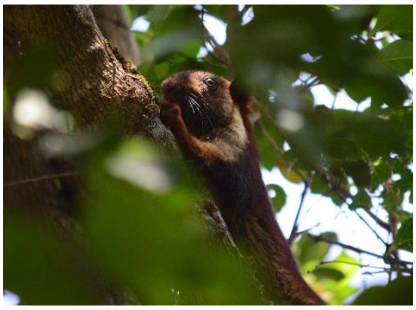
Evaluating the Outstanding Universal Value of Western Ghats (Sahyadri sub-cluster), UNESCO World Heritage Site for long-term monitoring of Ecosystem Services






Project Completion Report

submitted to

Sahyadri Tiger Reserve,
Kolhapur Wildlife Division, Maharashtra, India

भारतीय वन्यजीव संस्थान
Wildlife Institute of India

SAHYADRI TIGER RESERVE

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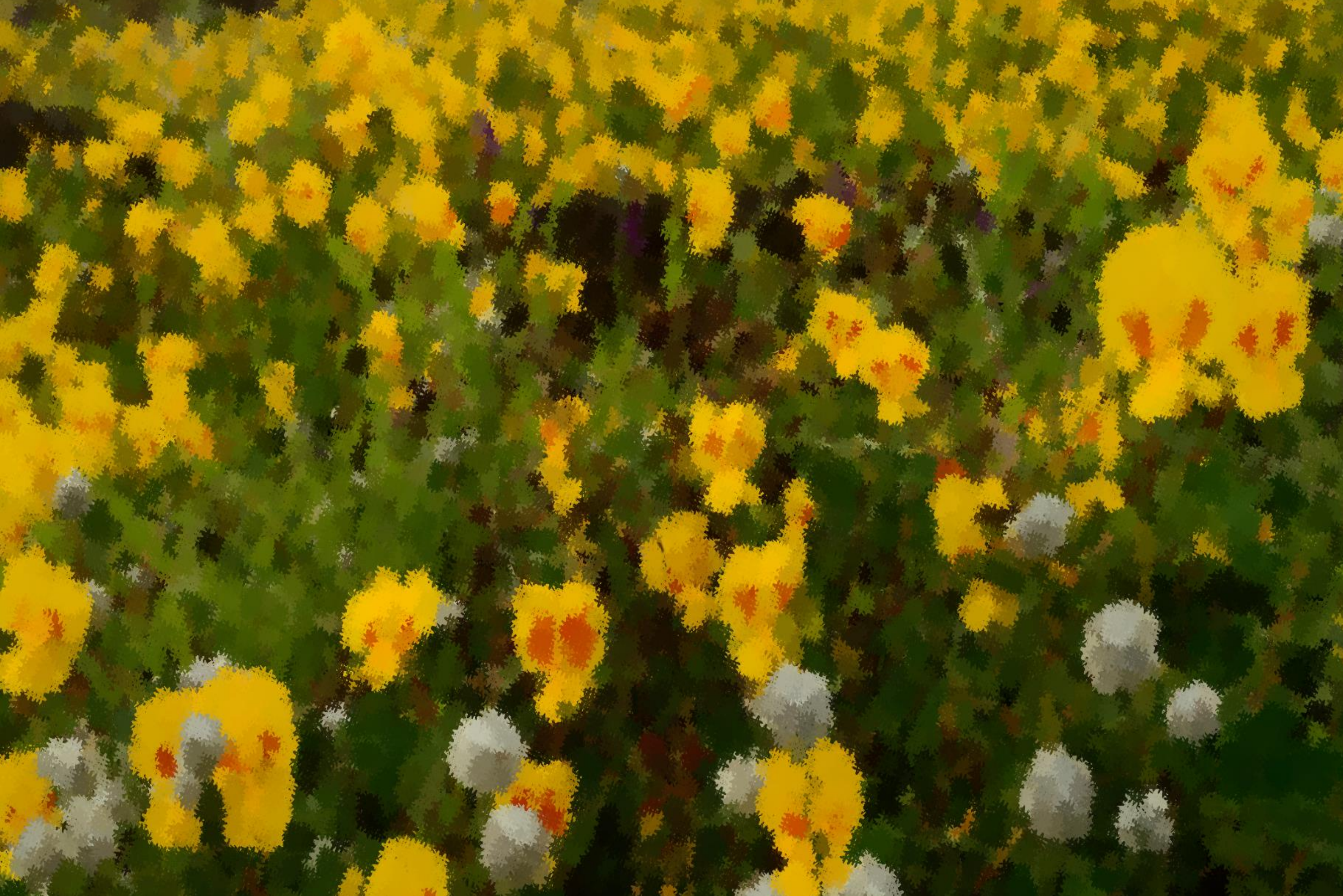
C2C-WII, Dehradun




