white-rumped vultures were estimated to be 11. A minimum of 53 vultures were recorded in March while a maximum of 76 Vultures were recorded in May. The average flock size of vultures recorded was 64.71 with Standard Deviation (S.D.) 7.3 (Table 3).

Table 3. Flock size of vultures in Gherabhir, Arghakhanchi.

S N	Date (2010)	No. of vultures observed	Average Flock size	Standard Deviation (S D)
1.	5th January	67	64.71	7.31
	27th January	62		
2.	17th February	58		
3.	16th March	53		
4.	13th April	65		
5.	23rd May	76		
6.	6th June	72		
Total	**January-June**	**453**	**64.71**	**7.31**

5.3 Species of Vultures

During the study period five species of vultures including Himalayan Griffon, Egyptian vulture and Lammergeier, with critically endangered Oriental white-rumped and Red-headed vulture were recorded. Red-headed vultures were not recorded in the months February and May (Annex 2). Red-headed vulture is also cliff breeding vulture of Nepal and mostly found in that habitat. Nesting site for this species was not identified during the study.

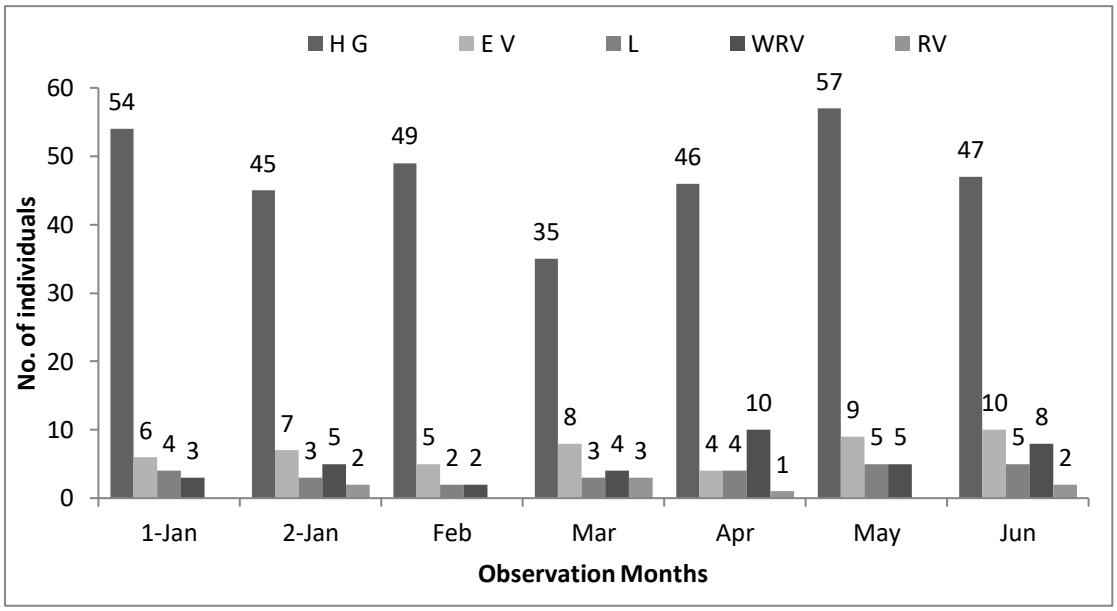


Fig:- 7. Species of Vultures in Gherabhir, Arghakhanchi.

5.4 Nest Census

In the breeding period of 2010 a total 33 nests of three different species of vultures were recorded. Among them 28 nests were by Himalayan Griffon, 3 by Egyptian vulture and two by Lammergeier. The Gherabhir cliff area was divided in to 8 plots according to observation point to monitor the nests (Annex 3). Himalayan Griffons were dominant species in Gherabhir by number of individuals as well as the number of nests. In the cliff opposite of Gherabhir there were no nest but several new and old droppings were recorded that may be the roosting sites.

