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ELEPHANT HABITAT SUITABILITY IN SOUTHERN PART OF KOLHAPUR DISTRICT WITH GEOINFORMATICS APPROACH

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ABSTRACT

Geospatial technology has played a role in conservation and management of the natural resources to understand human-wildlife conflicts. Recently due to habitat degradation and human encroachments in forest areas, there have been increase man-animal conflicts in different parts of the country. We applied geospatial techniques to assess the elephant habitat suitability in Southern Part of Kolhapur District. This region lies between 16° 20'N to 15^0 55'N Latitude and 74^0 0'E to 74^0 30'E Longitude, covering 2002.26 Sq.km area. Study region is frequently migrating by elephants from the states of Karnataka during November to June. The parameters were study for the, vegetation-cover, proximity to water-body, road-network, physiography, settlement, drainage pattern and slope. The LANDSAT ETM$^+$ satellite data was used to prepare LULC map for forest cover & Water reservoir. Spatial database in GIS domain comprising Settlements, Road Network were prepared at 1:50,000 scale with SOI toposheets and, slope map was created with the help of SRTM data. Site suitability map were prepared, we get 14440 ha land for elephant habitat by overlapping above all the maps. This study is applicable for forest conservation from Elephant encroachment which could be manage by the state government in order to minimize human - elephant conflicts and to reduces economical loss in the region.

KEYWORDS: Remote Sensing, GIS, Elephant-human conflict, Site Suitability *etc*.

INTRODUCTION

In resent era India facing a major problem in the field of wildlife management is Human - Elephant conflict (Kushwaha and Hazarika, 2004).The habitat analysis is considered most important in planning and management of protected area. Elephant (*Elephas maximus*) is the largest terrestrial mammal of India. The Asian Elephant represents one of the most seriously endangered species of large mammals in the world. It recognised as an endangered species in 1975 after the inclusion of its species (Convention on International Trade in Endangered Species of Wild Fauna and Flora) (Bits, 2002).

Human–Elephant conflict has emerged as a major issue in the field of Elephant management in Southern part of Kolhapur District (Kulkarni *et al*., 2008). During the month of November to June from Karnataka state Elephant migrate towards southern part of Kolhapur District for food and water. This region having dense forest as well as Tillari and Jangamhatti reservoir that provide big water source for Elephant. RS and GIS technology are most suitable for forest management and planning after 1990 few researchers in India start to use geospatial technology for habitat management. In this study RS and GIS technology use to evaluate suitable site for Elephant habitat in Chandgad, Ajara & Gadhinglaj tahsil of Kolhapur district (Gupta and Nathawat, 2009; Areendran *et al.,* 2011). The objective of study is to find out suitable site for elephant habitat and conservation.

Role of Remote Sensing & GIS in Animal Habitat Suitability Analysis

Remote Sensing is the small or large-scale acquisition of information of an object or phenomenon, by the use of either recording or real-time sensing device that are not in physical contact with the object. RS provides powerful tool to acquire accurate real time information of region essential for wildlife management (Kushwaha *et al*., 2000). It is coast effective and allows rapid qualitative and quantitative spatial assessment ancillary digital data can be incorporated to aid in vegetation classification and model development, and remotely sensed data can be used in temporal analyses habitat changes.GIS is a powerful set of tools used to collect, store, retrieve, transform and present spatially referenced data for the real world (Burrough and McDonnell, 1998). It has been widely used in many fields, such as resources and environmental evaluation and management, & urban as well as rural planning & management. Various study are indicate geospatial technology play vital role in field of habitat evaluation and management (Khanna *et al*., 2001; Nandy *et al.,* 2007).

