

**STATUS, DISTRIBUTION AND HABITAT PREFERENCE
OF SARUS CRANE (*Grus antigone*) IN WESTERN PART
OF NAWALPARASI DISTRICT, NEPAL**



**A DISSERTATION SUBMITTED IN PARTIAL FULFILLMENT OF THE
REQUIREMENTS FOR MASTER'S DEGREE IN
ZOOLOGY (ECOLOGY)**

BY

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RECOMMENDATION

Mr. Ram Prasad Sharma has successfully carried out the dissertation entitled "**Status, Distribution and Habitat Preference of the Sarus Crane (*Grus antigone*) in Western Part of Nawalparasi District**" under my supervision. This is candidate's original work, which brings out useful information in the Sarus Crane ecology. Hence, I recommend this dissertation to be accepted for partial fulfillment of the requirement for the degree of Master's of Science in Zoology (Ecology).

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ABSTRACT

The Sarus crane (*Grus antigone antigone*) is one of the threatened species of birds. Its population has been declining in many parts of Indian sub- continent including Nepal. Present study was carried out to assess status, distribution and habitat preference of the Sarus Crane in the Nawalparasi district. Road transect surveys methods were used to collect data on the Sarus Crane, its habitat and nest characteristics from April, 2005 to January, 2006. The conservation threats were analyzed by field surveys and questionnaire surveys. The frequency distribution of Sarus Crane was 280, 257 and 202 in pre-nesting, nesting and post nesting period respectively. The Sarus Cranes are uneven in distribution. The population size of Sarus Crane was fluctuated from 13 to 18 individuals with mean of 14.7 and very low density ($0.059/\text{km}^2$).

The Sarus Crane was found to use all available habitats, but preferred wetlands for foraging and nesting followed by grasslands and cultivated lands. The frequency of the Sarus Crane activities was highest in wetland (62.78%) followed by cultivated land (33.42%) and grassland (3.78%). Of the total nest recorded during the study, 4 were in the wetlands, 2 in cultivated land and 1 in grassland. The mean length, breadth and height of nest were 121.23cm, 101.41cm and 20.29cm respectively.

The Sarus crane facing threats such as land use change, lack of awareness, use agro-chemicals, over exploitation of wetland resources, sugarcane cultivation and disturbances in the foraging and nesting places. Population monitoring, further research, raising of awareness among the local people, protection and restoration of wetlands and discourage the people to use agro chemical are some of the ways to save the Crane in the Nawalparasi district.

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ABBREVIATION AND ACRONYMS

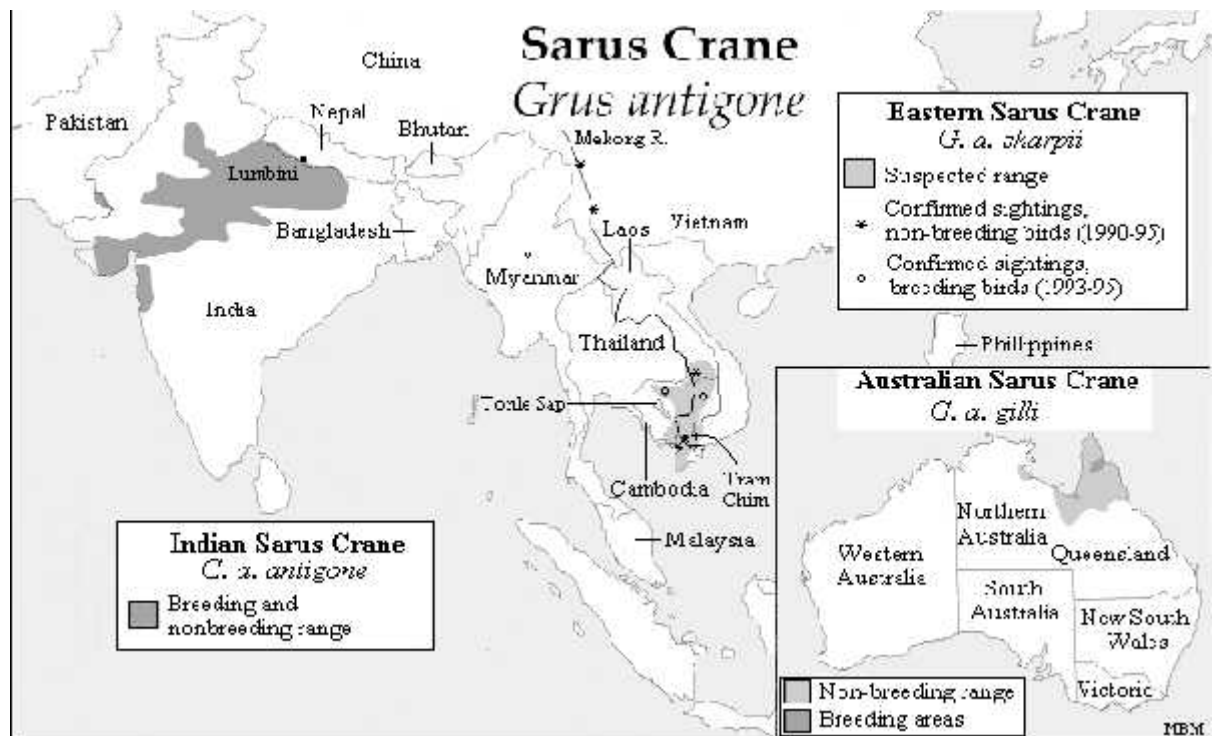
| | | |
|-------|---|---|
| DFO | = | District Forest Office |
| IUCN | = | International Union for Nature Conservation/ The World Conservation Union |
| VDC | = | Village Development committee |
| m | = | meter |
| cm | = | centimeter |
| km | = | kilometer |
| Sq | = | Square |
| N | = | North |
| S | = | South |
| Spp | = | Species |
| TU | = | Tribhuvan University |
| W | = | West |
| E | = | East |
| BCN | = | Bird Conservation Nepal |
| BPP | = | Biodiversity Profiles Project |
| HMG/N | = | His Majesty's Government of Nepal |
| RH | = | Relative humidity |
| BLI | = | Bird life International |
| GIS | = | Geographical Information System |
| DNPWC | = | Department of National Parks and Wildlife Conservation |

1. INTRODUCTION

1.1 Background

Sarus Crane, the world's tallest flying bird is only resident breeding crane in India, Nepal and South east Asia (Ali and Ripley 1980, Sunder *et al.*, 2000a). The *Grus antigone* belongs to the family Gruidae. Family Gruidae have altogether 15 species belonging to four genera and two sub-families (Ali and Ripley, 1995). The family Gruidae, commonly known as cranes is defined as large and long legged bird with a small and elevated hind toe and long necked members of the order Gruiformes (Johnsgard, 1983). An elevated and tapering bill that is often larger than the head, and nostrils are oval or nearly linear and are open from side to side, the upper half of the head is nearly naked and crimson skin is exposed in the Sarus Crane, toes are not webbed, but are connected at the base by a membrane and are moderately long (Suwal, 1999). The profile of extended wings is round and has ten functional primaries (& a vestigial 11th, in most case) with a seventh or eight primaries are the longest (Johnsgard, 1983). The molting of wing feathers makes the crane flightless once in a year or once in two years (Gole, 1989). There may be 18-25 secondary with inner ones often larger than the primaries, and usually with homo-coherent vanes that break up into hairy plumes and gives an impression of tail feathers (Gole, 1989b). The tail is moderately long and is composed of 12 feathers, no sexual dimorphism and all species are monogamous but usually gregarious during non-breeding season (Ali and Ripley, 1980). Plumage entirely pale grey, with the exception of the lower neck and tips of the wings which are whitish, head and upper neck bare the fore crown being greenish grey and very small ear coverts pale grey, otherwise the whole of the bare are in pale red with blackish hairs on nape and sides of neck, iris orange, bill greenish horn, leg and feet reddish (Johnsgard, 1983).

Three sub species of *Grus antigone* are recognized, with a total estimated population between 13,500 and 15,500 (Meine and Archibald, 1996). The Indian Sarus Crane (*Grus antigone antigone*) is a non-migrant sub species resident to the Indian Sub-continent (Inskipp and Inskipp, 1991). Current ranges of the Indian Sarus Crane include the plains of northern, northwestern and western India and the western half of the Nepal's Terai lowlands (Shrestha, 1996, Aryal 2004). The population has declined sharply over the last several decades and densely distributed in the Indian states of Utter Pradesh, Rajasthan, Gujarat, and Haryana and rarely appears in Indian Punjab, Pakistan and Western half of Nepal's Terai lowland (Gole, 1989). In India, percentage of breeding Sarus Crane is maximum in Gujarat state and Utter Pradesh (Chaudhary *et al.*, 1999). In Pakistan, Indian Punjab and western Bangladesh the Sarus Crane now occurs rarely (Meine and Archibald, 1996).



Source: Ellis, *et al.*, 1996

Figure: 1 Map showing global distribution of Sarus Crane

Among 15 species of Cranes, only four species have been recorded in Nepal (Shestha, 1996). Common Crane (*Grus grus*) and Demoiselle Crane (*Anthropoids Vigro*) are the high altitude passage migrants from the Palaearctic region, Black necked Crane (*Grus nigricollis*) a vagrant individual has been recorded in Nepal, they are Tibetan highland species and a small population migrants to Bhutan (Walkinshaw, 1973).

Sarus Crane is a resident species in Nepal and found in Kanchanpur, Sukla Phanta Wildlife Reserve, Kailali, Bardia National Park, Banke, Dang, Kapilbastu, Rupendehi, Nawalparasi and Chitwan National Park (BLI 2001, Suwal 1999). There are probably fewer than 500 individuals of Sarus Crane in Nepal and their range has been slowly shrinking for the last decade (Suwal *et al.*, 2003).