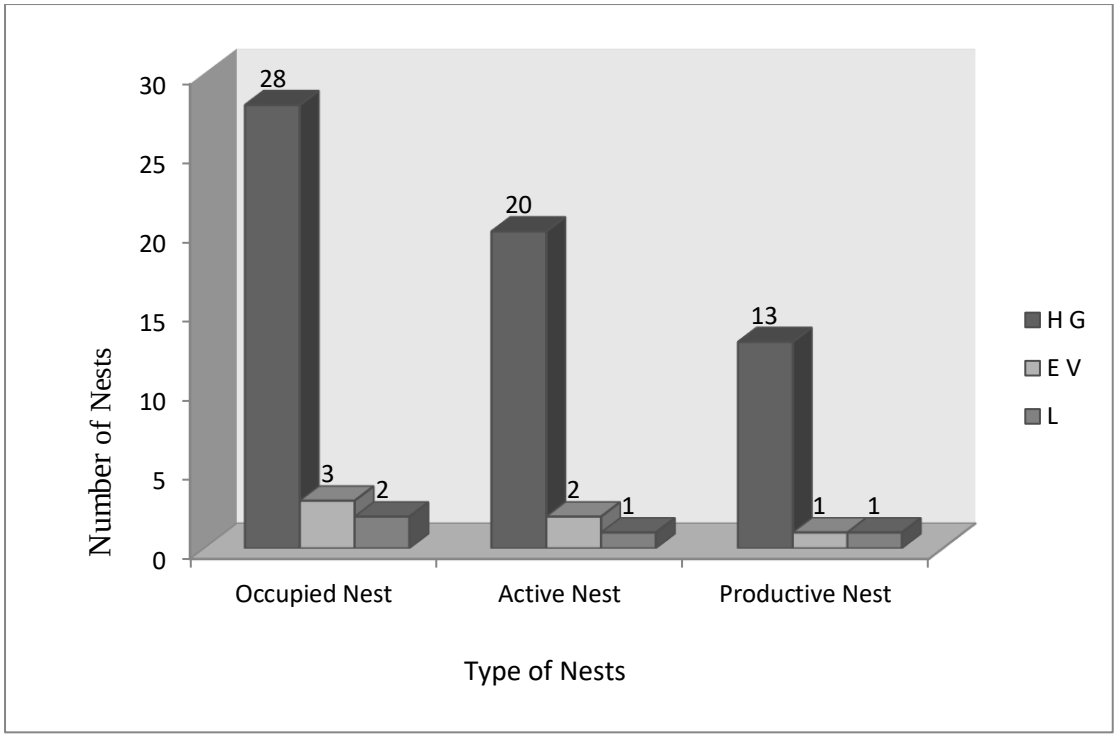


Fig:- 8. Number of Nests of three species.

5.5 Breeding Success

In 2010 field season, a total of 33 occupied nests were recorded in the Gherabhir cliff. There were 28 nests of Himalayan Griffon, 3 nests of Egyptian and 2 nests of Lammergeier recorded (Annex 4). Among them 20 active nests (having eggs) only 13 nests were productive (fledged chicks) of Himalayan Griffon. Of the two active nests of Egyptian vulture one was productive and one active nest of Lammergeier was successfully productive. Based on active nests as primary unit the breeding success of Himalayan Griffon was calculated 65% while based on occupied nest as primary unit the breeding success was 46.43%. Similarly, breeding success of Egyptian based on active nest as primary unit 50% was calculated while based on occupied nest as primary nest it was 33.33%. The breeding success of Lammergeier based on active nest as primary unit was 100% while based on occupied nest as primary unit it was 50%. Altogether 15 nests of Himalayan Griffon, 2 nests of Egyptian and 1 nest of Lammergeier were unsuccessful. As a whole the breeding success of vultures in Gherabhir colony was 65.22% based on active nests as primary unit while 45.45% based on occupied nest as primary unit.