Mass flowering at Kas Plateau, Maharashtra

Executive Summary

UNESCO recognizes Natural World Heritage Sites as areas representing pre-eminent spots of biodiversity that must be identified, protected and conserved by global community. These sites are selected for their Outstanding Universal Values based on magnitutde of biological and cultural significance. Sahyadri sub-cluster is one such site inscribed as a World Heritage Site in July 2012 based on the criteria:

a) Most important and significant natural habitats for *in-situ* conservation

b) Represents significant on-going ecological and biological processes

Sahyadri sub-cluster is one of the most exciting landscape for biologists for being the oldest mountain chains in the country which were once part of Gondwana land. In addition to its unique geological history, the endemicity in northern Western Ghats is exceptional. There are unexplored habitats in this landscape that still remain cryptic to most of us. Although the Western Ghats lay claim to unique landforms, flora and fauna, the hotspot of biodiversity is under threat due to high development pressure and fragmentation of the habitats.

The report is an outcome of one-year project conducted in Northern Western Ghats in Sahyadri landscape to look at the Outstanding Universal Values and conduct a landcape level survey to assess the ecosystem services in the region. The various services provided by the ecosystem were taken into consideration for evalution ranging from provisioning to regulating to cultural services. The idea was to provide a monitoring protocol to the forest department for long term perpetuation of the OUV in the region.

The report is divided into two parts wherein the Part I consists of nine chapters that give a complete overview of the study with details of each objective.

Chapter one contains detailed literature review, rationale and justification of the study. The study has three objectives: I. to look at disaster risks such as forest fire and carbon sequestration of the forest; II. To look at the socio-economic benefits derived from the forest by locals; III. To understand the indicator species approach for long term monitoring of the OUV in the study site. Chapter two gives a general idea of the study area and provides information on the topography, landscape features, forest type in each of the study site in the cluster: Chandoli National Park, Kas plateau, Koyana Wildlife Sanctuary and Radhanagri Wildlife Sanctuary.

Chapters three and four are linked to objective I of the project. Chapter three looks into the assessment of forest carbon stock whereas chapter four has estimated the forest fire risk zones in Sahyadri Tiger Reserve. Five and Six chapters focus on objective II of the project. Fifth chapter gives a detailed information on socio-economic dependence of local communities on forest in Sahyadri. Chapter six is dedicated to assessing the tourism benefits that the local communites derive from the WHS. Chapter Seven and Eight target objective III of the project. Seventh chapter introduces us with the indicator species concept and how it can be used for long term monitoring of OUV in a WHS. The chapter also gives detailed account of the indicator species selected for the study: a. Indian giant squirrel, b. Nilgiri wood pigeon, c. Koyna toad, and d. Amboli toad. Chapter eight proposes potential methods and techniques and protocols for monitoring of the faunal species (indicator species) which act as one of the most important OUV of a forest. The Last chapter concludes the report by talking of potential framework and suggestions for park managers and authories for mainitaing integrity and serenity of a WHS.

Part II consits of 4 dissertation reports that were completed by Master's students of Tata Institute of Social Sciences (TISS-Mumbai) during the duration of the project.

Koyna Wildlife Sanctuary, STR, Maharashtra

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Chapter One:

Introduction

1.1 Background

The Western Ghats region is tremendously diverse across its length, in climate, rainfall pattern, elevation, geology, topography, biota and landscape features (Prasad et al. 2009; Watve 2013). o Originally derived from local name of Sahyadri Hills; Western Ghats are formed by the Malabar Plains and the chain of mountains running parallel to India's western coast, about 30 to 50 kilometers inland. They cover an area of about 160,000 km² and stretch for 1,600 kilometers from the country's southern tip to Gujarat in the north, interrupted only by the 30 kilometers Palghat Gap (http://www.cepf.net/resources/hotspots/Asia-Pacific/Pages/Western-Ghats-and-Sri-Lanka.aspx).