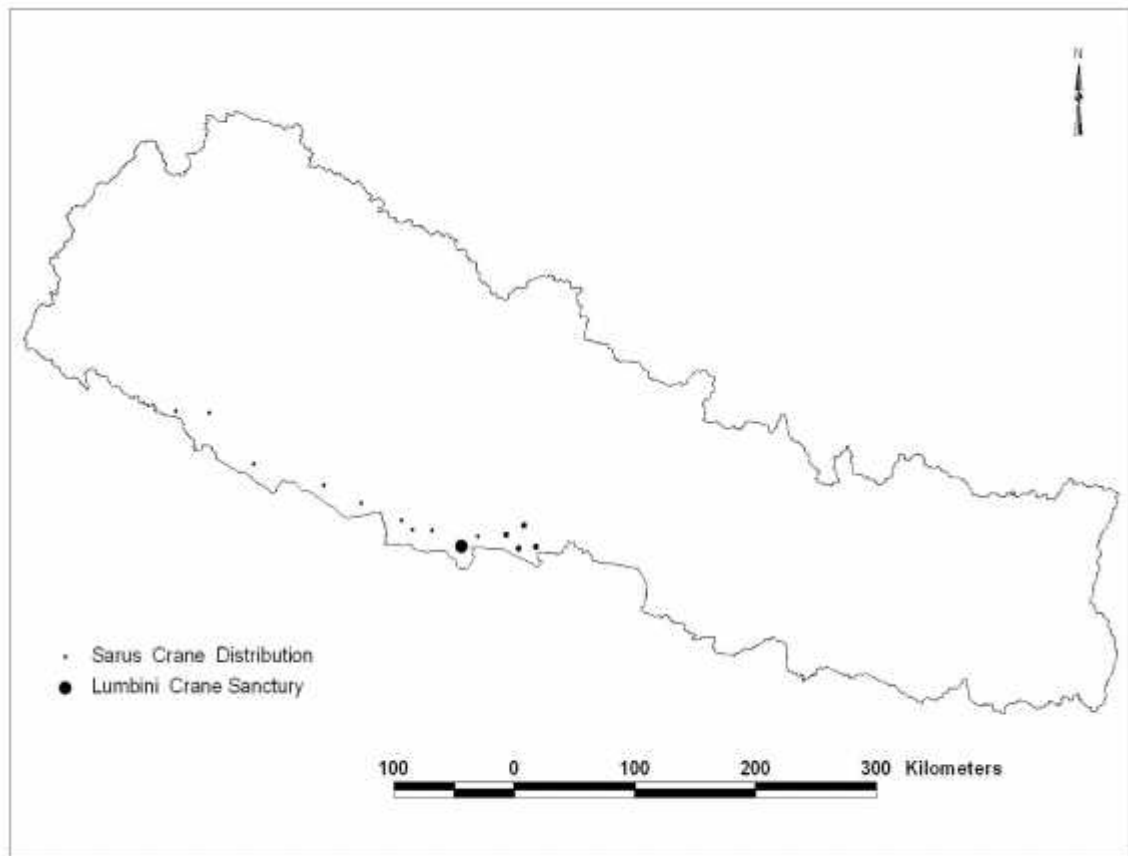


Fig: 2 Map showing distribution of Sarus Crane in Nepal

Sarus Crane occasionally seen in the damp cultivated field and usually lives in pair and sometimes seen in a flock of 40-60 during pre nesting season (April-may) (Suwal, 1999). They are more social during gathering; there would be display and trumpeting (Ali and Ripley, 1980). Sarus Cranes are mostly non- migratory in India but often make short seasonal movements between dry and wet seasonal habitats in Southeast Asia and Australia (Ali and Ripley, 1995). The Indian Sarus Crane has adapted to the dense human population in India and interact closely with people where tradition of tolerance prevail (Masatomi, 1994).

The Sarus Cranes utilize wide variety of landscapes, depending on food availability, cropping pattern and other seasonal factors (Mukherjee *et al.*, 2001). The Sarus Crane inhabit in open, cultivated, well water plains, marshlands and jheels (Ali and Ripley, 1980) and are well known for their ability to live in association with human habitation (Gole,1989; Meine and Archibald, 1996). The Sarus Cranes nests on flooded paddy fields and Marshes (Ali and Ripley, 1995).

The Sarus Cranes are omnivorous feeds on fish, frogs, lizards, crustaceans, mollusks, insects, locust, grasshopper, stubbles, tubers, corns of aquatic marsh plants, green shoot of grasses, cereals, and ground nut, pods, etc (Soothill and Soothill, 1982). Sarus Cranes consume about 4% of their body weight per day (Muralidharan, 1993). Most of their nutritional requirements are likely available in natural wetlands, but due to increase in agricultural activity, Cranes are increasingly forced to use crops fields for foraging (Ali and Ripley, 1995). Occasionally Sarus Crane feed eggs of other birds (Sunder, 2000).

The Sarus Crane reaches the sexual maturity at the age of five to seven years; the nesting is stimulated by the onset of wet season with associated flooding and environmental changes that favour nesting at this period (Johnsgard, 1983). The nesting season is mainly from July to October but may extend into December or even March (Soothill and Soothill, 1982). The pair produces a resonating trumpet

call as duet (Mukherjee *et al.*, 2001). The trumpet is uttered with neck fully stretched up by both birds, bills pointing to the sky, the wings of the male half stretched, body feathers shuffled, kept up for half a minute or more (Sunder, 2005). Courtship display is a mutual performance and it is very spectacular to see the dancing of these tall and big birds and the male initiate by suddenly flicking his wings half stretched bowing, half leaping, dipping and pumping his forepart of the body up and down throwing his head and trumpeting loudly (Soothill and Soothill, 1982). The female is tempted by this invitation and joins promptly, followed by vigorous contouring, prancing, capering and widely leaping at, around and away each other (Suwal, 1990). Twinge tossing also occurs during the display in which a male tosses a twig in the air and either one quickly hold it by the beak and toss in the year that whole performances would last for about two or three minutes (Ali and Ripley, 1995).

Sarus Cranes are generally monogamous, mating binds stay together throughout the year (Ali and Ripley, 1969). The male and female of a pair are known to strengthen the pair bond by synchronized behaviour such as duet calls, dance guard calls and alarm calls (Masatomi 1994; Archibald 1976). The pair shares most of the activity and generally lives together, except during the incubation, one of the mates has to leave the nest for short duration for foraging (Suwal, 1994).

Breeding densities and territory sizes are poorly known for most cranes, but in some species are apparently quite variable in response to local conditions (Parasharya *et al.*, 1989). In India nesting territories as small as one hectare are sufficient for the Sarus Crane of the quality of the water and vegetation is adequate and human disturbance is minimized (Gole 1989, 1991a).

Both sexes participate in nest building and select a secluded spot within their territory and unison call from that spot (Hume and Marshall, 1979). Walking away from that selected spot, they toss nesting materials (mainly the stems and leaves of sedges, cattails and other wetland plants) behind them over their shoulders (Suwal

1999; Aryal, 2004). They return to the nest site and pull materials within their reach before walking slowly away from the nest site and throwing additional materials behind them and repeat this sequence many times, large quantities of nesting materials accumulate at the low platform nest, while a "moat" of water from around the platform (Sunder, 2000a). Nest is a huge collection of rushes, reeds and straw about a meter in diameter (Archibald and Mirande, 1985).

Clutch size is two, eggs are greenish or pinkish white in color, sometimes spotted and blotted with brown or purple inner membrane bright organ (Johnsgard, 1983). The interval between the laying eggs is about 48 hours and incubation period is about 34 days (Ali and Ripley, 1983). The incubation duty is mostly performed by the female, while the male does the watch dog duty and usually the female does the overnight incubation (Johnsgard, 1983). Precocial chick is born, at the time of birth they are wet and very weak, may remain in the nest for nearly two days, after which they are able to walk and swim very well (Shrestha, 1995). The fledging period of the Sarus Crane is about three month and the young birds remain with their parents for up to ten months (Walkinshaw, 1973).

In non breeding period, juveniles either voluntary leave their parents or are driven off by the adult after the family return to the breeding territories (Ellias *et al.*, 1996). By the end of their second year, juvenile's birds have usually initiated their own attempts to form pair bonds (Masatomi 1994; Archibald, 1976).

Human pressure and associated changes in land use patterns and intensification in agriculture are major threats to the Cranes (Meine and Archibald, 1996). Egg stealing, hunting, trade in live birds and death due to ingestion of pesticides by adult birds are the other known threats (Gole 1989, Muralidharan 1993).

1.2 Statement of the Problems

Among three subspecies, the Indian Sarus Crane (*Grus antigone antigone*) is found in Nepal. The Indian Sarus Crane is still common in northern India, rare in southern part of Terai region of Nepal but has been extirpated from large portions of its historic range and continues to decline in areas where it still exists (Suwal, 1999). Small and isolated population of Sarus Crane occurs in parts of the southern lowlands Terai of Nepal. With a drastic reduction in its distribution range and a total of 12,000 individuals World wide (Gole 1989, 1991a), the Indian Sarus Crane is now considered as a globally threatened species (Meine and Archibald, 1996). Similarly the range as well as population of the Sarus Crane is in declining trend in Nepal also, because of loss and degradation wetland habitats and excessive use of agro-chemicals on field. Although, information on the various aspects of Sarus Crane ecology are available (Suwal, 1994) but these information are not sufficient to manage the residual population in the country.

1.3 Objectives

The aim of this research was to assess status of the Sarus Crane in Nawalparasi district. The specific objectives were to;

- determine distribution pattern,
- estimate population size,
- analyze habitat use and preference, and
- evaluate conservation threats of the Sarus Crane in the Nawalparasi district.

1.4 Rationale

Present study has generated current information on the distribution patterns, population status, habitat use and preference, and conservation threats of Sarus

Crane in the Nawalparasi districts. It is hoped that these information will be useful to prepare guide lines for management of Sarus Crane in the district.

1.5 Limitation

In this research, many obstacles were raised, being a student research, resources were limited so that it was difficult to conduct a research in the beginning. Due to lack of sufficient resources including man power, fine equipment and sufficient budget, the whole Nawalparasi district couldn't cover.

2. STUDY AREA

2.1 Location and Topography

This study was conducted in Western part of Nawalparasi district ($83^{\circ} 36' E$ to $84^{\circ} 36' E$ and $27^{\circ} 21' N$ to $27^{\circ} 47' N$). The specific study area is located South of Mahendra highway, east of Rupandehi districts, west of Daunne hill and North of Indian boarder (Figure 3). The elevation ranges from 100m to 300m from the average sea level. Topographically, the district can be divided into three regions as Mahabharata and Churia hills, inner Terai and Terai plain.