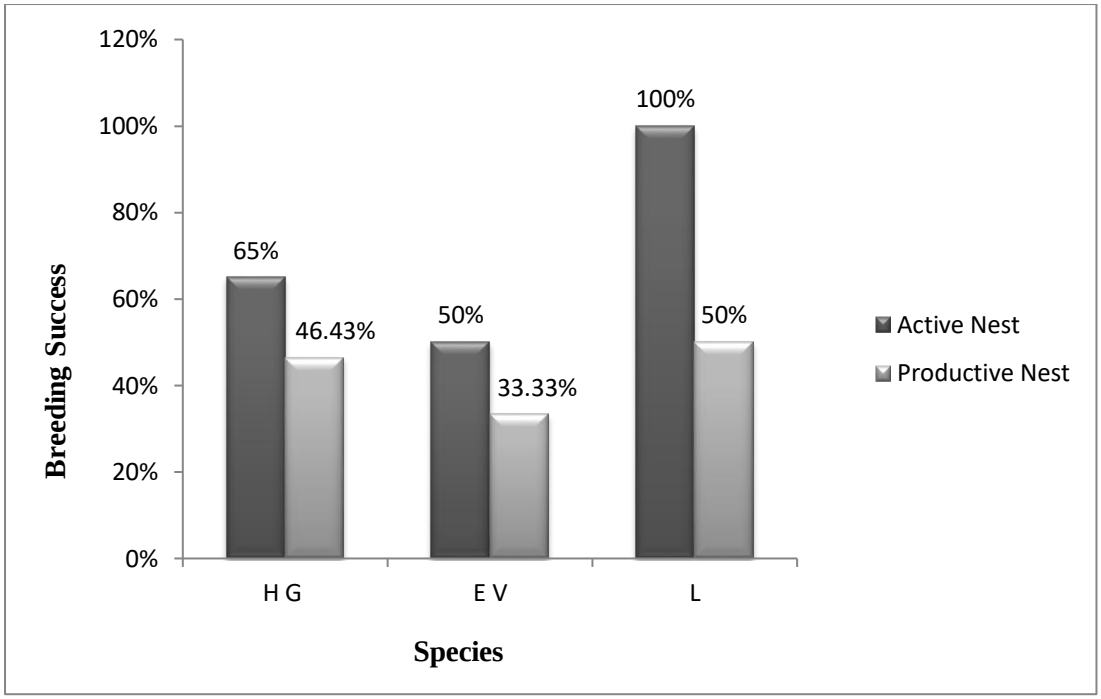


Fig:-9. Breeding success of three species of vultures.

5.6 Carcasses Availability

In my study period only one animal carcass was recorded in the month March 2010 near the study area (Annex 9). The recorded carcass was of domestic ox. The carcass was thrown openly in the gorge of mountain in Timure near Gherabhir. Unfortunately in our field visit carcass was completely finished with bones remains thus unable to record exactly the numbers of vultures feeding on that carcass. However, there was clear evidence that the carcass was fed upon by vultures based on the nature remains, bird droppings and feathers.

5.7 Dead Vultures

In study period 2010, one dead Himalayan Griffon was recorded in the month of January below the cliff. The dead body of that vulture was damaged stage (Photo plate 1 B); it might be dead for a month ago. The actual cause of death was not identified. According to local people before conducting my research in the month May 2009 about 10 vultures were killed by forest fire. That threats the vultures destructing their habitat.

5.8 Hypothesis testing

Null hypothesis, H_0: There is no significant difference in the flock size of vultures in different months at Gherabhir, Arghakhanchi.
Alternative hypothesis, H_1: There is significant difference in the flock size of vultures in different months at Gherabhir Arghakhanchi.

Calculated value of $\chi 2$ =5.96
Tabulated value of $\chi 2$ = 12.59 at 5% level of significance for 6 (7-1) degree of freedom (d.f.).

Here, The calculated value of $\chi 2$ = 5.96 < Tabulated value of $\chi 2$ =12.59

Since, calculated value of $\chi 2$ is smaller than that of tabulated value, the null hypothesis is accepted at 5% level of significance and it is concluded that there is no significant difference in the flock size of Vultures in different months at Gherabhir, Arghakhanchi in 2010 field season.

5.9.1 Questionnaire survey with the agro-vet professionals.

A total of 5 agro-vet (veterinary pharmacy) professionals were interviewed (Annex 5) from 4 different VDCs of Arghakhanchi district (Annex 5). The objective of the survey was to know the current trend on NSAIDs, their use and prevailing stocks in the Agro-vet shops of Arghakhanchi district and the attitude of Agro-vet professional towards vulture conservation. One respondent was Livestock Health Technician of District Livestock Service Office and another one was officer of Livestock Service Center Hansapur and others respondents were found Junior Technical Assistant (JTA).

5.9.2 Prevalence of Diclofenac and Meloxicam

Diclofenac was not recorded in the agro-vets of the Arghakhanchi district. According to the agro-vet professionals of Arghakhanchi district, drugs are supplied from the city of Butwal Rupandehi which is a Vulture Safe Zone where Human Diclofenac is strictly regulated banned so it is unavailable in the area. Meloxicam, the

vulture safe alternative was recorded in all the agro-vets in the forms of injection and bolus.

District Livestock Services Office (DLSO) Arghakhanchi certified that the official survey of licensed Agro-vet of district have no Diclofenac (Annex 6). My questionnaire survey and DLSO declaration certificate gave feedback to declare the district as Diclofenac Free Zone. DLSO and Nepal Para-veterinary and Livestock Association, Arghakhanchi with technical support of BCN declared Arghakhanchi as Diclofenac Free Zone in the presence of Chief District Officer of Arghakhanchi in 1st June 2011 (Annex 12 and photo plate).

5.9.3 Attitude on Meloxicam

Agro-vet professionals who had used Diclofenac in the past were supporting it because of its low price, and rapid effectiveness as compared to Meloxicam. They agreed that diclofenac was responsible for the decline of vulture population through secondary poisoning from carcasses. They believed that though expensive and slow in action Meloxicam has no side effect as Diclofenac. Since last year they were not seen and use the Diclofenac in treatment. The Meloxicam compare to Diclofenac, on the basis of the information given by the Agro-vet professionals (Annex 6).

