Habitat and acoustic survey and an action plan for bats conservation in the Kathmandu Valley, Nepal

First Phase Report

April 2017

Cover Photo:

A Greater Tube-nosed Bat (*Murina leucogaster*) netted over the stream at the edge of dense Bajrabarahi Religious Forest near Chapagaun (Photo by Gabor Csorba). Note: This species is captured after a gap of 129 years since Scully (1887).

Mr. Sanjan Thapa operating SM4BAT ZC at Gujeshowri (Photo: Hari Basnet)

Mr. Thapa operating GARMIN Etrex 10 GPS device (granted by Idea Wild) at Nagarjun Cave (photo: Sagar Dahal)

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Sanjan Thapa

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Executive Summary

Land use and land cover (LULC) of Kathmandu valley has significantly changed since 2000 due to infrastructure development, urbanization by population increment and in-migration. Pattern of land use land cover change of bat assemblage sites as well as possible impact of LULC on bat species assemblage in the area needs to be projected. The aims of the current project are; Carrying out a Phase 1 type habitat survey to determine and map the current land cover to use as a baseline against which future change can be measured; Developing an acoustic call library so that bats can be surveyed and monitored non-invasively; Drafting a local bat conservation action plan based upon the possible impacts of the land cover change. Fifteen sites in Kathmandu Valley were selected.

Phase I habitat survey was conducted. Monitoring survey was conducted during which mist nets were deployed to captured bats. On release of the identified captured bats, echolocation calls were recorded by operating two SM4BAT ZC detectors. The recorded calls were analyzed running Kaleidoscope viewer 4.0 software to procure spectrogram characteristics. The recorded and analyzed calls are used as reference calls for the acoustic monitoring of bats in 15 sites.

Fifteen sites consist of possible good habitats, however, six sites namely; Bajrabarahi, Nepal Academy, Guhyeshwari, Chobhar, Nagarjun and Godawari are best area for bats roosting and foraging. Changes in land use and land cover in near future in these areas may alter the bats assemblage there. In total, 14 bat species were captured from seven sites. Five species were captured Bajrabarahi while four species were captured at Chobhar. *Rhinolophus affinis* was found from three sites, depicting its extended distribution in comparison to others. *Myotis frater* and *Nyctalus lasiopterus* are two new species to the country (to be confirmed). However, bat echolocation could be recorded of seven species from five sites.

Acoustic monitoring will be continued and bat echolocation call library will be established and a local conservation action plan for conservation of bats in Kathmandu Valley will be drafted during the next phase of the project.

Rhinolophus affinis on flight in Nagarjun Cave

1. Introduction

1.1 Background

Land use and land cover (LULC) of Kathmandu valley has significantly changed since 2000 due to infrastructure development, urbanization by population increment and in-migration. LULC change may have affected the bat assemblage in the area lowering the species diversity, altering the distribution pattern and threatening the population. Twenty five species of bats were documented from Kathmandu Valley by Bates and Harrison (1997). However, During the Rufford Small Grants supported project "**Detailed monitoring survey of bats and their conservation through radio awareness programme and outreach programme to school children in Kathmandu** in 2009, only 13 species of bats were re-recorded from ten amongst 20 surveyed sites. Many specific sites and bat habitats were discovered then within Kathmandu Valley. Surprisingly, variation of bats in the re-recorded sites during the two phases of the project was known.

Altogether, 20 school awareness lecture program in 15 sites of the Kathmandu Valley was conducted. Nation-wide radio-awareness programme was successfully broadcast (Thapa et al. 2012). To the continuity of bat conservation in Kathmandu Valley, Bat Conservation International supported a project "**Conservation of bats; an initiative through bat house installation in Kathmandu Valley, Central Nepal"** in 2010. In this project bat house were constructed and installed at 12 sites in Kathmandu Valley. In total, 4000 Posters were printed and disseminated. Lectures on importance of bats and the need of bat house construction and installation were delivered to schoolchildren at three sites namely Tikabhairav, Kalanki and Sunakothi. Also discussion was organized for Sakriya Mahila Samudaik Ban Upabhokta Samuha, Chapagaun, (Active Women Community Forest User Group). Similarly, information was shared to general public (locals) and residents of the other eight sites. Bat house was exhibited at Science Expo-2011 at Tribhuvan University, Kirtipur, Kathmandu (Thapa 2011).

Most of these bat houses are degraded and damaged now. Bats of unknown species roost in the old and abandoned buildings and houses in urban areas of Kathmandu Valley. Due to the recent earthquakes in April 2016, most of these old and abandoned buildings and houses are demolished.

1.2 Objectives

The aims of the current project are;

1. Carrying out a Phase 1 type habitat survey to determine and map the current land cover to use as a baseline against which future change can be measured.
2. Developing an acoustic call library so that bats can be surveyed and monitored non- invasively.

3. Drafting a local bat conservation action plan based upon the possible impacts of the land cover change.

1.3 Rationale

Land use and land cover change (LULC) is one of the significant impulse of environmental change (MEA 2005), influencing occurrence and distribution of biodiversity (Fischer & Lindenmayer 2007). Forest fragmentation, in which the forest is reduced to patches, can be especially important in terms of biodiversity impact. Alteration due to LULC is one of the major reasons for fragmentation of habitats, ecosystems, and landscapes in most parts of the world (Leal et al. 2012; Schleuning et al. 2011); the major causes of forest fragmentation are conversion of forest land to crop land and poor management of activities such as logging and lopping (Crooks et al. 2011). Pattern of land use land cover change of bat assemblage sites as well as possible impact of LULC on bat species assemblage in the area needs to be projected.

Although few surveys were undertaken in Kathmandu valley, there has been no attempt to survey bat assemblage in urban areas of the valley since 1975 (except mist net was suspended in a location mentioned in Myers et al. 2000). Therefore, monitoring of bats in the urban areas was necessary. Also, Bat species diversity needs to be regularly monitored within a gap of 5 years. Hence, 20 previously surveyed sites should be monitored.

Local community residing in the valley have negative attitude to bats, which is a major prevailing threat for the long-term conservation of bats (Koju 2008; Manandhar 2015). However, without better understanding of the ecology and behavior of the bat species present the conservation impact of this is unclear. Although conservation awareness activities such as educating schoolchildren, poster dissemination, documentary shows, and bat boxes installation were carried out, however, an action plan for bat conservation was not prepared yet. The local bat conservation action plan is expected to guide an integrated conservation focused on bats.

2. Study Area

Kathmandu Valley (27°35'00"N 85°15'00"E, 27°50'00"N 85°37'30"E) is comprised of three districts namely Kathmandu, Lalitpur and Bhaktapur Districts. It is an oval shaped, flat bottomed basin valley with hills: Phulchowki, Chandragiri, Shivapuri and Nagarjuna at southern, south western, northern and north western corners, respectively. The study area occupies 395 square kilometers and is situated at an elevation of 1372 m to 2732 m.

Climate in Kathmandu Valley is characteristic temperate, influenced by the tropical monsoon. The average air temperature during summer season varies from 28–30 °C (82–86 °F) to 10.1 °C (50.2 °F) during the winter. The annual rainfall in Kathmandu city is about 1407 mm. The average humidity is 75%. Bagmati and Bishnumati are major rivers of this area with centripetal drainage system. The surrounding hilly area is covered with forest of *Alnus nipalensis, Pinus roxburghii, Prunus spp., Quercus* sps. And bamboo as major vegetation while the fauna like Leopard (*Panthera pardus*), Wild boar (*Sus scrofa*), Common langur (*Semnipethacus entellus*), Rhesus monkey (*Macaca mulata*) etc., numerous volant fauna (bats and birds) are present. It's a religious and tourist attraction centre of Nepal.

The Kathmandu Valley is a cultural and political hub of Nepal (https://en.wikipedia.org/wiki/Kathmandu_Valley). It was inscribed as a World Heritage Site by UNESCO in 1979. The project area comprises approximately 100km^2 and is entirely within the Valley; it contains the Shivapuri Nagarjun National Park (https://en.wikipedia.org/wiki/Shivapuri_Nagarjun_National_Park), 15 community forests, urban and sub-urban areas and agricultural landscape.

2.1 Sites

Altogether, fifteen project sites[1] were selected in urban, sub-urban and country side villages in three districts; Kathmandu, Lalitpur and Bhaktapur. At Kathmandu District, Chobhar and Nagarjun lie at the immediate exterior of the Kathmandu city while Pharping, Machhegaun, Paanimuhan and Sundarijal lie in the country side. Gokarna, Swoyambhu and Gujeshwori lie in the vicinity of the Kathmandu city while Bhrikutimandap and Hattisar (Nepal Academy) lie in the urban area. At Lalitpur District, Godawari and Bajrabarahi lie in the country side. At Bhaktapur District, Nagarkot and Suryabinayak lie in the countryside. Nagarjun, Panimuhan and Sundarijal lies in Shivapuri-Nagarjun National Park.

These sites were selected based upon one of the three features in the vicinity as follows;

1. Presence of caves

[1] Note: Maps and aerial photographs are taken from Bing and a circle of approximately 750m radius has been added to indicate preliminary survey area at each sites.

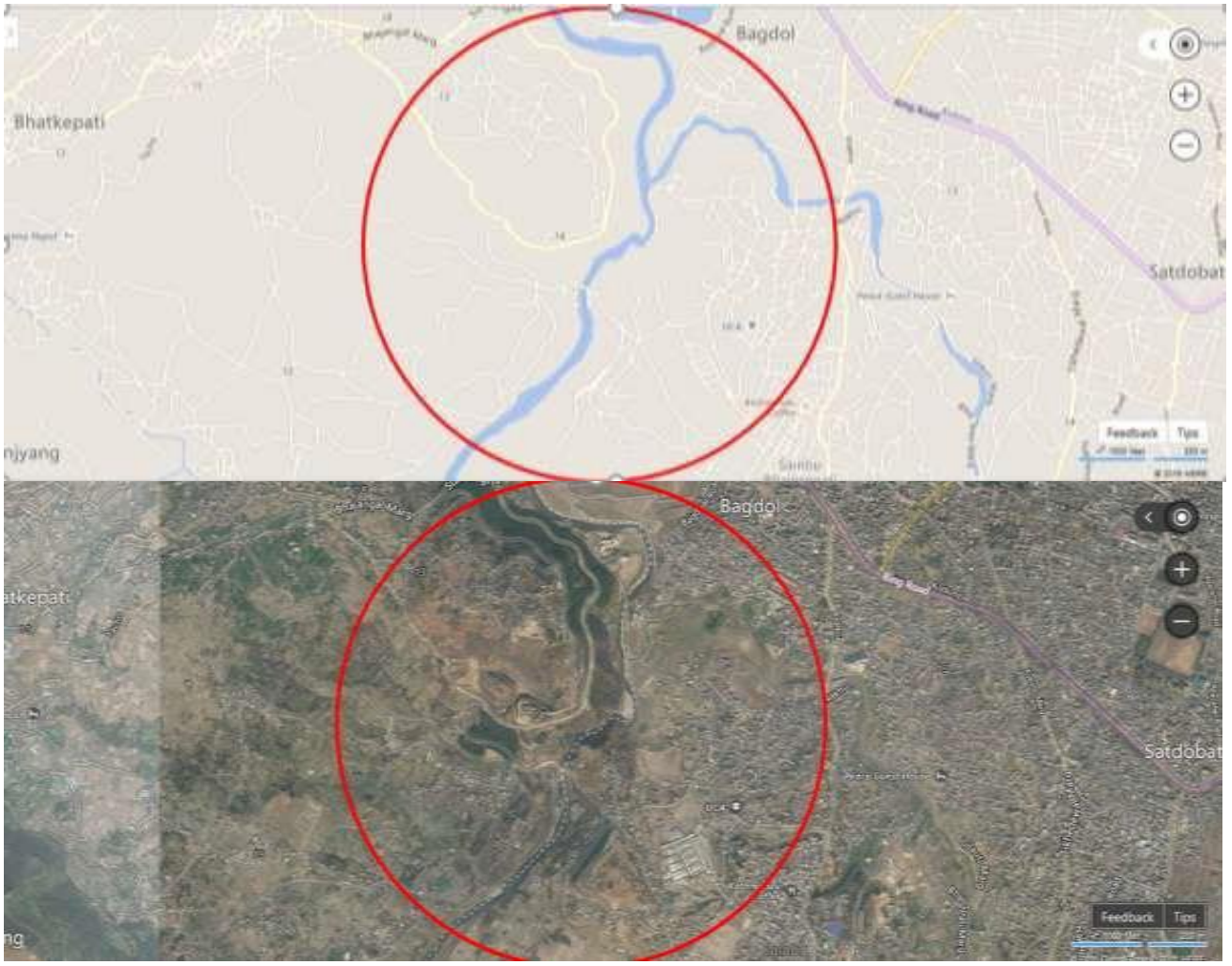
1. Presence of primary forest or plantation
2. Presence of water source

The study site includes different landscapes and ecosystems such as Agricultural field, forests, streams, settlements etc.

2.1.1 CHOBHAR

There is an amenity park called Manjushree Park with grass and sparse trees lies above a

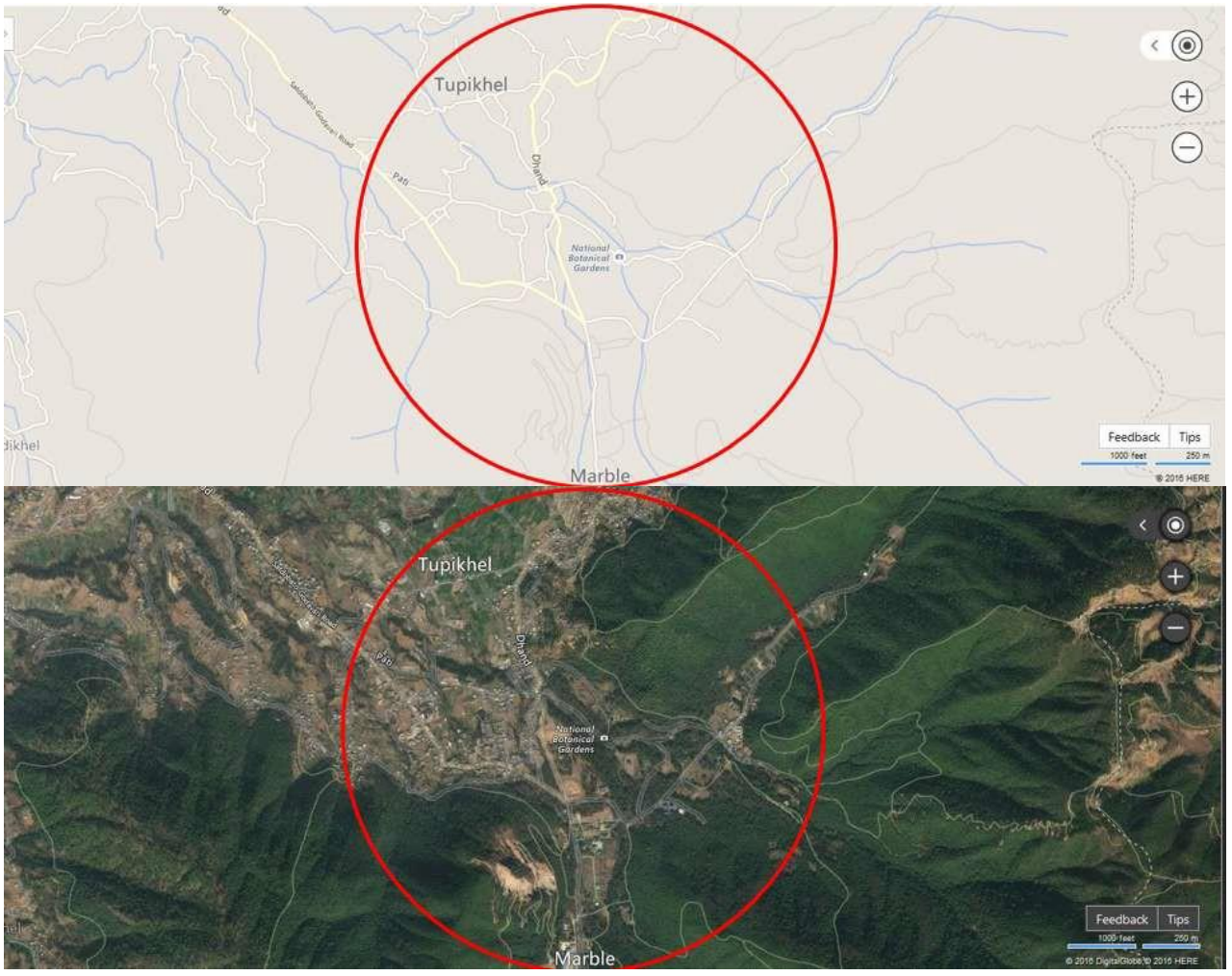
limestone and dolomite gorge through which River Bagmati escapes the Kathmandu Valley. The park includes a number of gated caves. Down the park, on the western bank of the River Bagmati is a Lord Ganesh Karyabinayak temple. The surrounding area consists of community forest with *Pinus roxburghii, Grevillea robusta*[2] and *Alnus nepalensis*. There is retail, residential and industrial development along the road and a former cement quarry on the higher ground to the northeastern side. It is located in the vicinity at 27° 39' 35.3" N, 85° 17' 39.2" E, and elevation 1404m a.s.l.



[2] Non native

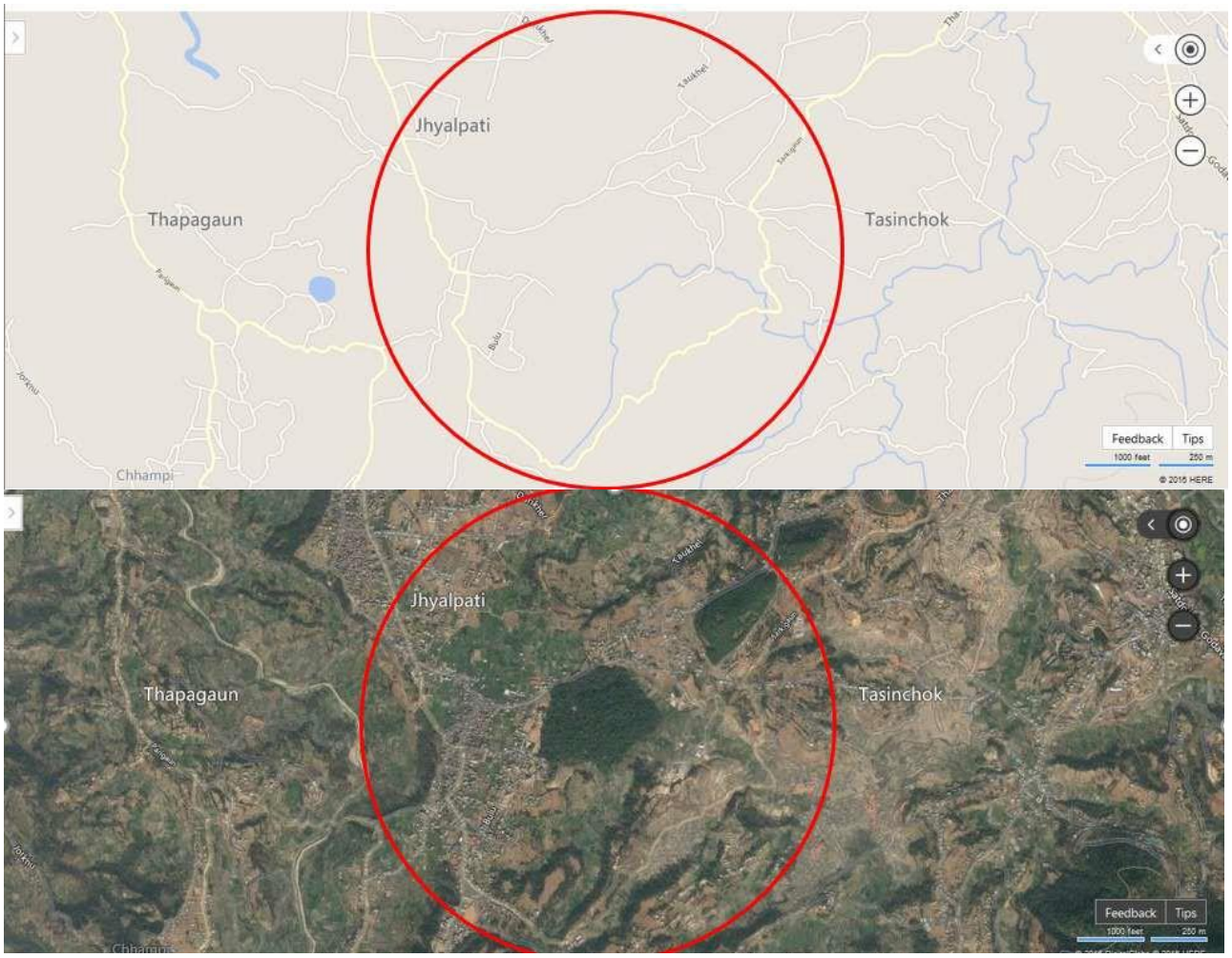
2.1.2 GODAWARI

It is located in the vicinity at 27°35'42.08"N 85°22'40.81"E, at an elevation of 1524m a.s.l. The area is moist, drained with water streams, lying in north facing slope. There is a botanical garden with amenity planting, pools and streams. Outside the garden are old temple sites with water tanks. The site is surrounded by mature community forests which used to be *Pinus roxburghii* and mixed forest, was reported to have been cleared 100 years ago. The community forests have dense vegetation of Chestnut *Castanopsis indica* (Katus), Box Myrtle *Myrica esculenta* (Kafal), Plum *Prunus cersoides* (Paiyun), Alder *Alnus nipalensis* (Utis), *Schima walichii* (Chilaune), Oak *Quercus sp.*, Rhododendron *spp.* (Gurans), Walnut *Juglans regia* (Okhar), *Michelia champaca* (Chaanp) etc. Common Leopard *Panthera pardus* (Chituwa), Indian Crested Pocurpine *Hystrix indica* (Dumsi), Squirrels, Bats are mammals sited frequently in the jungle. There is a cave on the upper level west to the botanical garden in the vicinity of Jungle and the site is noted for butterflies (and so likely to have good moth fauna).



2.1.3 BAJRABARAHI

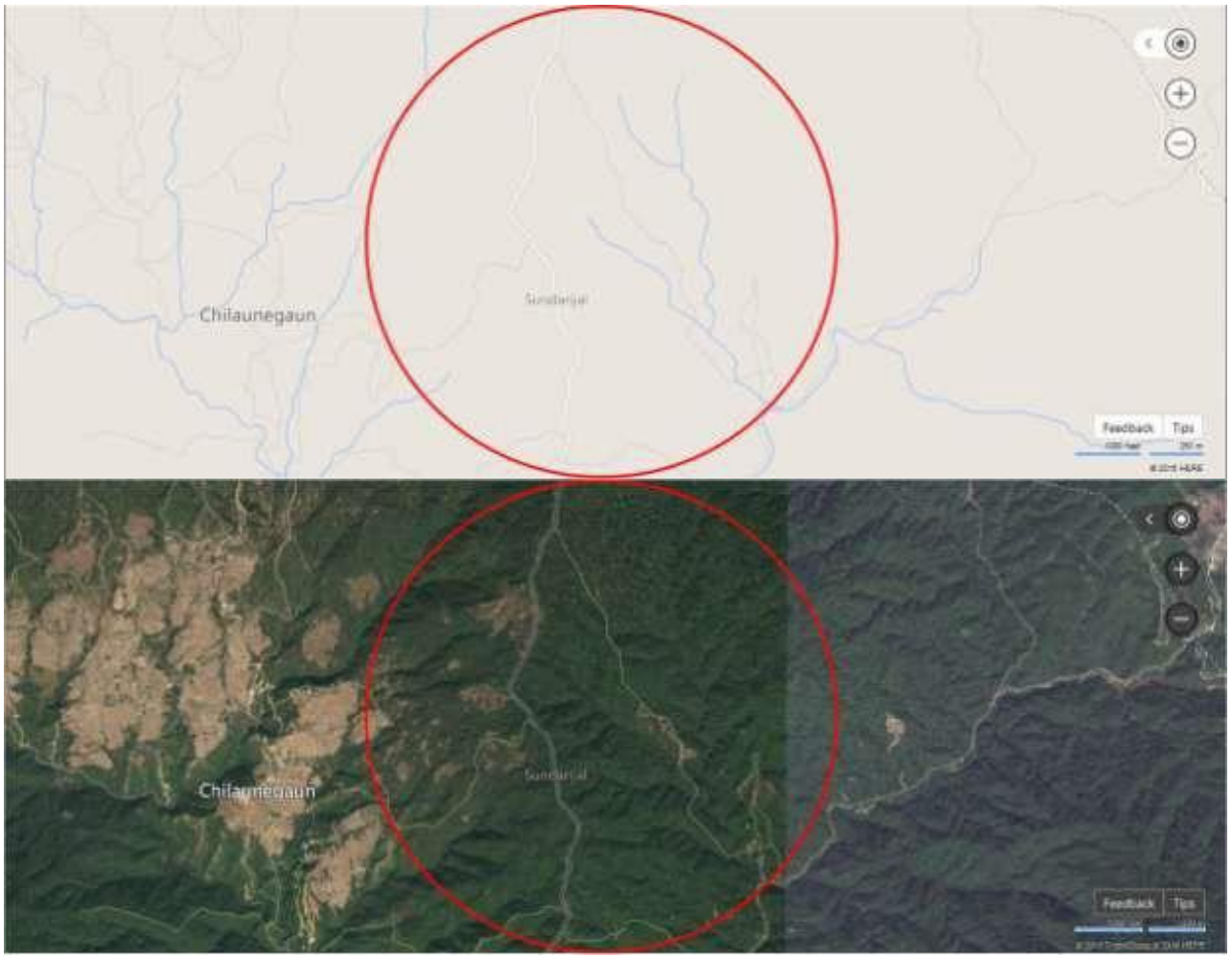
The site lies at 27°35'23.30"N 85°20'6.61"E, at an elevation 1485m a.s.l. Lord Bishnu temple set within extensive sacred forest. Twenty nine plants makes up the vegetation dominated by *Castanopsis indica*, *Choerospondias axillaris* (Lapsi), *Ficus* sp., *Myrica esculenta*, *Prunus cersoides*, *P. paschia* (Mayal), Oak *Quercus glauca* (Sano falant), *Schima wallichi* etc. Rose-ringed Parakeet, Oriole, Owl, Spotted Owlet, Woodpecker, Red-billed magpie, dove, drongo etc. makes up the avian fauna. Jackal and Jungle cats are the wild animals seen. Some areas extensively used for picnicking and leisure activities with sparse ground cover or bare ground. Steep slope down to a small stream at the edge in between agricultural fields and multi-aged mixed species broadleaved woodland with narrow pedestrian paths. Surrounding area is residential/tourism/agriculture. There is also a large parking area of bare ground.



2.1.4 SUNDARIJAL

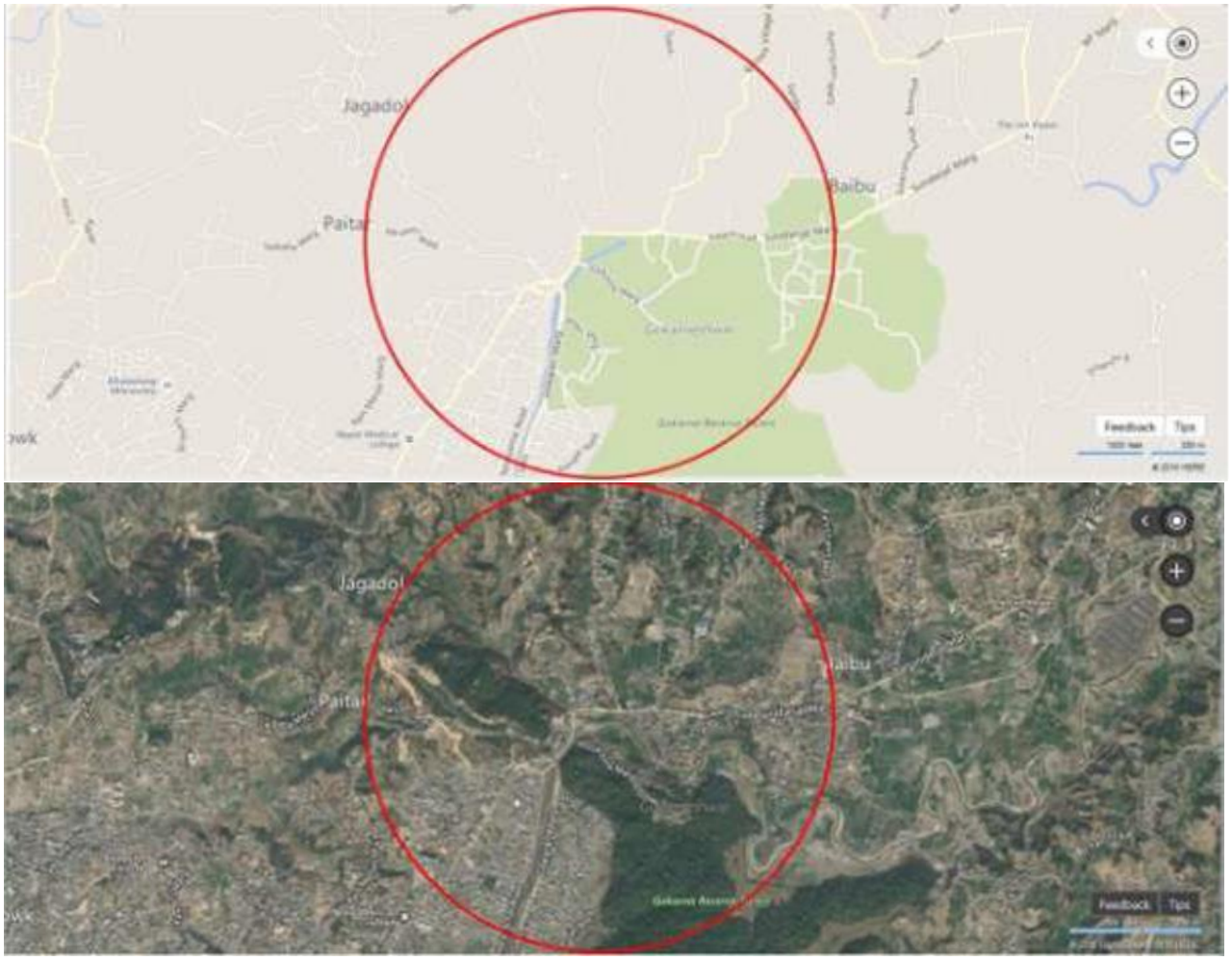
This is hydro-reservoir and tourist area at the eastern edge of Shivapuri Nagarjun National park.