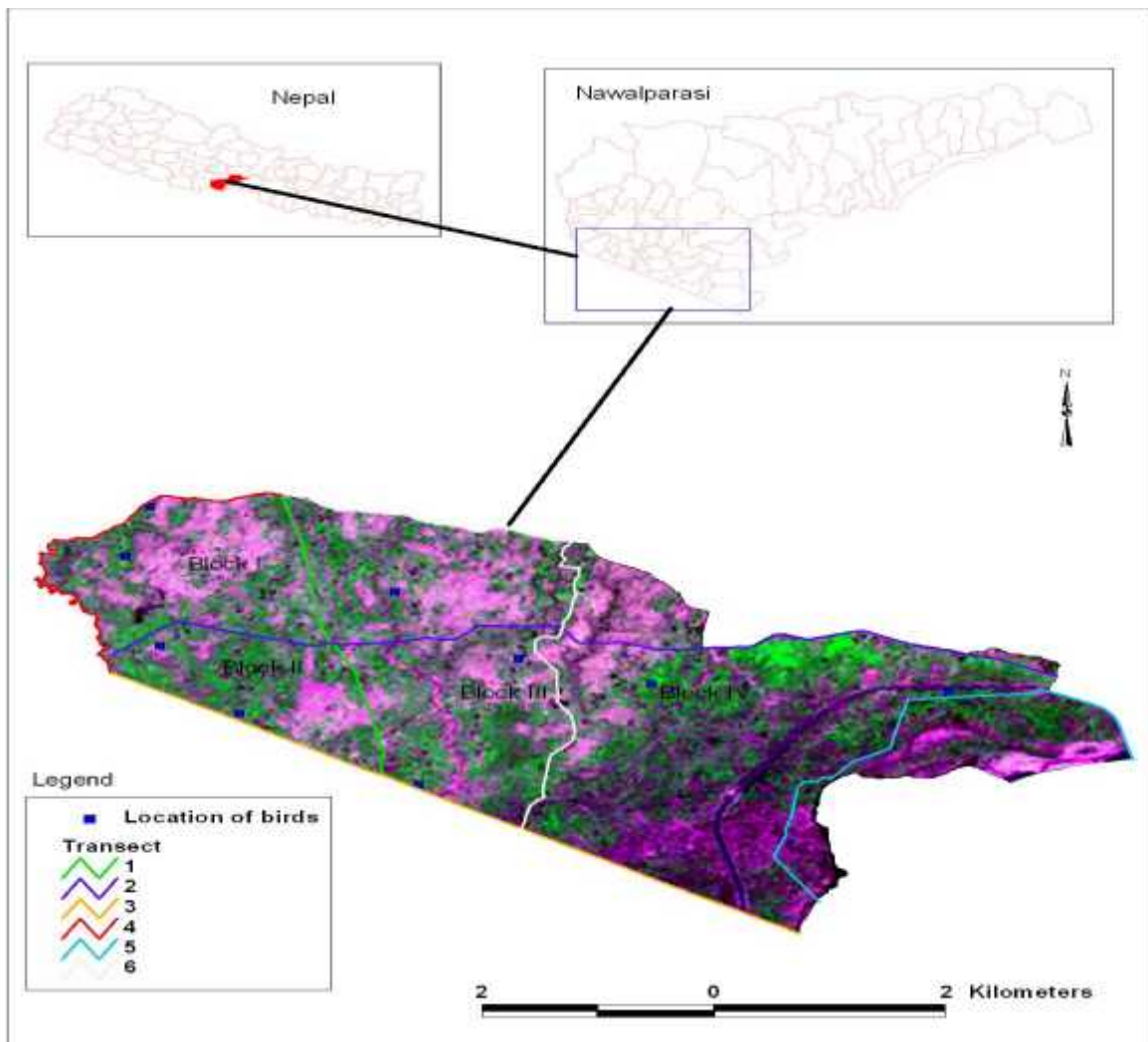


Figure: 3 Map showing study area

2.2 Geology and Soil

The geological formation of the district is alluvial plain with characteristics similar to the gangetic plain of India in the south while Siwalik in the North (Shrestha, 2000). The Siwalik hill is composed of coarsely bedded stone, crystalline rocks, clays and conglomerate in between the alluvial plains and Siwalik Hill is the dry zone commonly known as the Bhabar tract composed of boulder gravels and sand, the Terai flat plain is derived from the old as well as the new alluvium carried out by the rivers from the hills and mountains in the North (DFO 2002), The soil ranges from loamly sand, sandy loam, silty loam (IUCN, 1996).

2.3 Land Use

The total geographical area of the district is 219,510 ha. The forest (47.8%) is the biggest landform in the district followed by the agriculture and urban area (41.2%), scrub and grass (2.6%), river (water bodies) (3.1%).

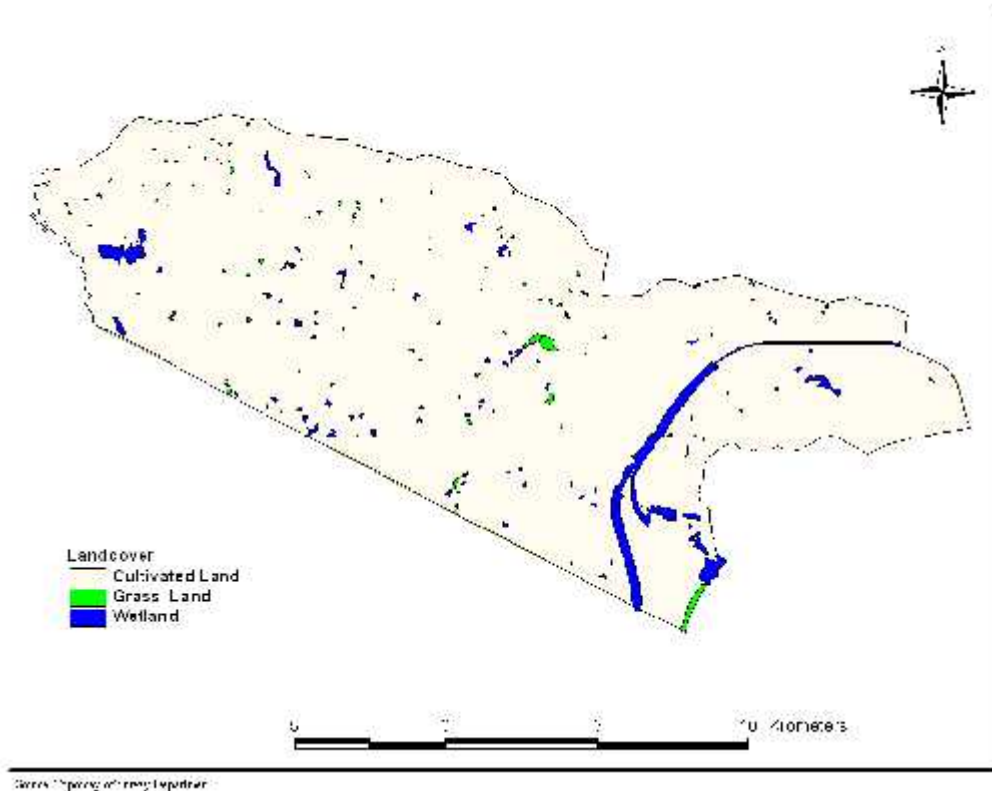


Figure: 4 Map showing Land cover by Sarus Crane in study area.

2.4 Climates

Nawalparasi comprises tropical and sub-tropical monsoon climate. June and July are the hottest month while December and January are the coldest month of the year.

The maximum temperature has been found 39.1°C in the month of June and minimum 07.7 in the month of January (Figure 5). There are four distinct seasons in this area, spring (pre-monsoon), summer (monsoon), fall (post-monsoon) and winter season. The pre-monsoon is the month of March, April and May. The maximum temperature is recorded for this season and it may cross over 37°C at times. The monsoon season lies on the month of June, July and August. About 80% of the precipitation occurs during this season.

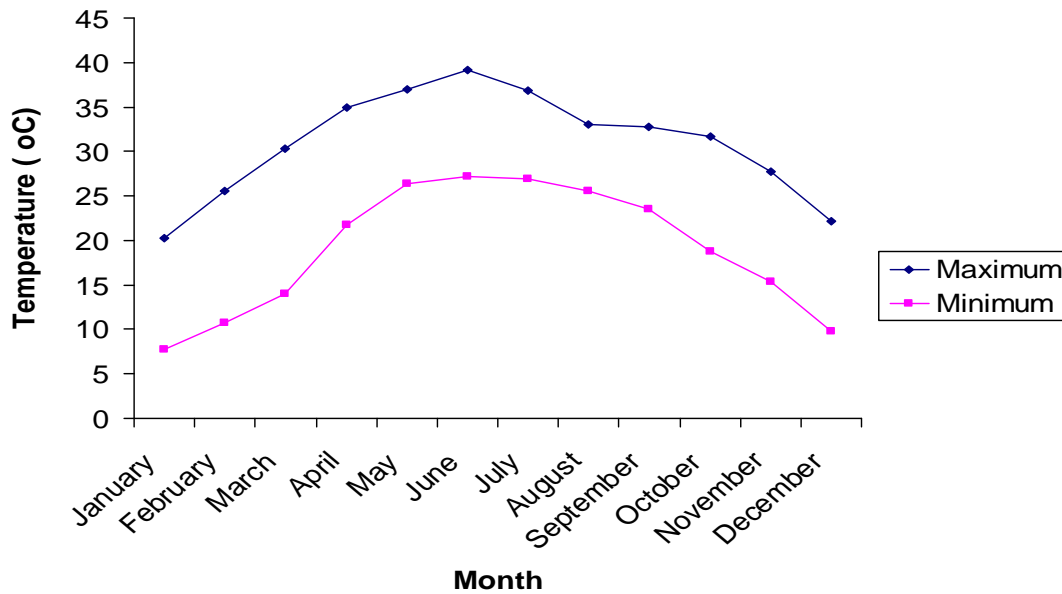


Figure: 5 Mean Monthly Maximum and Minimum Temperature Recorded at the Simari Meteorological Station, Nawalparasi (1997 to 2004).