MATERIAL AND METHOD

Study Area

The study area are the Sothern part of Kolhapur District, which includes Chandgad , Ajara & Gadhinglaj Tahsil. This region lies between 16° 20'N to 15^0 55'N Latitude and 74^0 0'E to 74^0 30'E Longitude covering a surface area of 2002.26 Sq. Km. It consist of the Sahyadri range, a rugged track of hills with steep slope & valleys popularly called 'Kokan ghat matha'. The elevation varies between 650 meters to 1100 meters above MSL. It is bordered by Belgaum District of Karnataka from east and south, Sindhudurg District from west and Budhargarh and Kagal Tahsil of Kolhapur District from North (Fig.1). Hiranyakeshi, Ghatprabha, Chitra, Tamraparni and Tillari

are the main rivers. The maximum temperature is 36^0 C and minimum 14^0C. The Region receives its major rainfall from the South west monsoon winds it also gets some rainfall from thunderstorms during the month of April and May. The rainy season is form during June to October. Average rainfall of Kolhapur district is 1138.5mm.
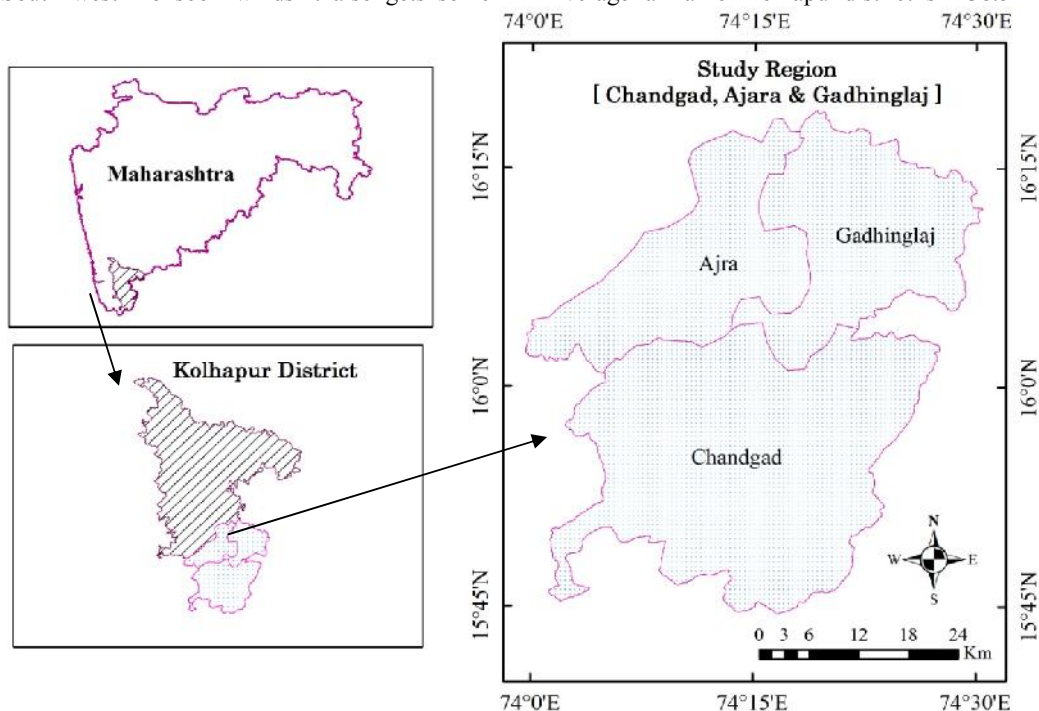

FIGURE 1. Location map of study area.

METHODOLOGY
Methodology is divided into four broad spectrums,
1. Field work 2. GIS Analysis 3. Remote Sensing Analysis 4. Site Suitability for Elephant Habitat

Field work
During the research work, field work was conducted for interview of farmers of Elephant encroachment affected villages. 5% villages of each tahsil of study region were interviewed & fill up the questionnaire by farmers for identifying various problems facing by farmer during the Elephant migration, like total agricultural area, total crop affected by Elephant, Which are the crop they grow, which methodology used to oppose Elephant etc.

GIS Analysis
All the GIS work had been performed on the SOI (Survey of India) Topographical map on 1:50,000 scale for digitizing of drainage, road and village location layer (Fig.2) and Creation of 2 km buffer for around road and village location (Areendaran *et al.,* 2008) shown in figure 3.