5.9.4 Attitude of agro-vet professionals

All of the technicians of DLS office and local agro-vet professionals agreed with the decline in vulture population from their areas. They were agreed with the Diclofenac as the main cause of vulture decline combine with the habitat loss and food shortage. They were silent about vulture conservation before launched through this research. They all were demanding further awareness programme about vulture conservation.

5.10 Community outreach education programs

We distributed 50 posters and about 300 pamphlets on vulture conservation to local people, farmers, vet professionals, students, teachers, members of community forests and local leaders. The events were conducted in Timure and Ratanmare Bazaar of Hansapur VDC and in Giddhapokhari in Khanadaha VDC. The color poster, A_4 size black and white pamphlet and an A_4 size blue pamphlet in Nepali language were distributed. They highlighted the vultures' plights and suggested simple measures that people can perform to conserve vultures. Bird Conservation Nepal published the posters and pamphlets for free distribution.

An awareness programme was launched in Dhakabang-3 Pipalneta, Arghakhanchi where Nepal Para Veterinary and Livestock Association, Arghakhanchi was organizing a Livestock Health Camp. In these programs, introduction and identification of vultures, their significance, main causes of their decline and need of their conservation were discussed. Local respondents and the agro vet professionals were made aware through one-on-one meetings.

The author also wrote about ten news and articles highlighting the newly discovered vulture habitat in Nepal and their conservation status in different national and regional media (Annex 13).

CHAPTER 6

DISCUSSION AND CONCLUSION

Most studies on vultures in south Asia are focused on White-rumped and Slender-billed vultures at lower altitude. Very little studies are found regarding mountain cliff breeding Himalayan Griffon, Egyptian vulture and Lammergeier. Gherabhir is a recently investigated habitat and this is the first known intensive study of Himalayan Griffon, Egyptian and Lammergeier vultures in single habitat of Nepal and possibly in the entire Himalayas. This study has set the foundation for the long term study on ecology and competition between these three vulture species. Most of the Himalayan Griffon, Egyptian and Lammergeier colonies are recorded from the higher Himalayan regions so this is the first records of large colony in mid hills of Nepal.

During a field visit with BCN team a new colony of Oriental white-rumped vulture, a Critically Endangered species was found in Pokhedanda Pine forest (Territory of Gherabhir) of Argha VDC -9, and Argha-4 Garlam, Arghakhanchi district on 21st May, 2010 (Photo plate). The colony lies at an average elevation of 1207 m and all 13 nests are on the trunks of *Pinus roxburghii* tree. Potential nesting sites of Arghakhanchi were studied beyond the scope of this research and 54 nests recorded for four different species of vulture (Bhusal K P 2010).

6.1 Population status

The population size of vultures in Gherabhir was 74 individuals among them Himalayan Griffon (HG) was estimated to be 57, Egyptian vulture 10 and Lammergeier 6. The average flock size of vultures recorded was 64.71 with Standard deviation (S.D.) 6.72.

The average flock size of Himalayan Griffon was recorded 48.7 with standard deviation 5.09. Karmacharya (2010) recorded the average flock size of vultures in Khodpe Baitadi was 11.2 with Standard deviation (S.D.) 2.83 and the average flock size of HG recorded were 7.9 with S.D. 1.58. The average flock size of Himalayan Griffon was maximum in the month of May and was found to be minimum in the winter season. Baral et al recorded 15 HG in Koshi and nine in lowland in 2001-2002 survey seasons. Himalayan Griffon number in Annapurna area seemed to have

declined starting from late 90s (Baral et al. 2002). Chalise recorded five Himalayan Griffons in the Siwalik area of Ilam district (Chalise 1999). Gurung et al. recorded 233 HG over 44 days between 23 October and 5 December, 2003 at Dhikur Phokhari, 10 km south of Annapurna Range and Virani et al. recorded 1307 HG over 109 days from November 2001 to May 2006 in Annapurna conservation area, Mustang.

Recorded the average flock size of Egyptian vulture was 5 with standard deviation 0.52. Gautam and Baral (2009) recorded seven breeding colonies in and around the Pokhara Valley during the 2008-09 breeding season. They recorded 75 Egyptian vultures in the Pokhara Valley during the 2008-09 breeding season.