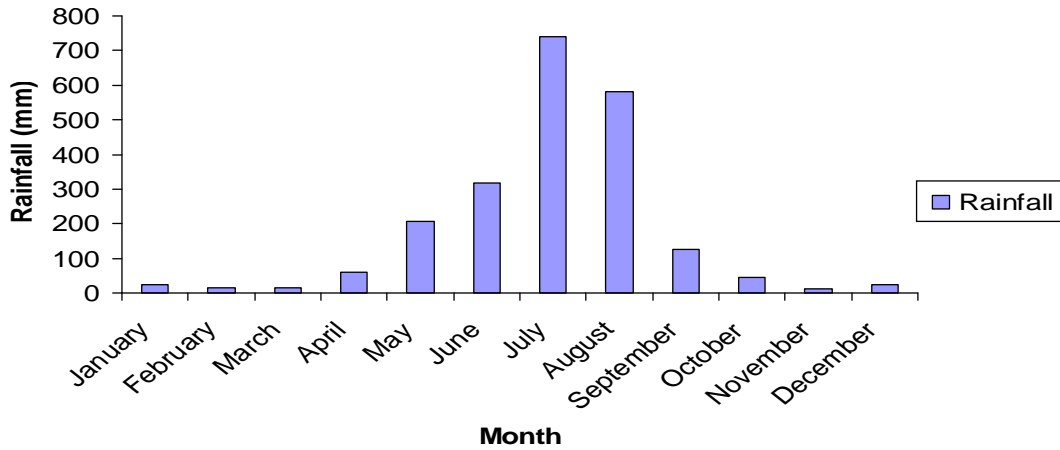


Figure: 6 Mean Monthly Rainfalls Recorded at the Simari Meteorological Station, Nawalparasi (1997 to 2004).

The Mean annual precipitation from 1997 to 2004 was 2159.85 mm. The Mean monthly precipitation ranges from 11.2 mm (November) to 738.6 mm (July) in Simari station at Nawalparasi Districts. July and August were most precipitous months.

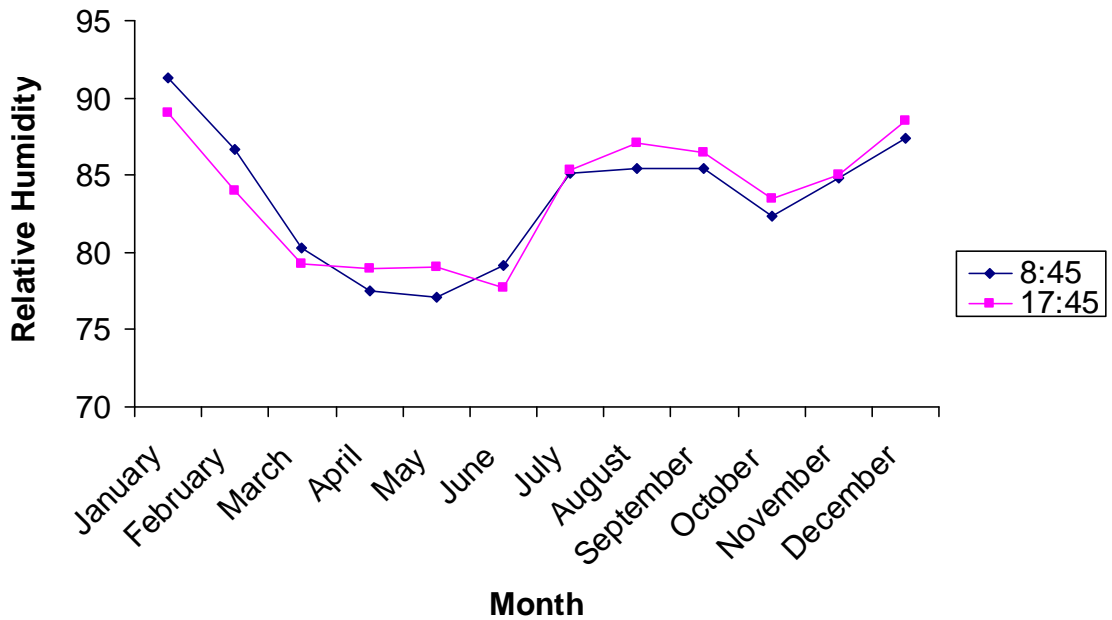


Figure: 7 Mean monthly Relative Humidity recorded at the Simari Meteorological Station, Nawalparasi (1997 to 2004)

The mean monthly relative humidity in the morning (8:45 hrs) ranges from 77.1% in April to the maximum of 91.3% in January while the mean monthly relative humidity in the evening (17:45 hrs) ranges from minimum of 79% in April and the maximum of 89% in January (Figure 6).

2.5 Vegetation

Nawalparasi district is characterized by diverse vegetation types comprising of tropical forest to lower temperate forest. About 56% of total area is covered by tropical and subtropical evergreen forests, while small proportion of area covered by the lower temperate type of vegetation. Therefore, Nawalparasi district is rich in floral diversity. Vegetation of this district comprises 94% Sal (*Shorea robusta*), 3% Sal Terai hard wood, 1% Terai hard wood, 2% Sissoo and others (DFO 2002).

The forest of study area broadly divided into three sub-types vegetation. These are Sissoo forest, Terai mixed hardwood forest and Sal forest (DFO 2002).

2.5.1 Sissoo Forest

Sissoo was planted by government as monoculture. This forest also includes *Terminalia alata*, *Schleichera oleosa*, *Syzgium cuminii*, *S. jambos*, *Adina cordifolia*, *Mallotus philippenansis* as main trees species.

2.5.2 Terai Mixed Hardwood Forest

Most of the forest is riverine type of mixed vegetation, thickets of bushes. It comprises trees such as *Acacia catechu*, *Phyllanthis emblica*, *Bombax ceiba*, *Anogeissus latifolius*, *Terminalia alata*, *T. bellarica*, *Aegle marmelos*, *Dillenia pentagyna*, *Ficus* sp. *Schleichera oleosa*, etc. shrubs include mainly *Eupatorium adenophorum*, *Acacia pennata*, *Ficus hispida*, *Vernonia cinerea* etc. The main grasses species are *Saccharum sponteneum*, *Imperata cylindrica*, etc.

2.5.3 Sal Forest

It is northern part of the study area which comprises rocky area, mainly consists of sand and sandy loam type of soil. Sal forest is restricted in Churia hill, which is dominated by Sal species (*Shorea robusta*). Other main tree species of this area are *Dalbergia latifolia*, *Ficus semicordata*, *Ougeinia dalbergiodes*, *Bauhinia vahlii*, *Pterocarpus marsupium*, *Desmodium oogeinense*, *Semecarpus anacardium*, *Anogeissus latifolius*, *Logerstroemia parviflora*, etc. The main grasses species of this area are *Digitaria adscenden*, *Eulaliopsis binata*, *Cymbopogon pendulus*, *Cyperus* species etc.

2.6 Fauna

Detail inventory of fauna of the Nawalparasi district is yet to be done. The corridor forest running from Chitwan to Banke and Royal Bardia National Park supports wide variety of fauna. Many wildlife species occurs in Nawalparasi including tiger (*Panthera tigris tigris*), leopard (*Pantheria paradus*), sloth bear (*Melursus ursinus*), spotted deer (*Axis axis*), grey wolf (*Canis lupus*), wild dog (*Cuon alpinus*), wild boar (*Sus scrofa*), langur (*Presbytis entellus*) (DFO 2002).

There are many species of birds are found in the district including Lesser adjutant (*Leptolilus javanicus*), Open billed stork (*Anastomus oscitanus*), Great stone plover (*Esacus recorvitustris*), Sarus crane (*Grus antigone*), Bengal florican (*Houbaropsis bengalensis*), Crested Serpent eagle (*Spitornis cheetal*), Stork billed kingfisher (*Pelargopsis capensis*) (BPP, 1995).

Forest of Churiya, Bhabar and Siwalik range support a good number of reptiles. Important species common to these areas include Yellow monitor (*Varanus flavescens*), House gecko (*Hemidactylus frenatus*), common cobra (*Naja naja*), king cobra (*Ophiophagus hanah*), Indian rock python (*Python molurus*) and Banded krait (*Bungarus fasciatus*), etc.

Altogether 68 species of fish were recorded during this area; *Barillus* species dominated all the fishes in terms of frequency distribution (Giri, 2005). Main dominant species in the study area are *Barillus* sps. Like *B. sahara*, *B. tileo*, *B. seenghala*, *Aorichthys aor*, *Channa punctatus*, *Channa orientalis*, etc. Similarly, important fish species in the river are *Tor tor*, *T. putitora*, *Labeo devo*, *Clupisoma gaura* (Shrestha, 2001). Different types of insects like scorpion, millipede, centipedes, grasshoppers, butterflies, moths, hoppers, ants and termites are common fauna in this area (DFO 2002).

3. METHODOLOGY

3.1 Reconnaissance Survey and Site Selection

A preliminary survey was carried out in March 2005 to locate the habitat and nesting site of Sarus Crane. During survey, interaction with the staffs of District Forest Office and local people were made on the distribution and abundance of the Sarus Crane. During reconnaissance survey, the study area has been divided into four blocks (Figure 2).

Block-I: The block I includes two Village Development Committees (Sukrauli and Germi) of the western part of the district adjoining with Rupandehi District. Most of the area is dominated by agricultural field. The Nandan Tal, situated in this block is suitable habitat for many wetland birds.

Block-II: It includes Sanai and Devgaun Village Development Committees (VDC) in the south and western part of the study area. There are a few wetlands, those serve habitat for wetland birds.

Block-III: It includes Badera and Rampur VDCs in which the habitat consists of large area of cultivated lands, a few wetland and grassland. It lies in southern part of study area adjoining with boarder of India.

Block-IV: The block IV includes Somani and Kudiya villages and lie in eastern part of study area. This block consists of some wetlands that are suitable habitat for Sarus Crane.

3.2 Field surveys

3.2.1 Bird survey

Status, distribution and habitat preference of Sarus Crane were determined by road transect surveys. The road transect surveys were carried out from April 2005 to January 2006. The entire study area has been divided into four blocks (Figure 3) for bird survey. A total of six transects, one each in Block-I and II; and two each in Block-III and IV were laid. The length of the road transects were 5.2 km, 9.8 km, 4.9km, 5.8 km, 7.1 km and 7km in transect I, II, III, IV, V and VI respectively.