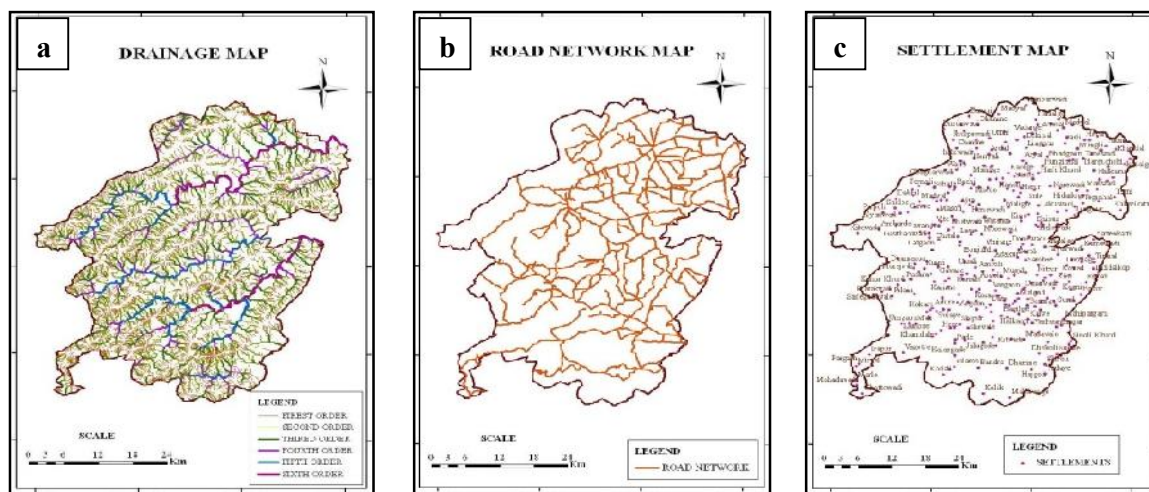**Digitization of the Layers and buffer analysis**

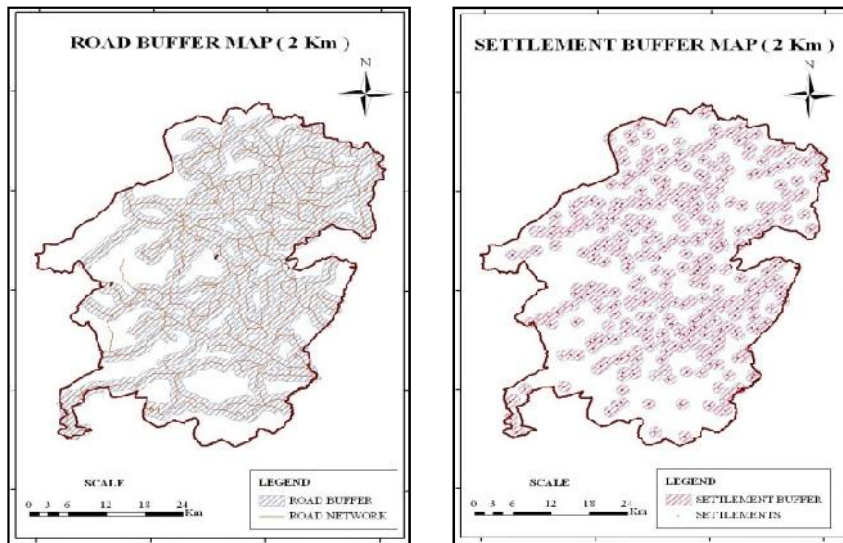**FIGURE 2.** Digitized layer of Road map(a), Village locations (b), Drainage along with tributaries(C).