The average flock size of Lammergeier was recorded 5 and 3.81 with standard deviation 0.39 in Gherabhir. Acharya *et.al* (2010) studied the status of Lammergeier around Upper Muatang, Nepal and recorded total of 67, 49, 21 and 13 in the years 2002, 2004, 2005 and 2008 respectively. A statistically significant decline was observed for the total numbers of birds along on all four transects combined, with an estimated multiplicative decline rate of 25.0% a year.

The flock size can not be considered as large or small and population cannot be concluded as increasing or declining due to lack of previous study in this area but according to locals these are rapidly declining from the study area.

Chi Square test reveals that there was no significant difference in the flock size of Himalayan Griffon, Egyptian vulture and Lammergeier vultures in different months at Gherabhir Arghakhanchi in 2010 during field season. Chaudhary et al (2010) has reported Himalayan Griffon migrating to low-lands of Nepal and Northern India in winter. On the basis of their findings, flock size should vary for different times of the year, specifically with lower numbers in winter, but this research does not finds that this happening. However the flock size of Himalayan Griffon was minimum in winter than that in summer.

6.2 Nest Census and Breeding Success

Among 20 active nests (having eggs) only 13 nests were productive (fledged chicks) of Himalayan Griffon. Based on active nests as primary unit the breeding success of Himalayan Griffon was 65% while based on occupied nest as primary unit the breeding success was 46.43%. Acharya et al. observed 58 and 61 HG nests in caves on vertical cliffs of ACAP in 2004 and 2005 respectively. Increase in the nest is due to the more coverage (recording new nest sites) in 2005 than 2004. They observed eight active nests (14%), 17 occupied nests (29%) and 33 unoccupied nests (57%) in 2004 and nine active nests (15%), 16 occupied nests (26%) and 36 unoccupied nests (59%) in 2005. Karmacharya (2010) studied the breeding success of Himalayan Griffon in Khodpe, Baitadi and recorded the breeding success was 75% based on active nests as primary unit while based on occupied nest as primary unit the breeding success was 27%.

Of the two active nests of Egyptian vulture one nest productive in. The breeding success of Egyptian vulture based on active nest as primary unit was 50% and based on occupied nest as primary nest was 33.33%. Gautam and Baral (2009) recorded the seven nests of Egyptian vultures, in Pokhara valley Kaski, Nepal with three nests had chicks. The breeding success of Egyptian vultures was calculated as 42.85% in the breeding season 2009.

One active nest of Lammergeier is successfully productive. The breeding success of Lammergeier based on active nest as primary unit was 100% while based on occupied nest as primary unit was 50%. Margalida *et.al* (1999) studied the nest use and interspecific relationships in the Bearded vulture for nest location in the eastern Pyrenees (NE Spain) and their influence on breeding success. A total of 40% (n = 70) of Bearded Vulture nests were usurped (expulsions) by other species, the Griffon Vulture being the species which occupied most nests (81%).

As a whole the breeding success of vultures in Gherabhir colony was 65.22% based on active nests as primary unit while 45.45% based on occupied nest as primary unit. Altogether 15 nests of Himalayan Griffon, 2 nests of Egyptian and 1 nest of Lammergeier were unsuccessful.

6.3 Threats

Most of the previous studies showed the use of Diclofenac as the main threats for the vultures. In the study area no Diclofenac was recorded due to the ban of import and production in Nepal. The NSAID Ketoprofen, was thought to be safe for vultures for a long time but later it was also found toxic (Venter L. *et al* 2009). The poisoning through feeding on deliberately poisoned carcasses that are placed out to kill other animals (e.g. dogs, jackals) also cause mass mortality of vultures. Outbreak of avian influenza around captive breeding site could pose a risk to vulture species as well. Adequate measures need to be adopted to prevent such risk (DNPWC/MoFSC/GoN 2009). Some Himalayan griffons descend to the lowlands during the winter and have been noted feeding together with other vulture species in mixed flocks. Therefore, it is likely that if the lowland breeding vultures are affected by some communicable disease, the same may be also affecting the Himalayan griffon (Baral *et al* 2002).

The occasional forest fire in Gherabhir in the dry season is the threats to vulture because at that time chick are developed in the fledging stage. Through Gherabhir there is constructing road to join Arghakhanchi and Gulmi run up to Dhorpatan Bajlung that certainly disturb the vulture's habitat (Photo plate). Beside these, excessive use of poisons and pesticides in the agriculture and the climatic variation are the main threats of vultures with other Raptors in that area.

CHAPTER 7

RECOMMENDATIONS

Arghakhanchi is newly discovered vulture habitat with critically endangered white-rumped vulture. Though Himalayan Griffon and Lammergeier are least concerned species, Egyptian vulture is endangered status so conservation measures should be given to protect them and prevent them from being extinct in near future.

