

Geo-informatics approach to Human-Leopard Conflict in Urban Forest Areas - a Case review of Sanjay Gandhi National Park (SGNP), Borivali, Mumbai

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ABSTRACT

Big cats have faced tremendous pressure for their survival; hunting in the past and loss of habitat and prey base along with poaching in the present time. Conflict with humans is affecting 75% of the world's felidae species. Tigers in conflict or those strayed into human habitation; differ considerably in behavior as compared to those in native/ natural habitats. The animals may be stressed, shy, elusive, secretive & even unpredictable thereby posing challenge in capture. These animals may even pose safety threats for human involved in capture as well as to general public. Sanjay Gandhi National Park (SGNP), one of the largest protected urban forest areas in the world, has faced numerous human-leopard conflicts in recent past. The proposed study is to make an attempt to devise a solution based on Geoinformatics approach for human-leopard conflict in urban forest areas, which will also yield insight about prevention of deaths of leopards due to poaching, road accidents and other reasons. Also, the proposed study makes use of modern tools like GIS technology, which can be effectively used in studying the existing complexities of human – leopard relationship & their conflict pattern in transitional region.

Keywords

Felidae, Human Leopard, conflict, Geo-informatics, urban forest

1. INTRODUCTION

Big cats have caught attention since long. People of all age groups and nationality have been fascinated by them. Big cats have faced tremendous pressure for their survival; hunting in the past and loss of habitat and prey base along with poaching in the present time. Conflict with humans is affecting 75% of the world's felidae species. The severity of conflict increases with felidae body mass and is of greatest conservation significance to 9 species – Caracal, Cheetah, Eurasian lynx, Jaguar, Leopard, Lion, Puma,

Snow Leopard and Tiger (*Inskip and Zimmermann, 2009*). India has five species of sub-family Felinae in family Felidae of the order Carnivora, namely Tiger (*Panthera tigris*), Leopard (*Panthera pardus*), Lion (*P. leo*), Snow leopard (*Uncia uncia*) and Clouded leopard (*Neofelis nebulosa*) (Prater, 1948). Of these, only the first two have comparatively wider zoogeographic distribution. All of them are in Schedule I of Wildlife Protection Act, 1972. (www.moef.gov.in)

Tigers in conflict or those strayed into human habitation differ considerably in behavior as compared to those in native/ natural habitats. The animals may be stressed, shy, elusive, secretive & even unpredictable thereby posing challenge in capture. These animals may even pose safety threats for human involved in capture as well as to general public. A lot of work has been done in the past to conserve big cats in India like "Project Tiger". However, there exist threats that have been inadequately addressed or not addressed at all. These threats serve to annul or reduce the effect of conservation efforts being made to save big cats. Benefits and loss of big cats (being at the apex of food chain) are correlated to the benefits and loss to other species as well. In such Scenario, it becomes very crucial that such threats need to be addressed on priority basis. Saving big cats is also linked to health of ecosystem, which in turn affects the human health (*Bhatnagar 2005*). The Sanjay Gandhi National Park was notified in 1974 is also known as Borivali National Park, is a unique National Park in that, it lies within the borders of a city. The park lies on the northern fringes of suburban Mumbai, India. It covers an area of 104 sq km. It is one of Asia's most visited National Parks with around 2 million annual visitors. The park also holds claim to be the largest park in the world located within city limits.

2. BACKGROUND

Interactions of human and wild animal are common from ancient times. Activities like poaching are very common

disturbance to wildlife. Poaching continues to be a threat for big cats. As per Ministry of Environment & Forest (MoEF) statistics, 51 tigers were killed in 2011. Poaching data for leopard and tiger for last 5 years have been given in **Table 1** (As per website of WPSI) (www.wpsi-india.org):-

Table 1: Poaching data for Leopard and Tiger

Year	Leopard	Tiger
2007	126	27
2008	157	29
2009	161	32
2010	180	30
2011	187	13

Source: www.wpsi-india.org

Besides intra-specific fighting and inter-specific fighting and shooting by law enforcing agencies also constitute reasons on the mortality of the big cats. Big cats kill or injure humans and their live stock as well. Since British time, documentation has been made of such mortalities. Following figures are available for year 1912 **Table 2** (London- His Majesty's stationery office, 1915)