FIGURE 3. Buffer analysis of Road network and Settlement

Remote Sensing Analysis

In this study LANDSAT ETM[+] (Year 2005, 30mtr spatial resolution) satellite image were used for the classifications of land use and land cover analysis and extract forest and water body area (Harris *et. al.,* 2008) in ERDAS software & SRTM Degree Tiles image were used to create physiography map viz., DEM, TIN, Slope, Aspect & hill shade (Yedage *et al.,* 2011)with spatial analysis tool in Arc GIS (fig.4).
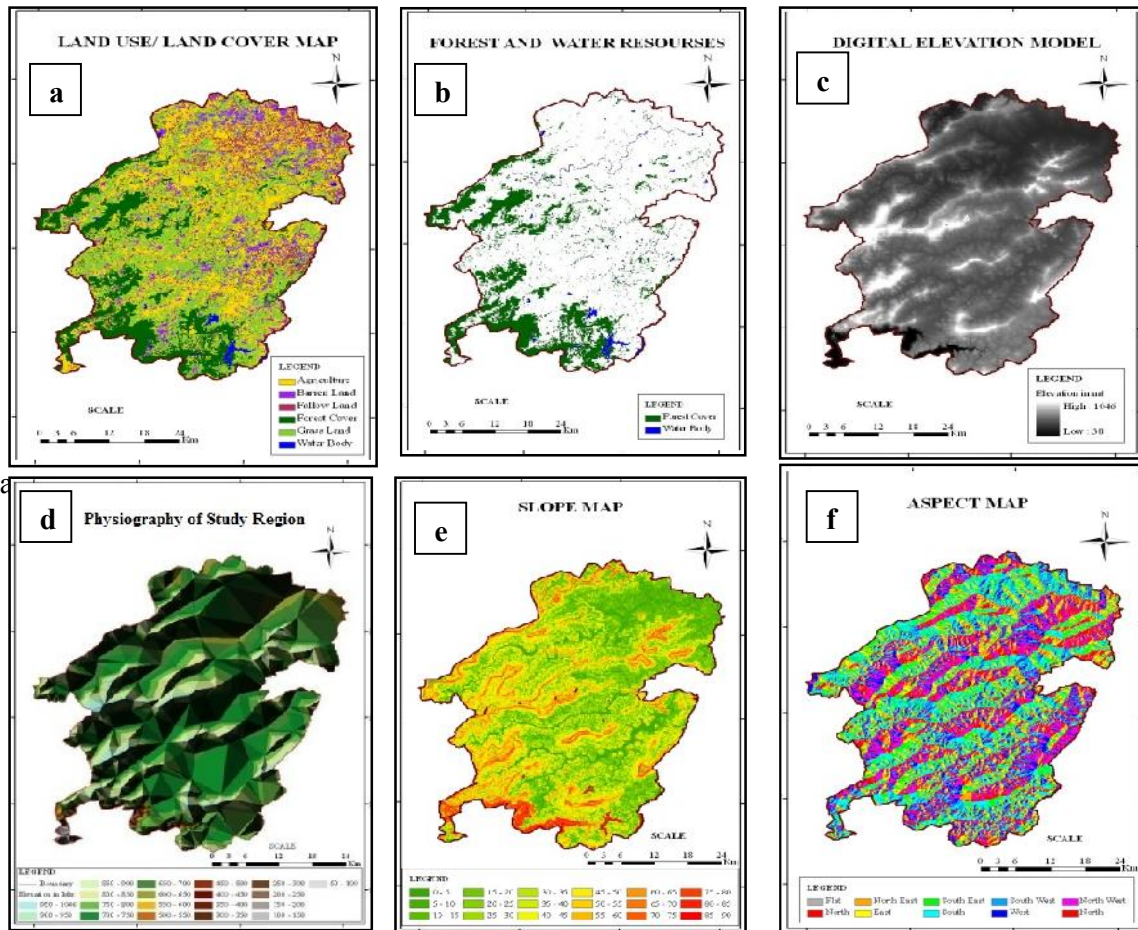

FIGURE 4. LULC map (a), Forest & water body (b), DEM(c), TIN(d), Slope map(e) & Aspect map(f).