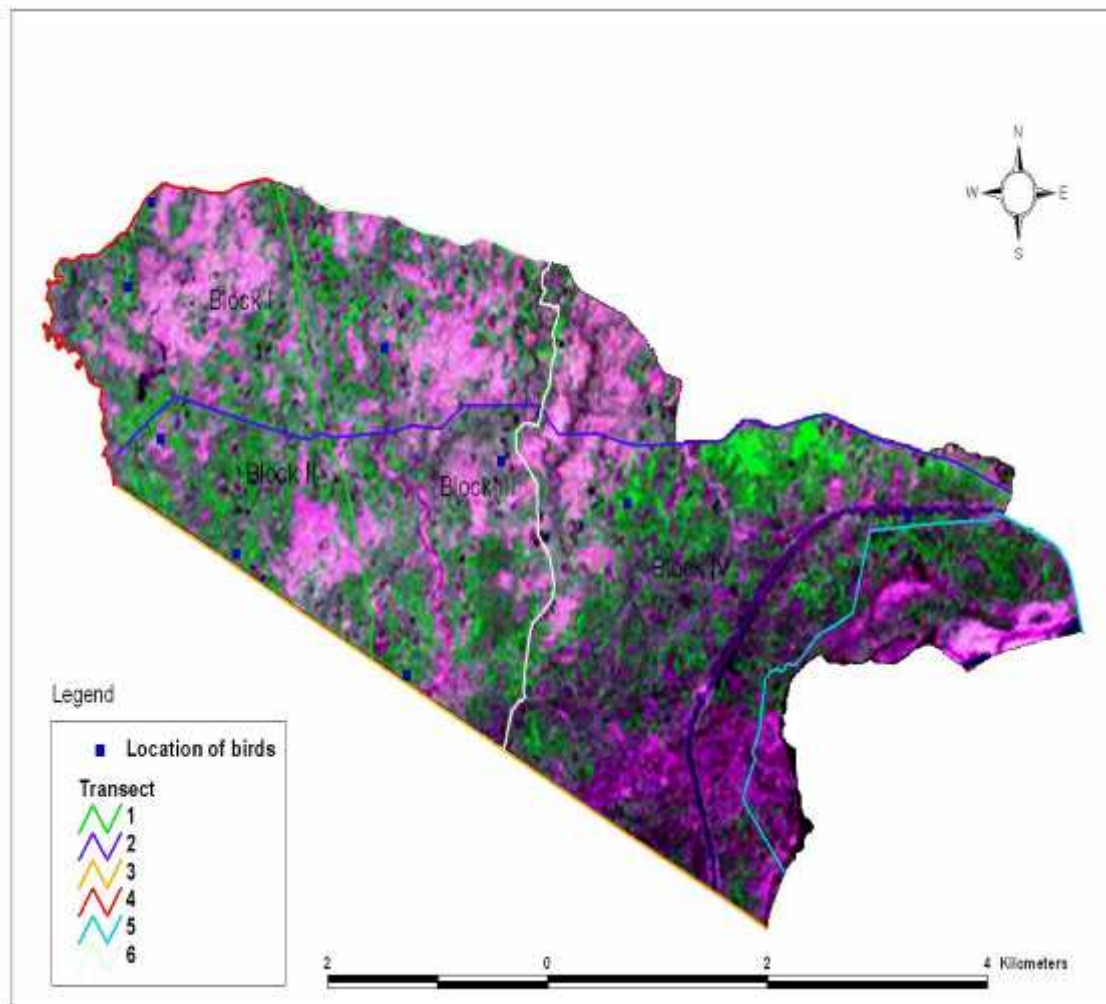


Figure: 8 Map showing transects in different blocks.

Road transects are often perceived as sources of disturbance to many birds species, although they are often used to census bird population (Sunder, 2005, Arnold 1994). Because of low level of traffics on the roads in the study area, assumed there was no disturbance on the Sarus Crane. Road surveys were carried out from 2nd to 7th of each month from April to January by bicycle. Everyday, I had visited and counted birds from all blocks. During transect survey bird presence of 250 m on either side of the road was monitored using binocular. Information on the number (single, pairs or families) and habitat types of each location of the Sarus Crane were recorded. The highest number counted in a day during six days period was used as total population for a month.

3.3 Distribution Pattern

The distribution of Sarus Crane in the Western Part of Nawalparasi districts was determined by analyzing the data collected during the transect surveys.

3.4 Habitats

3.4.1 Habitat Types

The entire habitat of the study area has been classified into different category on the basis of land cover types. The land cover map was prepared by using topographic maps of HMG/N and Landsat ETM Image of 2001. Geographical information system software Arcview 3.3 was used for spatial data analysis. The topo map was scanned and geo- referenced, and the georeferenced map was digitized using Arc View.

3.4.2 Habitat Use

The habitat use of the Sarus Crane was evaluated in cultivated land, wetland and grassland for pre nesting, nesting and post nesting stage. The presence of Sarus Crane was determined through transects surveys. The standing, foraging or showing other social activities by the Crane were recorded as the presence of bird

in specific habitat types. Habitat preferences were evaluated by comparing frequency distribution of animal locations on different habitat types with size of particular habitat types within the study area. The habitat use was taken by total number of Sarus Cranes observed during study period.

3.5 Nesting

The nest surveys were made to locate nest and nesting sites through the permanent transects during the nesting period of 2005 and 2006. The location, distance to nearest upland, shrubs, trees and houses or settlement, water depth around the nest and size of the nest (length, breadth and height) were determined for each observed nest.

3.6 Questionnaire Survey

Questionnaire survey to the local people, teacher, farmer and officers of District Agricultural Development Office Nawalparasi was carried out to know their views towards Sarus Crane (Annex: 2). Questionnaire deals about the Sarus Crane sighting, status, threats and conservation issues. Survey was carried out in the study area in all potential area of Sarus Crane habitat for knowing the perception of local people regarding its population status. The questionnaire surveys were conducted in Sukruali- 1, Sanai-5, Rampur-3 and Kudia 5. Total population of these wards was 2917. Among them 20% respondents were selected randomly for survey.

3.7 Data Analysis

The collected data were categorized and tabulated to determine distribution pattern, population status, habitat preference and nesting characteristics of Sarus crane.

3.7.1 Variance to Mean Ratio (S^2/\bar{X})

Data on animal location such as number of individuals, recorded in each habitat type were used to determine distribution pattern. The distribution pattern of the Sarus Crane was calculated by variance to mean ratio (Odum, 1971) which is based on the fact that in Poisson distribution, the variance (S^2) is equal to the mean.

If $S^2/\bar{X} < 1$, distribution is uniform

If $S^2/\bar{X} = 1$, distribution is random

If $S^2/\bar{X} > 1$, distribution is clumped

3.7.2 Chi – Square test for goodness of fit (χ^2)

A Chi- square goodness of fit test was carried to determine whether the individuals of the Sarus crane were distributed according to the availability of habitat types. The test was performed by setting the hypothesis that the Sarus crane was uniformly distributed in all habitat types. The hypothesis was tested at 1% and 5% level of significance.

Under H_0 , the test statistic is given by

$$\chi^2 = \frac{(O - E)^2}{E} \sim (n-1) \text{ df} \dots\dots\dots i$$

When, O = Observed frequency

E = Expected frequency

3.7.3 Population density

To determine the population density of the Sarus crane visibility area was included for the calculation and only visual records were included for calculation.

3.7.4 Spatial Analysis

Spatial analysis of habitat characteristics, use and preference was done by using Geographic Information System Software Arc view 3.3.

4. RESULTS

4.1 Distribution Pattern

The Sarus Cranes are recorded from the South- western part of the Nawalparasi districts. Daunne forest divided the Sarus Crane habitat into two parts. The Sarus Crane were distributed in all VDC, south of the east west highway, but not recorded from the eastern part of district. In Germi, Sanai, Rampur and Kudiya VDCs, the Sarus Cranes are recorded throughout the year and in Sukrauli, Hakui Devgaun, Badera and Somani, the Sarus Crane occurred only in July to August.

The distribution pattern of the Sarus Crane in Western part of Nawalparasi showed clumped pattern in pre nesting ($s^2/\bar{x} = 3.18$), nesting ($s^2/\bar{x} = 8.68$) and post nesting ($s^2/\bar{x} = 1.18$) stage. The variance/mean ratio is found to be significantly greater than 1. From the calculation we found $\chi^2 = 23.53$, the tabulated value of χ^2 at 1% and 5% level of Significance is 11.34 and 7.82. Since, cal. $\chi^2 > \text{tab } \chi^2$ at 1% and 5% so uneven distribution of Sarus Crane was found.

4.2 Population Size

Population of Sarus Crane was found quite dynamic. The population size ranged between 13 individuals in May, December and January, to 18 individuals in September. The mean population was 14.7 individuals during study period. The total number 147 individuals were counted in prenesting, nesting and postnesting stage.

Table 1 Number of Sarus crane recorded in different months

| Months | No. of birds |
|-----------|--------------|
| April | 14 |
| May | 13 |
| June | 14 |
| July | 14 |
| August | 16 |
| September | 18 |
| October | 17 |
| November | 15 |
| December | 13 |
| January | 13 |
| Total | 147 |
| Mean | 14.7 |

The population of Sarus Crane is 15 individuals (Table 1). The estimated population density of the Sarus Crane was 0.059 individuals in per sq. km. During the study period, Sarus Cranes were observed in single, pair or families (Table 2). Mostly Sarus Cranes were observed in pair; the maximum 36 individuals were in pre nesting stage similarly minimum 7 individuals were observed in nesting stage.

Table 2 Recorded population of the Sarus Crane by seasons

| S. N. | Season | Single | Pair | Family | Total |
|-------|--------------|--------|---------|--------|-------|
| 1 | Presenting | 9 | 18 (36) | 4 (10) | 55 |
| 2 | Nesting | 7 | 13 (26) | 3 (18) | 51 |
| 3 | Post nesting | 11 | 8 (16) | 3 (14) | 41 |

Note: Figures in parenthesis represent number of individuals for pair and family column

4.3 Habitat

4.3.1 Habitat classification

Based on the land cover map and field level investigation of vegetation 3 types of habitat have been identified in the study area (Table 3).

Table: 3 Habitat/land use types in the study area

| Habitat types | Area (sq. km.) | Percentage |
|-----------------|----------------|------------|
| Cultivated land | 238.13 | 96.38 |
| Wetland | 7.64 | 3.092 |
| Grassland | 1.28 | 0.52 |
| Total | 247.05 | 100 |

4.3.1.1 Cultivated land

Cultivated land is occupied by 96.38% in the study area. Cultivated land means land that has been cleared, improved and prepared to raise agriculture crops. The main crops like rice, wheat, maize, cereals and pulses are cultivated in the cultivated land. Due to increase in the human population in rural areas and the agricultural land of the district has been converted into village settlement, housing, industrialization and other development activities reduce the cultivated land that cause loss of wildlife habitat.