Following consideration should be made to conserve the vultures and prevent from extinction in the area.

1. The regular monitoring of vulture population and study of breeding success in the area is highly recommended.
2. There is an immediate need to advocate the land owners because vulture habitat lies in private land to save vultures and establish carcass dumping sites far from the human resident to provide sufficient food.
3. There might be other potential nesting sites in the nearby area including Gulmi and Pyuthan. Efforts should be made to identify those areas and make vulture study.
4. As the area is not in protected area system, separate participatory conservation approach should be develop.
5. As investigated the colony of critically endangered white-rumped vulture in the territory of the study area integrated conservation programme should launched and study the area as potential Important Bird Area of Nepal.
6. Being declare Diclofenac free district, monitoring of diclofenac should continue.

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ANNEXES

Annex 1. Summary of fieldwork efforts.

S N	Date	Day spent	Time spent (hrs)
1.	3rd - 4th November	2 days	14
2.	4th - 9th January	6 days	42
	26th - 28th January	3 days	21
3.	17th February	1 day	7
4.	14th - 20th March	7 days	49
5.	13th April	1 day	7
6.	22nd -26th May	5 days	35
7.	6th -7thJune	2 days	14
	January-June	**27 days**	**189 hrs**

Annex 2. Species of Vultures in Gherabhir, Arghakhanchi

	January		February	March	April	May	June		
Vulture Species	5th	27th	17th	16th	13th	23rd	6th	Average Flock Size	S D
Himalayan Griffon	54	45	49	35	46	57	47	47.57	6.31
Egyptian Vulture	6	7	5	8	4	9	10	7	0.14
Lammergeier	4	3	2	3	4	5	5	3.81	0.30
White-rumped vulture	3	5	2	4	10	5	8	5.28	0.21
Red-headed vulture	-	2	-	3	1	-	2	1.48	0.35
Total	**67**	**62**	**58**	**53**	**65**	**76**	**72**	**64.71**	**7.31**

Annex 3. Nest Census in Gherabhir, Arghakhanchi for field season 2010.

S N	Location	Plot no	Nest no	Latitude	Longitude	Altitude	Species
1.	Gherabhir	A	7	N:28°03’48.9’’	E:83°05’25.3’’	1991m	HG
2.	Gherabhir	B	1	N:28°03’49.3’’	E:83°05’26.8’’	2089m	L
3.	Gherabhir	C	3	N:28°03’51.6’’	E:83°05’28.1’’	2077m	HG
4.	Gherabhir	D	5	N:28°03’45.0’’	E:83°05’20.4’’	1846m	HG
5.	Gherabhir	E	3	N:28°03’43.5’’	E:83°05’24.4’’	1885m	HG
6.	Gherabhir	*	1	*	*	*	L
7.	Gherabhir	F	3	N:28°03’42.1’’	E:83°05’33.4’’	1854m	HG
8.	Gherabhir	*	2	*	*	*	E
9.	Gherabhir	G	4	N:28°03’40.3’’	E:83°05’43.6’’	1805m	HG
10.	Gherabhir	H	3	N28°03’37.6’’	E:83°05’50.3’’	1767m	HG
11.	Gherabhir	*	1	*	*	*	E
	Total	**8**	**33**	**_**	**_**	**_**	**3 Species**
HG = Himalayan Griffon, E = Egyptian, L = Lammergeier *=As above							

Annex 4. Breeding status of three vulture species in 2010.

Vulture Species	Occupied Nests	Active Nests	Productive Nests	Breeding Success (Active nest as primary unit)	Breeding success (Occupied nest as primary unit)
Himalayan Griffon	28	20	13	65%	46.43%
Egyptian	3	2	1	50%	33.33%
Lammergeier	2	1	1	100%	50%

Annex 5. Questionnaire Agro-vets in different VDCs of Arghakhanchi.

S N	Name of Agro vet	Places
1.	Sangam Agro vet	Hansapur-6 Ratanmare, Arghakhanchi
2.	Samikchha Agro vet	Khana-5 Badachaur, Arghakhanchi
3.	Vivek Agro vet	Sandhikharka-7 Arghakhanchi
4.	Banjade Agro vet	Sandhikharka-9 Arghakhanchi
5.	Chudali Agro vet	Dharapani-3 Arghakhanchi

Annex 6. Comparison of Meloxicam with Diclofenac by agro-vet professionals

S.N.	Characters	For Meloxicam	For Diclofenac
1.	Availability	Available easily	Not available
2.	Price	Expensive NRs 10-25/bolus NRs 69-76.8/injection	Not very expensive NRs 10-5/bolus NRs 35-60/injection
3.	Action	It is both anti-pyretic and anti-inflammatory	It is only anti-inflammatory but not antipyretic

Annex 7. Population Monitoring Form Model.