This hilly area with south and east facing slopes are dominated by *Pinus wallichiana*, *Prunus* spp., *Alnus nipalensis, Schima wallichii* and Bamboo as major vegetation. This site is located in the vicinity at 27° 46' 18.5" N, 85° 25' 35.4" E and elevation 1579m a.s.l. Rocky Bagmati River gorge with residential and tourist development. *Pinus roxburghii* on the upper slopes with ground cover. Mixed broadleaves in the gorge; abandoned terraces. Is income from tourism increasing and changing land use from agriculture?



2.1.5 GOKARNA

Gokarna Mahadev Hindu temple site, 5th - 8th century AD. Above an incised river valley, one side with the residential development and agriculture, the other uneven age mixed broadleaf woodland dominated by *Pinus roxburghii, Alnus nipalensis*. Good ground cover at Gokarna Golf Resort. Monkey are present but in low numbers. Bats confirmed roosting in the upper part of the temple. A Small River Bagmati channels through an upland.



2.1.6GUHYESHWARI

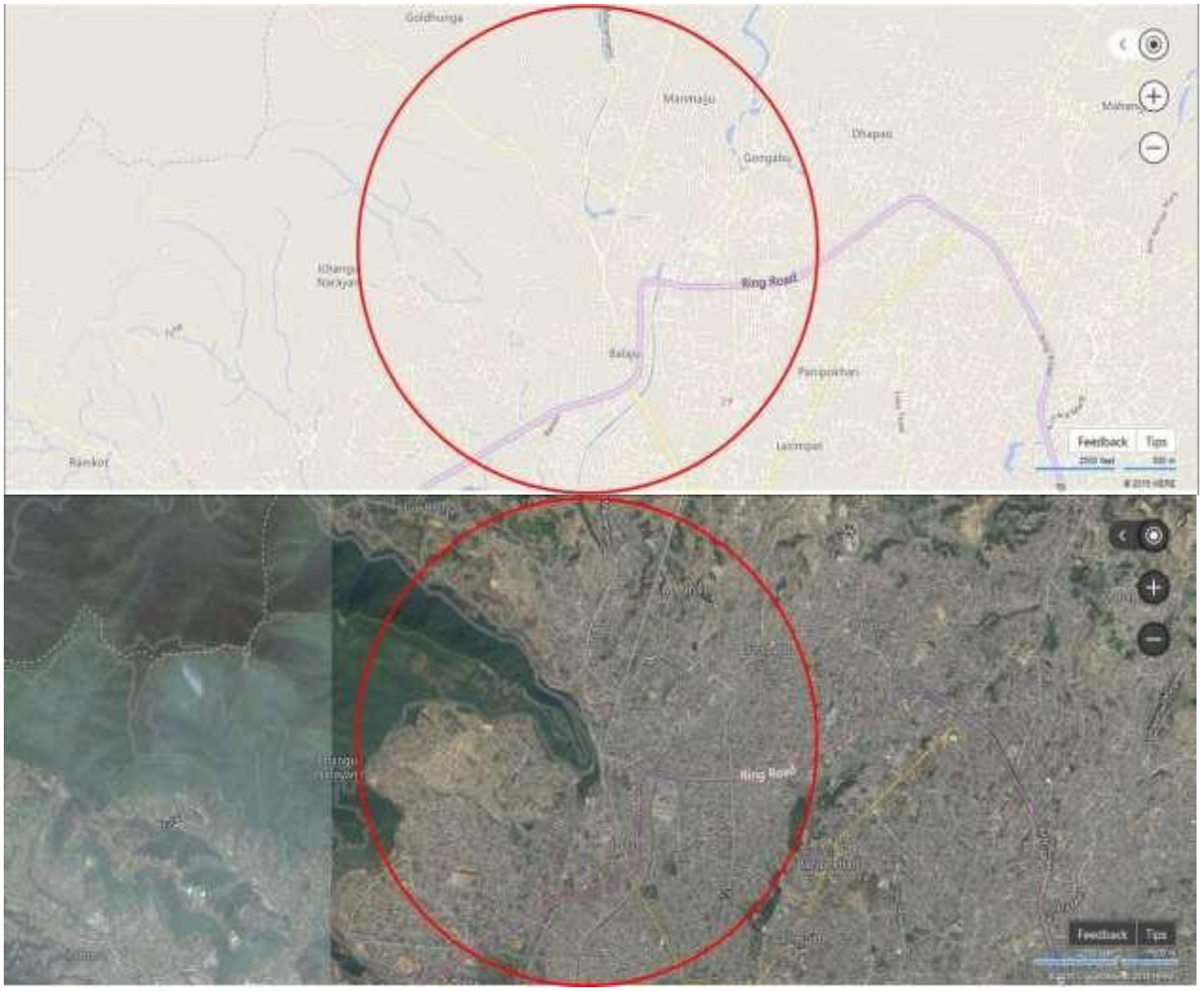
This site lies at 27°42'36.63"N 85°21'11.80"E at an elevation of 1332m a.s.l. Extensive World Heritage Hindu temple site with extensive damage from the 2015 earthquake. Broadleaved woodland dominated by Chestnut *Castanopsis tribuloides* (Musure Katus), *Schima wallichii*, *Syzgium* spp., Monkey Puzzle *Araucaria bidwillii*,Wild pear *Pyrus pashia* (Mayel), Oak *Quercus glauca* Saano falant, Woolly Oak *Q. lanata* (Saano baanjh), *Ziziphus incurve* (Haade Bayer), *Viburnum cotinifolium* and *V. erubescens*. On the slope above is Bagmati River below with dense urban development on the opposite bank. Monkeys are present in large flocks.

2.1.7 SWAYAMBHU

This site lies at 27°43'1.19"N 85°17'15.90"E, at an elevation 1326m a.s.l. Hill developed as a wooded amenity park (the Buddha Amideva park) containing a number of Buddhist temple sites and associated buildings. Mixed broadleaved multi-age woodland dominated by Pine, *Schima wallichii*, *Prunus* spp. and with well-developed ground layer. Hill surrounded by residential and tourist development. Very high numbers of monkeys (*Macaca mulatta*) were observed.

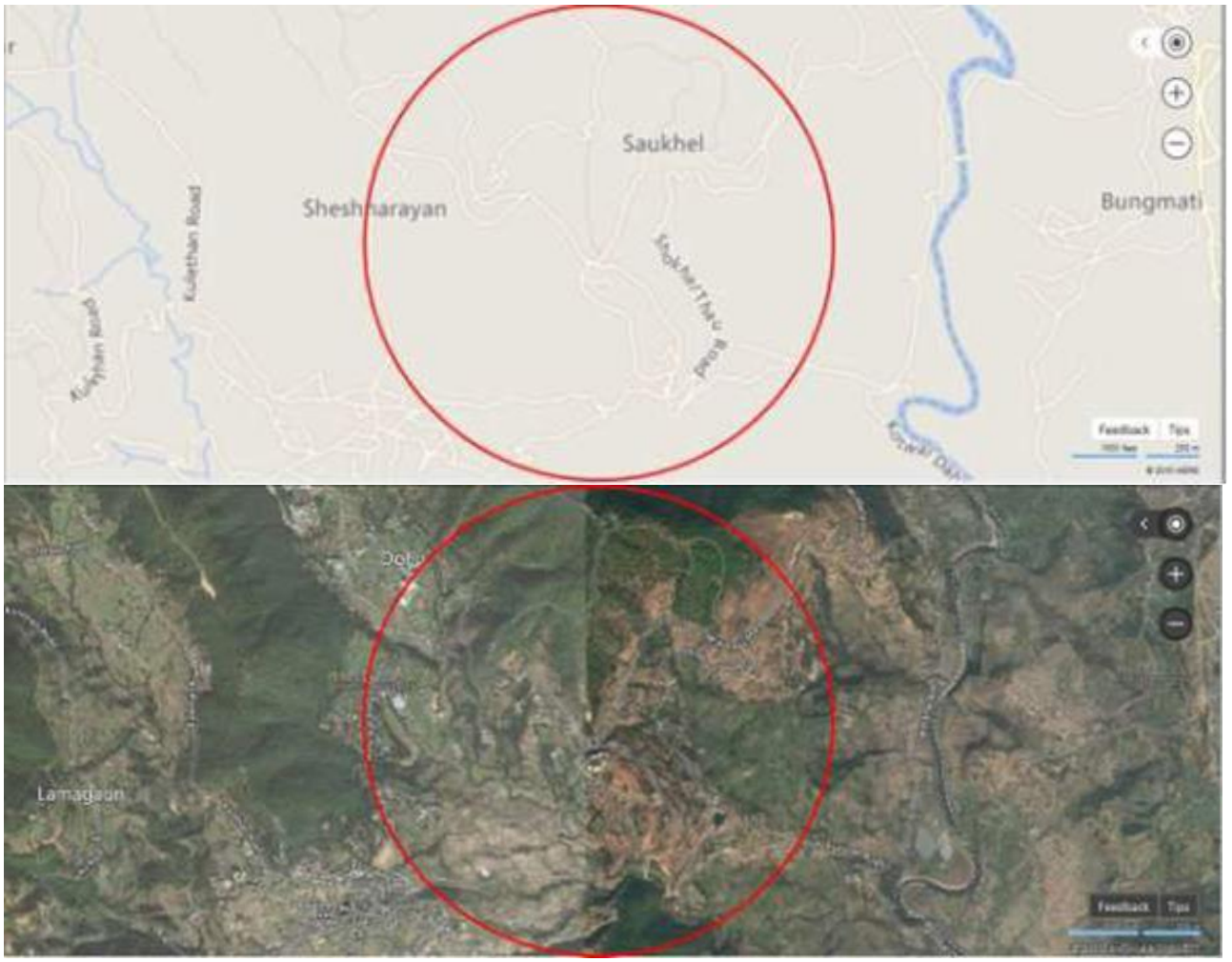
2.1.8 Nagarjun

On the edge of the Kathmandu Valley adjacent to the Shivapuri Nagarjun National Park (SNNP) with a gated cave on the hillside. Sparse residential development with subsistence agriculture. In SNNP multi-aged broadleaved woodland dominated by *Alnus nepalensis*, *Schima wallichi*, *Alnus nepalensis, Prunus* spp. and Chir Pine *Pinus roxburghii* (Raani Salla) with ground layer of *Ageratina adenophora*[3]. People at this site are involved in fish farming.



2.1.9 PHARPING

As the road was closed we were not able to get very close to the site. The first hydro-electric installation is nearby. There is a large lake which is visited for fish feeding in a nearby village and the valley is agricultural with cattle; hill slopes mixed woodland. The site lies at 27°36'46.97"N 85°17'22.53"E, at an elevation 1267m a.s.l.



[3] Invasive non native

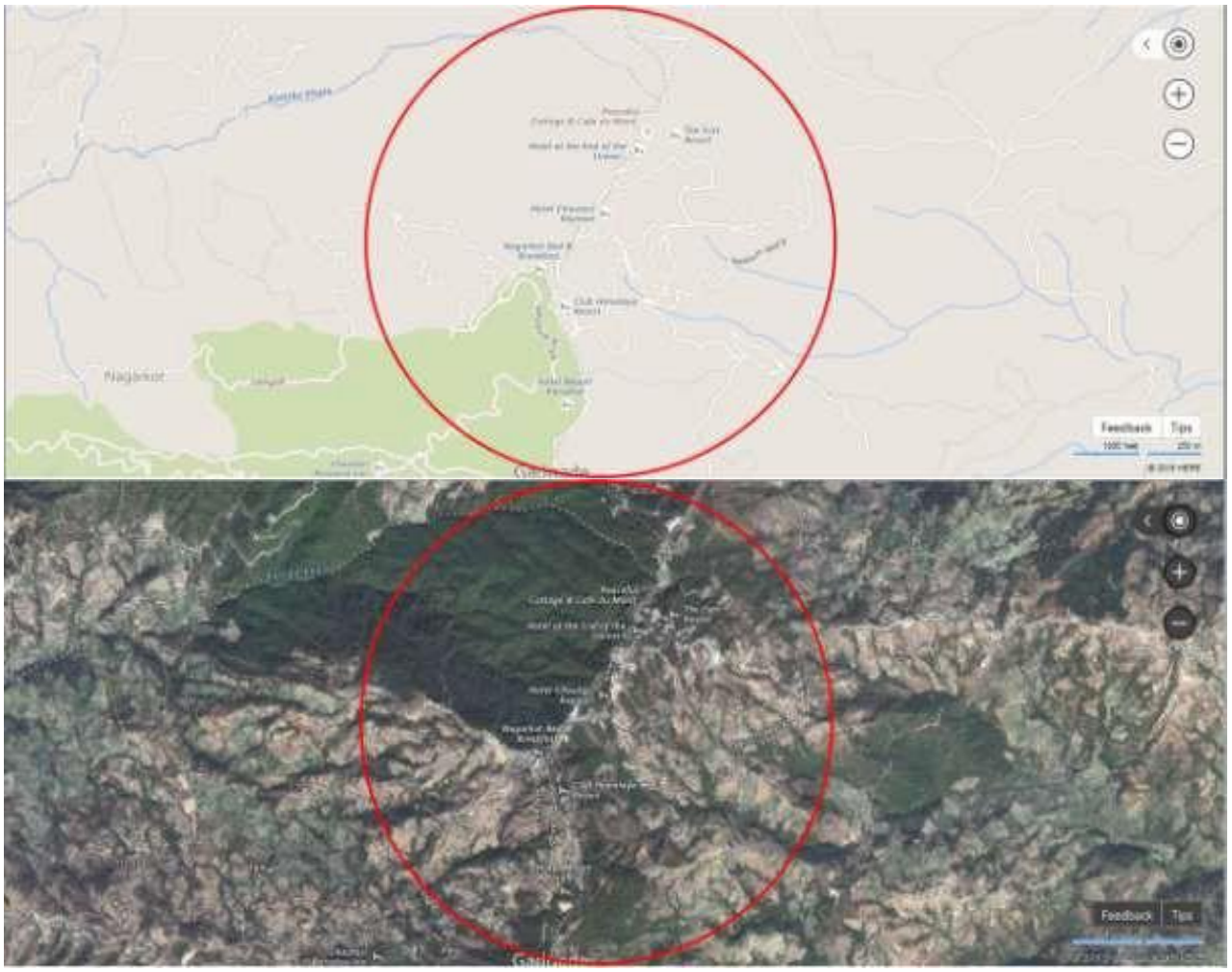
2.1.10 MACHCHHEGAUN

This area located at 27°39'38.75"N 85°15'13.63"E at an elevation 1493m a.s.l. This site is accessed via a track to the National Ethnographic Museum. The surroundings are mixed woodland dominated by *Myrica esculenta*, *Castanopsis indica*, Pine etc. with a ditch, likely to be seasonally full of water. Reportedly, it is a notable site for the spiny babbler (*Acanthoptila nipalensis)*. As this bird, an endemic to Nepal, is insectivorous this may indicate possibly a suitable foraging habitat for bats.

2.1.11 NAGARKOT

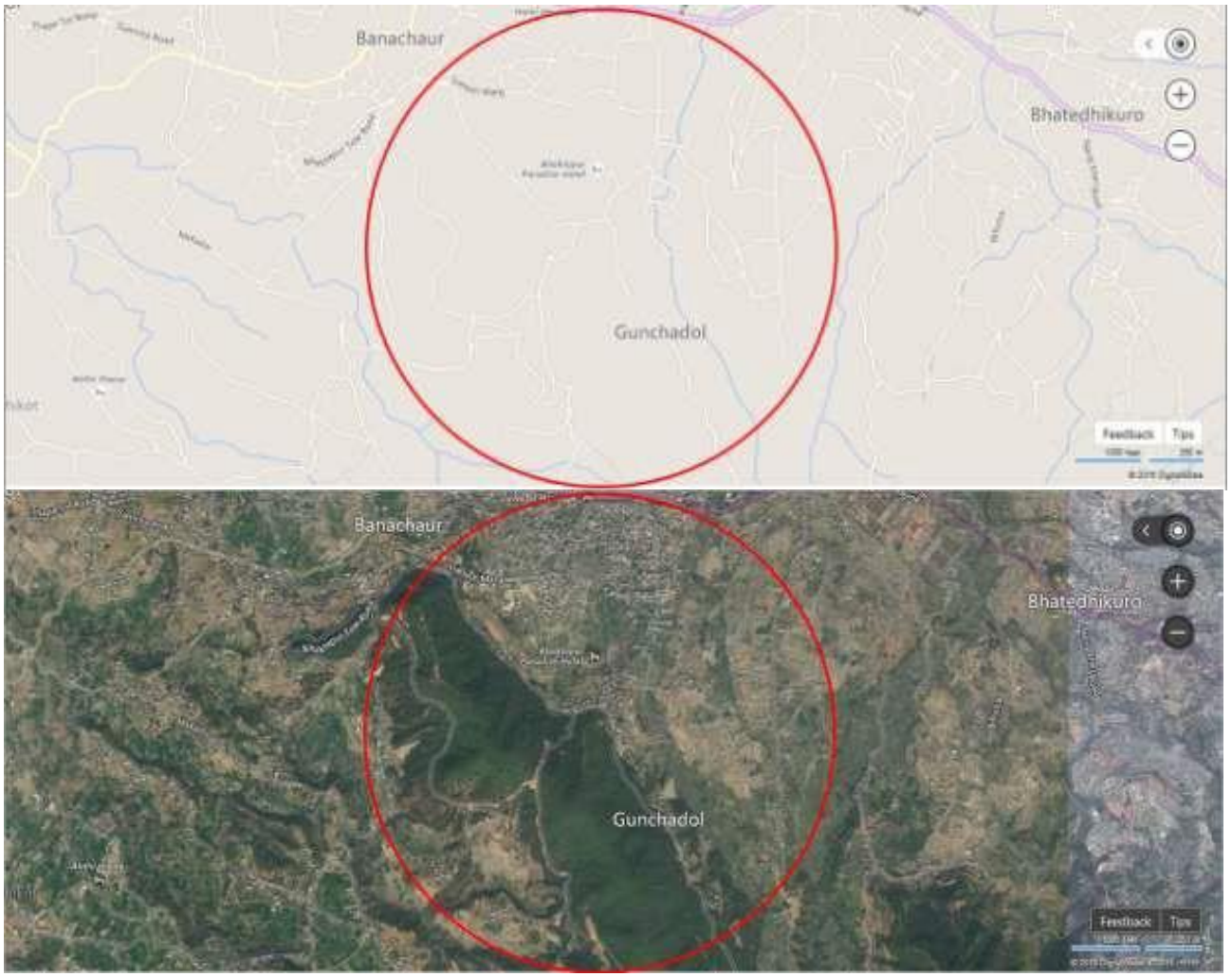
This is the highest survey site in the border of Bhaktapur and Kavrepalanchowk districts, with slopes facing east and west (27°43'15.37"N 85°31'15.95"E, at an elevation of 1829m a.s.l.).

There is distinct difference in vegetation from the others. Several conifers were seen, including *Pinus wallichiana*, and other non-natives such as *Eucalyptus sp., Cryptomeria japonica, Ricinus communis* and *Euphorbia pulcherrima* (Poinsettia). There were significant areas of open grassland on the slopes and active agriculture.



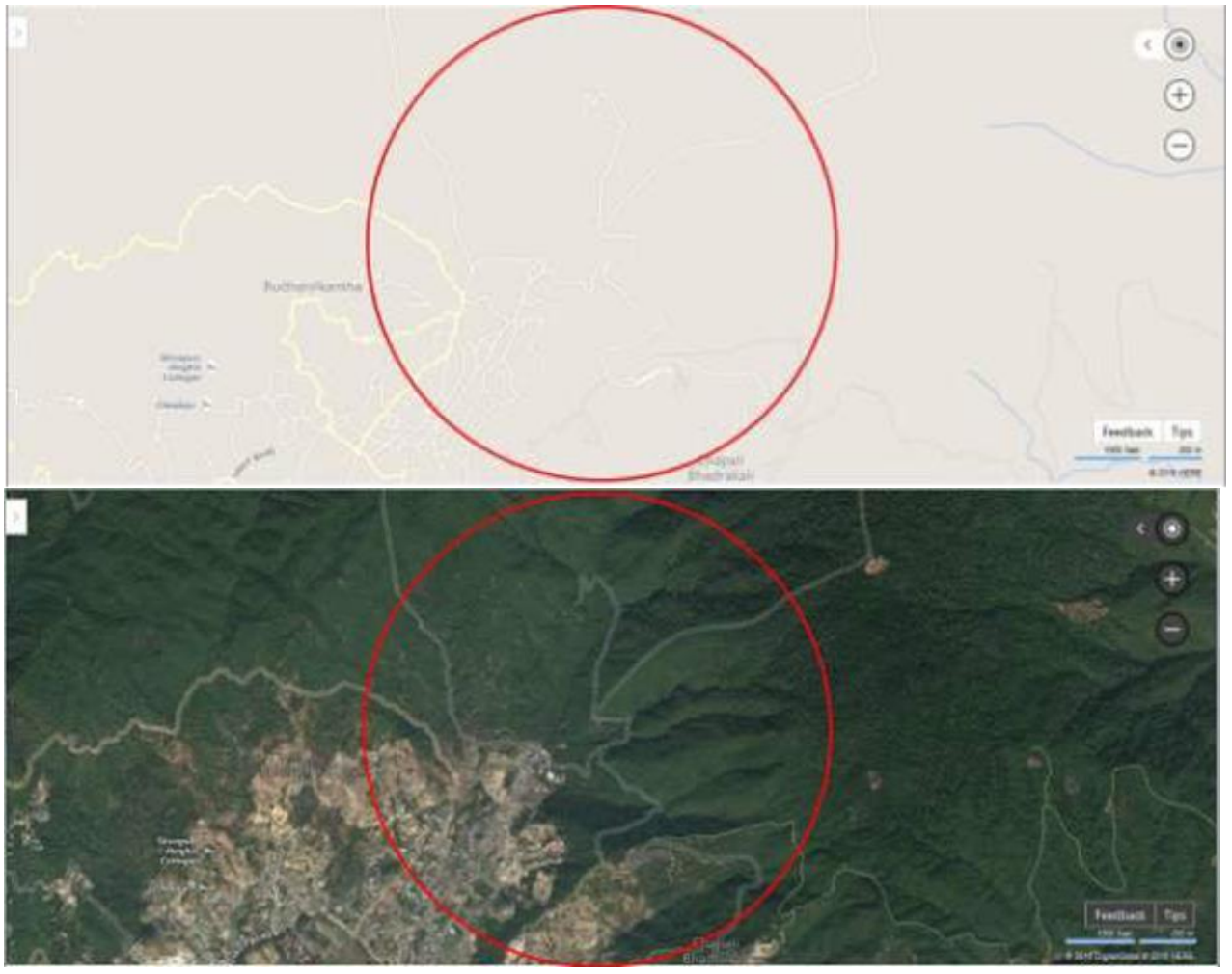
2.1.12SURYABINAYAK

The area lies at 27°39'25.60"N 85°25'25.27"E and at an elevation of 1384m a.s.l. The Ganesh Mandir Hindu temple is on a hillside, above urban development and backed by woodland (community forest) dominated by *Schima-Castanopsis* forest intermingled with pine. The wider valley is a mix of intensive agriculture and active brickfields and kilns. The soil is fertile clay.



2.1.13 PANI MUHAN GATE

The site lies at 27°47'2.09"N, 85°22'52.68"E, at an elevation 1992m a.s.l. On the southern side of the Shivapuri Nagarjun National Park, the survey site is reported as being just within the park which is wooded dominated by *Alnus nipalensis*, *Schima wallichii*, *Albizia* sp. (Siris), Cryptomeria *japanicum* (Dhupi Salla) etc. and has running water (fish farming was observed just outside the park). *Sus Scrofa*, *Panthera pardus*, *Hystrix indica,* Squirrels and bats are mammals seen in this site. The area was originally designated for watershed protection in 1976 and gazetted as a National Park in 2002. There is a Buddhist Monastery (Gumba) about an hour walk inside the park. The approach road is very poor, although in the process of reconstruction. This passes through a diverse mixture of large new houses setting among and older subsistence farmsteads.



2.1.14 NEPAL ACADEMY, KATHMANDU

This area lies in an urban surroundings. This government owned Academy has big area with a big Hall in centre of its campus. At the back of the hall, there is a small mango orchard. The campus has fringes of mixed trees surrounding the hall. There are shopping centres, banks, teaching and financial institutions in the vicinity of the academy.

2.1.15 BHRIKUTIMANDAP EXHIBITION HALL, KATHMANDU

This site is adjacent south to the Nepal Academy Hall and lies in the urban surroundings but close to an open area of grass (Tundikhel). Sighadurbar (Prime Minister's office) campus, Government agencies buildings, Nepal Army Headquarter, Nepal Police premises, teaching and financial institutions, shopping centre, Nepal Tourism Board campus, hospital etc. lies in the vicinity of this site. Several trade, cultural and educational fair, music concerts and other programmes are going on throughout the year in the Bhrikutimandap exhibition area. There is a natural park, artificial children park for fun, interspersed fringes of trees at the site.

Mist net erected at the entrance of a tunnel bridge over Tukuche stream near Bhrikutimandap.

Mist netting at the entrance of a cave at Manjushree Park, Chobhar (Note: gated cave with small channels through which small bats can only pass).

Recording bat echo locating calls during the release of the captured individuals at Chobhar.

Erecting mist nets over a stream at Bajrabarahi

3. Results

3.1. PHASE I HABITAT SURVEY (January- May 2017)

1. SITE I - BAJRABARAHI

1.1. Location

The area of study was Bajrabarahi religious site and the surrounding estate. The site included Chapaganu, Jharuwarasi and small portion of Thecho Village Development Committee (VDC) in Lalitpur District in the Bagmati Zone. The estate includes the famous temple of Goddess Bajrabarahi and is also famous for bird-watching.

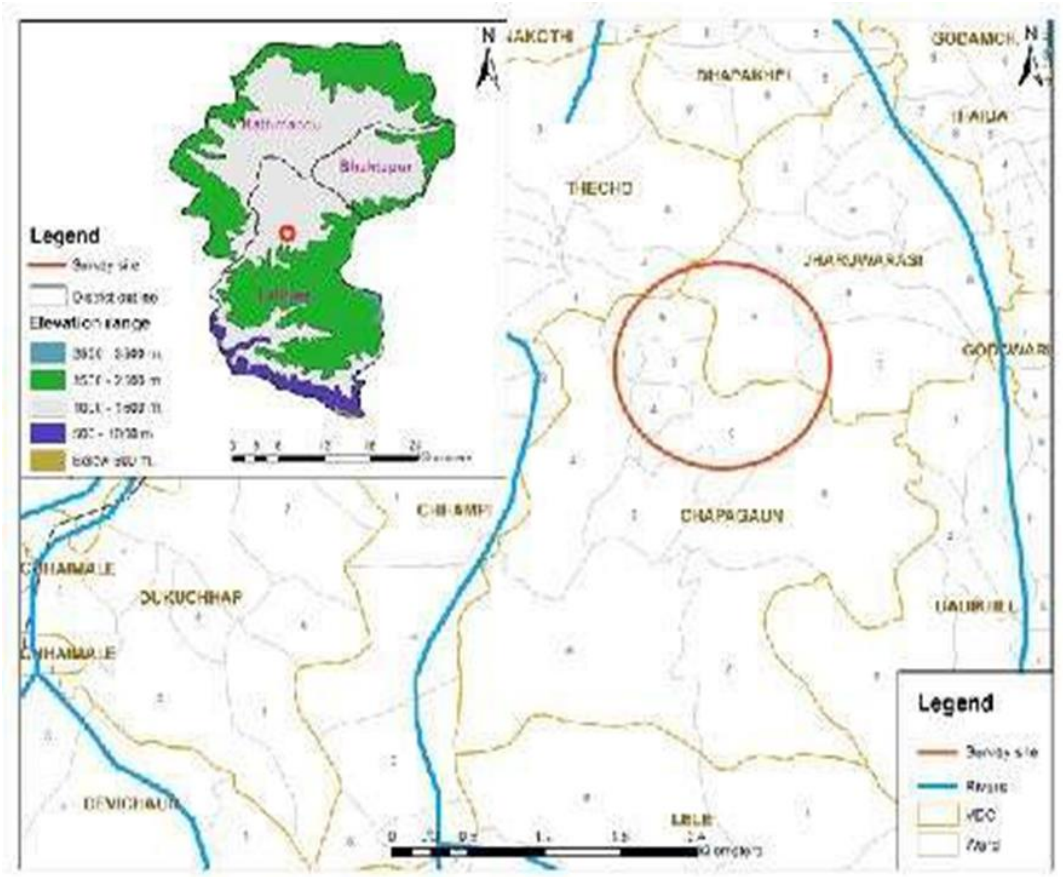


Figure 1. Map of Bajrabarahi survey site.