Site Suitability for Elephant Habitat:
By overlapping above all the maps we create site suitability map for elephant habitat by using Arc GIS software. Methodology is shown in figure 5.
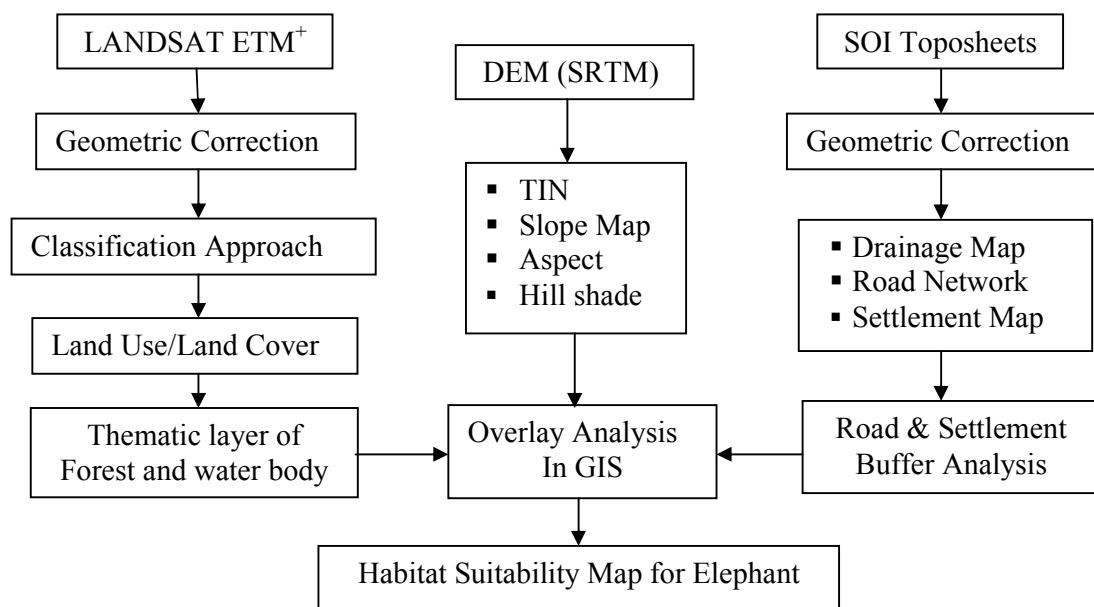

FIGURE 5. Flow diagram of the methodology

RESULT AND DISCUSSION
First time on February 2, 2004, two elephants were came to Hosur Village of Chandgad Tahsil from Karnataka in Kolhapur District. In Chandgad they had generally resided in the dense forest block around Kalanandigarh Hill. The migration of Elephant was continuously from 2004 to up to 2012.

Agriculture is also affected by Elephant migration, because they damaged large area of crops as well as injured to farmers, sometimes human death also happened. To another side human restricted Elephants from encroachment by using wrong methods, such as use of fire bomb, Sharpe headed iron rods which may harmful for Elephants and caused elephant death (in year 2004, 4 elephants were died) (Gavade, 2009). In study region,

from 2004 to 2012 four people were killed by Elephants and 2638 cases of crop damage were registered in forest departments for the compensation claim(loss caused by Elephant). It was found that Elephants occurred throughout in study area. According to present research, number of Elephant was highest in the south and east part of the study region. In natural vegetation & human populated areas Elephants were very commonly found. When they passing by corridor they destroy crops and sometime kill people. In Gadhinglaj tahsil Elephant visited in 2006 only, but in Chandgad & Ajra tahsil they visit frequently every year. Most of cases human elephant conflict occurs near forest and agriculture boundary due to expansion of agriculture land and human encroachment in forest area (Areendran et al., 2011).
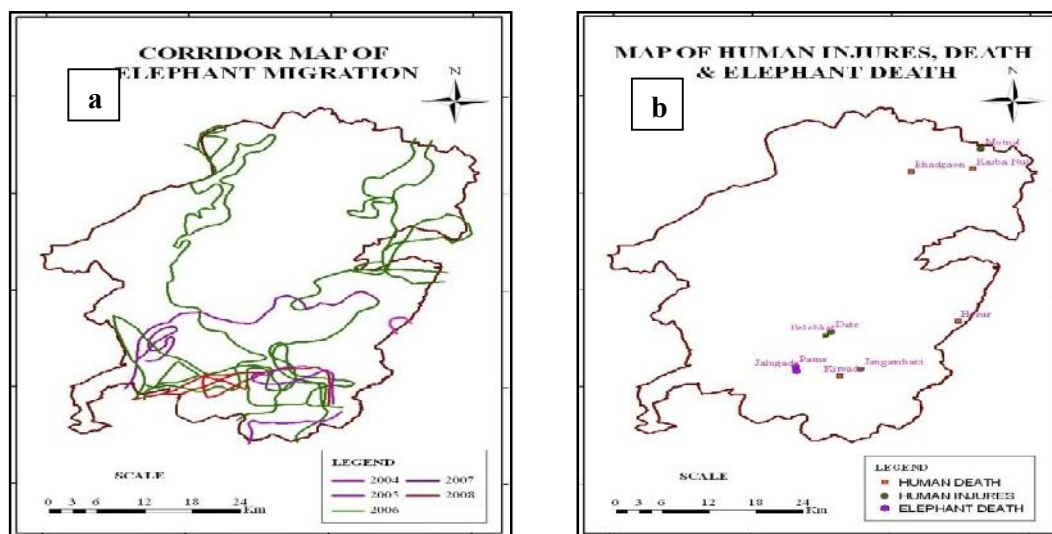