4.3.1.2 Wetland

About 3.092% of total study area occupied by wetland. The wetland of study area are ponds, rivers which are suitable habitat for Sarus Crane and some important wetlands in the study area are khairani river flooded area (4500ha), Nandan wetland (60ha), Hulasi wetland (70ha), Dhanewa wetland (500ha), Gandak barrage(500ha), Narsahi wetland (50ha) Bhumahi river (3800ha) and Bhutaha tal (10ha). Generally, wetland are lands where saturation with water is the dominated

factor determining the nature of soil development and the types of plant and animal communities living in the soil and on its surface. Due to increase in population that demand more land for production of agricultural crops so that some of the wetland are Government but local people claim that is their own property and they are cultivated agricultural crop especially the adjoining land owner encroaches the wetland.

4.3.1.3 Grassland

In study area, grassland occupied 0.52% in the bank of river like Turia River and Jharahi River. Grassland is the land covered with grass and used for cattle graze. Grassland also gives good habitat for Sarus Crane. Due to overgrazing, most of grassland are degraded that caused loss of Sarus Crane habitat.

4.3.2 Habitat Use

4.3.2.1 Foraging habitat Use and Preference

The habitat use of Sarus Crane was based on the analysis of all the observation of the species during 6 day visit (2nd to 7th) of each month from April, 2005 to January, 2006. Sarus Crane intensively used wetlands followed by cultivated lands and grasslands throughout year for foraging purpose.

Table: 4 Frequency of Habitat Use by Sarus Crane in Western Part of Nawalparasi District, (2005 -2006)

| Nesting stage | Wetland | Cultivated land | Grassland | Total |
|---------------|---------|-----------------|-----------|-------|
| Pre-nesting | 194 | 72 | 14 | 280 |
| Nesting | 157 | 90 | 10 | 257 |
| Post-nesting | 113 | 85 | 4 | 202 |

During the survey period most of the activities of the Sarus Crane were recorded from the wetlands followed by cultivated areas and grasslands. In wetlands and grasslands, the Cranes activities were higher in pre-nesting period, while in the cultivated area frequency of observation was high during nesting period.

4.3.3 Nesting Habitat

A total of 7 nests recorded in western part of Nawalparasi districts. Sarus Crane nests mainly on wetlands, cultivated land and grassland (Table 5). Among these four nests were analyzed. Sarus Cranes preferred to build nests chiefly in the wetlands (57.14%), cultivated land (28.57%) and grassland (14.28%).

Table: 5 Nesting habitat preference of Sarus Crane

| Nest habitat | Total Nest |
|------------------|------------|
| Cultivated Field | 2 |
| Wetlands | 4 |
| Grasslands | 1 |

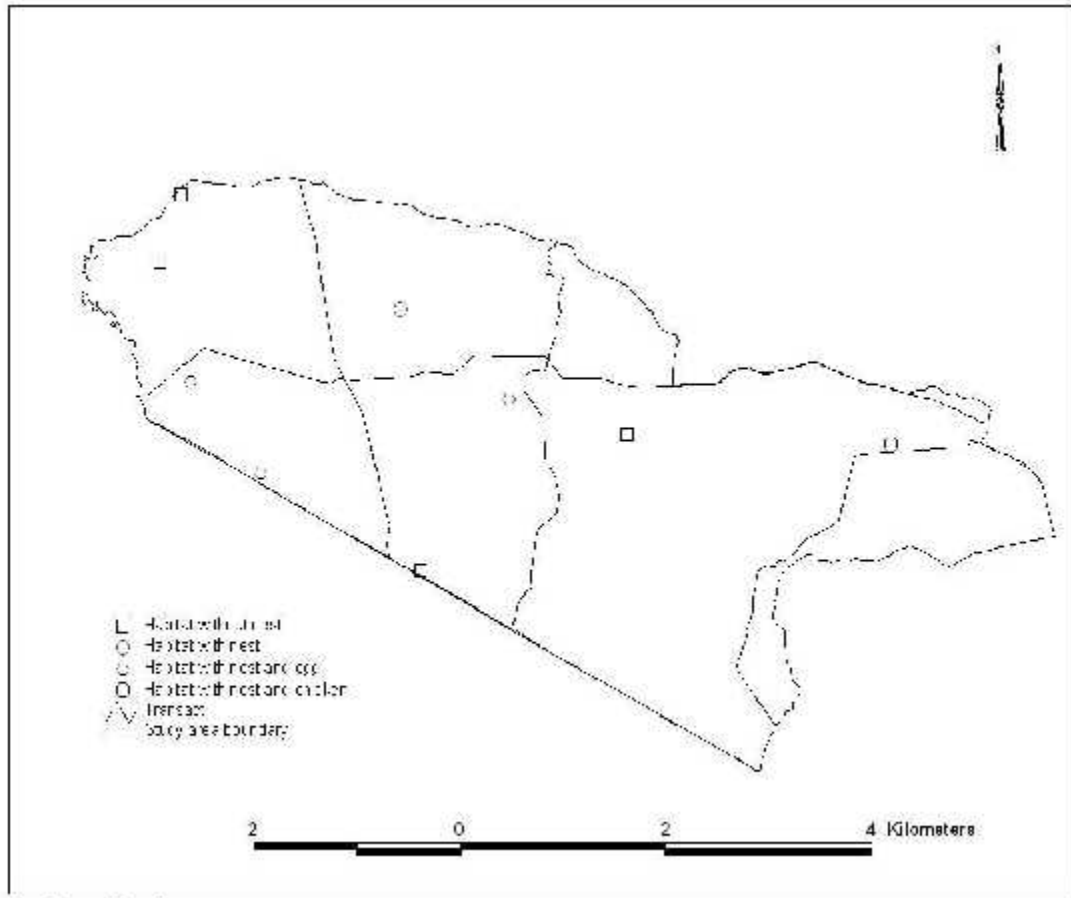


Figure 9 Map showing location of nest sites

4.3.3.1 Nest Location

Sarus Cranes prefer to build their nest far from settlements and trees. The mean distance from the nearest upland, distance to shrubs, distance to house, distance to tree and depth of water was 14.42m, 4.86m, 208.73m, 93.12m and 0.32m respectively. The highest distance of upland from nest was 15.22m and least distance was 4.10m. Highest distance of nest from shrub was 5.38m, least distance 4.10m. Similarly highest distance of house from nest was 214.64m and least distance 196.64m. The highest distance of tree from nest was 98.64m and least distance 87.31m. Similarly maximum depth of water was 0.34m and least depth 0.29m. Sarus Crane prefers to build nest near shrubs and away from settlement

areas. Sarus Cranes build their nest near shrubs. The mean water depth around the nest area was 0.32m (table 6).

Table: 6 Distance to nearest uplands, Shrubs, Trees, and House

| S.N | Distance to nearest | | | | Water depth (m) |
|----------------|---------------------|-----------|-----------|----------|-----------------|
| | Upland (m) | Shrub (m) | House (m) | Tree (m) | |
| N ₁ | 15.22 | 5.23 | 212.56 | 90.66 | 0.29 |
| N ₂ | 13.56 | 4.10 | 210.78 | 95.87 | 0.34 |
| N ₃ | 14.42 | 4.75 | 214.64 | 98.64 | 0.31 |
| N ₄ | 14.48 | 5.38 | 196.64 | 87.31 | 0.34 |
| Mean | 14.42 | 4.86 | 208.65 | 93.12 | 0.32 |

4.3.3.2 Nest Dimension

The Sarus Crane built oval and dome shaped nest with grasses, leaves, roots, herbs, shrubs and paddy plants. The mean length, width and depth of nest were 121.23cm, 101.41cm and 20.28 cm respectively (Table: 7).

Table: 7 Nest Dimension

| Nest dimension | N ₁ | N ₂ | N ₃ | N ₄ | Mean |
|------------------|----------------|----------------|----------------|----------------|--------|
| Nest length (cm) | 125.45 | 130.15 | 96.69 | 132.65 | 121.23 |
| Nest width (cm) | 102.62 | 95.68 | 84.42 | 122.95 | 101.41 |
| Nest depth (cm) | 18.76 | 20.28 | 21.22 | 20.86 | 20.28 |

A total of 8 eggs were observed from 7 nests. The hatching success was observed to be 25% (Table: 8).

Table: 8 Status of nest

| Blocks | Number of nests | Number of eggs | Hatching success |
|----------|-----------------|----------------|------------------|
| Block- 1 | 1 | 2 | 0 |
| Block-2 | 2 | - | - |
| Block-3 | 1 | 2 | 0 |
| Block-4 | 3 | 4 | 2 (chicken) |
| Total | 7 | 8 | 2 |

4.4 Habitat Preference

The Sarus Crane preferred wetlands. About 3 % of the total area covered by wetlands but the frequency of habitat use by the Cranes was 33.96 %. Similarly, grasslands have second importance for habitat preference, but the cultivated area has least importance (Table 9).

Table: 9 Habitat Use by the Sarus Crane in the Western Part of Nawalparasi District, Nepal (2005 – 2006)

| Habitat type | Available habitat | | Frequency of utilization (%) |
|------------------|-------------------|------------|------------------------------|
| | km ² | Percentage | |
| Cultivated lands | 238.13 | 96.38 | 62.52 |
| Wetlands | 7.64 | 3.092 | 33.96 |
| Grasslands | 1.28 | 0.518 | 3.52 |

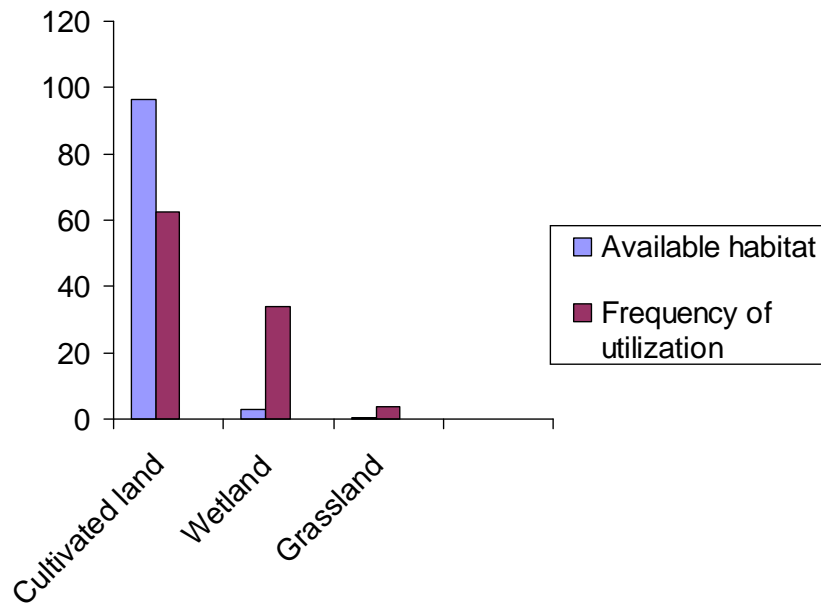


Figure: 10 Habitat Preference of the Sarus Crane in Western Part of Nawalparasi District, 2005 -2006

4.6 Conservation threats and measure

Land use change and high pressure in wetland are major threats to Sarus Crane in the Nawalparasi district. Other threats include overexploitation of wetland resources, wetland pollution, drainage of water, wetland loss and degradation due to expansion of agriculture, use of pesticide/insecticide and chemical fertilizers.