Table 2: Human & Cattle Mortality

Species	Human Mortality	Cattle mortality
Tiger	885	29158
Leopard	261	47697

There were substantially more leopards and tigers in 1912 than current scenario, also human population was less that time. However, with the decimating numbers of both these feline species, their conservation problem has assumed serious dimensions with three of the Indian feline species in the endangered category. In India, annually, on an average 60 human lives are taken by tigers. There are reports of human mortality by tigers in Sumatra as well (Nyphus and Tilson, 2004), whereas Seidensticker et al. (1990) mention of leopard menace in Nepal. In India, Human-leopard conflict has been studied using GIS and remote sensing approaches in Pauri Garhwal, Uttaranchal (Agarwal, et al., 2011). Bhatnagar (2012b) has reported feline-human conflict; while, some conflicts between lions and humans in Gir forest are also reported (Saberwal et al., 1994).

Of the 356 deaths reported in 2011 countrywide, 41 (12%) deaths were due to conflict with humans, 29 (8%) were due to accidents, 65 (18%) fatalities were ascribed to unknown reasons, and 186 (52%) occurred due to poaching. The report mentions that 14 leopards were killed during rescue operations and 21 by other animals. Many deaths were recorded, despite leopards being listed under Schedule I of the Wildlife Protection Act 1972 and should enjoy the highest degree of protection.

Sanjay Gandhi National Park (SGNP) is not exceptional case in this matter and there are reports of feline-human conflicts. DNA news paper (DNA, 2013) reported that the leopards were sometimes seen beyond the boundaries of the national park and it was noted that the quantum of their prey like dogs, pigs, disposed carcasses were extremely high outside the national park, among humans and therefore the leopards were more attracted towards getting into the residential territory of people. As SGNP is very close to urban settlements hence, requires more precise measures to protect wildlife.

There is sub-species variation in leopard over its zoogeographic range detected by molecular studies and compared with morphological studies (Bhatnagar, 2012a). Besides checklist of Asian Pantherinae (Bhatnagar, 2012c) and classified list of Feline caniores from Asia has also been reported (Bhatnagar, 2012b). Along with this, studies on alarm response in some prey leopard species have also been done (Bhatnagar, 2008; Bhatnagar and Mathur 2010). The status of various Indian big cat species is given in Table 3.

Table 3: Status of various Indian Big Cats species

Species	IUCN status
Panthera tigris(Linnaeus,1758)	Endangered
Leopard(Panthera pardus) (Linnaeus,1758)	Near Threatened
Clouded leopard Neofelis nebulosa (Griffith,1821)	Vulnerable
Snow leopard Panthera uncia (Schreber,1775)	Endangered
Lion P. leo (Linnaeus,1758)	Endangerd

3. STUDY AREA

Sanjay Gandhi National Park (SGNP), also known as Borivali National Park, is a unique National Park, which lies within the borders of a city. The park lies on the northern fringes of suburban Mumbai, India. It covers an area of 104 sq km. It is one of Asia's most visited National Parks with 2 million annual visitors. The park also holds claim to be the largest park in the world located within city limits. Sanjay Gandhi National Park (SGNP) is the miraculously preserved green oasis in the center of urban sprawl of Mumbai.

It is one of the largest protected urban forest areas in the world. Over 1000 species of animals and plants are found here. This national park is "one of the very few" that is surrounded by a metropolis like Mumbai, yet sustaining sizable population of big cats like leopards. As per a camera trap study, there are nearly 21 leopards in Sanjay

Gandhi National Park (SGNP). Human-leopard conflict in and around Sanjay Gandhi National Park (SGNP) are very frequent. Between 1991 and 2013, there were 176 instances of human-leopard conflict. In June 2004, leopards were responsible for the deaths of 20 humans within the span of a week. This was not the first attack: for the past 10 years, there have been attacks attributed to leopards stalking children and adults outside the park fringes.