SN	DATE (Y/M/D)	TIME	SITE NAME	GPS READING	VULTURE SPECIES	NUMBER	STAGE	REMARKS

Annex 8. Nest Monitoring Form Model

Nest No.:	Observer:	VDC/City:
Vulture Species:	GPS:	District:
Cliff/Tree No:	N:	Zone:
Cliff/Tree Height:	S:	
Nest Height:	Altitude:	
Nest location:		

SN	DATE (Y/M/D)	TIME	STATE OF MOTHER			STATE OF CHICK	REMARKS
			NESTING	INCUBATING	OTHER		

Annex 9. Carcass Monitoring Form Model

SN	DATE (Y/M/D)	TIME	LOCATION	GPS READING	TYPE OF CARCASSES	NUMBER	VULTURE SPECIES	NUMBER	OTHER SCAVENGER	REMARKS

Annex 10. Dead Vulture Monitoring Form Model

SN	DATE (Y/M/D)	TIME	LOCATION	GPS READING	VULTURE SPECIES	TIME SINCE DEATH	REMARKS

Annex 11. Veterinary Survey Form

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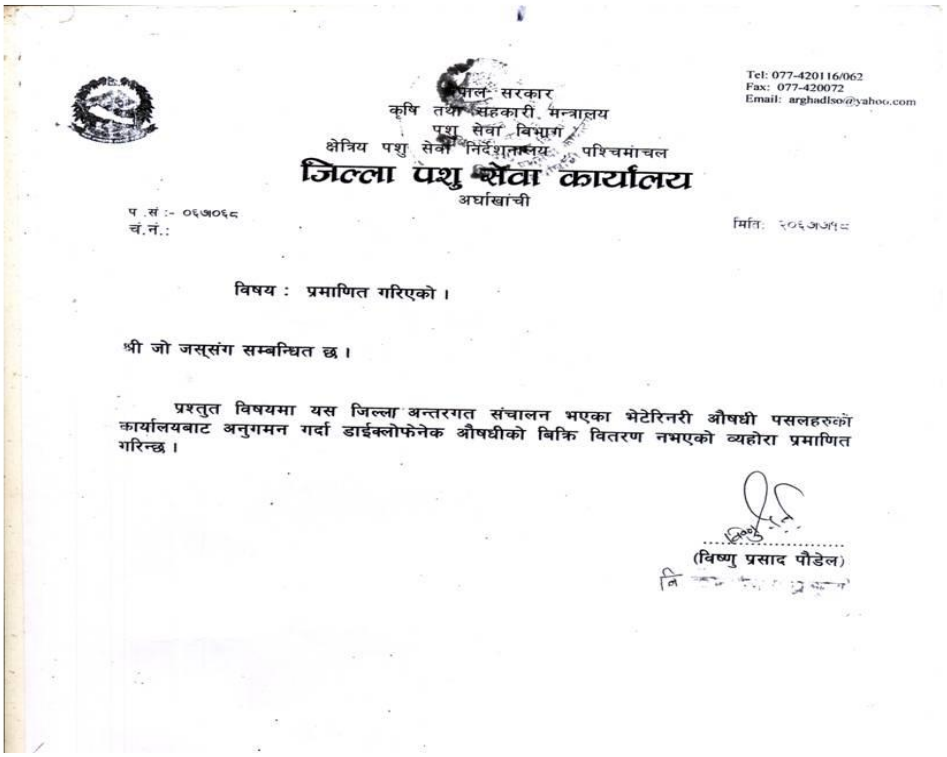
Adapted from BCN vulture conservation programme.

Annex 12:- Certificate of Diclofenac survey of DLSO Arghakhanchi.



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प.सं :- ०६७७०६८
चं.नं.:

मिति: २०६७।७।१८

विषय : प्रमाणित गरिएको ।

श्री जो जस्संग सम्बन्धित छ ।

प्रश्तुत विषयमा यस जिल्ला अन्तरगत संचालन भएका भेटेरिनरी औषधी पसलहरुको कार्यालयबाट अनुगमन गर्दा डाईक्लोफेनेक औषधीको बिक्रि वितरण नभएको व्यहोरा प्रमाणित गरिन्छ ।

.....
(विष्णु प्रसाद पौडेल)

Annex 13:- News of Awareness and DFZ program in Rajdhani Daily.