1.2. Land Tenure

According to legends, the temple was first established in 1666 A.D. by Shrinewas Malla. It is believed that there was a pond in the middle of the forest from where the Goddess Bajrabarahi was incarnated and hence, years later, the temple was created right where the pond once existed.

1.3. Site-status

Famous for its religious purposes, Bajrabarahi is a historically important area for Hindu devotees. However, the area has been highly recommended for activities like bird-watching and researches for birds and plants found in this area.

The estate also provides various off season vegetables that is later sold in major markets all over the country.

1.4. Physical Features

With the majority of area used for irrigation, the land of this site is fertile and whilst there are forest areas around the temple, there are human settlements outside the forest and agriculture area. During the non-agricultural period of time i.e. Jestha till Mangshir, some parts of the land were used for clay brick production as a source of income for the people living in the area

Figure 2. Vast agricultural land of the site

New construction sites are being plotted with hill-cutting methods for more housing purposes. Towards the edge of the agricultural land is situated a stone tap that acts as a source of water. However, due to various environmental changes, the tap only runs with water during rainy seasons of the country.

Figure 3. Hill cutting for construction purposes

1.5. Biological Features

Figure 4. Black-naped woodpecker

As stated previously, Bajrabarahi area is specific for various kinds of flora and fauna. Birds such as black drongo (*Dicrurus macrocercus*), black-naped woodpecker (*Picus guerini*), emerald dove (*Chalcophaps indica*) etc. are found in the premises of the site, giving bird watchers a pleasure in their pursue of different species of birds.

Figure 5. Crops preserved for seeds

The vast agricultural land in this area provides vegetables like potatoes, cauliflower, tomatoes and are supplied throughout the country. Few green houses were being used to cultivate these crops and preserve their seeds for genetic diversity. This included tomatoes, cucumber and even cauliflowers for seed preservation.

Bajrabarahi"s forest includes various plants and trees such as lapsi (*Choerospondias maxillaries*), Himalayan coralberry (*Ardisia macrocarpa*), Nettle (*Urtica dioica)*, Banyan (*Ficus benghalensis*), sacred fig (*Ficus religiosa*), *Schima wallichii* and many other flora species that provides habitat for bats along with other species of birds and animals in this area. This makes the forest of a national importance to promote conservation and diversity of various species found within the premises. Although there wasn't any sighting of animals in the sight, past records have shown that animals like tigers, leopards, jackals and wild boars. To support the claims, carcasses of animals have been discovered in the area, hence making the estate an important site for conservation of such rare and endangered species.

For studies purposes, species of common monkey has been introduced in the forest area and has easily adapted in the premises. However, the impacts and changes the establishment has brought in the biodiversity is yet to be confirmed.

Figure 6. Carcass of a dog found in the site

1.6. Cultural Features

The most prominent cultural feature of this area is the famous temple after which the place is named. The historic architecture of the temple allows it to be an abode to bats due to its enclosed and dark design.

1.7. Access and Visitor Facilities

Access to the temple and the picnic grounds for recreation is open to anyone who visits the area. However, it is likely that the population is controlled by the Municipality people there during the peak days of religious ceremonies in the temple.

1.8. Target Table

	Target	Description
1	**The Forest**	The forest around the temple area has been used for bat mist netting for the research. This forest, filled with edible fruits and trees that create a dense and dark cave like hollow area is highly suitable for bats to move to and fro in the habitat.
2	**Small Natural Stream**	A small water stream flows through the agricultural land and the forest area. Although barely visible in the dry weather, the stream is said to get thicker in rainy season and acts as a water source for the animals found around the area
3	**Bajrabarahi Temple**	The temple, built around the 17th century has an antique design. The use of woods and bricks in this temple allows the bats to nest inside the dark environment

4	**Old houses**	The old structured houses made of wood, mud and bricks seemed providing roosting habitat for the bats. Although the April earthquake 2015 had devastated majority of old houses, the ruins were left abandoned which seem providing cavities for the bats

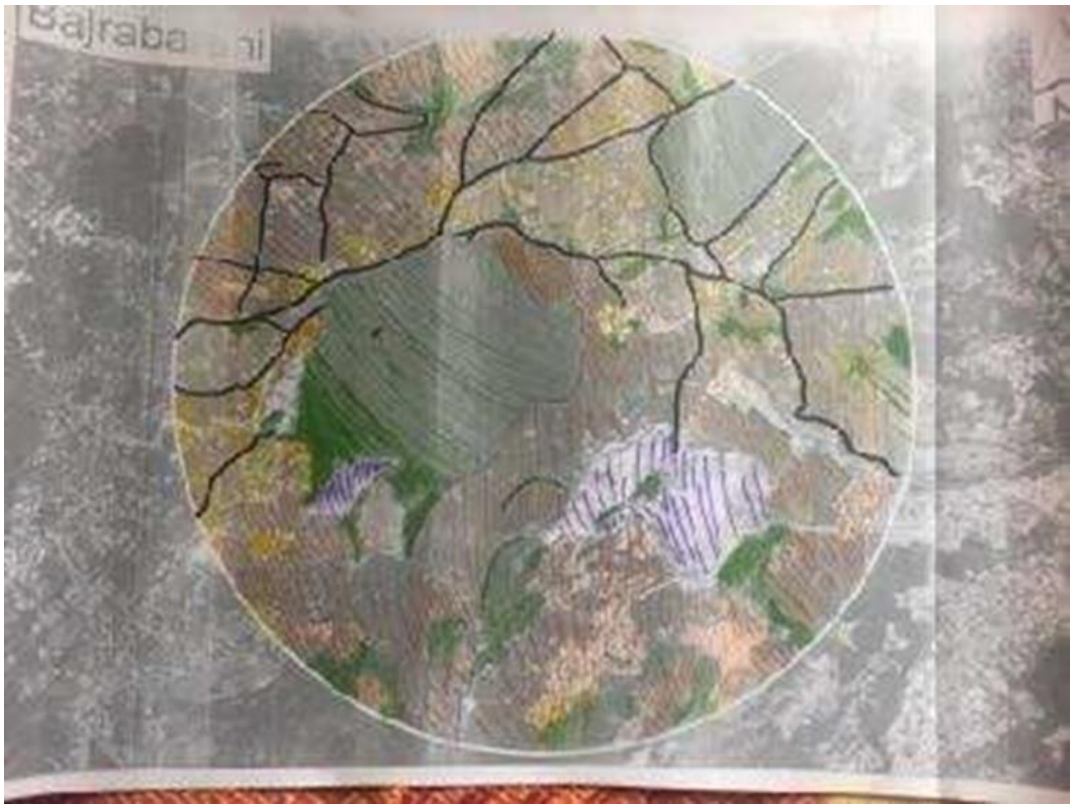


Figure 7. Bajrabarahi Phase I map

2. SITE II - NEPAL ACADEMY

2.1. Location

This site is situated in central Kathmandu valley, making it an urban estate of a metropolitan city in Kamaladi. Located in between human settlements, Nepal Academy is a national institution of Nepal to promote various subject matters of Nepal.

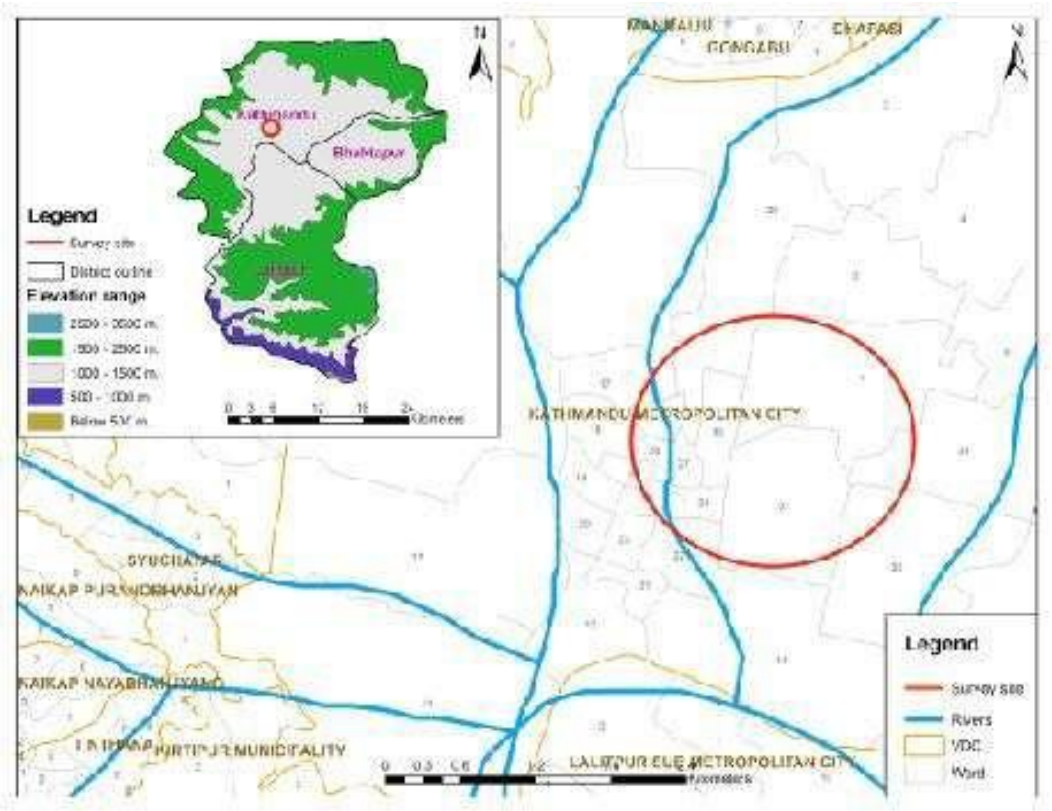


Figure 8. Map of Nepal Academy survey site

2.2. Land Tenure

Formed in 1957, the academy commissions research and promotion of cultural and intellectual endeavor of language, literature, culture, philosophy and social sciences of Nepal by coordinating national and international activities. The academy is governed by Nepal Academy Act 2064 B.S. under Nepal Law Commission.

2.3. Site Status

Surrounded by concrete buildings, the academy annually organizes various different programs associated with the focus of prospering Literature and Art to commemorate various different artists of Nepal. Following the passage of the Royal Nepal Academy Act in 1974 and after being named as Royal Nepal Academy, the institute was renamed to Nepal Academy after the transition of Nepal into a Democratic Federal Republic in 2008. It stands as a concrete building with few patches of tall trees and small gardens around its premises. The radius taken for survey of this site overlaps another radius of a site chosen close by - Bhikutimandap.

Figure 9. Nepal Academy Hall

2.4. Physical Features

Metropolitan in nature, this site has few sighting of trees and very rare old-fashioned houses in comparison to concrete housing around its premises. Although the academy itself doesn't host residences, the buildings nearby are for human settlements, but there are various other landmarks that falls inside the 1km radius taken for the survey.

Figure 10. Old designed houses with pigeon holes

The Narayanhiti Palace for instance, is in the northern side of the site, which long served residence and principal workplace of the reigning Monarch of the Kingdom of Nepal. After the 2006 revolution against monarchy and declaring Nepal as a republic country, the palace now stands as a public museum with vast array of courtyards, gardens and buildings.

Figure 11. Narayanhiti Palace Museum and the traffic in front

Lying in front of Rani Pokhari and a little west from the Academy stands Ghanta Ghar (Hour House), Nepal' first public tower clocked was built by Rana Prime Minister Bir Shumsher after being inspired by Big Ben of London

2.5. Biological Features

On the northern-east side of the site, there is another pond, Kamalpokhari (Lotus Pond), famous for having lotus flowers floating on top of its surface during blooming seasons.

The Academy, has a small garden around its building where various medium sized shrubs to tall trees have been designated. The garden is mainly surrounded by coniferous types of pine trees

Figure 12. Coniferous types of pine trees

In the south side of the site, there is a small river that seems almost non-existent as it is extremely narrow and flows in between concrete buildings and houses. Furthermore, pollution and garbage disposal of households distracts the flow of this river and gives an unpleasant smell as one passes by.

2.6. Cultural Features

Just a few blocks further from the academy, there is a temple of Lord Ganesh and is especially busy on Tuesdays. There are few scattered trees in the area and a pond beside it too.

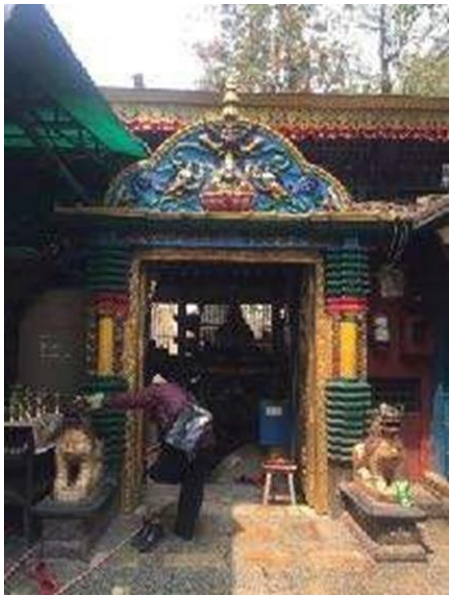


Figure 13. Ganesh Temple just outside the premises of the Academy

Slightly south-west to the academy, there is the infamous Rani Pokhari (Queen"s Pond), a historic artificial square-shaped pond that dates back to the 17th century. This was constructed by King Pratap Malla to console his queen who was distraught with grief after their son was trampled to death by an elephant. A temple dedicated to Hindu deity Shiva stands at the center of the pond and is reached from the street by a causeway. However, the temple has been heavily destroyed after the April 2015 Nepal Earthquake and is still being constructed.

2.7. Access and Visitor Facilities

Although not open to public access, the Academy hosts various cultural programs at times and visitors interested are granted access into the premises. Since the majority of programs are conducted inside the building, the garden outside is left undisturbed.

2.8. Target Table

	Target	Description
1	**Rani Pokhari**	This religious and ancient pond that once stood as the water resource, is currently being re-constructed after facing heavy damages by the 2015 Earthquake. The water has been drained and entrance is currently forbidden
2	**Kamal Pokhari**	The pond is found in between the concrete metropolitan city and although very less is done in regards to the conservation of this pond, the society hasn't let the water dry up completely due to the various roles it plays, from a leisure area to a source of water for birds and bats.
3	**Palace Garden**	Garden in the palace museum has different types of plants, from tall trees to shrubs. Since they are preserved to enhance the natural aesthetics of the palace garden, this area is essential for bats and their roosting.
4	**Academy Garden**	Another garden, though not as extensive as that of the palace, the small garden in the premises of the academy has plenty of tall trees, making another suitable area for bats to create their own habitat.

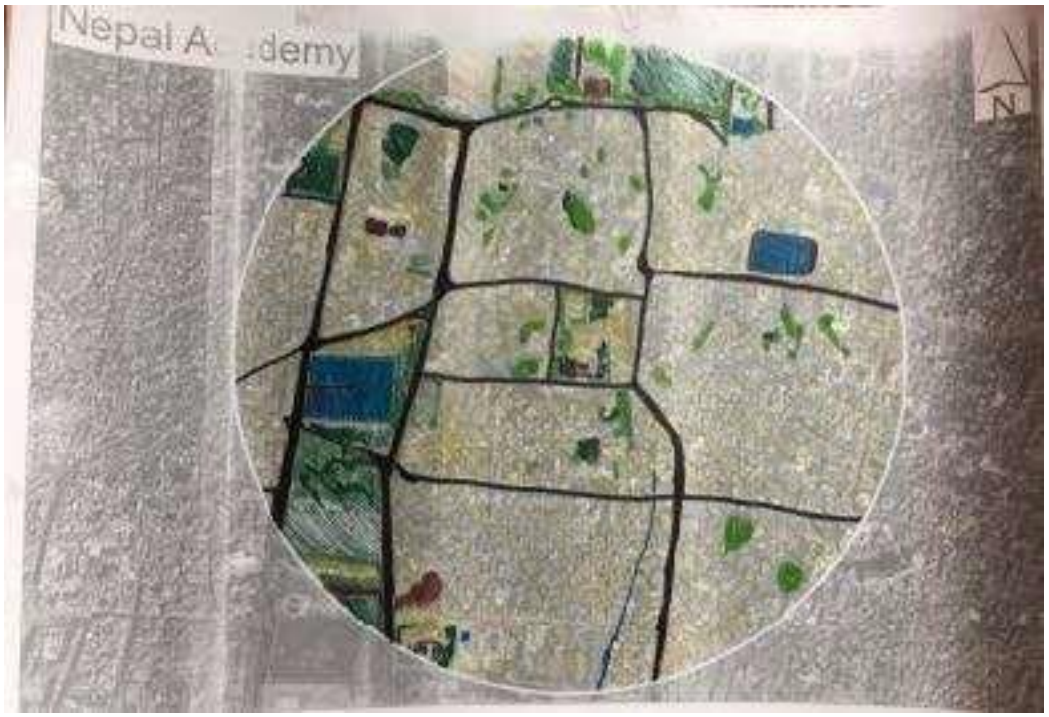


Figure 14. Nepal Academy Phase I map

3.1. Location

Designated as an exhibition ground, the site is located in the central part of Kathmandu valley. It is an urban estate situated in Pradarshani Marga and has been providing a ground for people to exhibit their work without prejudices.

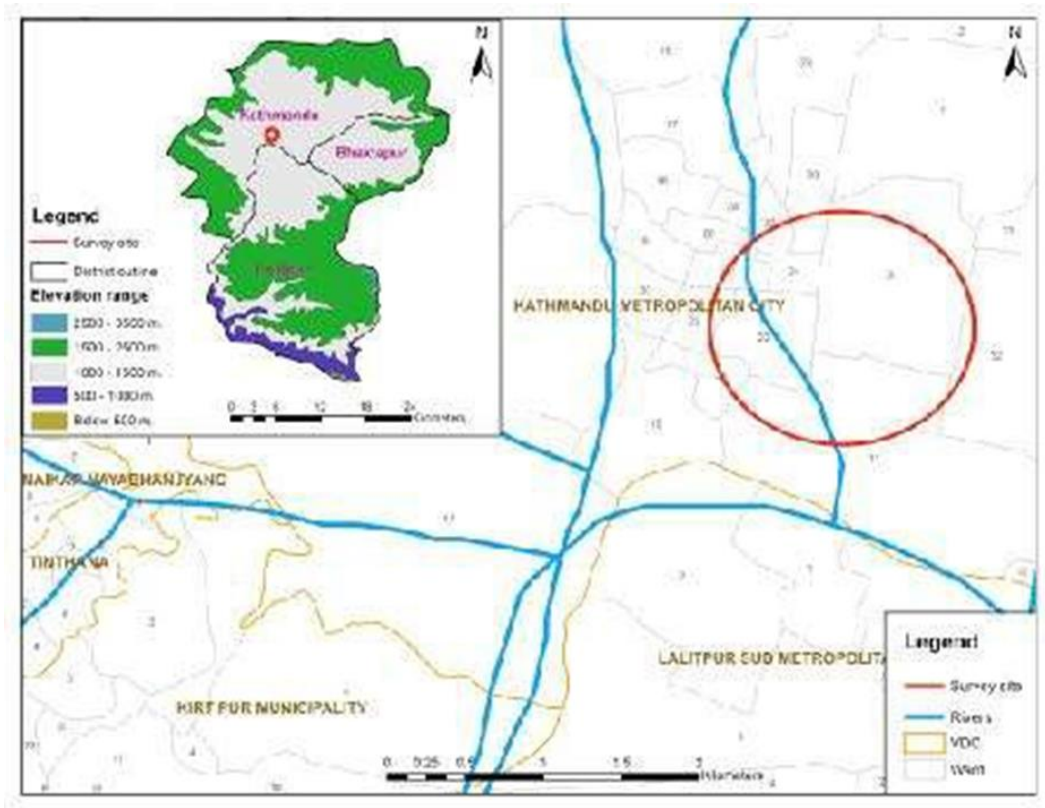


Figure 15. Map of Bhrikutimandap survey site

3.2. Land Tenure

With various officials stationed nearby the exhibition ground, the site is also co-joined with a fun park and a garden for recreational purposes. It is a Government building and is administered by the Government of Nepal.

3.3. Site Status

Known for the numerous events and exhibition the hall holds every once in a while, this exhibition ground also serves as a leisure and recreational setting with its fun park based right next to the hall. A small park based in between this fun park and the hall is another pleasant feature for visitors who want to have a secluded time of their own amidst the crowded metropolitan city.

Figure 16. Entrance of the fun park

Alongside, the Nepal Tourism Board that is a national organization of Nepal established in 1998 by an Act of Parliament to form a partnership between the Government of Nepal and private sector tourism industry. The organization aims to market Nepal as an attractive tourist destination and provides platform for vision-drawn leadership for Nepal's tourism sector.

3.4. Physical Features

Being a metropolitan area, the estate has concrete houses and buildings for human settlement and although there are few scattered trees around these houses, the majority of the radius has concrete houses. Western side from the site is a large open grass-covered ground called Tundikhel, rectangular in shape and has a north-south orientation. Having a history that dates back to the 18th century, this area today serves as a spot for religious festivals, rock concert venue, Public Park and recreation. Having an army camp just opposite to it, this open land also has military parade and horse race track for practices.

Figure 17. Tundikhel ground

A temple of Bhadrakali serves another landmark around the site that has few number of thick trees and features as a suitable area for bat habitat.

Southern-east side from Bhrikutimandap has Singha Durbar (i.e. Lion"s Palace) that was built by Chandra Sumsher JBR in June 1908. This is an old palace that is now being used as a compound to house government offices and the headquarters of Radio Nepal and Nepal Television. However, after the massive 2015 Nepal-earthquake, most of the palace has been designated unsafe for use.

3.5. Biological Features

Since it is located in a concrete metropolitan city, trees are very scarce and are either thinly scattered or found confined in a specific area. For instance, although there are a couple of trees in the area around the radius, the densest trees is around the temple where it is considered holy and conserved for religious purposes. At such, some of the most common tree is sacred fig (Ficus religiosa).

Figure 18. Sacred fig beside the temple

3.6. Cultural Features

In the south-western side of the site, a temple called Bhadrakali and is considered to be one of the renowned "Shaktipith" of Nepal. Recorded to have been built in the year 1817, the temple was erected after a priest dug the small hill to find the statue of Goddess Bhadrakali. A black stone statue considered as the main deity, this temple welcomes pilgrims every Saturdays and during the ten days festival of Dashain, during the months of September-October.

3.7. Access and Visitor Facilities

The exhibition ground is open to visitors depending on the type of event held inside. The fun park and the garden on the other hand requires visitors to pay before entering the premises.

3.8. Target Table

	Target	Description
1	**Singha Durbar**	The ancient monument has been standing in the centre of the city for years and is infamous for its historical architects. Made up of materials like clay, woods and cement, this building has been a prevailing abode for bats, especially after the earthquake that isolated the entire premise.
2	**Bhadrakali Temple**	Filled with old houses and high trees around its premises, the temple and its premises is another suitable place for bats to roost. Unless occasional religious days, when pilgrims flock around the temple, the area is rather quite, pleasant and undisturbed.
3	**Loose scattered**	Few scattered trees found within the radius of the site can also be considered of equal importance to bats and their habitat area.

Figure 19. Bhrikutimandap Phase I map

4. SITE IV – GUHYESHWORI

4.1. Location

Similar to Bajrabarahi, this site is named after the famous temple dedicated to Adi Shakti and is located at the banks of River Bagmati of Kathmandu Valley

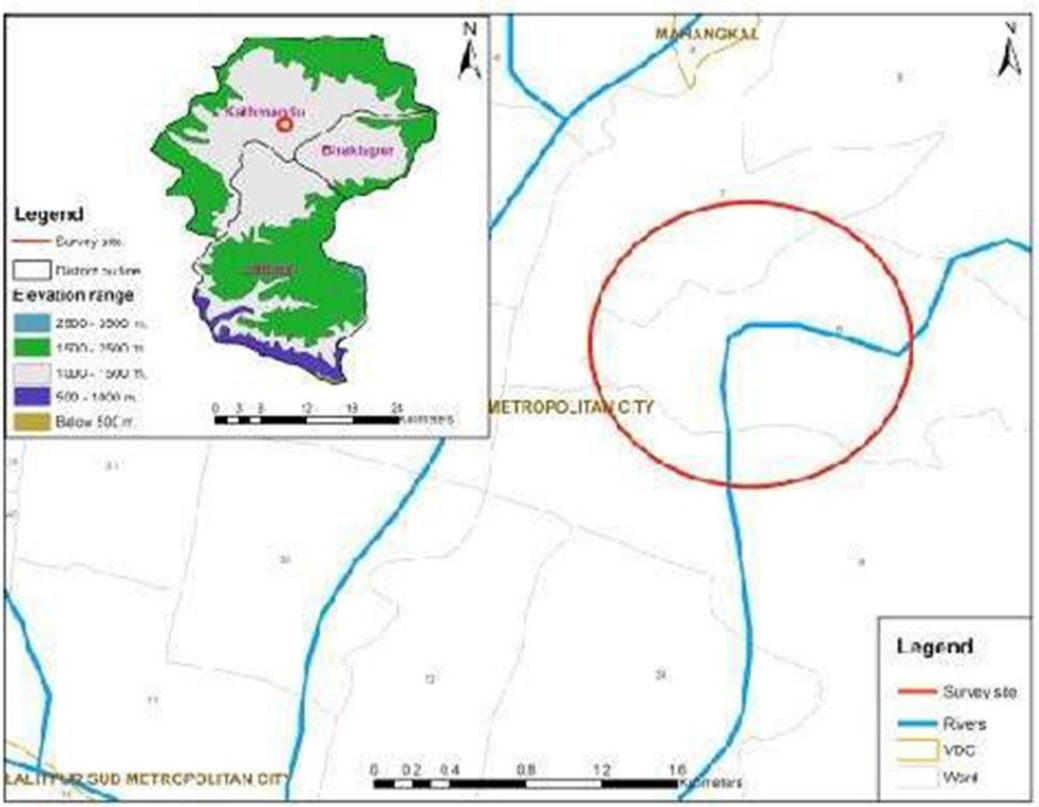


Figure 20. Map of Guhyeshwori survey site

4.2. Land Tenure

First built in the 17th Century by King Pratap Malla, it has a pagoda-style architect and is considered an important pilgrimage destination for general Hindu and Tantric worshipers. This holy temple portrays the female side of the divine (considering the male to be Pashupatinath) and is surrounded by the vast forest of sacred groves that extends up to Pashupatinath, another religious site for the mist netting.

Figure 21. Temple of Guhyeshwori

4.3. Site Status

A holy site with religious historical background, Guhyeshwori holds great value to Hindus as well as the Buddhists. The site is specially crowded during the first 10 days of Dashain, the main festival of Hindus in Nepal, and devotees from various parts of the valley come to worship the Goddess.

The forest holds a religious importance due to the mythical story of how the Hindu Lord Shiva came to the area of Sleshmantak Forest in the form of a male deer to escape from his boredom. Today, the forest consists of a Deer Park, preserved for the barking deer population.

Figure 22. Deer Park entrance

4.4. al Features

The site has wide sacred grove forest area, Sleshmantak Forest, conserved for religious purposes and consists of a wide range of plant and animal species. However, outside the forest area, there are human settlements and houses and buildings surround the 750m radius taken for the survey. Two of the most popular Hindu temples: Pashupatinath and Guhyeshwori can be located within the area and while the forest and human settlement has cohabited successfully, the river Bagmati flows through the area, dividing the two temples in each bank. Old established houses and temples made up of clay, wood and bricks are preserved here in the area for religious purposes. These constructions become an asset for bat roosting.