FIGURE 6. Corridor map and Village location map of human elephant conflict.

In corridor map of elephant we observed that purple colour shows routine path of elephant migrations remains same from 2004 to 2008 show in figure 6(a). In figure 6(b) mention about human injured, death and elephant death occurred in respective villages of study region. In survey we take interview of farmers it was observed that most of the farmers are not satisfied by forest department policies because they afforded very less compensation for victims, process for compensation claim is very lengthy and complicated, rules are nonspecific for victims. We were observed that, Forest department of Kolhapur not implement solution for Elephant migration into the southern part of Kolhapur district, also they were no

management to protected area and suitable habitat condition for Elephant survival. In another side formers try to oppose Elephant, but they were unable to protect their own agricultural area from encroachment of elephant. After the overleaping all maps (Settlement, road-network, drainage, LULC, slope and physiography) we prepare site suitability map for elephant suitable habitat area (14440ha within chandgad and Aajra tahasil show in figure7) to avoid human elephant conflict and protect elephant from humans activity and humans from economical loss which is happened due to encroachment of elephant.
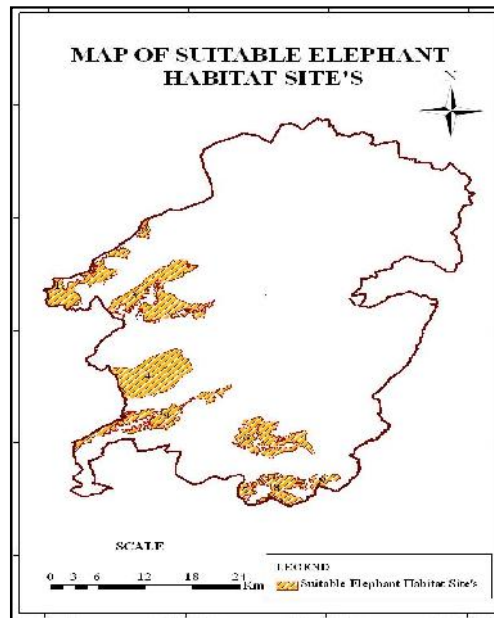

FIGURE 7. Site Suitability Map for Elephant Habitat

Rehabilitation of settlement for Elephant habitat site:
The site suitability map show the some villages are come under this area so, it's necessary to re-habitat these villages which come under the suitable area for Elephant,

these are Kitavade located to the North-East side of Ajara tahsil having 1019 population with 191 house hold as per 2001 census.
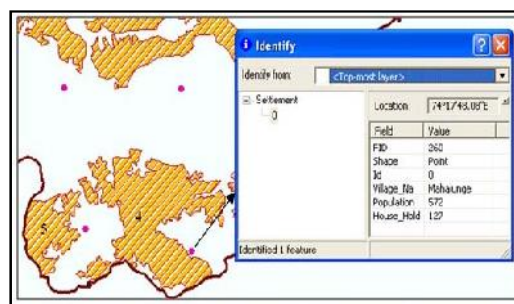