The importance of Western Ghats as a global biodiversity hotspot is well established (Myers et.al., 2000). The Western Ghats are among the ecologically richest regions of India, next only to the Himalayas in the diversity of biological species. The climate and rainfall pattern here have led to a variety of unique plant and animal species. There are about 4000 species of flowering plants of which 1500 species are endemic, about 28 genera of mammals, 275 genera of birds and 58 species of reptiles are present in the Western Ghats (http://thewesternghats.indiabiodiversity.org/biodiversity_in_india) The Western Ghats provide habitat for several orchid species and house a variety of medicinal plants. The region is also rich in iron, manganese and bauxite ores. The biological diversity of the Western Ghats is not only important or as the resource base of the diverse human communities who live in the region, but also for maintaining the life support system of the peninsular region. The mountain chain of the Western Ghats represents geomorphic features of immense importance with unique biophysical and ecological processes. Globally it has been recognized as one of the world's eight "hottest hotspots" of biological diversity and is also inscribed as a UNESCO World Natural Heritage site. The UNESCO Criteria IX and X for natural sites are suitably linked to the 39 serial landscapes in the site that collectively form the best representatives of non-equatorial tropical evergreen forests anywhere and are home to at least 325 globally threatened flora, fauna, bird, amphibian, reptile and fish species (http://whc.unesco.org/en/list/1342).

Sahyadri Sub-cluster is part of the serial site of UNESCO's World Heritage Site of the Western Ghats cluster containing four site elements viz. Radhanagri Wildlife Sanctuary (16°21′00″ N and 73°57′00″) Chandoli National Park (17°11′ 00″ N and 73° 46′ 30″ E) Koyana Wildlife Sanctuary (17° 34′ 30″ N and 73° 46′ 30″ E) and the Kas Plateau (17°43′ 30″ N and 73° 49′ 30″ E). The inscribed total area of the site is 1026.6 sq. km. (Table 1.1). It also forms part of the Sahyadri Tiger Reserve that was constituted under the Wildlife (Protection) Act, 1972 in 2012.

Table 1.1 India's List of Serial and Single Natural World Heritage Properties Serial Site Nominations: Western Ghats Cluster (ref: Western Ghats nomination dossier http://whc.unesco.org/uploads/nominations/1342rev.pdf).

Sub-cluster	Site	Site Element Name	Area (km^2)	State
(1) Agasthyamalai	1	Kalakad-Mundanthurai Tiger Reserve	895.00	Tamil Nadu
	2	Shendurney Wildlife Sanctuary	171.00	Kerala
	3	Neyyar Wildlife Sanctuary	128.00	Kerala
	4	Peppara Wildlife Sanctuary	53.00	Kerala
	5	Kulathupuzha Range	200.00	Kerala
	6	Palode Range	165.00	Kerala
		SUB-TOTAL	*1,612.00*	
(2) Periyar	7	Periyar Tiger Reserve	777.00	Kerala
	8	Ranni Forest Division	828.53	Kerala
	9	Konni Forest Division	261.43	Kerala
	10	Achankovil Forest Division	219.90	Kerala
	11	Srivilliputtur Wildlife Sanctuary	485.00	Tamil Nadu
	12	Tirunelveli (North) Forest Division (part)	234.67	Tamil Nadu
		SUB-TOTAL	*2,806.53*	
(3) Anamalai	13	Eravikulam National Park (and proposed extension)	127.00	Kerala
	14	Grass Hills National Park	31.23	Tamil Nadu
	15	Karian Shola National Park	5.03	Tamil Nadu
	16	Karian Shola (part of Parambikulam Wildlife Sanctuary)	3.77	Kerala
	17	Mankulam Range	52.84	Kerala
	18	Chinnar Wildlife Sanctuary	90.44	Kerala
	19	Mannavan Shola	11.26	Kerala
		SUB-TOTAL	*321.57*	
(4) Nilgiri	20	Silent Valley National Park	89.52	Kerala

	21	NewAmarambalam Reserved Forest	246.97	Kerala
	22	Mukurti National Park	78.50	Tamil Nadu
	23	Kalikavu Range	117.05	Kerala
	24	Attapadi Reserved Forest	65.75	Kerala
		SUB-TOTAL	*597.79*	
(5) Talacauvery	25	Pushpagiri Wildlife Sanctuary	102.59	Karnataka
	26	Brahmagiri Wildlife Sanctuary	181.29	Karnataka
	27	Talacauvery Wildlife Sanctuary	105.00	Karnataka
	28	Padinalknad Reserved Forest	184.76	Karnataka
	29	Kerti Reserved Forest	79.04	Karnataka
	30	Aralam Wildlife Sanctuary	55.00	Kerala
		SUB-TOTAL	*707.68*	
(6) Kudremukh	31	Kudremukh National Park	600.32	Karnataka
	32	Someshwara Wildlife Sanctuary	88.40	Karnataka
	33	Someshwara Reserved Forest	112.92	Karnataka
	34	Agumbe Reserved Forest	57.09	Karnataka
	35	Balahalli Reserved Forest	22.63	Karnataka
		SUB-TOTAL	*881.36*	
(7) Sahyadri	**36**	**Kas Plateau**	**11.42**	**Maharashtra**
	37	**Koyana Wildlife Sanctuary**	**423.55**	**Maharashtra**
	38	**Chandoli National Park**	**308.90**	**Maharashtra**
	39	**Radhanagari Wildlife Sanctuary**	**282.35**	**Maharashtra**
		SUB-TOTAL	***1,026.22***	
GRAND-TOTAL			**7,953.15**	