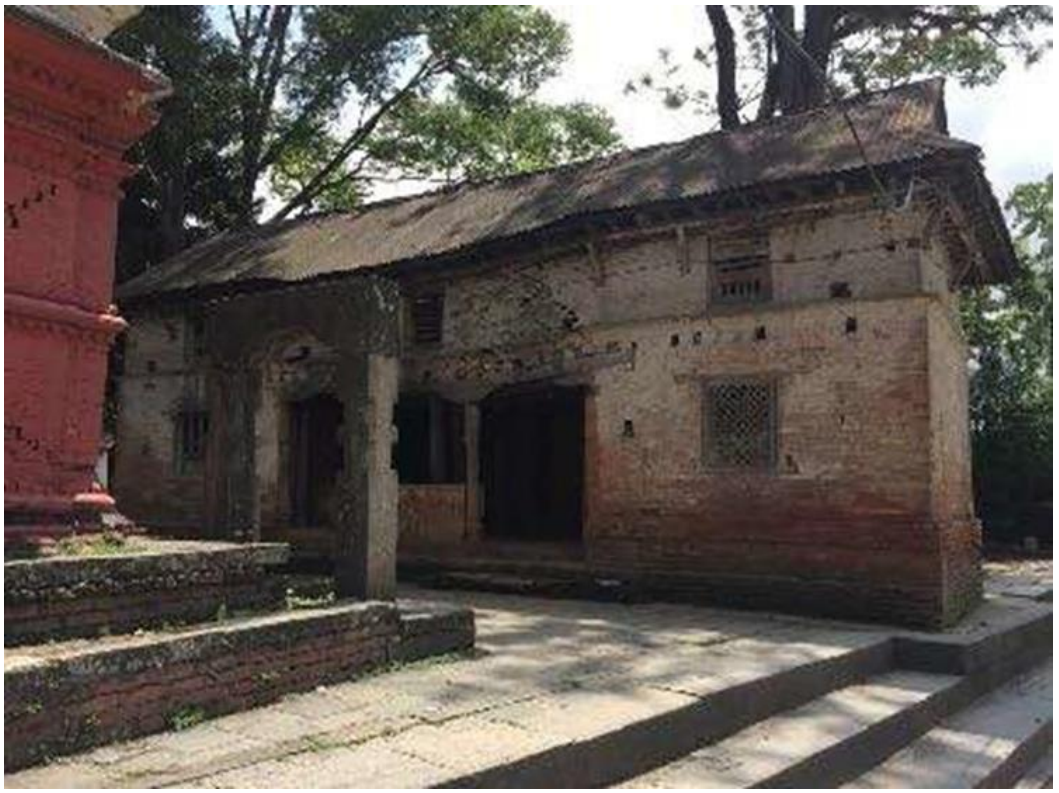


Figure 23. One of the old house in the premises

4.5. Biological Features

Overlapping with the Pashupatinath temple area, Guhyeshwori shares the sacred grove of this adjoined site where various different trees have been recorded. The groves consist of Nepalese Hog Plum Tree (*Choerospoandias axillaris*), *Schima pyrus* forest, *Myrsine persea* forest and *Quercus myrsine* forest.

Animals found in these sacred grove in majority is the rhesus macaque (*Macaca mulatta*) whilst there has also been sightings of barking deer (*Muntiacus muntjac*), Chital (*Axis axis*) and Blackbucks (*Antelope cervicarpa*) around the premises of the forest.

Figure 24. Rhesus Macaque within the temple area

The River Bagmati has been a prominent feature that flows across the area. Despite being of a major religious importance, the river at present suffers from the industrialization and construction heaps that are dumped in the banks of this river today.

Figure 25. River Bagmati, impacted by industrialization

4.6. Cultural Features

Mythological tale tells that Sati Devi, Lord Shiva"s first wife felt humiliated after her father insulted her husband and accused of various shortcomings. This angered the Goddess in such immense passion that she jumped into the flames of fire and self-immolated in the worshipped fire. Grief- stricken with his beloved wife's death, he began to wander across the earth with her body resting on his shoulders. The temple of Guhyeshwari marks the spot where her knowledge fell: hence the name derives from this event i.e. Guhye means main knowledge and Ishwari means Goddess.

Apart from the temples in this area, the site is also renowned for cremation by the riverside of holy Bagmati. With the belief that being cremated beside this holy water, various castes groups of Nepal cremate the body of their deceased in this area while few prefer burial sites located around the forest land.

Figure 26. Bagmati River flowing through the Pashupati Area

4.7. Access and Visitor Facilities

The temple is strictly accessible only to Hindu pilgrims and have controlled any foreign visitors to enter the premises although the forest and surrounding estate is open to other sightseers. Premises around the temple is specially crowded and busy during main festivals of Nepal, Dashain and Tihar.

4.8. Target Table

	Target	Description
1	**Sleshmantak Forest**	This forest provides not only an essential habitat to the deer's in the secluded park, but also to various other animals such as the rhesus macaque and not forgetting, the bats
2	**Bagmati River**	Although suffering from extreme dumping and pollution, the river Bagmati still has few areas that are clean and preserved, especially around the cremation area. This water hence is the only near water sources for any mammals or birds living around the area.
3	**Guhyeshwari Temple**	The ancient buildings, surrounded by various other similar built monuments with small gaps around the ceilings are considered to be one of the best places for bat roosting
4	**Pashupatinath Temple**	As Pashupatinath is considered one of the main temples for the Hindu religion, it is rare for the temple premises to be quite and secluded. However, the area does consists of few dark and old houses, providing bats for their settlement
5	**Old Houses**	The old structured houses made of wood, mud and bricks seemed providing roosting habitat for the bats.

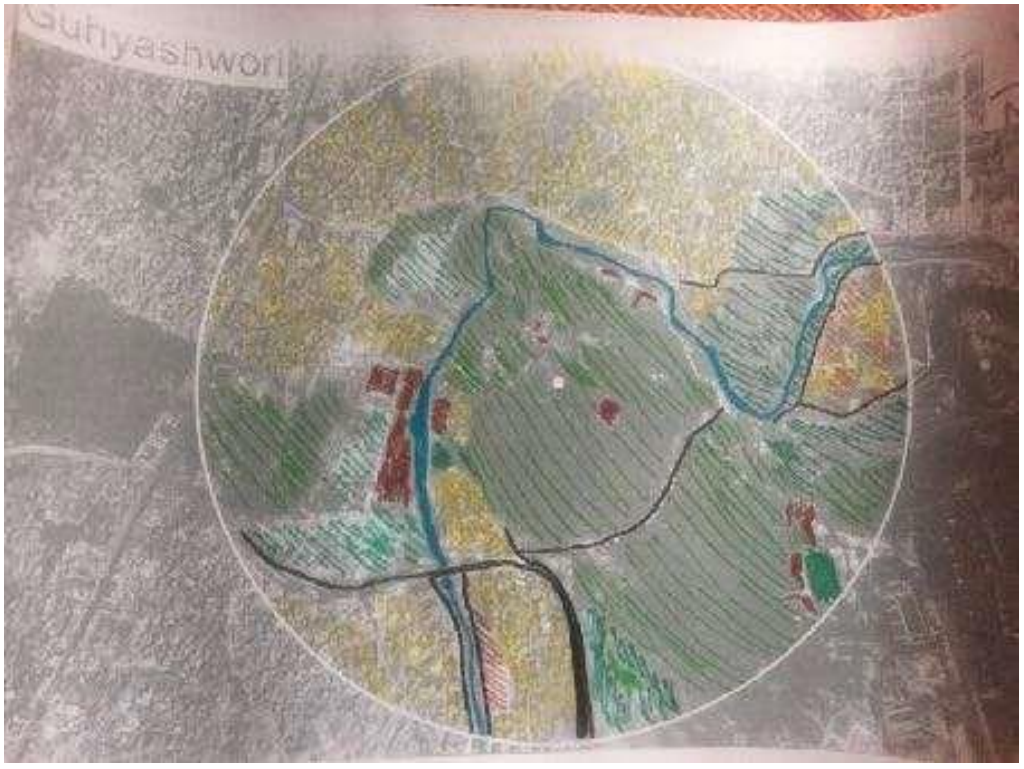


Figure 27. Guhyeshwori Phase I map

5. SITE V – SWAYAMBHUNATH

5.1. Location

Located in the western side of Kathmandu valley, this is another one of the religious sites for the survey and is affiliated to Buddhist religion.

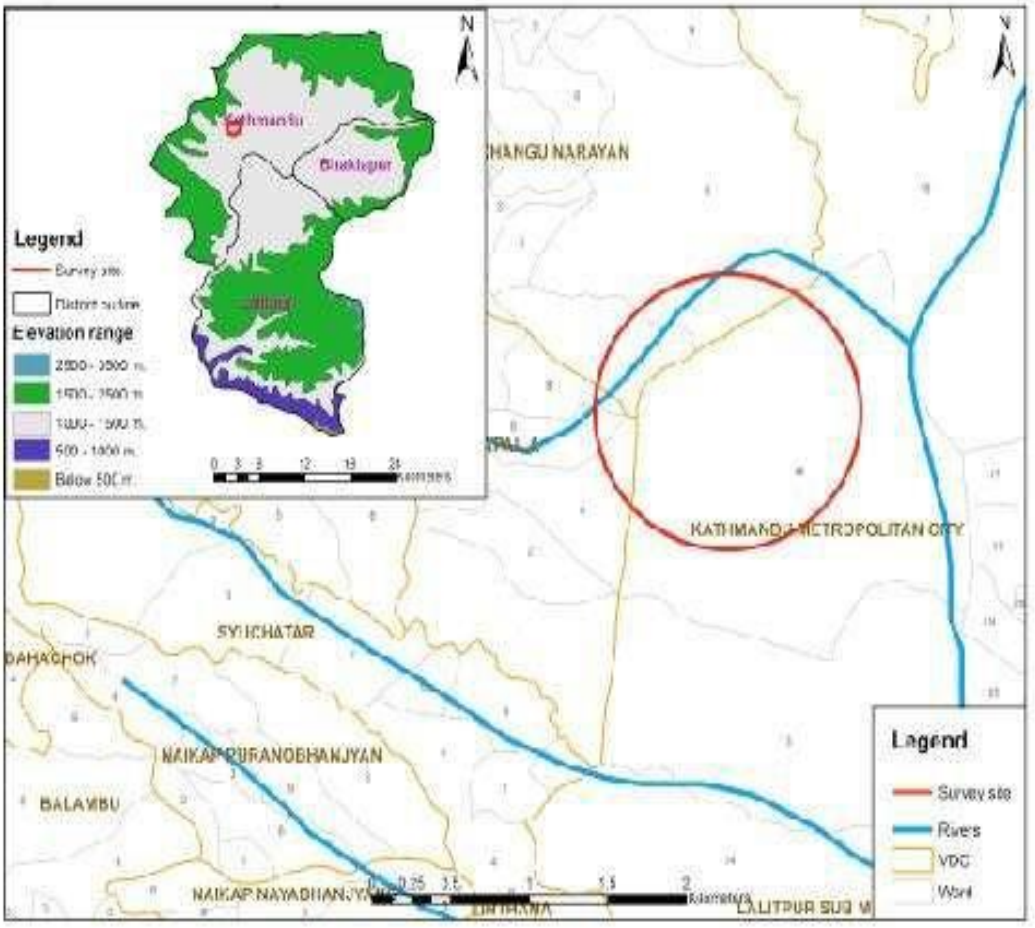


Figure 28. Map of Swayambhunath survey site

5.2. Land Tenure

Resting on a hillock 3 kilometers west of Kathmandu valley, the site is said to have been evolved more than 2000 years ago. Legends says that once the Kathmandu valley was a lake in which Swayambhu hill existed as an island where a natural crystal stupa stood on top of it. When Buddha visited this place, he declared it to be a wish-fulfilling stupa and any contacted with the wind that passes over the stupa receives liberation from the cycle of existence.

Figure 29. Land cover of the religious forest

In the northern side of the stupa is The Shri Karma Raja Maha Vihar Monastery where the main seat of H.H. the 16th Gyalwa Karma Rangjung Rigpe Dorje in Nepal, directed by the abbot Sabchu Rinpoche. The Karma Kagyu Lineage of this monastery is mostly known to govern the activities and maintenance of the estate.

5.3. Site Status

Swayambhu is designated as UNESCO World Heritage Site and has its earliest records going back to stone inscription of 5th century. The word literally means "self-existent one" and has been honored by kings, monks and pilgrims alike, allowing the stupa to be restored and repaired in numerous occasions due to the religious and cultural values the estate possesses.

Figure 30. The magnificent Swayambhunath Stupa

5.4. Physical Features

Around the stupa, there are various concrete attractions that symbolizes Buddhist culture like monasteries, shrines and temples for Hindu pilgrims, nullifying the differences between religions. The estate is famous for its sacred forest protected by the Federation of Swayambhu Management and Conservation (FSMC) that has established Swayambhu Environmental Park in order to conserve the indigenous plants found in the forest. Apart from the forest, the surrounding mostly has human settlements with concrete housings. Yet, there are few agricultural areas around the north-eastern side of the site.

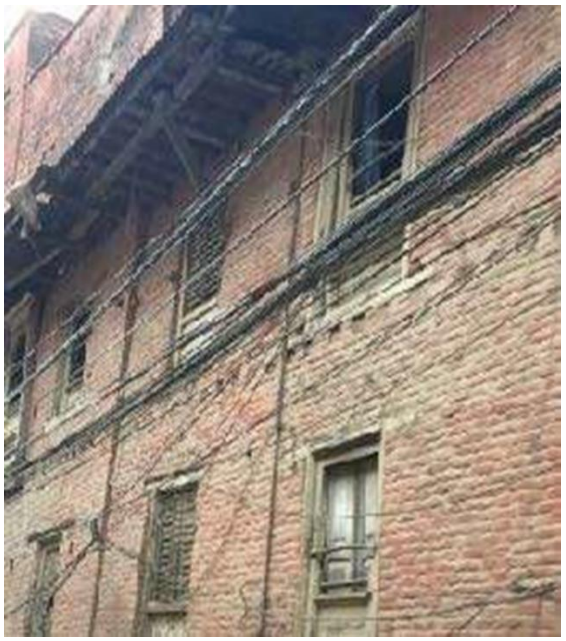


Figure 31. Old style house, good for bats to roost

5.5. Biological Features

The most predominate species of tree in the sacred forest are primarily pine (*Pinus raxburghii*), *Schima wallichi* and Indian wild pear (*Pyrus pashia*). After having had declared the forest as sacred and a priority for conservation, two protected plants *Aesculus indica* and *Podocarpus nerifolia* was planted in 2010, but the results are yet to be reported.

Figure 32. Sacred grove of the site with varieties of tree species

Popularly known as the „Monkey Temple", Swayambhu has held abode to Rhesus macaques (*Macaca mulatta*) for a long time. The species have become a symbol of attraction for tourists along with pilgrims who come to visit the "holy monkeys". The Five-striped squirrel (*Funambulus pennanti*) is another mammal species found in this estate.

With a mixture of resident, migrants and visitor birds, the forest is filled with 64 diverse species of birds like peregrine falcon (*Falco peregrines*), dark kites (*Milvus migrans*), dark-throated thrush (*Turdus ruficollis*), spotted dove (*Streptopelia chinesis*) and common kestrel (*Falco tinnunculus*). Some of the bird species found in the forest are listed in CITES II and III categories like the slaty- headed parakeet (*Psittacula himalayanal)* and the cattle egret (*Bubulcus ibis*) respectively.

Figure 33. Abundant number of rhesus macaque in the area

5.6. Cultural Features

Swayambhunath stupa is said to represent the mind of Buddha himself that offers peace, freedom and enlightenment and pacifies any physical and mental difficulties such as sickness, famine and conflicts of any person. It also holds specific importance to have generated Swayambhu Purana, a Buddhist scripture about the origin and development of Kathmandu valley and details of all the Buddha's who came to Kathmandu.

Buddhism and Hinduism blends in harmony in the estate as the notable Harati Devi Temple that resides in the premises of the stupa and is popular especially among mothers seeking blessings for their children.

Festivals enthusiastically celebrated in Swayambhunath are Buddha Jayanti and Loshar, when pilgrims visit the temple to view the lotus pattern on the stupa created by the monks with saffron- colored paint.

5.7. Access and Visitor Facilities

Open to all religions, the entrance fee for tourist foreigners and SAARC country visitors is Rs. 200 and Rs. 50 respectively per person that goes for the development of the estate of Swayambhunath Stupa.

5.8. Target Table

	Target	Description
1	**Sacred Grove**	While the forest is essential to bats and their habitat, the fact that the grove is conserved due to religious purposes makes it an undisturbed area, bringing less distraction for the animals and birds living in the forest.
2	**Rhesus macaque**	The extreme amount of the macaques that can swing and transport themselves anywhere around the area could bring habitat destruction problems among the bats.
3	**Old houses**	The old structured houses made of wood, mud and bricks seemed providing roosting habitat for the bats.

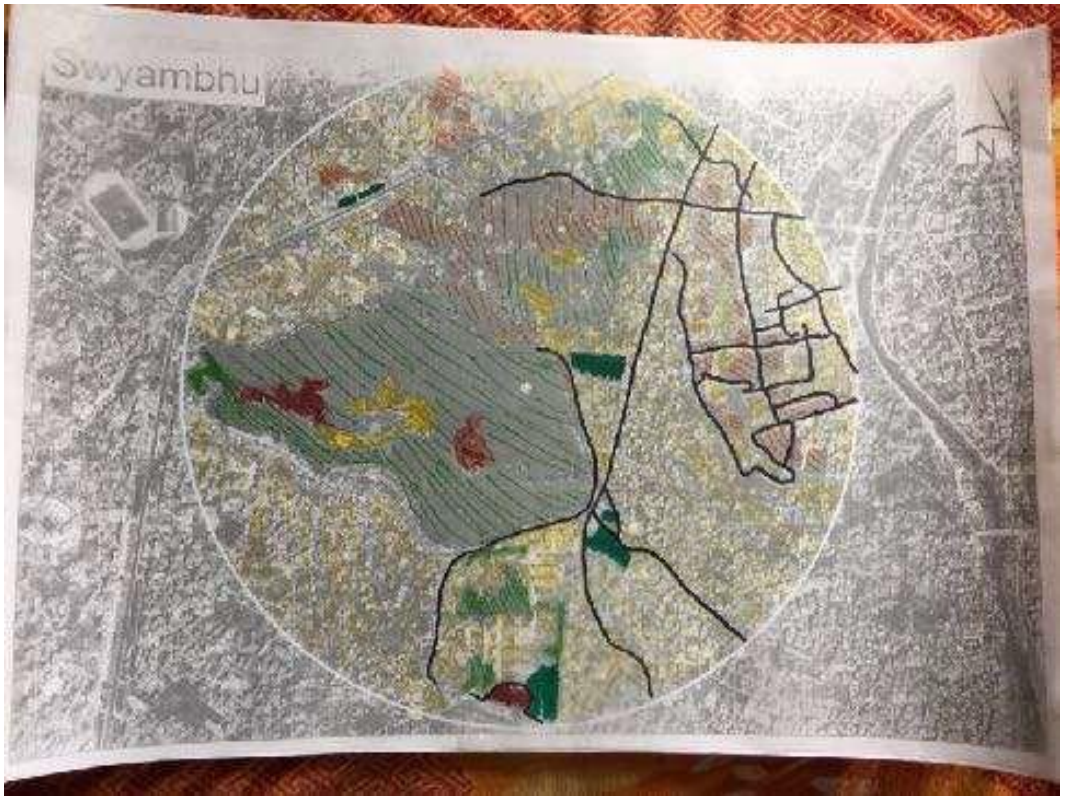


Figure 34. Swayambhunath Phase I map

6. SITE VI - CHOVAR

6.1. Location

This site is a village in Kathmandu District in the Bagmati Zone and a part of Kirtipur Municipality. Located 6 kilometers south west from Kathmandu valley, Chovar is full of natural and cultural beauties.

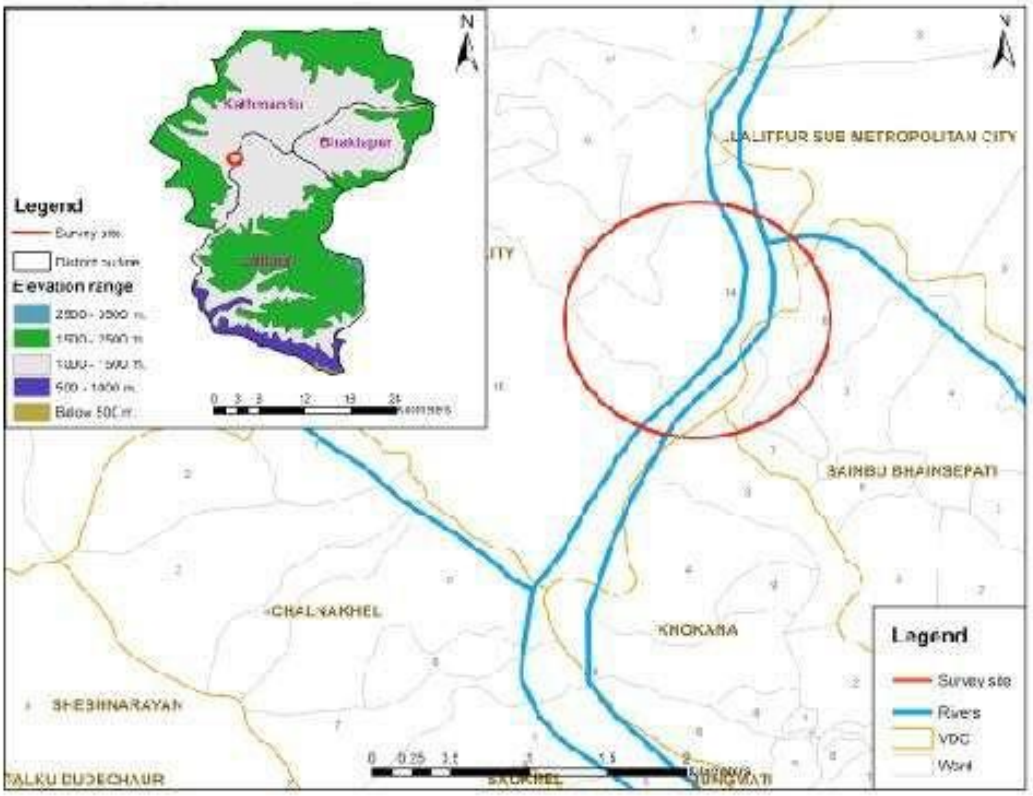


Figure 35. Map of Chovar survey site

6.2. Land Tenure

Legends have been passed out regarding the gorge found in this village that was apparently carved out by a mighty blow of the sword of Manjushree - a bodhisattva associated with Mahayana Buddhism - that helped drain the lake of Kathmandu valley during ancient times. The gorge still helps in gushing out the valley's water to the plains beyond the hills. The forests nearby is managed by Jalbinayak Community Forest Users" Group for conservation and maintenance.

Figure 36. Chovar gorge

6.3. Site Status

Known for its historical importance, the estate is filled with natural beauty like hills, gorges and caves that has been recorded to date back to Pleistocene era. The temples found around the area are also famous for its ancient histories. Furthermore, the Manjushree Park gives a recreational environment for the visitors of this beautiful area.

Figure 37. Manjushree Park

6.4. Physical Features

Chovar, having been historically known to drain the water of Kathmandu valley is surrounded with hills and canyons and has Bagmati river exit through its corners. The rocky hills preserve the greenery of this picturesque location while the river flowing through the gorge provides water source for people living in the area nearby for agriculture located in the southern side from the site.

Opened by the Jal Binayak Community Forest Users" Group, Manjushree Cave is that is said to be 1250m long although only 350m of the cave is opened for visitors. This has been recorded as the second largest in Nepal and the third largest in Asia and has been home to thousands of bats for the area. Two small ponds have been located inside the cave 40m and 60m away from the entrance and becoming a source of water for the bats inside the cave.

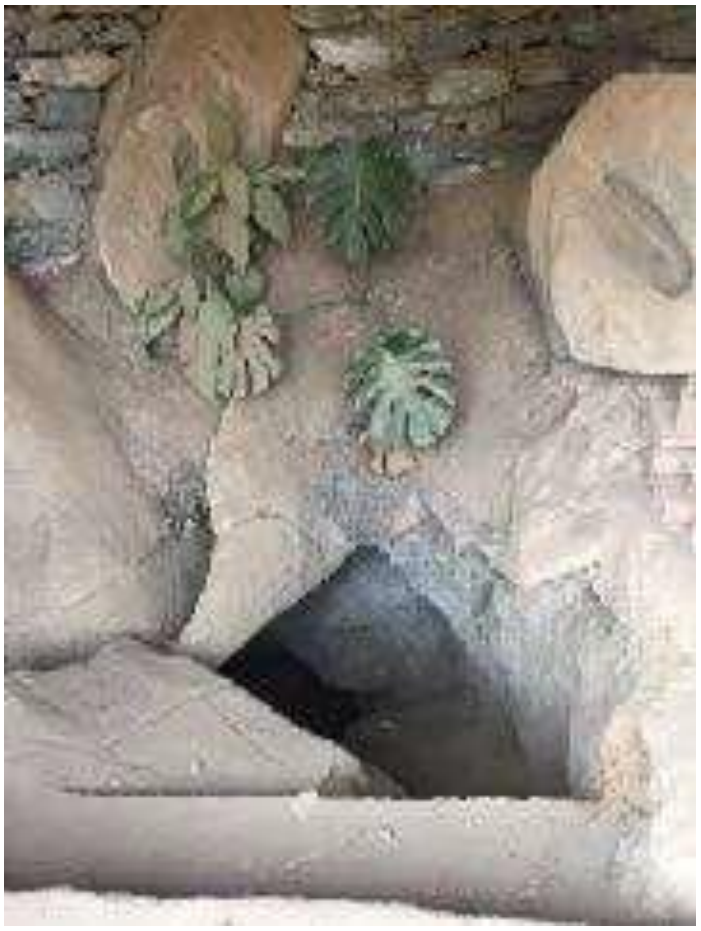


Figure 38. Manjushree Cave

Possibly due to its complex geography, there wasn't a thick community of human settlements, although some had found residential area around the southern side of the site where it was plain in comparison to its rocky and hilly northern side. Though new houses were built with concrete cements, some old-traditional houses and buildings were also noticed around the areas where historical temples were located.

Figure 39. One of the old style houses

In the south-eastern side of this site, there was ruins of an old cement factory that was once built for cement manufacture. After having exploited the community' land, the river, agricultural production, the local community protested against the factory and finally, Government and the shareholders shut the factory down in 2002.

Figure 40. Remains of the banned cement factory

6.5. Biological Features

The tree coverage mostly consisted of coniferous pine trees across the estate. However, there were few number of bamboo bushes, Nepali hog plum (*Choerospondias axillaries*), *Bauhinia variegata*, mulberry trees and *Prosopis cineraria*.

Figure 41. River Bagmati, as it exits the valley through the gorge

There were few rock pigeons around the temple area and common house crow species around the banks of the river. Their habitation could correlate to the extreme pollution in and around the Bagmati River that seems to be unmanaged. There are however various other birds reported in the area like Asian Koel, Common sandpiper, Cattle egret, Barn swallow and Common myna.

Locals though didn't have a massive areas for agriculture, there were few irrigation plot-lands where maize, spinach, soybeans were grown. Furthermore, they had varieties of fruits growing in this irrigation area like plums, avocado and figs.

Figure 42. Common crow

6.6. Cultural Features

Apart from its tourism contribution, Chovar is a shrine to pilgrims who come around to visit historical temples that are revered by both Buddhists and Hindu pilgrims. Jal Binayak temple is dedicated to the half-elephant God Ganesha and has a history directly correlating to the story of Manjushree. It has been believed that when the blow of Manjushree drained the water from Kathmandu valley, it also allowed the snakes to escape with the flow of the water. Since snakes are considered auspicious in Nepal for rain, to prevent drought after their exit, Lord Ganesh appeared in the form of Jal Binayak and located those snakes in another small lake a bit further from these huge gorge. This lake today is called Taudaha, situated a bit further from Chobhar.

Figure 43. Temples in and around Chobhar area (Left: Jal Binayak Temple, Right: Adinath Lokeshwor Temple)

The Adinath Lokeshwor temple has a shikhara-style shrine in front of the temple with a shivalinga inside it. It is there that is believed to be the entrance to the cave that leads through the mountains to the Chobhar Gorge. Originally build in the 15th century, this three storied pagoda was later reconstructed in the 1640. The unique thing about this temple is the massive number of utensils hung around the temple that represents offerings of pilgrims to God for the prayers that had been answered.

6.7. Access and Visitor Facilities

The temples and the gorge are free to view although the Manjushree park entrance is Rs. 20. In order to explore the cave, one has to pay the price that depends upon the length of the route that the visitor wants to visit and the cost includes the headlamp and a cave guide. Located at the base of the gorge is a 114 year old suspension bridge, the first one of Nepal that was built in 1903 by Chandra Shamsher with the help of Scottish engineers to join Kirtipur with Lalitpur. This bridge is now used to give the visitors a better view of the gigantic gorge and enjoy the sight.

6.8. Target Table

	Target	Description
1	**Manjushree Cave**	The enclosed environment that goes deep inside a hill gives the bats a suitable domain for habituation.
2	**The Forest**	Though not a thick coverage of forest, the coniferous pine trees were tall and hence can give the bats a pleasant spot for resting
3	**Bagmati River**	River flowing out of the gorge becomes the major source of water for the bats and any other animals or plants.
4	**Traditional Houses**	With old, traditional houses made of wood, clay and flat tins, the cape of these houses gives bats a place for them to roost.