अर्घाखाँची चौधौं
डाइक्लोफेनेकमुक्त जिल्ला

राजधानी समाचारदाता
काठमाडौं, १८ जेठ

गिद्ध संरक्षण जनचेतना विस्तारका क्रममा अर्घाखाँचीलाई 'डाइक्लोफेनेक'मुक्त जिल्ला घोषित गरिएको छ ।

जिल्ला पशु सेवा कार्यालय अर्घाखाँची, नेपाल पन्छी संरक्षण संघ र नेपाल पारा भेटेरेनरी एन्ड लाइभस्टक एसमेसिएसनले संयुक्त रूपमा सदरमुकाम सन्धिखर्कमा बुधबार कार्यक्रम गरी जिल्लालाई डाइक्लोफेनेकमुक्त घोषणा गरेका हुन् ।

कार्यक्रममा अर्घाखाँचीका प्रमुख जिल्ला अधिकारी, स्थानीय विकास अधिकारी, जिल्ला पशु कार्यालय अध्यक्ष, स्थानीय राजनीतिक दलका प्रतिनिधिलगायत गिद्ध संरक्षण क्षेत्रमा कार्यरत संरक्षणकर्मी गरेर करिब ५० जना सहभागी थिए ।

यससँगै नेपालमा डाइक्लोफेनेकमुक्त जिल्ला संख्या ३४ पुगेको लामो समयदेखि गिद्ध अध्ययन अनुसन्धान गरिरहेका संरक्षणकर्मी कृष्णप्रसाद भुसालले राजधानीलाई बताए ।

भुसालका अनुसार नेपालमा पाइने ९पर, सानो खैरो, सेतो, सुन, हिमाली, राज, खैरो र हाडछेर गरी आठ प्रजातिका गिद्धमध्ये अर्घाखाँचीमा सानो खैरो, राज र खैरोबाहेक बाँकी पाँच प्रकारका गिद्ध पाइन्छन् ।

जनावर बिरामी हुँदा दुखाइ कम गर्ने प्रयोग गर्ने 'डाइक्लोफेनेक' औषधि दिइएको जनावर मरेमा त्यसको सिनो खान आउने जति सबै गिद्ध मर्ने हुँदा सन् २००९ देखि नेपालका विभिन्न जिल्लालाई डाइक्लोफेनेकमुक्त जिल्ला घोषणा गर्न सुरु गरिएको थियो ।

यसअघि, नवलपरासी, रूपन्देही, दाङ, बाँके, बर्दिया, कैलाली, कञ्चनपुर, पाल्पा, चितवन, इलाम, कास्की, लमजुङ र कपिलवस्तु डाइक्लोफेनेक मुक्त जिल्ला घोषणा भइसकेका छन् ।

डाइक्लोफेनेकमुक्त जिल्ला घोषणा भइसकेपछि जिल्लामा डाइक्लोफेनेक बिक्री वितरण र प्रयोगमा पूर्ण बन्देज लागेको छ ।

Annex- 14 Published Articles in different Newspapers

S N	Media	Category	Name of Article	Published date	Web link address
1.	Gorkhapatra	National Daily	Exercise and Achievements in vulture conservation.	2067-01-03 (April 16, 2010) Friday	http://www.gorkhapatra.org.np/gopa.detail.php?article_id=33286&cat_id=18
2.	Gorkhapatra	National Daily	Drastically decline of natural scavengers.	2067-05-20 (Sep. 5, 2010)	http://www.gorkhapatra.org.np/gopa.detail.php?article
3.	Munal	BCN publication	Hopeful rays in vulture conservation.	Ahoj 2067	http://www.birdlifenepal.org/download.php?f=60
4.	Rajdhani	National Daily	Vulture conservation for biological stability.	2067-07-18 (November 4, 2010)	http://www.rajdhani.com.np/
6.	Arghakhanchi.com	Online news journal.	Biological potentiality of Gherabhir, Arghakhanchi.	2067-11-17 (March 1, 2011)	http://www.arghakhanchi.com/index.php?action=news&id=PVVUTzBFVE0=
7.	Arghakhanchi News	weekly newspaper	Vultures of Arghakhanchi and their importance.	2068-01-18 (May 1, 2011)	-

PHOTO PLATES

PLATE 1

A. Gherabhir, nesting cliff.

B: Dead Himalayan Griffon.

PLATE 2

C: Himalayan Griffon Nests

D: Himalayan Griffon mating in Nest.

E: Egyptian vulture in Nest.

PLATE 3

F: Lammergeier and its Nest.

G: Adult Lammergeier (Ishowry Chaudhary).

H: Nest Monitoring.

PLATE 4

I: Awareness and DFZ programme.

J: Newly Find WRV Nest with Egg.

K: Road Construction near cliff.