About 60% of local people believe that the number of Sarus Crane is decreasing due to increase in population that demand more land for the production of agricultural crops. Sarus Crane territories are found alongside human associated disturbance that causes strong effect on the breeding and nesting pattern for the birds. Stealing of eggs, hunting and poaching are the primaries threatening cause of Sarus Crane.

5. DISCUSSION

Germi, Sanai, Rampur and kudiya are considered as the important site for the existence of Sarus Crane. Nandal Tal and floodplains of Khaireni River supports relatively good number of the Sarus crane. Shrestha (1996) reported the distribution of Sarus Crane concentration is higher in central region at Rupandehi Districts. The Cranes are seasonal in distribution in Sukrauli, Hakui, Devgaun, Badera and Somani.

The distribution of Sarus Crane in Western part of Nawalparasi district was differ in different season prenesting ($S^2/\bar{X} = 3.188$), Nesting ($S^2/\bar{X} = 8.86$) and post nesting ($S^2/\bar{X} = 1.187$) stage. The distribution pattern of the Crane was uneven or clumped due to uneven distribution of resources such as food, water and shelter; and human settlements. Clumped pattern of distribution is common in nature, almost the rule when individuals are considered (Odum, 1971).

The population size of Sarus Crane was small fluctuated from 13 individuals during May, December and January to 18 individuals in September with mean 14.7 individuals. Shrestha (1996) had counted 128 and 131 individuals of Sarus Crane in Rupandehi and Kapilbastu district respectively, using accessible road. Monthly variation of Sarus Crane population could be correlated with habitat status, climatic conditions as well as availability of food. Local migration towards the Rupandehi districts and India has been reported for the seasonal fluctuation. Seasonal linear diurnal movement appears to be the main cause of monthly population fluctuation of the Sarus Crane, Such movements are greater during the pre-nesting period or summer seasons in search of suitable nesting place and low level of movement during nesting and post nesting periods are due to their commitment to incubate the eggs and raise their offspring (Suwal, 1999).

The Sarus Cranes were observed in single, pair and families in different seasons in the habitat consisting of wetlands, agricultural fields and grass lands. Sunder (2000) also reported that the mosaic of wetlands and agricultural fields has perhaps contributed to the healthy population of Sarus Crane in single, pair and families in the districts of Etawah and Mainpuri in Uttar Pradesh, India. Walkinshaw (1973) studied four separate pairs during nesting at Keoladeo Ghana National park, the four pair establishes separate territories from 40 to 60 ha.

The population density of Sarus Crane in Western part of Nawalparasi districts was very low (0.059/km²). The estimated population density of Sarus Crane in Lumbini was 0.6 individuals per sq. km (Suwal, 1999). Parasharya *et al.* (1996) also estimated density 0.314 birds per sq. km. in the irrigated paddy growing area of Kheda district Gujrat, India. The low population density can be attributed to the lack of suitable habitats particularly large wetlands. Over 95 % of the study area are occupied by agricultural fields, that are prone to human disturbances throughout the, appear to be another cause for low population density.

The Sarus Crane found to be used all available habitats but to the frequency of habitat use was higher in wetlands in relation to the proportion of the habitat. As a water bird, the Sarus Crane was observed with high frequency in the wetlands that provide water and food throughout the years. They also used the grasslands located at the edge of the river or other body and cultivated fields for the foraging purpose. The Sarus Crane (*Grus antigone antigone*) occasionally seen in the damp cultivated field and usually lives in pair and sometimes seen in a flock of 40-60 during pre nesting season (Suwal, 1999). The habitat use of the Sarus Crane depends on food availability, cropping pattern and other seasonal factors (Mukherjee *et al.*, 2001). Ali and Ripley (1980) reported that the Sarus Crane inhabits in open, cultivated, well water plains, marshlands and jheels.

The frequency of observation was higher in wetland and grassland during the pre-nesting period, while in the cultivated land they were more abundant during nesting period. In western part of Nawalparasi 280, 257 and 202 individuals found in pre-nesting, nesting and post nesting period respectively. Suwal (1999) also made similar observation in Lumbini with the frequency distribution of Sarus Crane as 404, 354 and 401 in pre-nesting, nesting and post nesting stage respectively. During post nesting period, the cranes are moved out in search of suitable habitat and food. The cultivated habitat provides relatively good foraging conditions during the nesting period.

Among the 7 nests, 57.24% were observed in wetland, 28.75% in cultivated land and 14.28% in grassland. The number of nests located in the Nawalparasi was very smaller than the Lumbini area, where Suwal (1999) identified 24 nesting locations, among these 38% were in paddy fields, 33% in ponds, 25% in flooded grasslands and 4% in the flooded tree plantation. Parasharya *et al.* (1996) observed the Sarus Crane while building their nest in the paddy field, the nesting pair uprooted 10-50 sq. m. freshly transplanted paddy plants.

Sarus Crane built oval and dome shaped nest with grasses leaves, roots, herbs, shrubs, paddy plant and radius of top of nest was 0.4m. Nest is a huge collection of rushes, reeds and straw about a meter in diameter (Archibald and Mirande, 1985). Ali and Ripley (1983) described the nest of Sarus Crane as a huge pile of reeds, rushes and straw about a meter in diameter at the top. Iquable (1992) observed a floating huge pile of vegetation, the radius on the top was 0.8 meter. The mean length, width and height of the nest were 121.23 cm, 101.41 cm and 20.28cm respectively. Suwal (1999) estimated the mean length, width and height of the nest were 103.73cm, 86.38cm and 26.50cm respectively. Walkinshaw (1973) recorded the average height of Sarus Crane nest above the water to the nest rim was 17cm (3 to 25 cm). Gole (1991a) recorded that the size of the nest territories ranges from 1ha in a populated area to 27 ha within protected area.

The Sarus Crane preferred to build their nest near the Shrubs (4.84m) and away from human settlement (208.75m). The mean depth at water surroundings the nest was 0.32 m. Suwal (1988) observed water depth at Lumbini area was 24.75cm deep. Walkinshaw (1973) observed the water depth at Keoladeo Ghana Sanctuary was about 12-18 inches, deep.

The habitat destruction of Sarus Crane was the main cause to reduce the number of Sarus Crane rapidly. Change in land use and loss of natural wetlands are regarded as the most serious threats to this species where other include the mortality due to collision with high tension, electric cable, indiscriminate use of pesticides hunting, egg stealing, capturing of adult birds for the pet trade and disturbance by the farmer in the fields during the nesting period (Gole, 1989, Parasharya, *et al.*, 1989, Muralidharan, 1992, Meine and Archibald, 1996, Sunder *et al.*, 1999). Due to the lack of appropriate policies, people participation is shaded and conservation authority is not dealing people correctly and People themselves are also not taking any interest in the conservational task. Local People are not conscious to the wildlife and environment. So they don't care about Sarus Crane that reduced the number of Sarus Crane rapidly. Lack of the conservation education and conservation awareness activities are not practically implemented.

6. CONCLUSION AND RECOMMENDATION

Sarus Crane is found in the wetland of Western Terai of Nepal. In Western part of Nawalparasi district a small and very sparsely distributed population of the Sarus Crane existed in the wetland, cultivated land and grassland. They are seasonal and clumped in distribution.

The population density of Sarus Crane in Western part of Nawalparasi districts was very low ($0.059/\text{km}^2$) due to lack of suitable habitats particularly large wetlands and excessive human disturbances in the agricultural fields. The population size of Sarus Crane was small fluctuated from 13 to 18 individuals during the study period due to the change in habitat status, climatic conditions as well as availability of food. Local level seasonal linear movement appears to be the main cause of monthly population fluctuation of the Sarus Crane. Such movements are greater during the pre-nesting period or summer seasons in search of suitable nesting place.

The Sarus Crane was found to use all available habitats, but analysis of the proportions of available habitat and frequency of use clearly indicated that the Sarus Crane preferred wetlands followed by grasslands and cultivated lands. The wetlands provide water, food, nesting and shelter to the bird. Cultivated land has low habitat value because of human disturbances and lack of water during the dry season. They also used the grasslands located at the edge of the river or other body and cultivated fields for the foraging purpose. Similarly, the Sarus Crane highly preferred the wetland for nesting purpose.

Sarus Crane built oval and dome shaped nest with grasses leaves, roots, herbs, shrubs, paddy plant and radius of top of nest was 0.4m. The mean nest length, width and height of the nest were 121.23 cm, 101.41 cm and 20.28cm respectively. They usually built nest far from the settlements.

The population of Sarus Crane is reported to be declining due to land use change particularly conversion of wetlands into the agricultural lands and drainage of water, lack of awareness, use agro-chemicals, over exploitation of wetland resources, sugarcane cultivation and disturbances in the foraging and nesting places. Some of the local people have negative attitude towards the Sarus Crane because they believe the bird destroys the cultivated paddy crop.

Following are some of the recommendations, which could possibly be helpful in order to manage the residual population of the Sarus Crane in the Nawalparasi district.

1. The population size of the Sarus Crane in the Nawalparasi district is very small and sparsely distributed, thus it is essential to monitor them to understand the population dynamics and movement.
2. Further research on the feeding ecology, breeding behaviour and ranging patterns are most urgently needed to manage the Sarus Crane. Application of radio telemetry and Geographical Information System (GIS) is beneficial to study the ecology and habits of Sarus Crane.
3. The wetlands in the Nawalparasi district should be protected or restored to save the Sarus Crane and other water birds from local extinction.
4. Local people should be discouraged to use agrochemical, and unauthorized harvesting and encroachment wetland resources.