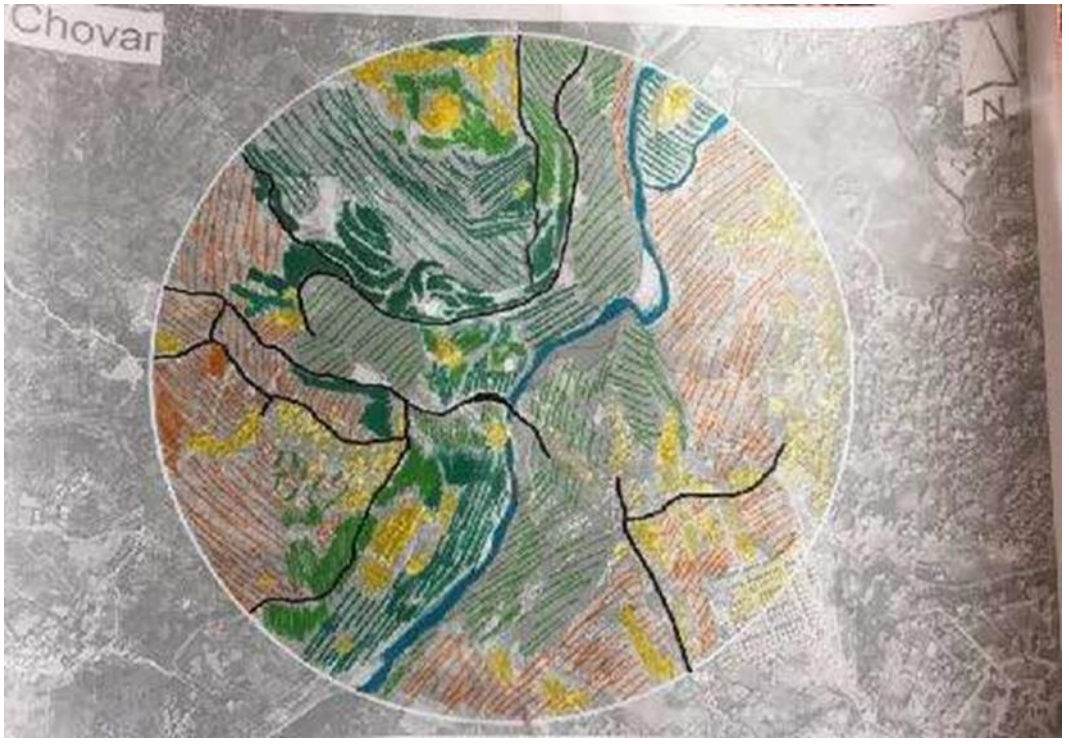


Figure 44. Chovar Phase I map

7. SITE VII - MACCHEGAUN

7.1. Location

Located further south west and 7-8km far from Kathmandu Valley, Machhegaun is a village development committee that emerges after crossing the Kirtipur municipality westwards.

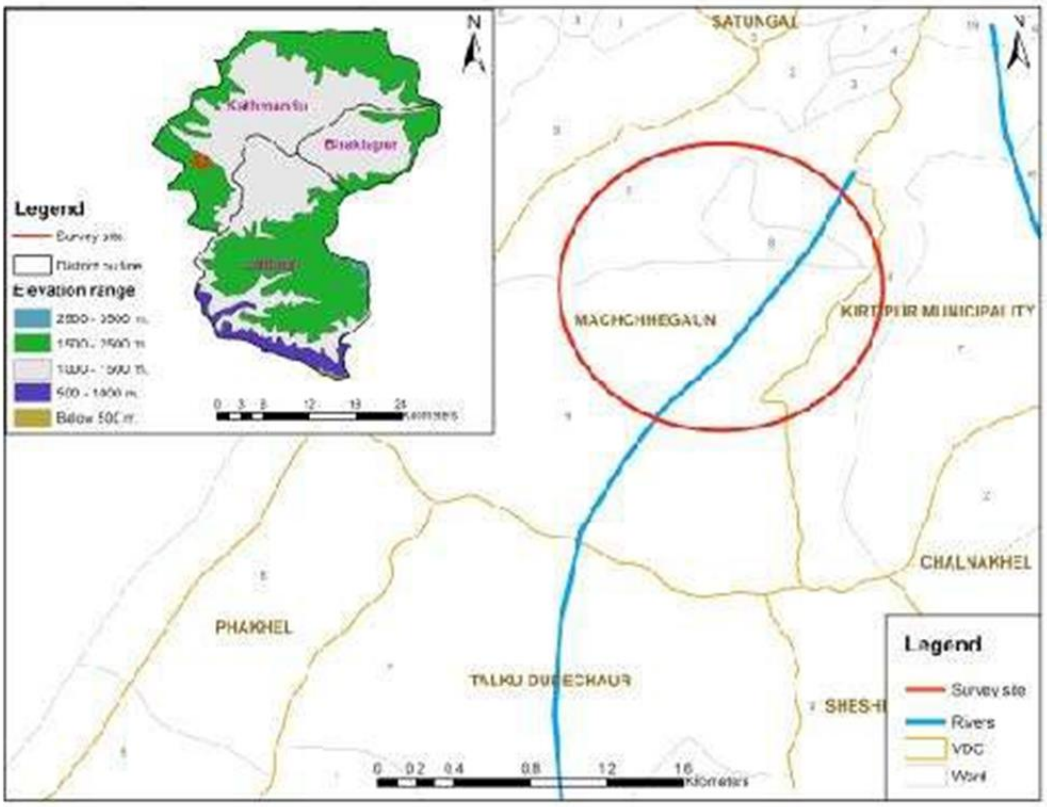


Figure 45. Map of Machhegaun survey site

7.2. Land Tenure

Despite Kathmandu facing problem for drinking water and environmental pollution, the VDC hasn't gone through extreme scarcity due to the effective and active management programs supported by Nepal Government and UNDP project for water management and environmental protection since 2010.

7.3. Site Status

It has been said that during ancient time, a young boy found a small fish about to die while he was having a bath in a river. He brought the fish to his home and put it in a small pot of water.

The next day, the boy woke up to see the fish grown bigger for the small pot. Hence, he placed the fish in a pond nearby but the fish outgrew the size of the pond too. Realizing that the fish was no ordinary one, the boy bowed with respect and then Lord Vishnu emerged from the mouth of the fish. A temple was created in between that pond and today, the village is named after this legend - Machhegaun where *Machha* is fish and *Gaun* means village.

Figure 46. Temple of Machhenarayan

7.4. Physical Features

Despite its religious background, Machhegaun has vast forest areas that extends further southern from the settlement designated space. These forests are high hills covered with different ranges of forests and plant types.

Settlement of human is majorly in the north eastern side, towards Kirtipur valley and includes housing of concrete cements along with houses made up of stones and local clays. The latter consists of much suitable environment for bats to reside in between the cracks and spaces of the house.

Figure 47. Forest hills and agricultural lands

Figure 48. One of the old houses in the area

Agricultural areas are mostly in patches where loose tree areas and human settlements are found amidst the irrigated lands.

Figure 49. Agricultural land

7.5. Biological Features

The different types of trees in the village included Nepali hog plum (*Choeropondias axillaris*), pine trees, sacred fig (*Ficus religiosa*), bamboos, *Elaeocarpus ganitrus*, pomegranate (*Punica granatum*), and shrubs of poinsettia (*Euphorbia pulcherrima*).

Figure 50. Bamboo bush found in the area

Agricultural crops included maize, wheat, potato, soybeans and chayote squash. Though they are not exported in large mass, the residences use these crops for personal use and few market exports. After harvesting, these crops are stored for winter use.

Although much wasn't said about wild animals sighting in the village, rumors have been circulated among residences regarding few sightings of leopards around the forest areas. Few villagers had cattle in their homes, most probably for milk and dung production for household purposes.

Figure 51. Traditional cowshed made with clay and wood

7.6. Cultural Features

The village hosts a fair once every three years for a whole month in between April to July. It is then when the village is highly popular, or else there aren't much people apart from the residents visiting the place.

7.7. Access and Visitor Facilities

Despite being far from the metropolitan cities, Machhegaun has well developed roads that extends to almost every corners of the neighborhood. The access to the village with local transport is also available from Kathmandu Valley. Machhenarayan temple, the main historical attraction of this area is also free for visitors and pilgrims of every religion.

7.8. Target Table

	Target	Description
1	**Old Houses**	Made up of traditional equipment such as woods, mud and bricks are suitable roosting areas for the bats.
2	**The Forest**	The forest near the village had trees that provides habitat and edible fruits for bats and their roosting.
3	**Cattle stables**	Stables made with traditional equipment's for the cattle can become another suitable roosting feature for bats as they provide secular and dark environment.

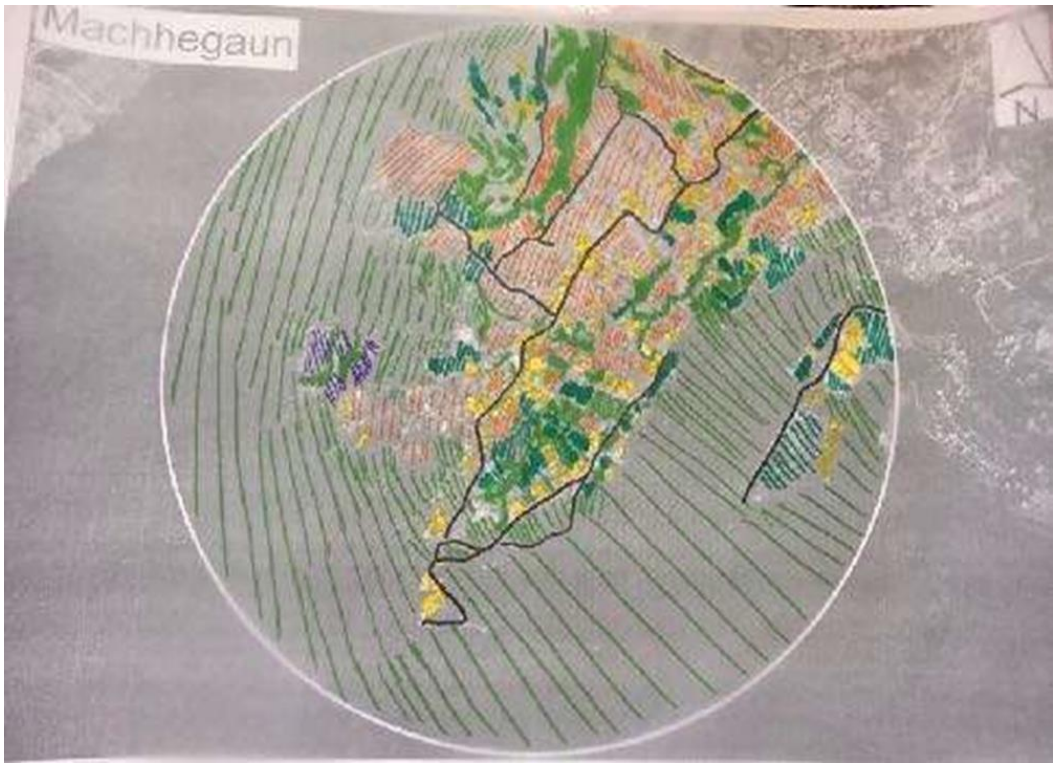


Figure 52. Machhegaun Phase I map

8. SITE VII - NAGARJUN

8.1. Location

Nagarjun is a municipality located in Kathmandu district in Bagmati Zone of Nepal. Situated in the north-west part of Kathmandu valley, it is a hilly area that spreads unto 7 kilometers of range.

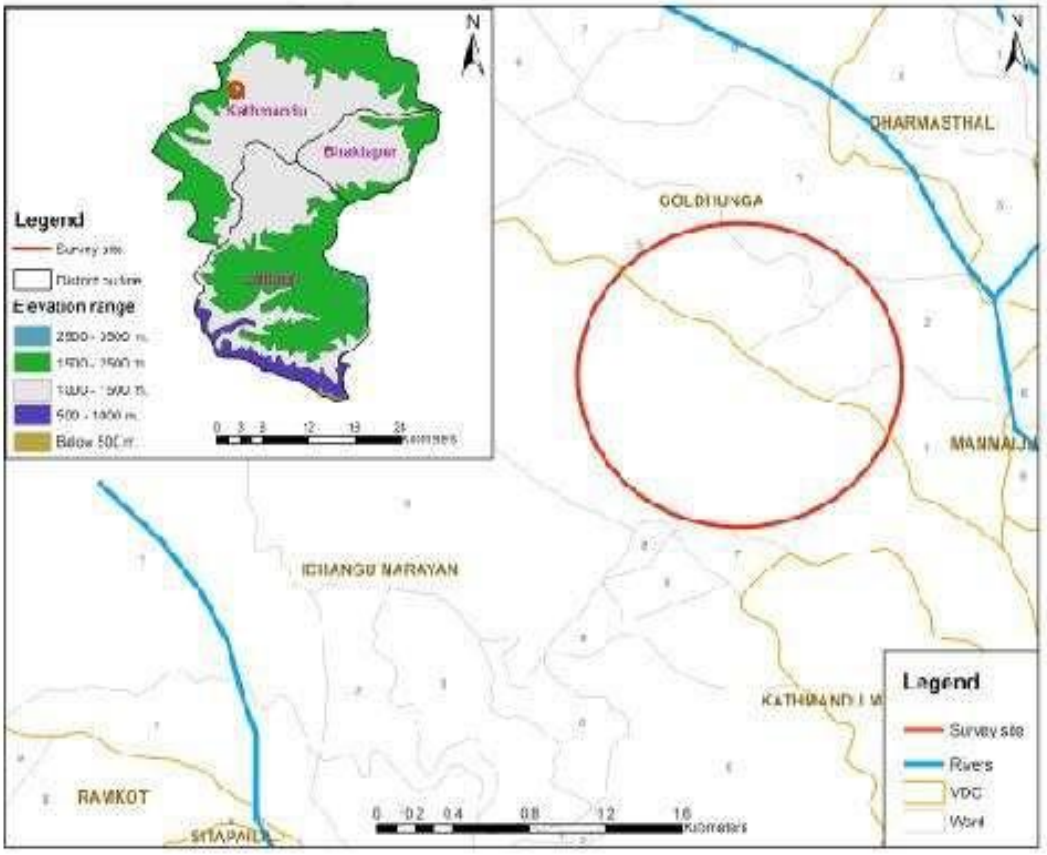


Figure 53. Map of Nagarjun survey site

8.2. Land Tenure

As of 2014, the estate has been formed into a municipality after merging five existing VDCs namely Bhimdhunga, Ichankhu Narayan, Ramkot, Seuchatar and Sitapaila. The central office of the conjoined municipality is situated in Sitapaila.

8.3. Site Status

Naturally rich with greenery and exotic plant species, Nagarjun is a conserved forest land that combines with Shivapuri forest area to be assembled as Shivapuri Nagarjun National Park.

Established in 2002, the park covers an area of 159 sq. kilometers and has been an important water catchment area. Today, this site is one of the last areas around Kathmandu valley that remain undisturbed and is popular for hiking, bird watching and mountain biking.

8.4. Physical Features

The south-western side of the site covers the Nagarjun forest reserve that is a hilly forest area with rich and diverse flora-fauna species. Also in the site is an army camp that serves protection for the visitors around the national park. The north eastern side is occupied with human settlement and patches of agricultural areas whereas the north western side of the area has extended farmland areas with loose forest patches around the irrigated land.

8.5. Biological Features

Being a part of Shivapuri Nagarjun National Park, the estate is rich in diversity of flora and fauna and has been an area famous for its natural abundance. Tree species like *Schima castanopsis*, wild Himalayan cherry (*Prunus cerasoides*) and a vast vegetation of Eastern Himalayan broadleaf formulates the forest patches of the site Mammals and reptiles like monocled cobra (*Naja kaouthia*), Himalayan keelback (*Amphiesma platyceps*), olive oriental slender snake (*Trachiscium laeve*), variegated mountain lizard (*Japalura variegata*), many-keeled grass skink (*Eutropis carinata*), black-spines toad (*Duttaphrynus melanostictus*) and long-legged cricket frog (*Zakerana syhadrensis*) have been recorded in the site of Nagarjun.

Birds that ornithologists have recorded in the area are Eurasian eagle-owl (*Bubo bubo*), slender- billed scimitar-babbler (*Pomatorhinus superciliaris*), white-gorgeted flycatcher (*Anthipes monileger*), barred cuckoo-dove (*Macropygia unchall*) and golden-throated barbet (*Psilopogon franklinii*). These become a figure of significance for bird watchers in the area.

8.6. Cultural Features

The Nagarjun forest consist of Ichangu Narayan, the western Narayan temple of the four cardinal points of Kathmandu valley. Although there are specific days when massive number of pilgrims come around to visit the temple, there is no local vehicles going towards this monument. Instead, one has to hire a taxi from the bottom of the hill and travel towards the temple for worship.

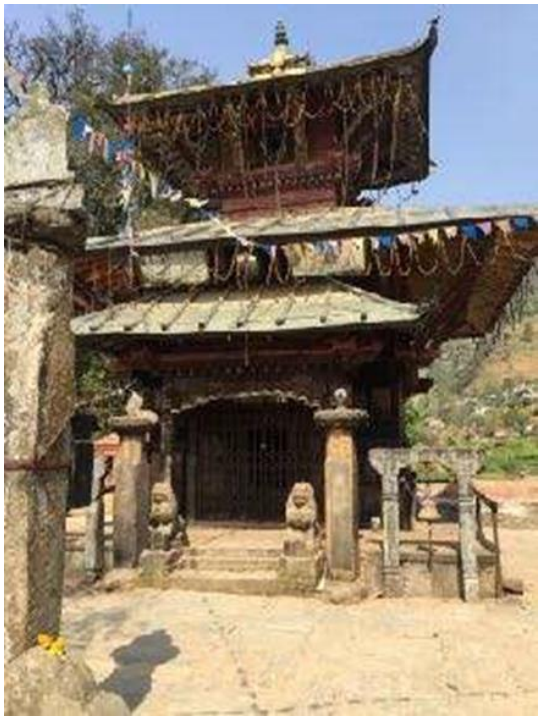


Figure 54. Ichangu Narayan temple

8.7. Access and Visitor Facilities

The Nagarjun area experiences hikers and pilgrims equally and are free to roam inside the premises for short trips or maybe longer stays too. However a certain amount of entrance fee is required to be paid before entering the premises: Rs. 50 for Nepalese citizen, Rs. 300 for SAARC countries citizens and Rs. 500 for foreigners.

8.8. Target Table

	Target	Description
1	**Old Houses**	Made up of traditional equipment such as woods, mud and bricks are suitable roosting areas for the bats.
2	**The Forest**	The forest area of the site provides habitat and edible fruits for animals, birds and most significantly, bats.
3	**Reptiles**	The different varieties of reptiles found in the forest area of this site could bring danger to bat and their residences. However, since it is a process of ecological cycle, issues in decline of bat population shouldn't be of much problem unless massive reduction

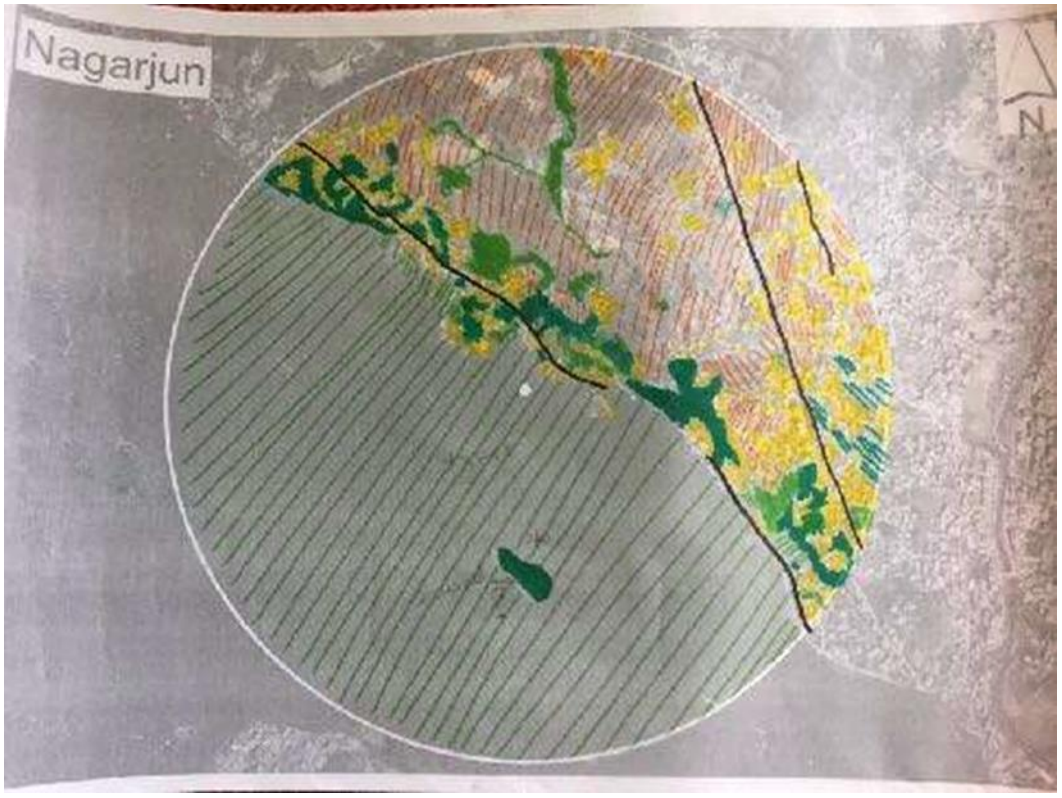


Figure 55. Nagarjun Phase I map

9. SITE IX - NAGARKOT

9.1. Location

A former Village Development Committee, Nagarkot is a municipality 32km east of Kathmandu in the Bhaktapur district of Bagmati Zone. Located approximately 7000 ft above sea levels, it is considered as one of the most scenic spots to view sunrise and the Himalayas due to its elevated height of 2,195 meters.

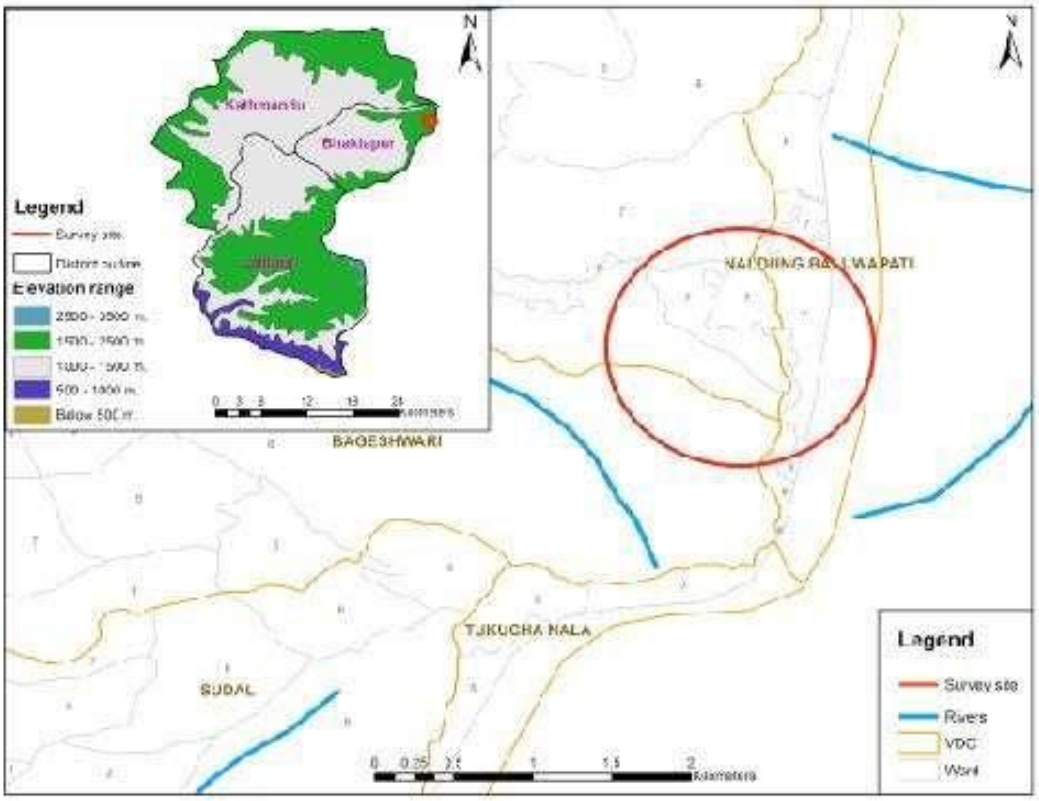


Figure 56. Map of Nagarkot survey site

9.2. Land Tenure

As of 2015, Nagarkot has been replaced from being a VDC to a municipality. Kusum Community Forest is one of the community forest users" group that focuses on the conservation and development of forest resources of Nagarkot municipality.

9.3. Site Status

Nagarkot has had the reputation as the best place to enjoy Himalayan views from the comfort of a hotel's balcony. Hence, the site is particularly busy between October and March, when the climate is most suitable to view the mountain range that includes Annapurna, Manaslu, Langtang and many more infamous ranges of the country.

The active nature loves and outdoor enthusiasts are known to participate eco trails, hiking and paragliding from the Nagarkot municipality, making the site popular among foreigners who would like to dwell just outside Kathmandu valley.

Figure 57. Eco-trails of Nagarkot

9.4. Physical Features

Bulks of the area taken inside the radius of 750 meters is forest land with different kinds of trees, plants, animals and birds. This diversity allows visitors to enjoy brisk walks, hiking and bird watching activities.

Going west from the allocated site, the estate has farming land where residences have used staircase irrigation system with few patches of trees inside the farmlands. The presence of farmlands automatically includes human settlements within the area. Hence, although in a minimum number, there is availability of human settlement around the agricultural land.

Figure 58. Agricultural land areas with on-going construction

9.5. Biological Features

The community forests within the Nagarkot estate thrive through floras of diverse species like pine trees (*Pinus roxburghii*), rhododendron (*Rhododendron arboreum*), chest nut, walnut, berries, nettle (*Girardinia diversifolia*), *Albus nepalensis, Pinus roxbirg, Schima wallichii*, wild berries, *Quercus semecarpifolia*, teak (*Tectona grandis*), reed (*Phragmites karka*) and fern bushes.

Figure 59. Flowering plants of Nagarkot

Birds that have been sighted in this region are large billed crow *(Corvus macrorhynchos)*, long tailed shrike *(Lanius schach)*, barn swallow *(Hirundo rustica)*, great barbet *(Psilopogon virens)*, grey wagtail *(Motacilla cinerea),* great tit (*Parus major)*, grey bush chat (*Saxicola ferreus)*, Himalayan bulbul *(Pycnonotus leucogenys*) and Himalayan black-pored tit (*Machlolophus xanthogenys)*.

Figure 60. Bird in Nagarkot forest

Around the forests of Nagarkot, animals like Indian muntjac (*Muntiacus muntjak*), wild boar (*Sus scrofa)*, golden jackal (*Canis aureus*), Indian grey mongoose (*Herpestes edwardsii*), rabbits, Indian giant squirrel (*Ratufa indica*) and Indian pangolin (*Manis crassicaudata*).

9.6. Cultural Features

Although the majority of visitors in Nagarkot go for hikes and trekking route, few pilgrims are known to take the route to Change Narayan, a temple listed in the UNESCO World Heritage Site Kathmandu Valley. The route is popular among people family travelers with children and elderly due to the easy trek towards the temple.

9.7. Access and Visitor Facilities

Maximum area of the Nagarkot forest is accessible for hiking and bird watching. Few areas of this forest however is restricted due to army camps based in specific region. These camps are located for security purposes throughout the municipality.

9.8. Target Table

	Target	Description
1	**The Forest**	The forest area of the site provides habitat and edible fruits for animals, birds and most significantly, bats.

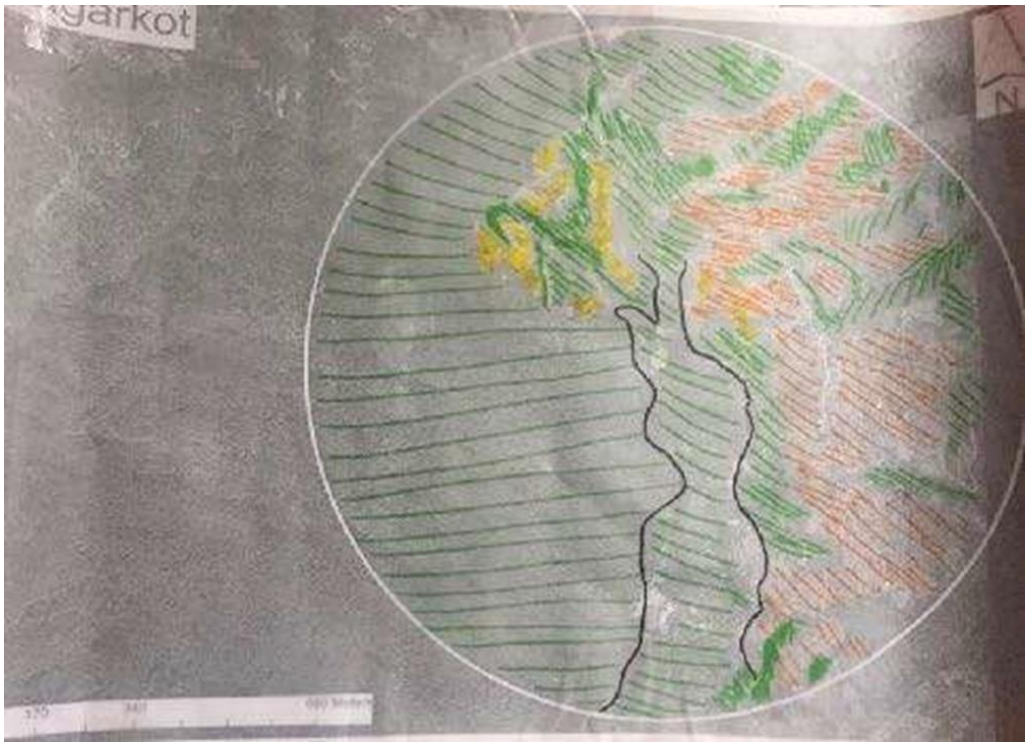


Figure 61. Nagarkot Phase I map

10. SITE X - PANIMUHAN

10.1. Location

The site falls in the north-eastern side of the Kathmandu valley and is a part of the northern side of Shivapuri-Nagarjun National Park (SNNP).