Leopards come close in the vicinity to human settlements in search for food. Around 90% of leopard diet consists of dogs, rodents and wild boar. While, stray dogs attracted to the garbage dumped by humans on the edge of the park—constitute 60 % of leopard diet. Settlements including slums (settlements by non-indigenous people), padas (tribal settlements) and high-rise buildings continue to swell in and around the park. Few of the settlements are also present inside park.

The park has faced a number of problems similar to those faced by national parks elsewhere in the world, involving conflicts between natural and human interests. The lack of space in Mumbai has pushed residential colonies right up to the park boundary. This boundary is poorly fenced and has often allowed wild animals into human habitations. Slums have mushroomed around the park as well.

4. AIM & OBJECTIVES

Main aim of undertaking the proposed study is to make an attempt to devise a solution for human-leopard conflict in urban forest areas based on Geo-informatics approach, which will also yield insight about prevention of deaths of leopards due to poaching, road accidents and other reasons. Objectives of the proposed study are as follows:

- Analyzing the spatial and temporal aspects of leopard locations in SGNP using GIS and conventional methods such as Scat detection, pugmarks
- Analyzing the temporal and spatial aspects of human populations in the vicinity of SGNP using GIS to know changes in space and time
- Analyzing the temporal and spatial aspects of agricultural, forest vegetation, water resources and other relevant anthropogenic factors and natural and man-made resources that have the potential to affect the human-leopard conflict to know changes in space and time
- Analyzing spatial and temporal aspects of human-leopard conflicts and mortalities in and around SGNP
- Predicting the probable sites for human leopard conflict using GIS analysis.
- To suggest implementable remedial measures based on the outcome of the study

The proposed studies will help decision makers to understand and assess the complexities of human leopard conflicts in urban forest environment & implement respective remedial measures.

5. METHODOLOGY

The proposed work envisages use of GIS, Remote Sensing and conventional methods to approach the human –leopard conflict in SGNP. Advances in computer and information technology have introduced new group of tools, methods, instruments and systems. Rapid developments in new technologies such as Remote Sensing and Geographical Information System provide new approaches to meet the demand of resources related modeling (Mermut and Eswaran, 2001; Salehi et al. 2003).

The high resolution satellite data will help to prepare various thematic maps using digital classification method. Broad vegetation classes will be delineated. Spatial database in GIS domain incorporating digital elevation model and settlements and other relevant information will be created. To gain insight into conflict zones, a spatial grid of 0.5 km x 0.5 km needs to be created. In each cell of the grid, human–leopard conflict level and associated landscape characteristics including human population level (density) will get recorded. Each grid will also have various layers on anthropogenic data as well as data on other biotic and abiotic factors. Various GIS techniques such as buffering, overlaying, multi-criteria analysis etc. can be used to create a human-leopard conflict map of SGNP and nearby areas.

6. THEMATIC LAYERS

Following GIS layers are required for the proposed studies (Table – 4):

Table - 4

Map layers	Type
District Boundary	Polygon
Block / Tehsil Boundary	Polygon
SGNP Forest area Boundary	Polygon
Water body	Polygon
Vegetation Classes	Polygon
Roads	Line
Drainage	Line
Contours	Line
Village	Point
Village boundary	Polygon

Survey of India (SOI) toposheet at scale of 1:50,000 or larger scale will be used to create above mentioned layers, while data for big cat species will be created from

available literature / reports. Apart from these, information on various species of a particular area will be also created.

7. CONCLUSIONS

The proposed studies on Human-Leopard Conflict in Urban Forest Areas using Geo-informatics approach will help researchers, decision makers across the scientific community to analyze, visualize the conflict prone zones with layers of anthropogenic and biotic factors. It will also help to study geographically referenced data independently or overlaid and analyzed through multi-criteria analysis.

Various spatial data layers like big cat species, administrative boundaries, village points, species geographic distribution etc. may help in deducing various complex relationships between Human and Leopard conflict in growing urban sprawl in the vicinity of SGNP. Understanding the Human and Leopard conflict is difficult and further minimizing such event is challenge. Hence, modern tools like GIS and Remote Sensing technology can be effectively used in studying the existing complexities of human – leopard relationship & their conflict pattern in transitional region.

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