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ANNEX-I

Maximum and minimum Temperature record from Simari station of Nawalparasi District, from 1997 to 2004.

| | | years | | | | | | | | |
|-----------|----------|-------|------|------|------|------|------|------|------|------|
| Months | Max./Min | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | Mean |
| January | Maximum | 22.7 | 18.8 | - | - | - | 22.6 | 15.8 | 21.7 | 20.3 |
| | Minimum | 7.6 | 9 | 2.5 | 11.8 | - | 7.3 | 8 | 8 | 07.7 |
| February | Maximum | 26 | 26.1 | - | - | - | 25.2 | 24.5 | 25.5 | 25.5 |
| | Minimum | 8.4 | 11.9 | 6.8 | 14.2 | - | 11.1 | 10.6 | 12.5 | 10.8 |
| March | Maximum | 31.7 | 28.5 | - | - | - | 31.2 | 28.7 | 31.5 | 30.3 |
| | Minimum | 14.4 | 14.1 | 12.3 | 13.8 | - | 15 | 13.9 | 14.4 | 14.0 |
| April | Maximum | 34.2 | 35.1 | - | - | - | 34.9 | 35.7 | 35.3 | 35.0 |
| | Minimum | 18.9 | 23.7 | 22 | 22.9 | - | 21.1 | 23.5 | 20.5 | 21.8 |
| May | Maximum | 38.1 | 41.1 | - | - | - | 34.5 | 34.6 | 36.7 | 37.0 |
| | Minimum | 22.7 | 30.2 | 27.1 | 27 | - | 27.2 | 23 | 27.4 | 26.4 |
| June | Maximum | 40.5 | 40.9 | 41.5 | 38.3 | - | 34.9 | 37.4 | 40 | 39.1 |
| | Minimum | 26.8 | 27.7 | 29.1 | 27 | - | 27.6 | 23.7 | 28.5 | 27.2 |
| July | Maximum | 38.2 | 33.3 | 40.5 | 36.7 | - | 34.6 | 34.1 | 40.4 | 36.8 |
| | Minimum | 36.4 | 25.2 | 29.3 | 27 | - | 27.6 | 25 | 28 | 26.9 |
| August | Maximum | 34.9 | 20.6 | 38.5 | 33 | - | 33.6 | 33.2 | 36.6 | 33.0 |
| | Minimum | 25.4 | 21.7 | 25 | 26.4 | - | 26.8 | 26 | 27.1 | 25.5 |
| September | Maximum | 33.3 | 28.9 | 35.5 | 32.4 | - | 31.2 | 33.5 | 34.5 | 32.8 |
| | Minimum | 24.8 | 19.5 | 19.5 | 24.5 | - | 24.9 | 24.9 | 26.5 | 23.5 |
| October | Maximum | 31.3 | 27.3 | 34 | 31.8 | - | 32.5 | 32.5 | 31.5 | 31.7 |
| | Minimum | 18.4 | 17.2 | 12.3 | 20.7 | - | 20.4 | 20.3 | 21.5 | 18.7 |
| November | Maximum | 27.8 | 25.9 | 27 | 26.4 | - | 29.6 | 28.3 | 29 | 27.7 |
| | Minimum | 14 | 17.4 | 11.9 | 17 | - | 14.6 | 14.5 | 18.5 | 15.4 |
| December | Maximum | 21.1 | 24.6 | 20.5 | 22.7 | - | 23.5 | 22.2 | 20.2 | 22.1 |
| | Minimum | 9.8 | 11.2 | 9.2 | 8.3 | - | 10.3 | 8.3 | 11.3 | 9.8 |

Relative Humidity recorded from Simari station of Nawalparasi District, from 1997 to 2004 at 8:45AM and 17:45 PM.

| | | Years | | | | | | | | |
|-----------|-------|-------|------|------|------|------|------|------|------|------|
| Months | | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | Mean |
| January | 8:45 | 96 | 91 | 94 | 81 | - | 88.9 | 95.9 | 92.3 | 91.3 |
| | 17:45 | 87 | 91 | 90 | 82 | - | 93.3 | 88.2 | 91.5 | 89.0 |
| February | 8:45 | 84 | 86 | 88 | 85 | - | 86.8 | 87.5 | 89.5 | 86.7 |
| | 17:45 | 78 | 78 | 87 | 83 | - | 84.4 | 86.8 | 90.6 | 84.0 |
| March | 8:45 | 71 | 88 | 84 | 83 | - | 74.1 | 76.3 | 89.6 | 80.3 |
| | 17:45 | 66 | 80 | 87 | 86 | - | 78 | 77 | 90.8 | 79.3 |
| April | 8:45 | 62 | 79 | 87 | 83 | - | 71.1 | 72.4 | 88 | 77.5 |
| | 17:45 | 62 | 81 | 87 | 82 | - | 78.8 | 72.2 | 90.1 | 79.0 |
| May | 8:45 | 68 | 69 | 80 | 83 | - | 80.6 | 71.7 | 87 | 77.1 |
| | 17:45 | 68 | 89 | 85 | 81 | - | 73.8 | 88.8 | 88.5 | 79.1 |
| June | 8:45 | 73 | 73 | 88 | 84 | - | 88.1 | 68.5 | 80 | 79.2 |
| | 17:45 | 67 | 73 | 87 | 83 | - | 62.4 | 87.4 | 83.8 | 77.7 |
| July | 8:45 | 79 | 87 | 89 | 86 | - | 86.5 | 79.5 | 88.8 | 85.1 |
| | 17:45 | 77 | 86 | 90 | 87 | - | 83.6 | 88.6 | 84.5 | 85.3 |
| August | 8:45 | 85 | 90 | 90 | 84 | - | 82 | 84.3 | 89.3 | 85.4 |
| | 17:45 | 85 | 91 | 92 | 86 | - | 85.1 | 82 | 88.6 | 87.1 |
| September | 8:45 | 85 | 87 | 81 | 83 | - | 84.9 | 86.6 | 90 | 85.4 |
| | 17:45 | 85 | 89 | 84 | 90 | - | 88.4 | 83.3 | 86 | 86.5 |
| October | 8:45 | 81 | 87 | 80 | 81 | - | 79.6 | 82.1 | 85.4 | 82.3 |
| | 17:45 | 85 | 88 | 80 | 80 | - | 85.7 | 80.9 | 85 | 83.5 |
| November | 8:45 | 88 | 89 | 83 | 90 | - | 79.8 | 82.8 | 81 | 84.8 |
| | 17:45 | 88 | 89 | 81 | 90 | - | 75 | 89.8 | 82 | 85.0 |
| December | 8:45 | 92 | 87 | 86 | 89 | - | 87.2 | 85.6 | 85 | 87.4 |
| | 17:45 | 92 | 87 | 86 | 90 | - | 88.3 | 90.3 | 86.0 | 88.5 |

Monthly **Rainfall** in Simari Station at Nawalparasi district (1997 to 2004)

| Months | Years | | | | | | | | |
|---------------|--------------|-------------|-------------|-------------|-------------|-------------|-------------|-------------|-------------|
| | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | Mean |
| January | 23.9 | 18.0 | 15.0 | 0.0 | - | 62.5 | 51.0 | 0.0 | 24.4 |
| February | 0.0 | 27.0 | 0.0 | 0.0 | - | 33.0 | 42.0 | 0.0 | 14.6 |
| March | 2.5 | 27.5 | 0.0 | 0.0 | - | 0.0 | 62.5 | 5.4 | 14.0 |
| April | 49.5 | 62.0 | 0.0 | 209.0 | - | 32.0 | 15.0 | 60.0 | 61.1 |
| May | 122.0 | 76.0 | 90.0 | 333.0 | - | 125.0 | 452.0 | 245.0 | 206.2 |
| June | 214.0 | 199.0 | 476.0 | 745.0 | - | 297.0 | 60.0 | 240.5 | 318.8 |
| July | 413.5 | 1017.0 | 686.0 | 453.5 | - | 797.0 | 733.0 | 1070.0 | 738.6 |
| August | 415.5 | 975.5 | 646.0 | 426.0 | - | 261.5 | 696.5 | 648.8 | 581.5 |
| September | 151.5 | 79.0 | 199.0 | 210.5 | - | 0.0 | 172.5 | 68.3 | 125.8 |
| October | - | 14.0 | 178.0 | 10.0 | - | 0.0 | 38.5 | 40.6 | 44.5 |
| November | 16.0 | 0.0 | 40.0 | 0.0 | - | 22.5 | 0.0 | 0.0 | 11.2 |
| December | 107.5 | 0.0 | 59.0 | 0.0 | - | 0.0 | 0.0 | 0.0 | 23.8 |

Interview form for Sarus Crane:-

1) Respondents / Name: -

Age:-

VDC/Village/District

2) Occupation.

3).Information based on Sarus Crane.

Do you know Sarus Crane? Y/N

Have you seen the Sarus Crane?

-Where.....

-How many.....

-When.....

4).Do you know about traded of Sarus Crane?

Which part: - eggs...../ body..... live/ death.

5). Do you know about its population trend increase or decrease or same in recent years?

If Increase: - Previous..... Recent

Decrease: - Previous Recent.....

6).What is your opinion about Sarus Crane? Good / bad

Why:

7). Do you know Sarus Crane being killed by human/ animal in your area?

If yes

By whom

Why

8).Does it damage the agriculture crops? If yes

Which crop..... When..... How.....

9). Do you need compensation when crane damage your crop? Y/N if yes
what type of compensation

10).Where is it live in your VDC? Farmland Shrub land
.....

11). Do you look its nest in your VDC? Y/N

If yes When Where.....

12).Do you know in legal status?

13). Does it come in your VDC? Regularly or sometimes When
.....

14) Do you know any INGO or NGO are working for its conservation?

15) What type of pesticides/ fertilizer used by farmers
quantity.....

16) In your opinion what is it's threaten causes.....

17) Do you have any idea for good management of it?

18) Other residing wildlife or birds?

Plate 1: A Pair of Cranes in Nandan Taal

Plate 2: A Crane Watching Food in Pond

Plate 3: A Pair of Cranes Foraging near Nest in
Cultivated Land

Plate 4: A Crane in Grassland

Plate 5: Hulashi Wet Land

Plate 6: A Crane Searching Food

Plate 7: A Pair of Cranes Foraging in Cultivated
Land

Plate 8: Sarus Cranes are flying

Plate 9: A Crane flying in Cultivated Land

Plate 10: Cranes incubating

Plate 11: A Crane Searching Food in Grassland

Plate 12: Sarus Cranes are foraging near nest in
Cultivated Land