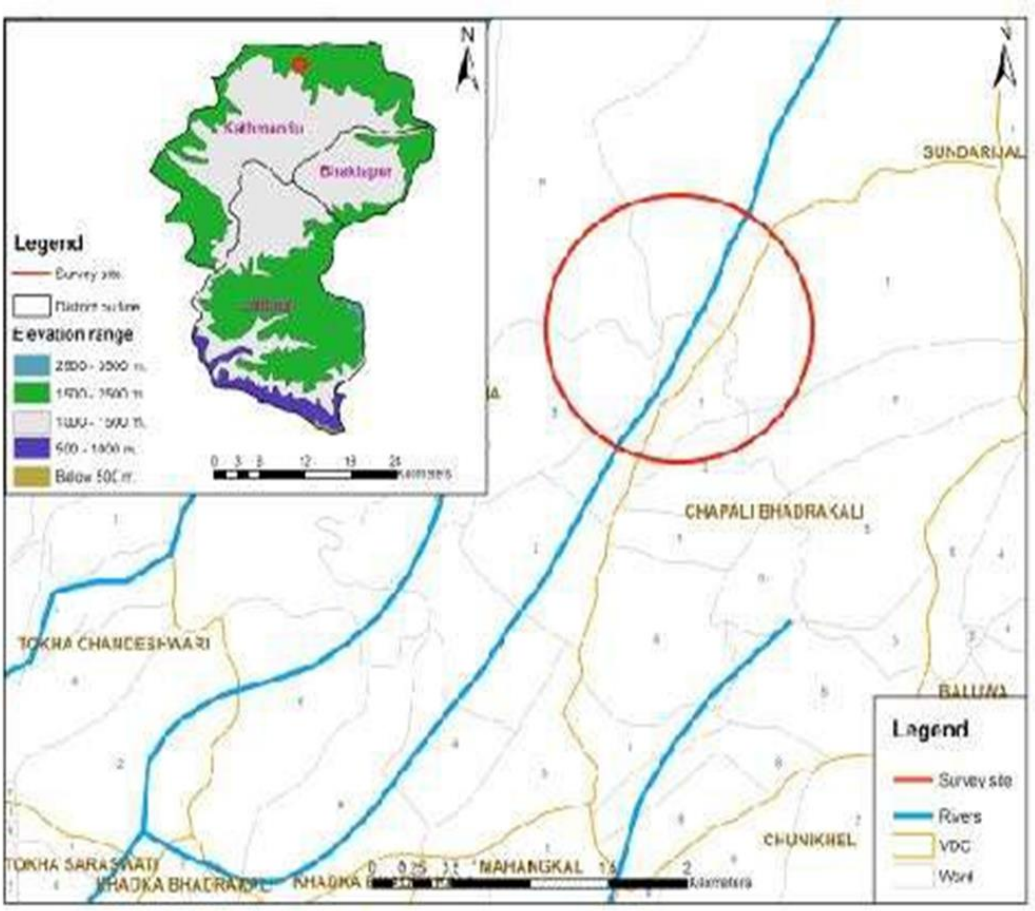


Figure 62. Map of Panimuhan survey site

10.2. Land Tenure

The office of Panimuhan is the headquarters to manage SNNP. Working under the supervision of Government of Nepal, Ministry of Forests and Soil Conservation, Department of National Parks and Wildlife Conservation, The SNNP office is governs the Sunadrijal, Dhakalchaur and Nagarjun sectors of the National Park.

10.3. Site Status

Located headquarter of the National Park, the site governs the whole SNNP under the Government of Nepal for its conservation action. Due to its rich forest area, the estate is also famous for having Nepal Vipasanna Meditation Centre which is located in the foothills of the forest areas. This meditation center is almost four acres wide and provides courses for meditation and encourages various other spiritual teachings to the youth of Nepal.

10.4. Physical Features

The majority of this site that falls under the 750m radius is covered with forest patches that is a part of conserved wildlife reserve SNNP.

The south western part of this area consists of few human settlements and loose forest patches. There are few agricultural areas around the settlements but most of the irrigated land are purely for personal purposes instead of cash crop trade.

10.5. Biological Features

The area of Panimuhan has a vast area of forest land with various different types of flora and fauna. Birds such as house crow (*Corvus splendens*), black kite (*Milvus migrans*), common myna (*Acridotheres tristis*), Eurasian tree sparrow (*Passer montanus*), spotted dove (*Spilopelia chinesis*), blue-throated barbet (*Psilopogon asiaticus*), barn swallow (*Hirundo rustica*), blue whistling thrush (*Myophonus caeruleus*) and rock pigeon (*Columba livia*).

The trees and plant species found in this area includes *Alnus nepalensis*, rhododendron, *Castonopsis indica, Schima wallichi, Cinnamomum camphora*, bamboo and other mixed broadleaf types of forest trees. An occasional fruit trees such as banana and litchi were also spotted around the area.

10.6. Cultural Features

The nearest monument from the entrance of the Panimuhan office is the Nagi Gumba, a Buddhist monastery that allows visitors and pilgrims to rest and temporary resident in the premises.

10.7. Access and Visitors Facilities

Since the Panimuhan office is located inside the Nagarjun-Shivapuri National Park, the entrance fee is the same as of Nagarjun: Rs. 50 for Nepalese citizen, Rs. 300 for SAARC countries citizens and Rs. 500 for foreigners.

10.8. Target Table

	Target	Description
1	**Old Houses**	Made up of traditional equipment such as woods, mud and bricks are suitable roosting areas for the bats. Although not many, the few houses found around the agricultural areas are indeed helpful for bats and their habitat.
2	**The Forest**	The forest area of the site provides habitat and edible fruits for animals, birds and most significantly, bats.

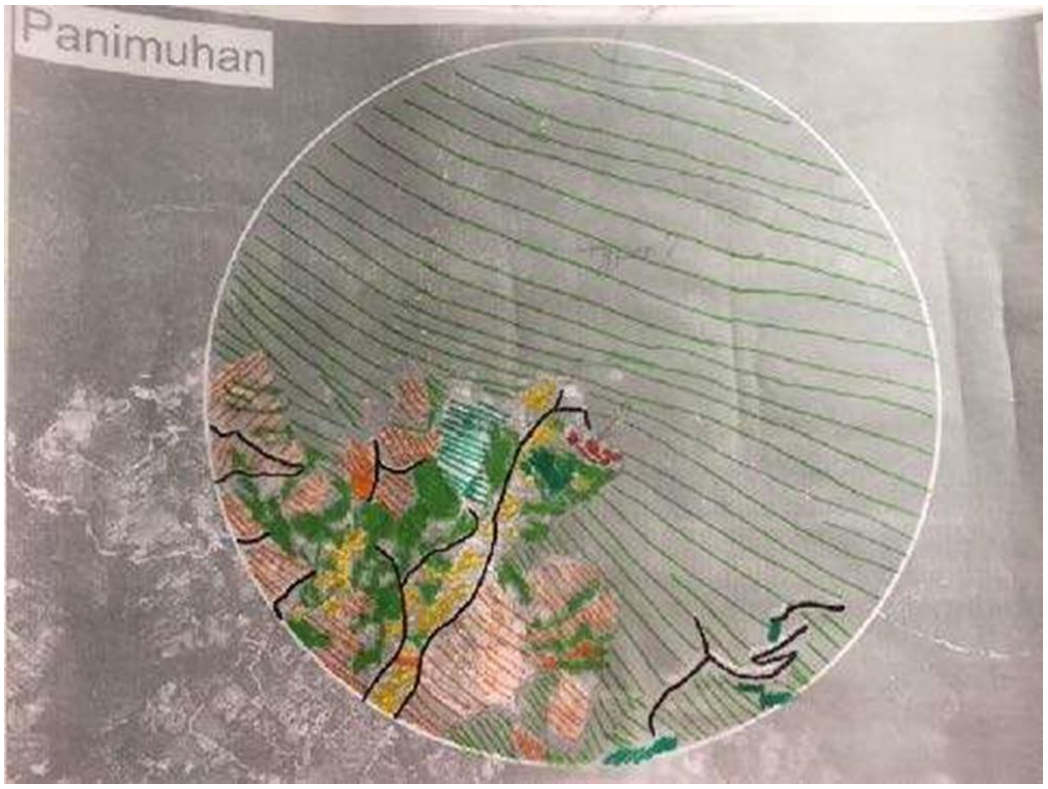


Figure 63. Panimuhan Phase I map

11. SITE XI - PHARPING

11.1. Location

Situated about 19 kilometers south of Kathmandu, Pharping, often identified as Yanglesho, is a sacred village especially for Buddhist pilgrims who visit the location for monasteries and ancient historical Buddhist beliefs.

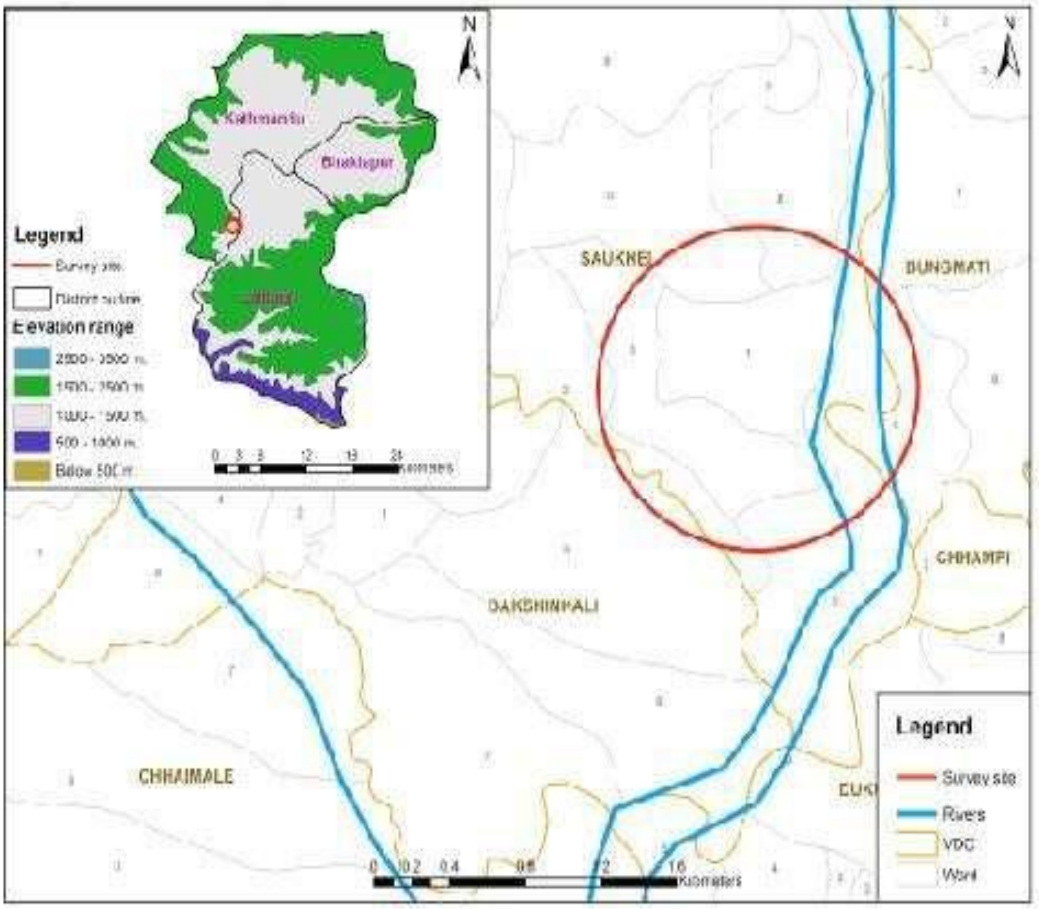


Figure 64. Map of Pharping survey site

11.2. Land Tenure

Previously known as Pharping VDC, the town, along with various other villages has been combined to form the new Dakshinkali Municipality that governs the actions and regulations throughout the area.

11.3. Site Status

Pharping has been important for religious purposes to followers of the Nyingma tradition as it has been believed that it was here that Guru Rinpoche - Padmasambhava achieved the state of Mahamudra. Apart from that, its religious caves and being a circuit to other religious sites makes the place an even more important feature.

Figure 65. A Buddhist headstone

11.4. Physical Features

Two major caves are abode to the estate: Asura Cave and the Yanglesho cave that holds of historical and religious importance for both Buddhists and Hindu visitors. Furthermore, the presence of various different monasteries in the area from every tradition gives pilgrims an experience towards the perfect blend of history and modern architecture.

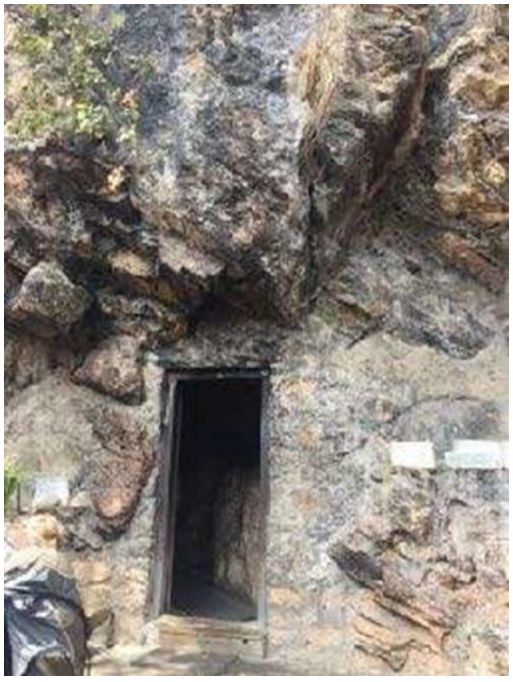


Figure 66. Religious Yanglesho Cave

Vast agricultural land surrounds the estate with different types of crops cultivated by locals. In the eastern side, flows the river that provides water resources to the irrigation land.

Few patches of scattered trees and even lesser human settlement is found within the targeted site radius, although maximum human settlement is towards the western side from the designated site, where numerous monasteries can be found.

11.5. Biological Features

The common types of trees were usually seen in the site, including the sacred fig (*Ficus religiousa*), *Bauhinia variegata* few coniferous types of trees in the surrounding Maize, wheat, corn and potatoes are the major crops grown in the area. The site is also famous for Choerospondias axillaris and pear fruits during its harvesting season.

Figure 67. Mixed trees and plants

11.6. Cultural Features

According to legends, sage Padhmasambhava had meditated in these caves for over 12,000 years and it was in this estate that he began his practice with the mandala of Glorious Yangdag's Nine Lamps. Since Nepal has both Buddhism and Hinduism blended harmoniously, there are other legends that says the Goddess Dakshinkali devoured her devotees causing a lot of grievance among the villagers. In desperation, the villagers took their sorrow to the "Realized One" - Padhmasambhava - who managed to subdue the violent goddess and asked to choose between perishing or sustaining herself only on animal sacrifices. Having said to have chosen the latter option, a temple still stands nearby Pharping where animals are still sacrificed in her honor.

11.7. Access and Visitor Facilities

The monasteries and caves are all free of cost and any visitors of any religion are happily welcomed in this area. A local bus passing from the valley towards the Dakshinkali Temple is accessible and visitors can drop off in between the stops to enter the site.

11.8. Target Table

	Target	Description
1	**Old Houses**	Made up of traditional equipment such as woods, mud and bricks are suitable roosting areas for the bats. Although not many, the few houses found around the agricultural areas are indeed helpful for bats and their habitat.
2	**Loose-scattered trees**	Few of the loosely scattered trees provides essential habitat environment for bats to roost and suitable edible fruits for animals, birds and most significantly bats.

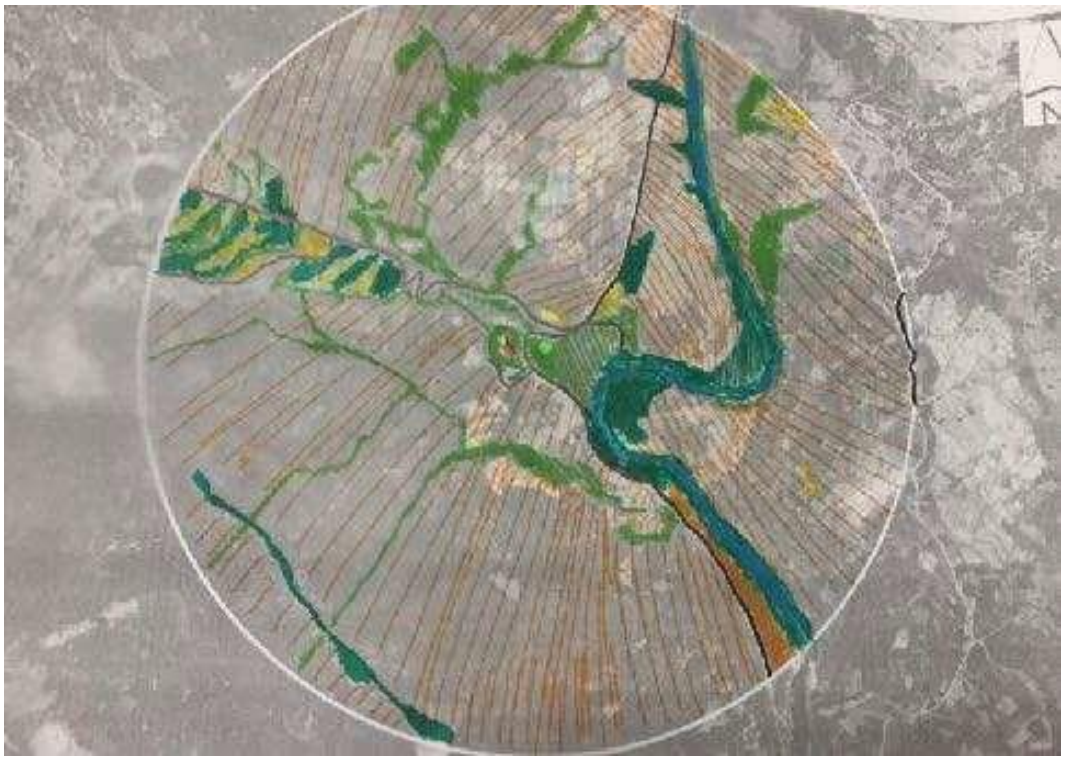


Figure 68. Pharping Phase I map

12. SITE XII - SUNDARIJAL

12.1. Location

Sundarijal is a village development committee in Kathmandu District in the Bagmati Zone and was named after the Hindu Goddess, Sundarimai. It is located 15 kilometers northeast of the capital city and covers an area of 5.18 square kilometers

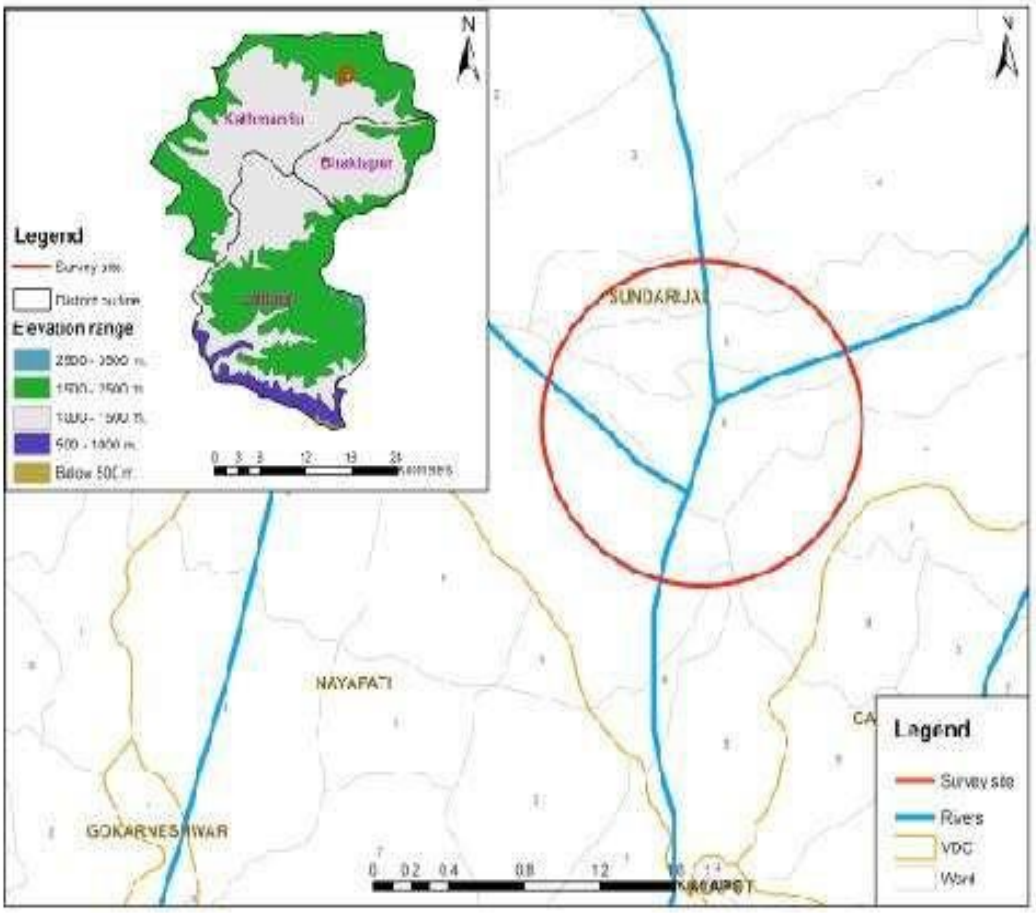


Figure 69. Map of Sundarijal survey site

12.2. Land Tenure

Covered mostly with hilly terrains with few flat areas, Sundarijal is mostly covered by forests and is part of the majority of Shivapuri National Park. Though located in Kathmandu, the VDC also touches Nuwakot and Sindhupalchowk Districts to the north.

12.3. Site Status

The estate is famous among tourists for hiking and canyoning due to the area's natural beauty, including the waterfalls and rivers. Along with the National Park adjoined with the VDC and with a 640 kW hydropower plant, Sundarijal is an important site for its various features.

12.4. Physical Features

Majority of the area that falls inside the radius from the point is the forest of Sundarijal and although there are few agricultural lands in the north eastern side, human

settlements is very few.

12.5. Biological Features

The vegetation mostly consists of pine, oak, rhododendron and other forest types. The records shows to have sighted animals like Himalayan black bear (*Ursus thibetanus laniger*), leopard (*Panthera pardus*), jungle cat (*Felis chaus*) and rhesus monkey (*Macaca mulatta*).

Birds such as Great barbet (*Megalaima virens*), White-throated kingfisher (*Halcyon smyrensis*), Common pigeon (*Columba livia*), Spotted dove (*Streptopelia chines is*), Steppe eagle (*Aquila nipalensis*) and Himalayan bulbul (*Pycnonotus leucogenys*) to name a few are found in the estate making the site another popular area for bird watching.

Few of the agricultural crops in this area includes millet, maize, barley, wheat and potatoes. Farmers usually use the traditional techniques with no interference of modern technology. The use of staircase irrigation is specially sighted inside the radius of the site.

12.6. Cultural Features

Sundarijal enshrines the Sundarimai Temple that places high value during the main festivals celebrated throughout the country. Many people walk barefoot to this temple in order to collect the hot water from river flowing inside the forest and offer it back to Pashupatinath.

12.7. Access and Visitor Facilities

Like the Nagarjun and Panimuhan sites, Sundarijal too includes the same price for visitors to enter the premises. Since it is also a part of Nagarjun-Shivapuri National Park, the cost of entrance is the same as of the Nagarjun site.

12.8. Target Table

	Target	Description
1	**Old Houses**	Made up of traditional equipment such as woods, mud and bricks are suitable roosting areas for the bats. Although not many, the few houses found around the agricultural areas are indeed helpful for bats and their habitat.
2	**The Forest**	Vastly covering the radius of the site, the forest with mixed type of trees allow bats to easily access within the dense tree canopies for roosting. Furthermore, being a protected area, less disturbance by human activities becomes an essential improvement in the settling of those mammals.

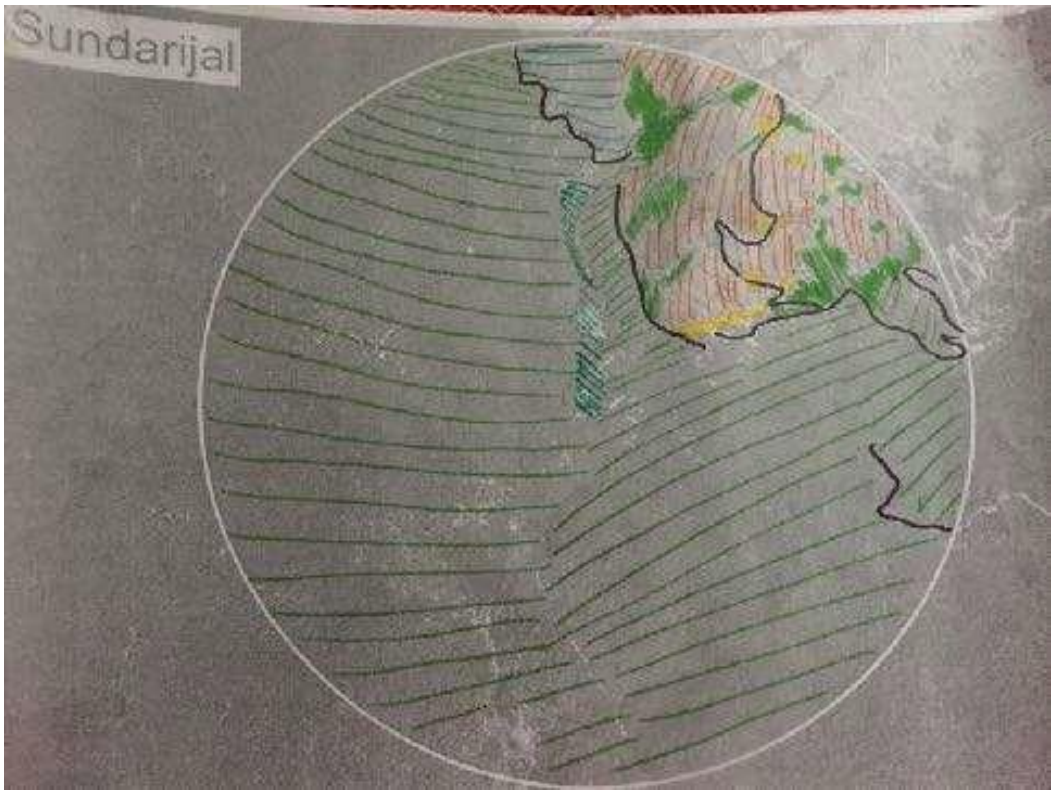


Figure 70. Sundarijal Phase I map

13. SITE XIII - GOKARNA

13.1. Location

Gokarna is a municipality in the central development region of Kathmandu District in the Bagmati Zone that was formed by merging five existing villages, Sundarijal, Nayapati, Baluwa, Jorpati and Gokarna as of 2014.

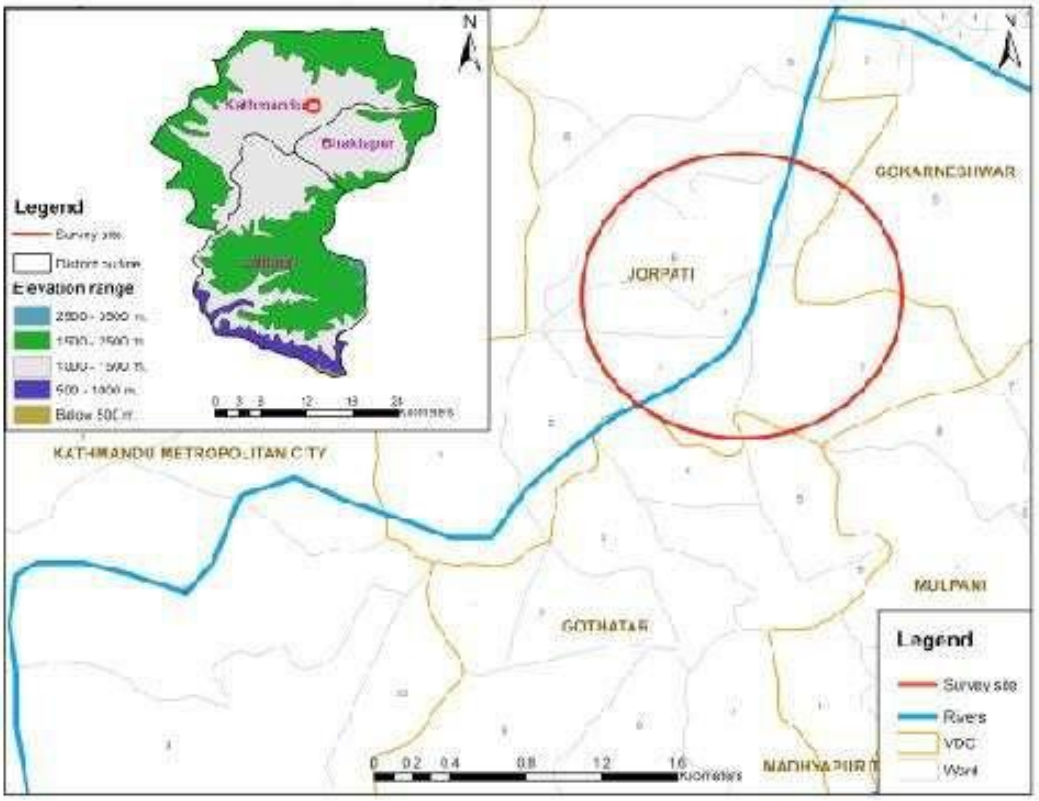


Figure 71. Map of Gokarna survey site

13.2. Land Tenure

The forest of Gokarna was previously used as a private royal hunting grounds for kings of Nepal. The quiet, natural and peaceful environment just outside the valley spreads up to 700 acres of forest along with a vast area of grassland that has now been converted into golf- course

The only intact forest of the Valley that has been representing as a forest reserve for over 500 years and has Bagmati River flow in the western side from the forest grounds.