FIGURE 8. Location and details of Mahalunge village

Ambarde located near to Kitavade village having very less population which is 424 & 95 households. Bhogoli East part of Chandgad tahsil having 967 populations with 190 house hold this village located under the dance forest area. Kolik village located near to Karnataka state in south this village under maximum affected area having 795

population & 185 households. Mahalunge village very near to Karnataka State in south boundary of Chandgad tahsil having 572 population and 127 house hold this is continuously affected village because this village very near to Tillari Dam and having dense forest area shown in figure 8.
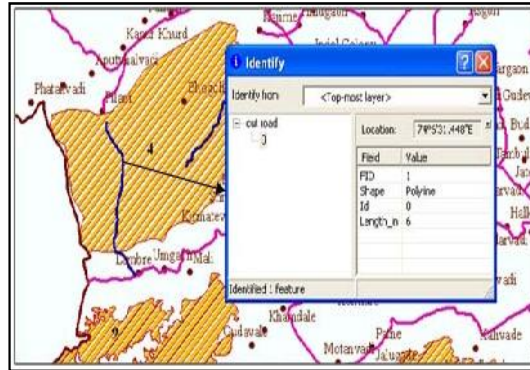
Renovations of Road

FIGURE 9. Location and details of Renovation road.

For further site suitability analysis, three road are cover under the forest area and it's necessary to divert this road for survival of various species, especially nomadic species like elephants (Rangarajan *et al.,* 2010) to avoid human elephant conflict. Alternative road is discovered which is helpful to maintain the biodiversity of forest in silence zone. Detailed are as follow. The ring road of Dhamapur to Gavse, the length of renovation road is 6 Km (Fig. 9) and alternative path is via Ibrahimpur, Ajara to Gavse is possible. Another road length is 7Km go toward Kajirne to shirgaon road. The third road between Lambare to Pillani Village length of the road is 6 Km and alternative road is available via Umgao, Chandgad, & Kanurbudrukh.

CONCLUSION & SUGGESTIONS
Integration of GIS, Remote sensing and GPS technologies have proved to be effective in assessment of habitat suitability and dispersal corridors for wide ranging species. The suitable site for elephant we get from the study is must be properly managed/ protected by local public and forest department to avoid human elephant conflicts and to reduce economical loss by the elephants. It will helpful to increase environmental and people prosperity. Effective management of corridors would go a long way in ensuring symbiotic relationship between elephants and human in the state.

SUGGESTIONS
- Barriers such as trenches or fences will be effective and they should regularly maintain (Rangarajan et al. 2010).
- Cultivation of non edibles crops in elephant arrival areas (ex. chili, capsicum, Tobacco, sun-flower)
- Elephant conservation should be associated with local people participation.
- The Maharashtra Forest Department has learnt the techniques of elephant management quickly and is managing the present situation quite well.
- There needs to be coordination and communication between forest officers of the Maharashtra and Karnataka states in terms of objectives, strategy and action to be taken for management of elephants.
- The largest continuous forest habitat is in Radhanagari Sanctuary with an area of about 350 sq. km. If elephants do reach here there is a possibility

that they may make a home considering the large area available here.
- People also need to be educated about the conservation, importance of the elephant so that beats are treated with more sympathy.
- Forest Department can introduce a web-based GIS on recent occurrence of the elephants, their location, numbers, area of activity, time of finding and direction of movement can be uploaded by the users.
- Aforestation of barren land under thin forest with favorable plants for Elephant.
- Rehabilitations of those villages which are coming under site suitability zone with discussions with the people of those particular villages.
- Remove the unwanted roads comes under site suitability zone forest which are having alternative roads with the help of Government & Forest Department.
- Try to change the strategy of opposing Elephant which is not harmful for Elephant.
- Forest Department have to reduce the compensation rule & increase the amount level of area/ crops damaged by Elephants.
- Farmers try to protect their own agriculture area with creation of natural vegetation compound like compound of cactus tree, Create compound using combine boundary which is economically chief, try to cultivate those crops which are doesn't like by Elephant.

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