13.3. Site Status

Having had the status of royalty, 100 acres among the 700 of the forest has now been crafted into resort buildings and pastures for golfing purposes. The Gokarna Forest Resort if one of the finest retreat estate with lots to offer for its visitors. The estate also holds up the name of being the finest golf course of the country. Designed by the team behind Gleneagles course in Scotland, the golf course has 72 course and 18 holes throughout the area.

Most recently, it had provided space for refugees from the 2015 earthquake as a relief action at time of need.

13.4. Physical Features

Within the 750 radius of the site, there is a mixture of forest lands to grasslands and concrete human settlements. Further south from the site, there are more open lands used for agriculture that is supported by the Bagmati River.

Figure 72. Densely polluted and heavily concrete area of the site

Few construction sites have been sighted within the radius that is contributing towards building new settlement areas.

13.5. Biological Features

Being a hunting reserve in early days, the forest grounds of Gokarna has animals like spotted deer (*Axis axis*), barking deer (*Muntiacus vaginalis*), wild cats, pangolins and the infamous rhesus macaque (*Macaca mulatta*).

There aren't much tree coverage in the area apart from few scattered loose trees due to the extreme condensed concrete human settlements. The majority of trees can be found around the Golf course with different kinds of trees such as walnuts, *Choerospondias axillaris*, sacred fig and few coniferous types of trees.

The River Bagmati flows just around the center of the site. Few trees are planted around the banks of the river and a bridge stands in between the river for transportation to pass by to reach the other side of the river.

Figure 73. River Bagmati at Gokarna

13.6. Cultural Features

The Gokarneshwor temple located at the edge of the forest which has inscriptions that is recorded to 1582 A.D. by Gopiran Bharo. The historical story of the temple explains how Lord Shiva roamed the forests as a deer and when the Gods captured him by holding onto his horns, they broke into three pieces among which one was buried in where the temple is now located. This temple has been famous for sons who have lost their fathers to perform their final rites and rituals.

13.7. Access and Visitor Facilities

The easiest access to this site is through local buses, either coming up to the dense city area, or going pass the bridge towards eastern side of the site.

13.8. Target Table

	Target	Description
1	**Old Houses**	Made up of traditional equipment such as woods, mud and bricks are suitable roosting areas for the bats. Although not many, the few houses found around the agricultural areas are indeed helpful for bats and their habitat.
2	**The Forest**	Vastly covering the radius of the site, the forest with mixed type of trees allow bats to easily access within the dense tree canopies for roosting. Furthermore, being a protected area, less disturbance by human activities becomes an essential improvement in the settling of those mammals.

Figure 74. Gokarna Phase I map

14. SITE XIV - SURYABINAYAK

14.1. Location

Suryabinayak Municipality is located almost 19km south-east from the Kathmandu valley in the Bhaktapur district.

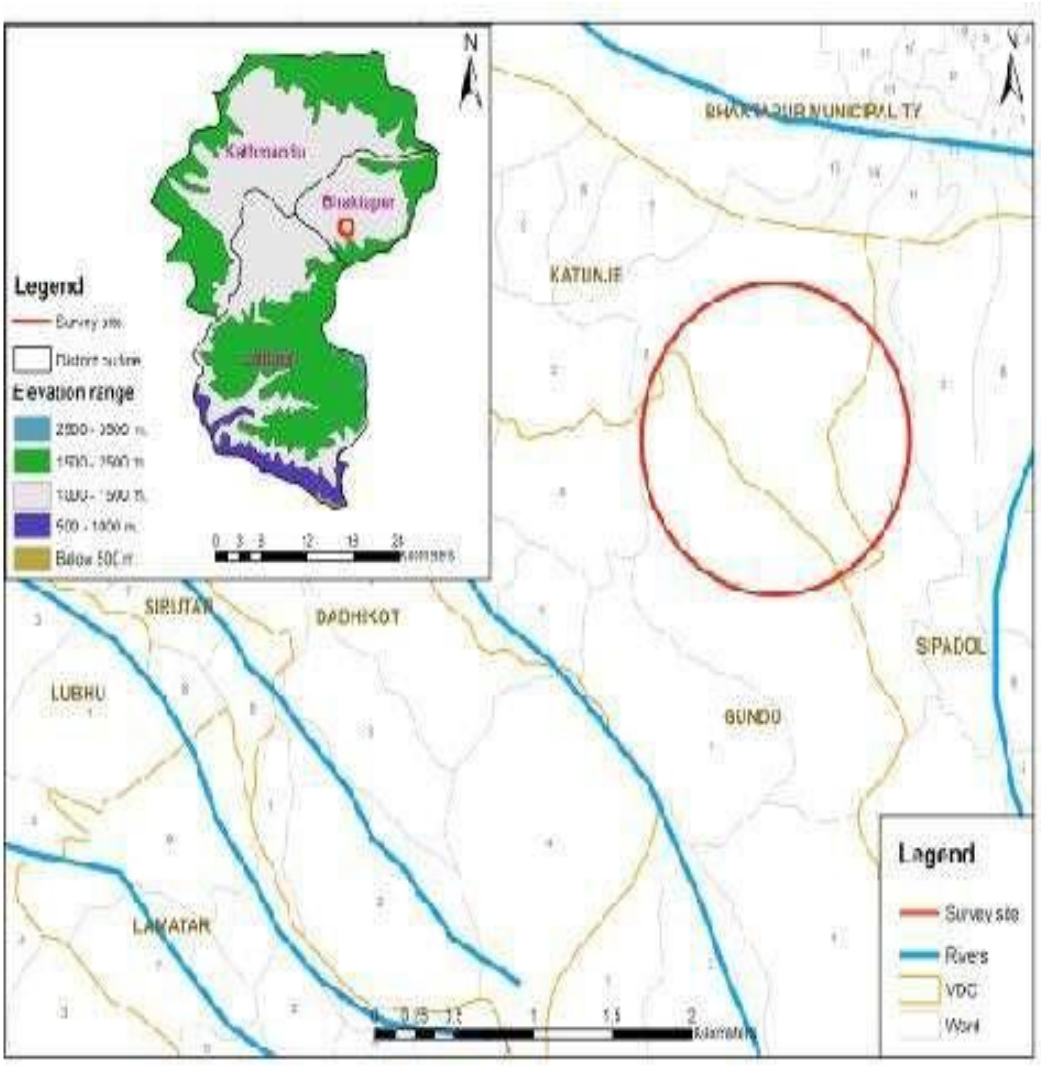


Figure 75. Map of Suryabinayak survey site

14.2. Land Tenure

The municipality is governed by the Government of Nepal for overall management, whilst Seti Devi Community Forest has been designated to govern the forest area of the land.

14.3. Site Status

The estate was classified as a municipality in 2071 B.S. by the Local Governance and Community Development Program (LGCDP) - II under the Ministry of Federal Affairs and Local Development (MoFALD).

Suryabinayak is also extremely famous for its temple, Suryabinayak that has been dedicated to the Hindu God Ganesh.

14.4. Physical Features

The 750m radius taken for this site covers a mass range of forest patch that falls in the south western and western part of the estate. Within the forest lies the infamous temple and the grove within the premises of the temple has been considered sacred. Beyond that, the forest area is sustained with community forest user groups who conserve and manage the resources of the forest patch.

Figure 76. Suryabinayak Municipality office

Majority of the farmland falls in the south-east part of the area that is segregated from human settlement areas. However, housing and farmlands are interlinked in the North West side of the radius and less irrigation land is determined in comparison to the other side of the area.

Figure 77. Agricultural areas with natural greenhouses

Just few meters north from the site lies the Araniko Highway that extends from Kathmandu with Kodari. This highway meets the need of people to visit the capital city either by personal transport or public transits. This could've motivated thicker human settlement in the northern side of the site in comparison to the total area coverage.

14.5. Biological Features

Various tree species in this area includes eucalyptus, pine, Asian pear (*Pyrus pyrifolia*), bayberry (*Myrica esculenta*), *Schima wallichii*, hazelnut, *Rhododendron arboretum, Greveilla robusta, Ficus religiosa, Salix sps*. banana and areca nut (*Areca catechu*).

Figure 78. Rhododendron arboreum flowering in the forest areas

After having proposed an idea of an open zoo in the Suryabinayak area by the Ministry of Forests and Soil Conservation, the official cabinet has given approval to establish a zoo. This would mean various species of native birds such as white-throated kingfisher (*Halcyon smyrnensis*), Asian koel (*Eudynamys sclopacae*), rose-ringed parakeet (*Psittacula krameri*), fire-breasted flowerpecker (*Dicaeum ignipectus*), migratory birds like common hoope (*Upups epops*), Chestnut-heaed bee- eater (*Merops leschenaulti*) Himalayan swiftlet (*Collocalia brevirostris*) and some nationally threatened species like barn owl *(Tyto alba*), dark-sided thrush (*Zoothera marginata*), and globally threatened species like the steppe eagle (*Aquila nipalensis*).

Only a couple of rhesus macaque was cited in the Suryabinayak forest, although various different species animals have been recorded as cited by previous researchers. Yellow-throated marten (*Martes flavigula*), hoary-bellied squirrel (*Callosciurus pygerythrus*), rhesus macaque (*Macaca mulatta*), small Indian mongoose (*Herpestes javanicus*) and Indian muntjac (*Muntiacus muntjak*) are some of the mammals that have been previously cited by researchers of the area.

14.6. Cultural Features

The ancient temple of Suryabinayak is believed to have been built over 1500 years ago by the Lichhavi King Vishnu Dev Barma and is dedicated to the Hindu God Ganesha. Located in a marvelous site where the first rays of the rising sun strikes the temple, the pilgrims believe that it is the way of the Sun God to pay homage to Ganesh and seek blessings for the whole day.

The temple is also famous within parents who come over to pray for their ailing children while in recent years, there has been a tradition of getting married in the temple.

Figure 79. A Sacred fig tree used for worshipping

14.7. Access and Visitor Facilities

Being a religious site, Suryabinayak is mostly busy on Tuesdays, specific day to worship Lord Ganesh. Vehicles are accessible till the base of the temple, from where pilgrims and visitors walk to the temple through the stairways. The temple and the forest area is accessible to all visitors without any payment.

14.8. Target Table

	Target	Description
1	**Old Houses**	Made up of traditional equipment such as woods, mud and bricks are suitable roosting areas for the bats. Although not many, the few houses found around the agricultural areas are indeed helpful for bats and their habitat.
2	**The Forest**	Vastly covering the radius of the site, the forest with mixed type of trees allow bats to easily access within the dense tree canopies for roosting. Furthermore, being a protected area, less disturbance by human activities becomes an essential improvement in the settling of those mammals.
3	**Cattle stables**	Stables made with traditional equipment for the cattle can become another suitable roosting feature for bats as they provide secular and dark environment.

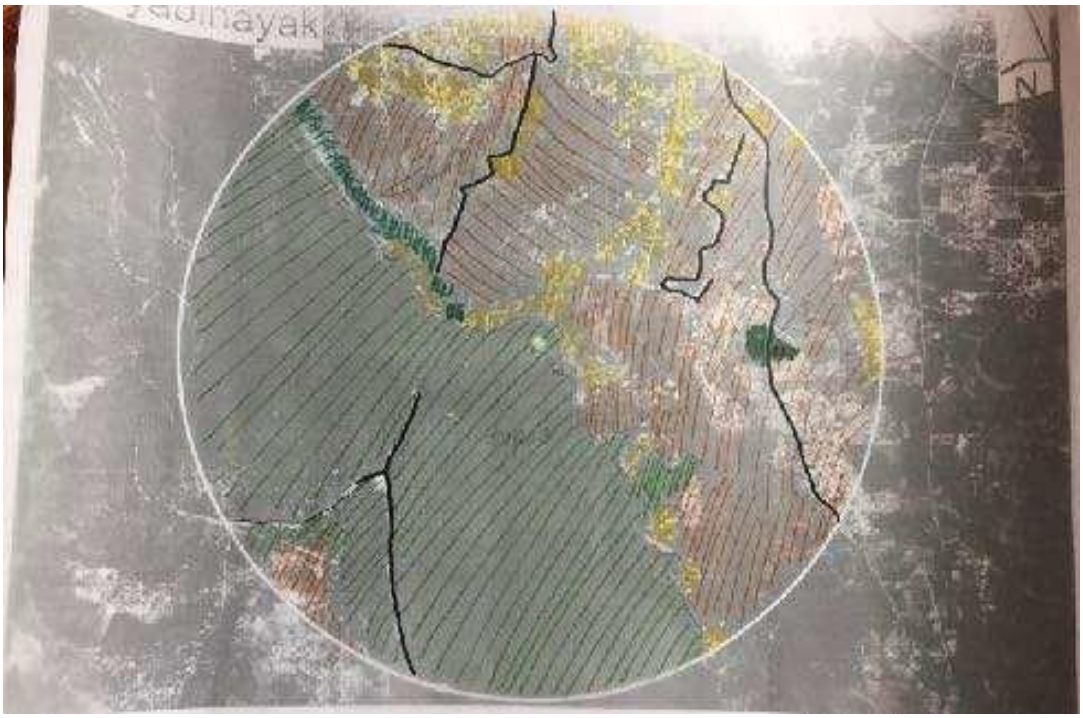


Figure 80. Suryabinayak Phase I map

15. SITE XV- GODAWARI

15.1. Location

The site is situated 11 kilometers east of Lalitpur central district and 14 kilometers south from Kathmandu. It is located in the Lalitpur District of Bagmati Zone.

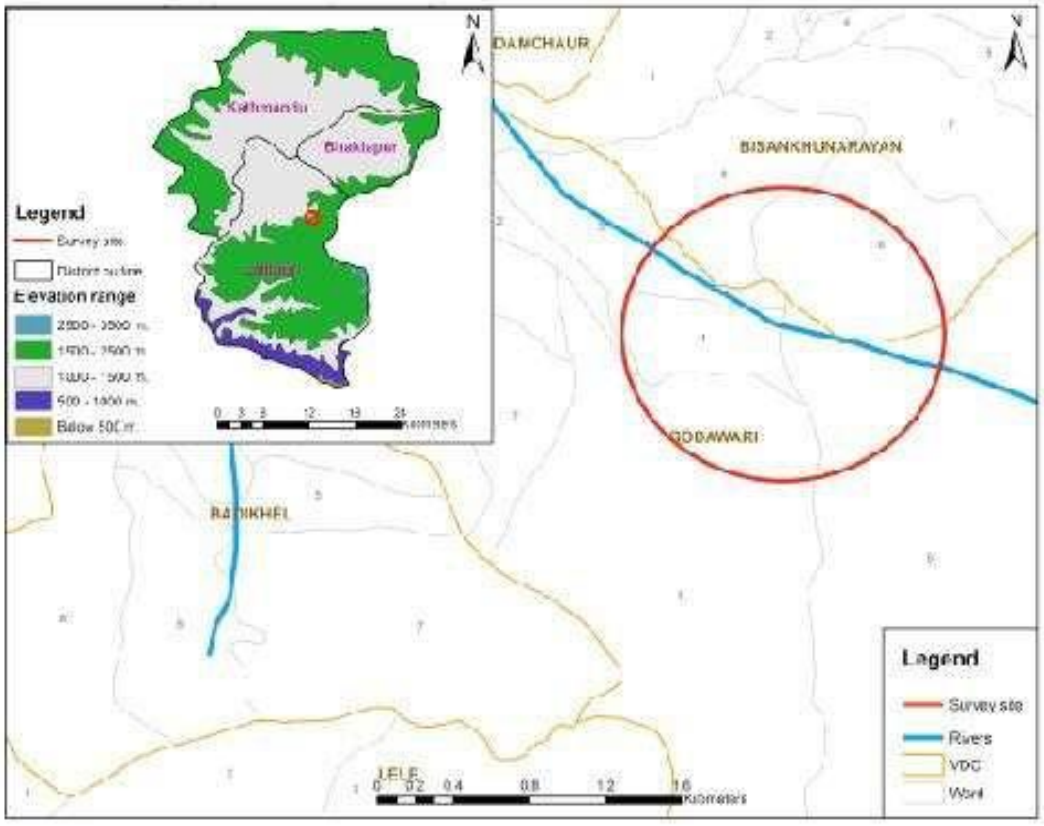


Figure 81. Map of Godawari survey site

15.2. Land Tenure

Since December 2014, the Nepal Government have merged Godavari and 4 other village development committees to create the Godavari Municipality that governs and manages everything going on inside the municipality.

15.3. Site Status

Having Nepal's famous National Botanical Garden with different plants and trees, Godavari is famous for its rich and diverse environment. The site is also famous for being the hiking route towards higher hills like the Pulchowki heights were bird watching is a prominent activity among nature lovers who gather round for this activity at least once a month. There is also the temple of Naudhara and the shrine of Bishanku Narayan that is often visited by pilgrims for religious rituals.

15.4. Physical Features

Due to the areas" thick forest patches, Godavari is known to receive greater rainfall annually, which is recorded to be 42% higher compared to that of Kathmandu, making the place cooler and humid during both summer and winter as well.

The Godavari Botanical Garden is located inside the radius of the site that conducts as a plantation area containing exotic and local flora of the Godavari area. This is preserved and can be accessed through a small levied payment in the entrance of the garden area.

Around the north-western part of the area, there are few agricultural lands alongside human settlements as well.

15.5. Biological Features

Mixed broad-leaved evergreen forests is the majority of vegetation cover of the area with trees like *Schima wallichii, Alnus nepalensis, Castanopsis indica, Quercus glauca, Quercus semicarpifolia* and various other oak trees species. Shrubs of *Rhododendron arboretum* and *Symplocus racemes* are also found in the forests of the area

Different species of birds like Alexandrine parakeet (*Psittacula eupatria*), Red-billed blue magpie (*Urocissa erythrohyncha*), Lesser racket-tailed drongo (*Dicrurus remifer*), Common myna, Fire- breasted flowerpecker (*Dicaeum ignipectus*) and Striated Laughing thrush (*Garrulax striatus*) to name a few. These are prominent birds among bird enthusiasts during their bird watching sessions. Mammals found in the area include leopard (*Panthera pardus*), yellow-throated marten (*Martes flavigula*) and orange-bellied Himalayan squirrel (*Dremomys iokriah*) that enhances the attraction of the estate.

15.6. Cultural Features

Temples of Naudhara and Bishanku Narayan are both located further away from the radius of the site. Yet, both these hold prominent cultural and historical value and welcomes pilgrims from across the country. Bishanku Narayan, especially is popular among pilgrims during the month from mid-April - May.

15.7. Access and Visitor Facilities

From Kathmandu valley, one can easily access local transportations towards the site in Rs. 20 that wouldn't take longer than 20 minutes, unless of extreme traffic or busy hours. The entrance fee for the Botanical Garden however is Rs. 20 for Nepalese citizens, Rs. 60 for SAARC countries and Rs. 250 for foreigners.

15.8. Target Table

	Target	Description
1	**Old Houses**	Made up of traditional equipment such as woods, mud and bricks are suitable roosting areas for the bats. Although not many, the few houses found around the agricultural areas are indeed helpful for bats and their habitat.
2	**The Forest**	Vastly covering the radius of the site, the forest with mixed type of trees allow bats to easily access within the dense tree canopies for roosting. Furthermore, being a protected area, less disturbance by human activities becomes an essential improvement in the settling of those mammals.

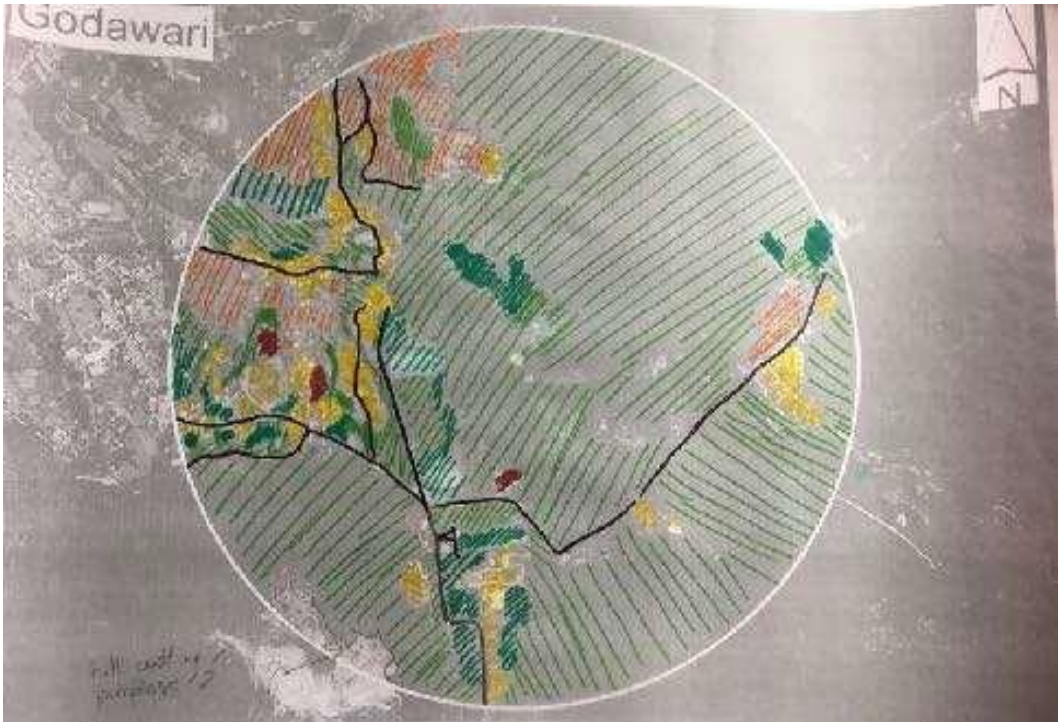


Figure 82. Godawari Phase I map

3.2 Species Diversity

Table 1. Bat species captured during the field survey

S.N.	Surveyed sites	Species captured	Individual captured
1	UN Park, Jwagal, Lalitpur	Cynopterus sphinx	1
2	Chobhar (Manjushree park with cave and Karya Binayak Temple)	Hipposideros cineraceus	4
		Rousettus leschenaultii	1
		Rhinolophus affinis	1
		Megaderma lyra	2
3	Bajrabarahi	Murina huttoni	1
		Murina leucogaster	1
		Myotis sicarius	5
		Myotis frater	3
		Myotis nipalensis	2
4	Macchegaun		0
5	Gujeshwori	Nyctalus lasiopterus	2
6	Swoyambhu		0
7	Godawari	Rhinolophus sinicus	3
		Rhinolophus affinis	1
8	Nagarjun	Rhinolophus pusillus	2
		Rhinolophus affinis	6
9	Nagarkot		0
10	Sundarijal		0
11	Gokarna		0
12	Suryabinayak		0
13	Pharping		0
14	Panimuhan		0
15	Bhrikuti Mandap	Miniopterus fuliginosus	2
16	Nepal Academy		0

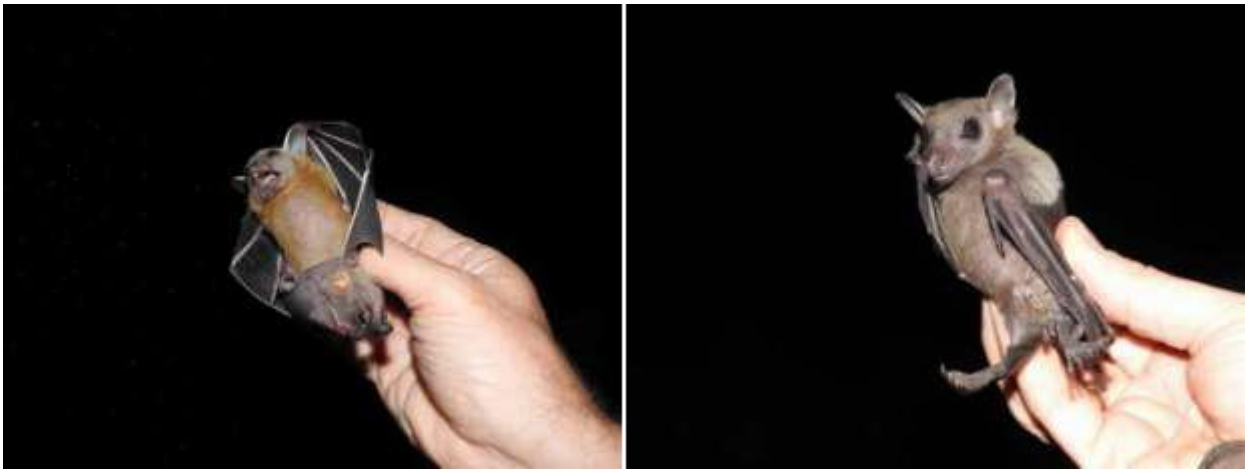
Photo plates of captured bats

Myotis sicarius

Myotis nipalensis

Nyctalus lasiopterus *Megaderma lyra*

Rhinolophus sinicus *Rhinolophus affinis*



Cynopterus sphinx *Rousettus leschenaultia*

Hipposideros cineraceus

Myotis frater

Miniopterus fuliginosus

Murina huttonii

3.3 Acoustics survey

Table 2. Conditions of calls record of different bat species at different sites

Site	Date	Species	Condition for recording bat	N
Bajrabarahi	30-Aug-16	*Myotis sicarius*	release	1
		Myotis nipalensis	release	1
		Myotis frater	release	1
Chobhar (Karyabinayak)	24-Oct-16	*Rhinolophus affinis*	Release	1
Godawari	09-Sep-16	*Rhinolophus sinicus*	release	1
Nagarajun	16-April-17	*Rhinolophus pussilus*	release	1
	20-April-17	*Rhinolophus affinis*	release	1
Bhrikuti	07-May-17	*Miniopterus fuliginosus*	release	1

Table 3. Spectrogram values of different species

Spectrum Measurements	Unit	*Myotis sicarius*	*Myotis nipalensis*	*Myotis frater*	*Rhinolophus affinis* (Karyabinayak)	*Rhinolophus sinicus* (Godawari)	*Miniopterus fuliginosus*	Balkhu 3 Aug (Probably Pipistrelle)	*R. affinis* (Nagarjun)	*R. pussilus* (Nagarjun)
Tstart:	(s)	1.648719	1.488305	2.167508	2.132784	0.427697	1.030736	0.354057	0.245394	0.433283
Tend:	(s)	1.677692	1.511141	2.214042	2.165918	0.454829	1.059742	0.381151	0.299019	0.45502
Fstart:	(kHz)	33.80743	36.31608	29.5934	4.229496	64.38398	44.37556	37.2096	27.8784	87.2448
Fend:	(kHz)	64.63885	52.94779	73.85256	93.9888	91.17259	61.561	72.216	100.4784	108.4416
Fpmin:	(kHz)	0	0	0	76.5	82.5	0	39	59.25	97.5
Fpmax:	(kHz)	42.75	43.5	40.5	86.25	90.75	52.5	46.5	0	0
Fpmean:	(kHz)	39.83257	41.93254	37.10006	80.70888	86.50433	50.46794	43.71716	83.14923	100.3239
Fppeak:	(kHz)	37.61882	41.22441	35.32913	82.4713	87.00251	49.51059	43.01371	83.79151	100.4314
Zero-crossing measurements										
Tstart:	(s)	1.648719	1.488305	2.167508	2.132784	0.427697	1.030736	0.354057	0.245394	0.433283
Tend:	(s)	1.677692	1.511141	2.214042	2.165918	0.454829	1.059742	0.381151	0.299019	0.45502
Fstart:	(kHz)	33.80743	36.31608	29.5934	4.229496	64.38398	44.37556	37.2096	27.8784	87.2448
Fend:	(kHz)	64.63885	52.94779	73.85256	93.9888	91.17259	61.561	72.216	100.4784	108.4416

N:		1	1	1	1	1	1	1	1	1
Dur:	(ms)	7.876954	4.859354	4.152968	17.85099	22.93685	5.552677	17.91666	43.18164	15.86133
TBC:	(ms)	0	0	0	0	0	0	0	0	0
Fmax:	(kHz)	51.87119	48.76498	41.11953	83.02703	87.15332	60.11455	57.18441	84.16438	104.4055
Fmin:	(kHz)	36.68092	40.02648	34.63634	80.85611	67.89158	48.19491	41.20068	80.31716	93.11228
Fmean:	(kHz)	40.11703	42.80404	36.60033	82.46043	85.45202	51.86687	43.98141	83.73929	99.86556
Fc:	(kHz)	39.89779	40.15858	34.91022	81.92	85.33334	48.38995	44.04358	82.47352	98.3103
Tc:	(ms)	6.244793	4.464171	2.276665	17.85099	20.73893	4.661401	12.65689	43.18164	15.0358
Sc:	(OPS)	0.910798	35.3728	15.45229	0.545713	0	41.1056	58.66939	0	0
Fk:	(kHz)	39.90284	43.11632	35.20946	82.47352	85.33334	52.29031	45.34873	82.47352	98.3103
Tk:	(ms)	6.044272	1.565734	1.47979	0.048252	1.415364	1.940698	11.93879	0.097006	1.040361
S1:	(OPS)	316.9723	139.0341	431.2193	-593.107	-997.724	-388.949	385.334	-597.047	273.7133

Table 4. Comparison of species recorded over time

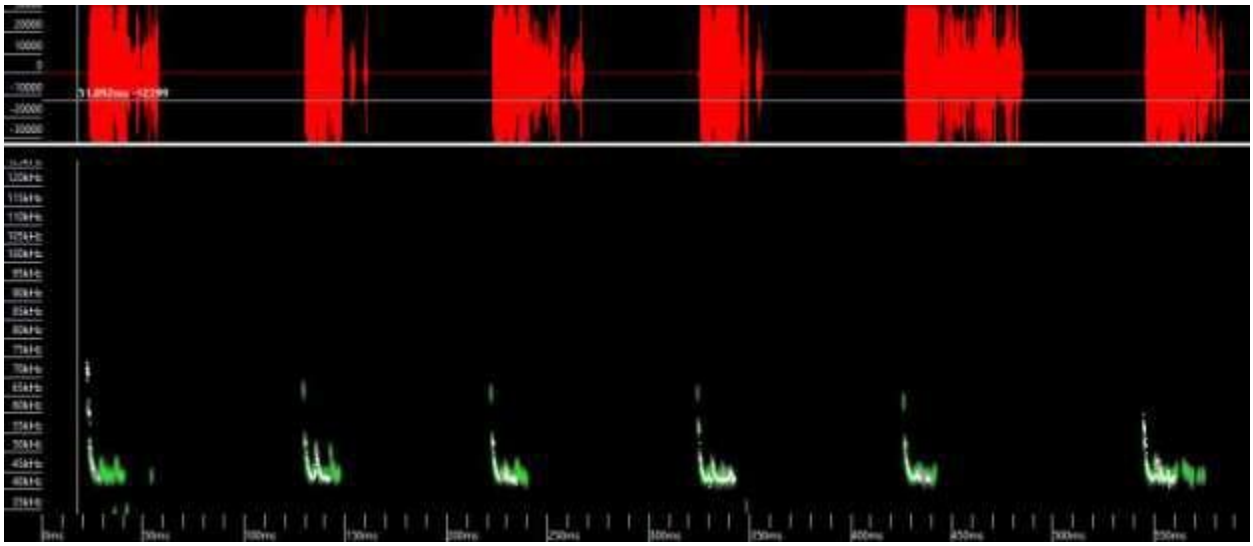
Location	Bat species recorded			
	Before	Rufford First Small Grant Project		Rufford Booster Grant (Aug.-Oct., 2016)
		First shift (Nov., 2009 Jan., 2010)	Second shift (May., 2010-Jul., 2010)	
Banss Bahari	*Rhinolophus luctus*; *Myotis sicarius* (Fry, 1925)			
Bajrabarahi (Chapagaun) 1485m a.s.l.	-	*Pipistrellus* sp.	*Myotis sicarius**	*Myotis sicarius*
			Rhinolophus ferrumequinum	*M. frater*
				M. nipalensis
				Murina huttonii
				Murina leucogaster
Bhrikuti Mandap	-	-	-	*Miniopterus fuliginosus*
Bouzini	*R. affinis* (Fry, 1925)			
	R. luctus (Hinton and Fry, 1923; Fry, 1925)			
	Hipposideros armiger (Hinton and Fry, 1923; Fry, 1925)			
	Pipistrellus javanicus (Fry, 1925)			
Chalnakhel 1423m	*R. luctus* (Hinton and Fry, 1923);	-	-	
Chhettrapati	*Cynopterus sphinx*(Abe, 1971)	-	-	-
Chobhar (1404m)	*Megaderma lyra*; *R. ferrumequinum*; *R. affinis*; R. pusillus; Hipposideros armiger	*H. cineraceus*	*H. cineraceus*	*Megaderma lyra*
			R. pusillus	*Hipposideros cineraceus*

	H. armiger (FMNH 162223, FMNH 162224 in Pearch			*Rhinolophus affinis*
	Rousettus leschenaultii(ROM 74734 and ROM 74735 in Pearch, 2011)			*Rousettus leschenaultii*
	Hipposideros cineraceus (Thapa			
Gokarna (1354m a.s.l.)	-	-	-	
Godawari 1562m a.s.l.	*Nyctalus noctula* (Bates and Harrison, 1997) at 1200m *Rhinolophus pussilus* (HZM 1.16287 in Pearch 2011)	*M. csorbai*	*M.muricola*	*Rhinolophus affinis*
	H. armiger (HZM 1.16286 in Pearch 2011)	*R. affinis*	*R. affinis*	*Rhinolophus sinicus*
		H. armiger	*R. macrotis*	
	Rhinolophus sinicus (Abe 1971; Bates and Harrison 1997), *Myotis silingorensis* (Abe, 1971), *Rhinolophus pearsonii* (Abe, 1971) *Myotis sicarius* at 1350 m*; Pipistrellus javanicus* (Bates and Harrison, 1997)		*Myotis* sp.	
Hattiban	*H. armiger* (Fry, 2015)			
Hattisar 1400m a.s.l. (near Nepal Academy)	*Miniopterus schreibersii* (Csroba et al. 1999); *M. schreibersii* at Tindhara Pathsala (Kock, 1996)			
Jhor 1525m a.s.l.	-	-	-	
Kakani	*Pipistrellus javanicus* (Hinton and Fry, 1923); *Miniopterus schreibersii* (Bates and Harrison, 1997)			

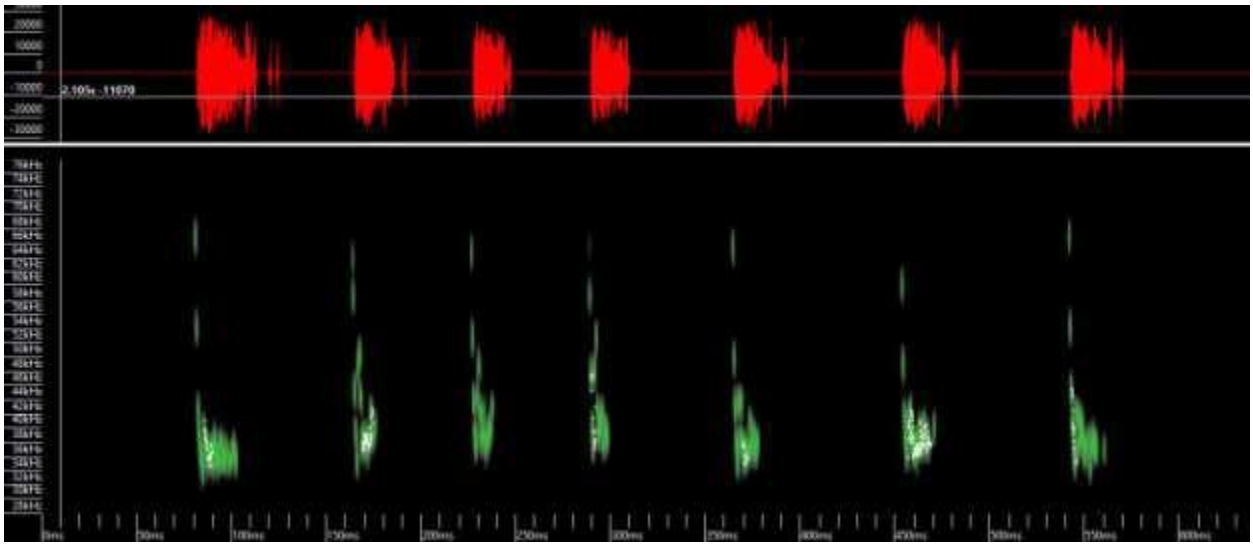
Lakuribhanjyang 2035m a.s.l.	-	-	-	
Machhega n 1560m a.s.l.	-	-	-	
Muhanpokhari (Panimuhan) 1992m a.s.l.	-	-	*Miniopterus fuliginosus*	
			Pipistrellus javanicus	
Nagarjun 1373m a.s.l.	*Megaderma lyra* (1410m)	*R. macrotis*	*R. affinis*	*R. pussilus*
	in 1994; *R. affinis*;	*R. ferrumequinum*		*R. affinis*
	H. armiger (Csorba *et al.* 1999) ; *R. affinis* from Dike pako Cave (Kock, 1996)	*R. affinis*		
	R. pusillus (Bates and Harrison, 1997; Malla, 2000)			
	M. lyra;			
	Miniopterus schreibersii (Malla, 2000)			
	R. pusillus (Thapa *et al.* 2009)			
Nagarkot 1829m a.s.l.	*P. javanicus*; *Falsistrellus affinis; Rhinolophus ferrumequinum* (Bates and Harrison, 1997)	-	*H. armiger*	
			R. affinis	
Nagdaha 1378m a.s.l.	-	-	-	
Narayanhiti Museum (in the vicinity)	*Miniopterus schreibersii*(Myers et al. 2000)			

Pharping 1267m	*Miniopterus schreibersii* (Bates and Harrison, 1997)	*R. affinis*	*M. nipalensis*	
Phulchowki	*R. sinicus* (Bates and Harrison, 1997)	-	-	
Sankhu-Bajrayogini 1474m a.s.l.	-	-	*R. affinis*	
Slesmantak forest (Pashupati-Gujeshwori area)1332m a.s.l.	-	-	-	*Nyctlaus lasiopterus*
Sundarijal 1579m	*R. pusillus* (Sinha, 1973)	-	*H. armiger*	-
	R. pearsonii (Bates and Harrison, 1997) (FMNH 94120 in Pearch 2011)			
	R. sinicus (ROM 74726 in Pearch 2011); *Hipposideros armiger* ((ROM 74723) in Pearch 2011) *Myotis csorbai* (ROM 74724 in Pearch 2011)			
	R. ferrumequinum (ROM 74722 and ROM 74725 in Pearch 2011)			
	H. armiger (Thapa *et al.* 2009)			
Suryabinayak 1384m a.s.l.	-	-	-	
Swoyambhu 1326m a.s.l.	-	-	*Nyctalus lasiopterus*	-
Taudaha 1295m a.s.l.	-	-	-	
Thankot	*Rhinolophus sinicus* (Hinton and Fry 1923)			

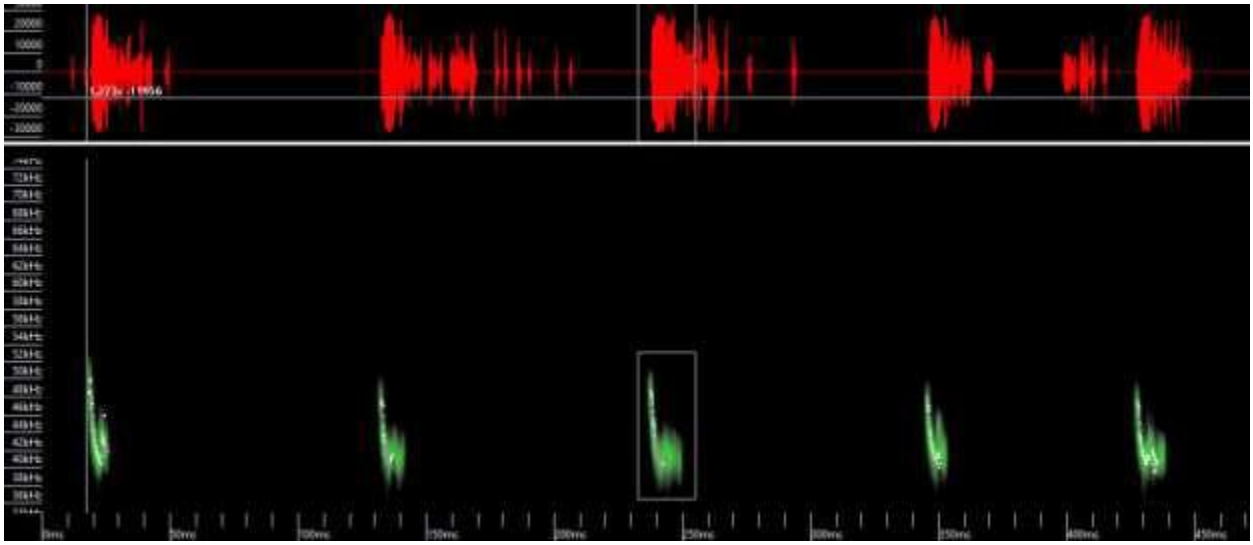
Spectrograms of different species captured in Kathmandu Valley



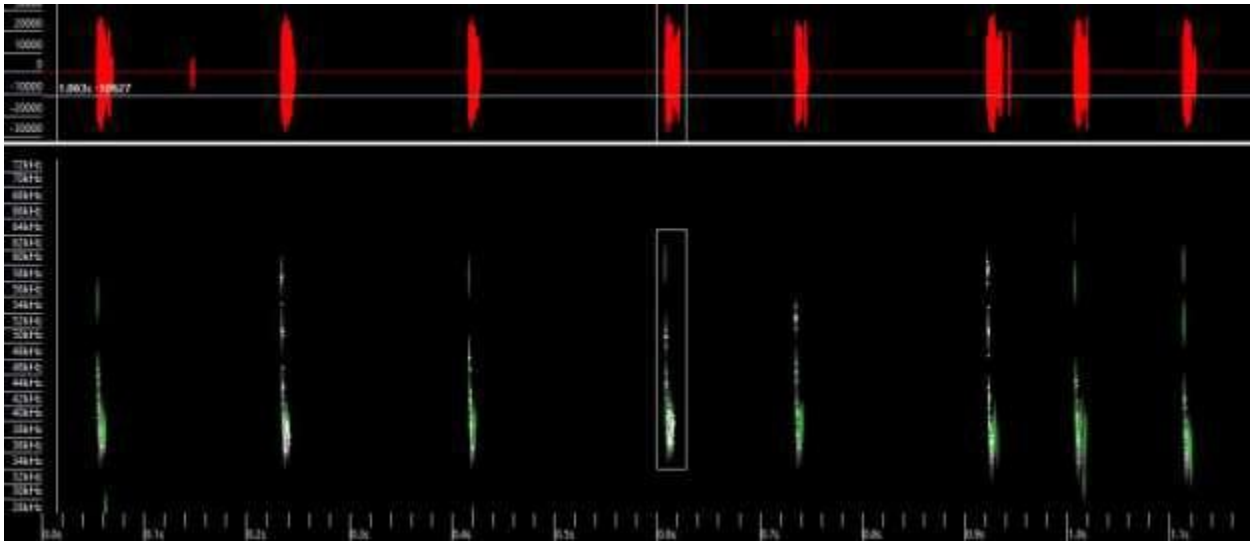
Unknown bat species (Probably *Pipistrellus* sp.) at Balkhu on August 3, 2016



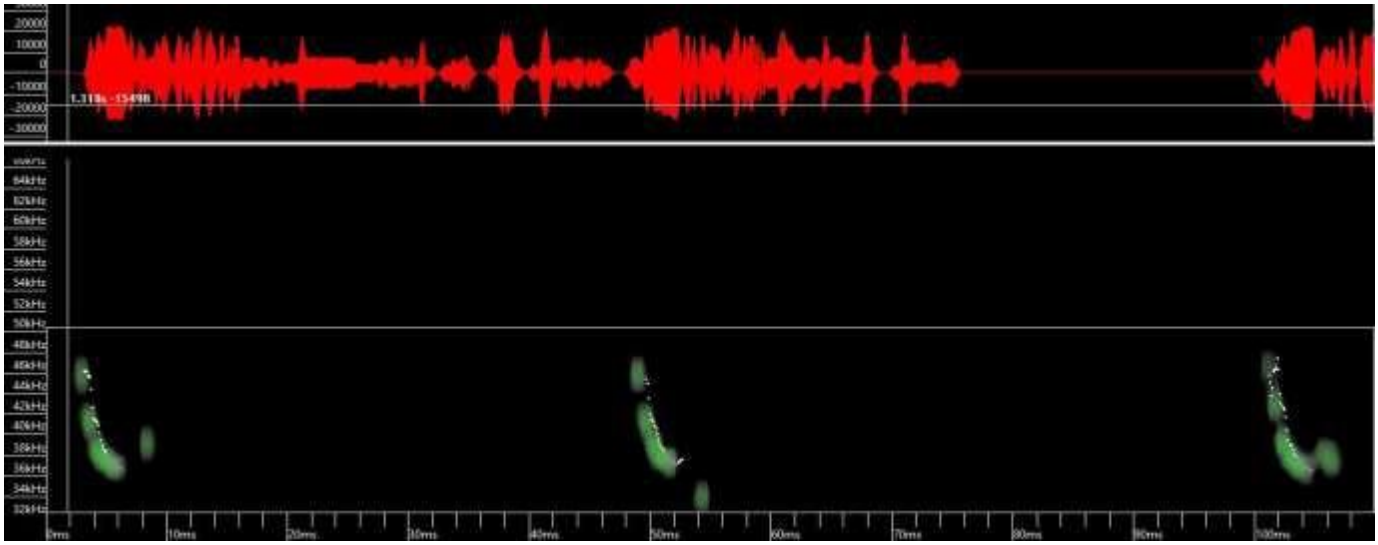
Myotis frater



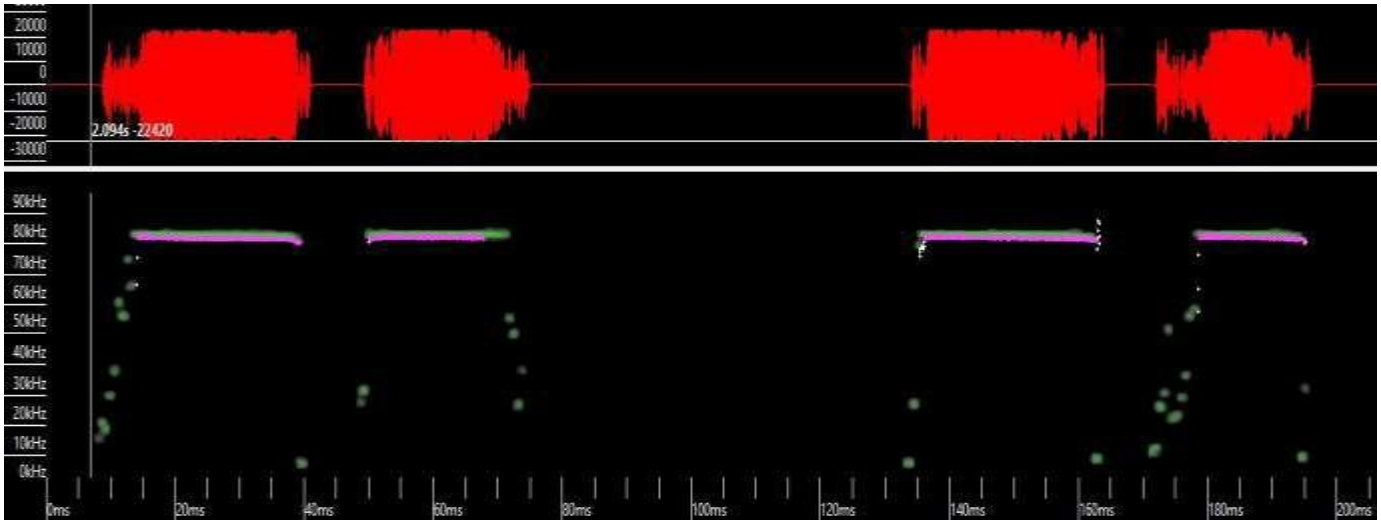
Myotis nipalensis



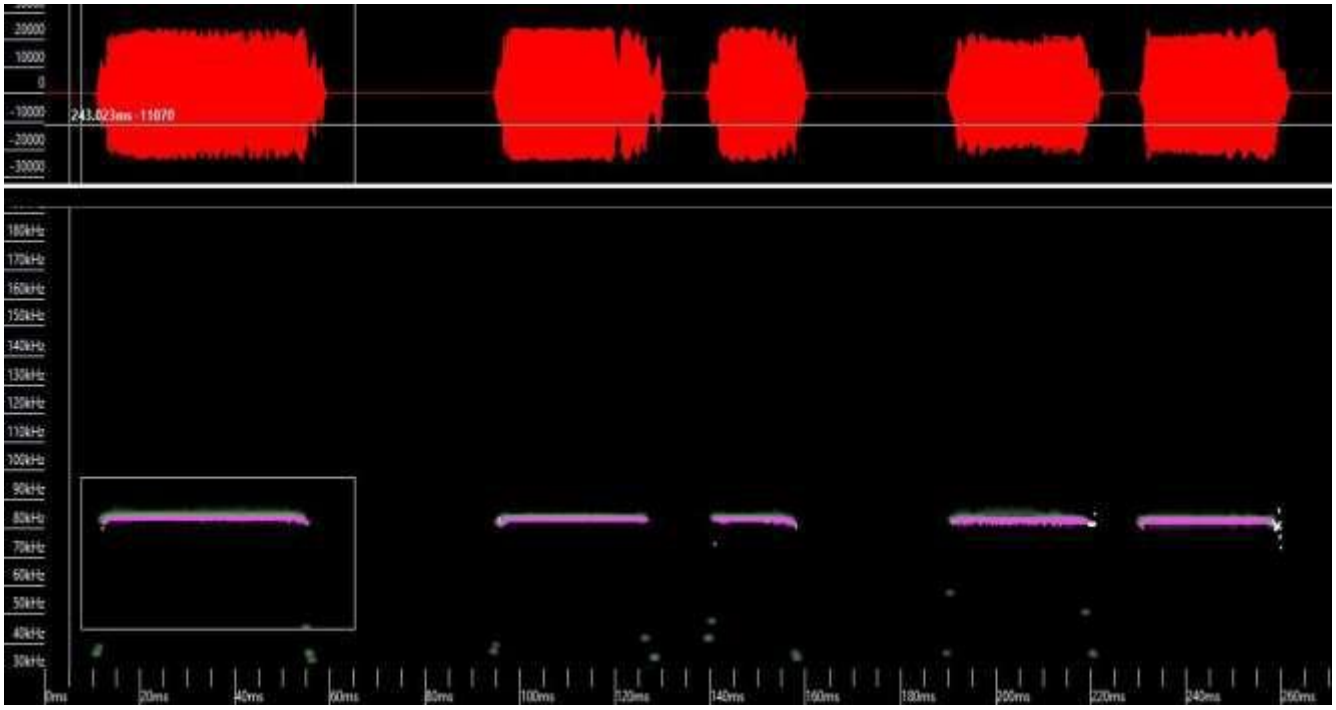
Myotis sicarius



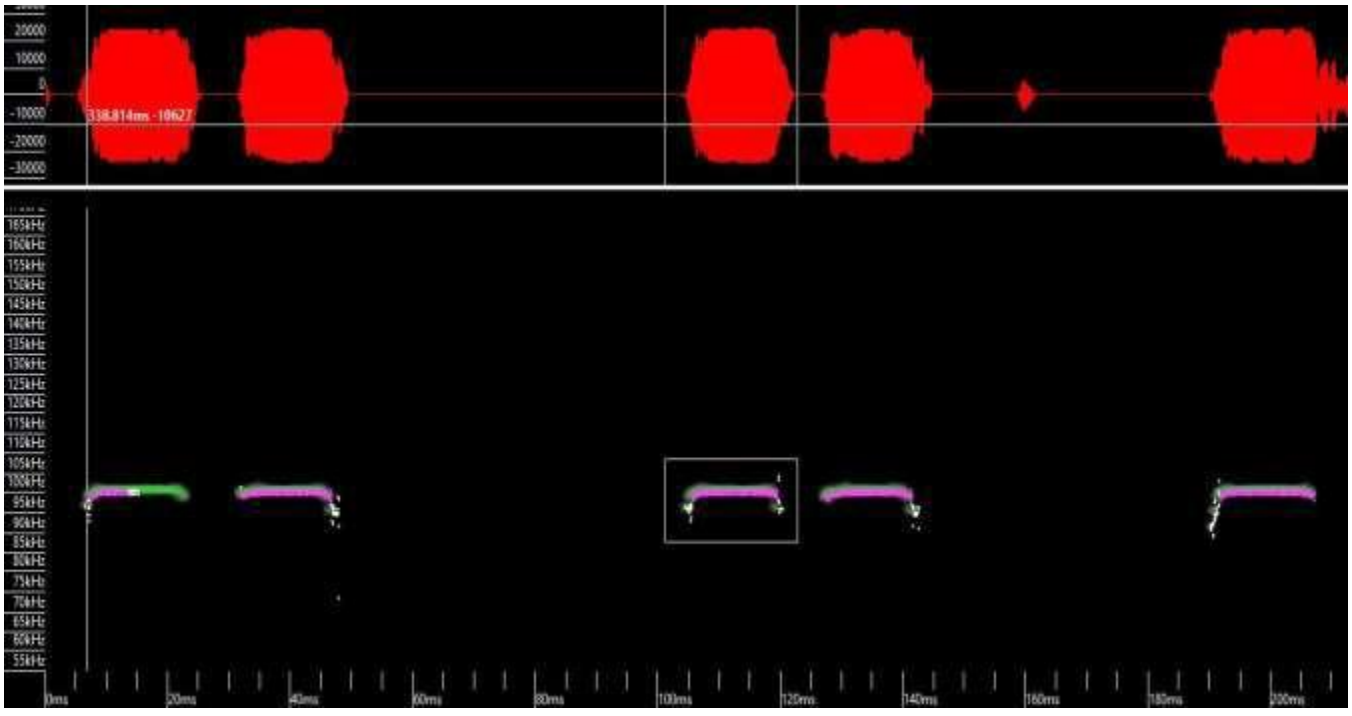
Nyctalus lasiopterus



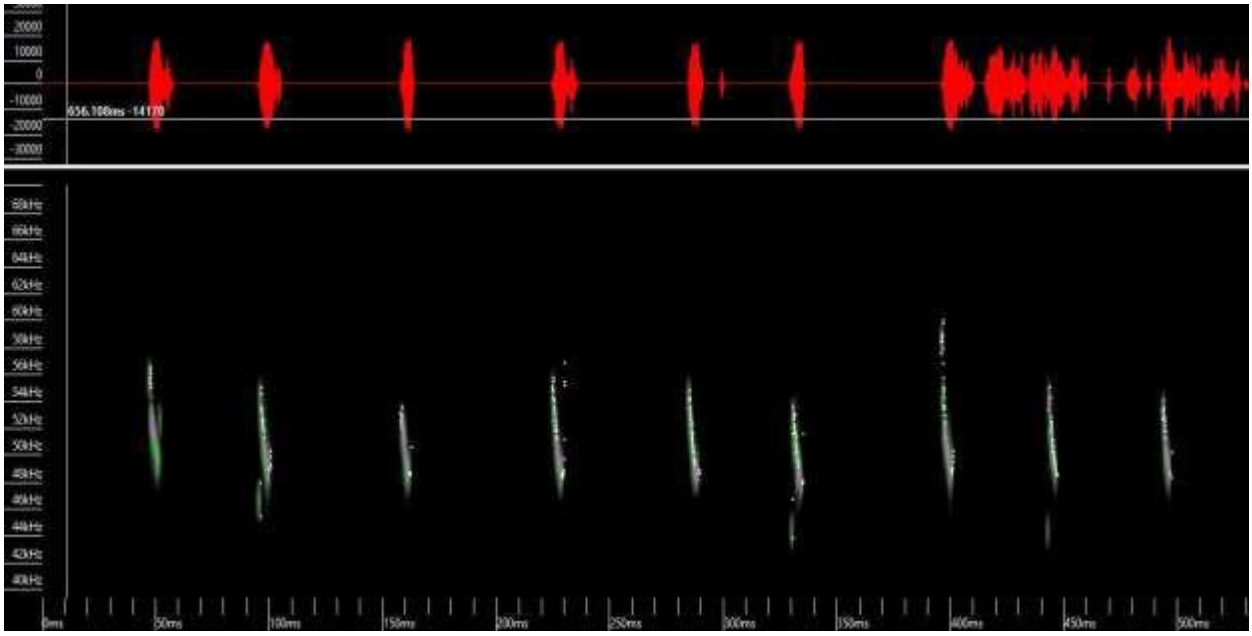
Rhinolophus affinis at Karyabinayak temple, Chobhar



Rhinolophus affinis at Nagarjun



Rhinolophus pussilus



Miniopterus fuliginosus

4. Next Steps

1. Acoustic monitoring continue
2. Bat call library establishment and display
3. Conservation Action Plan for bats in Kathmandu Valley.

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