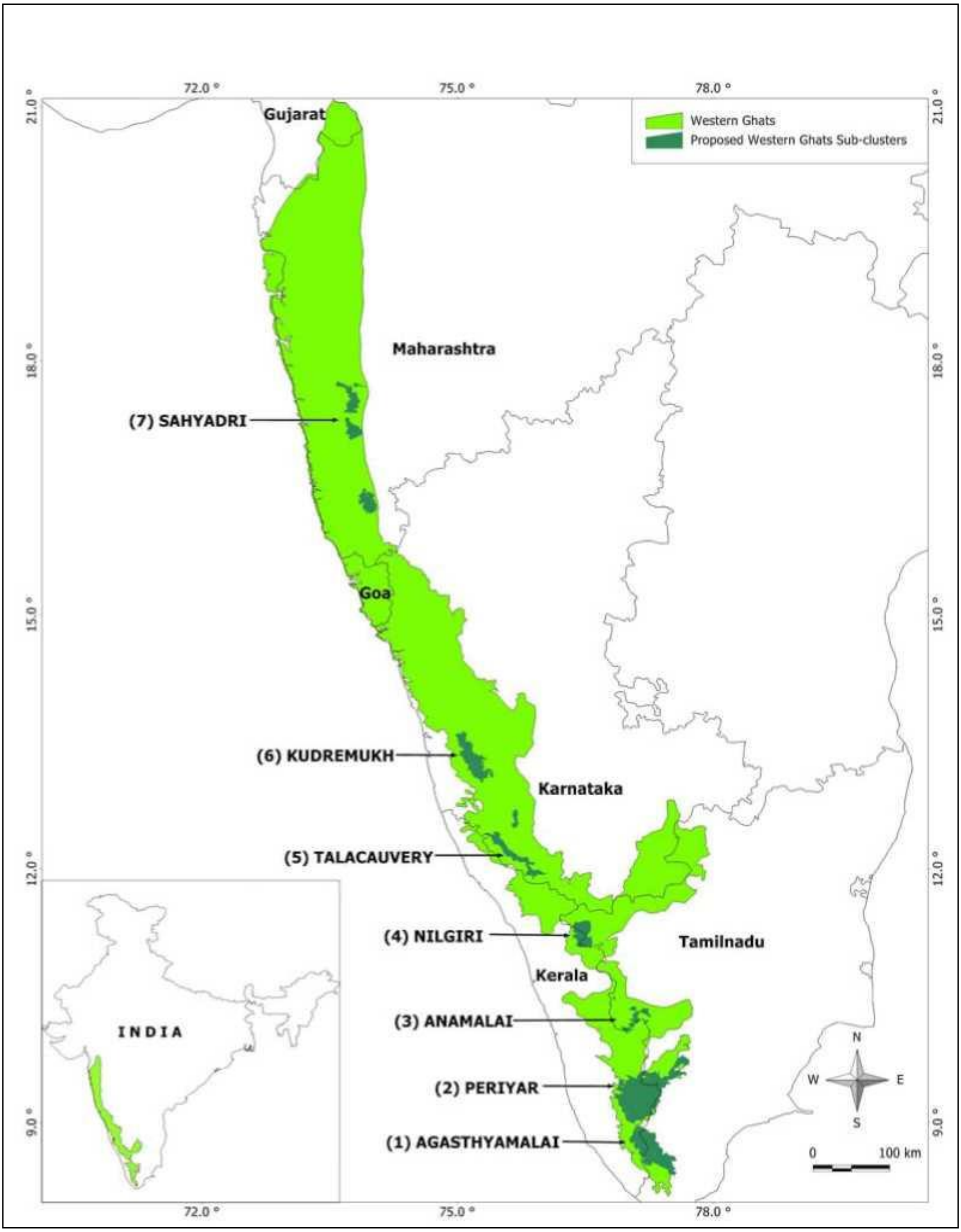


Figure 1.1 Map of the Western Ghats, showing the 7 sub-clusters included in the serial nomination

1.2 Rationale for the Study

The study emanates from the research priority needs of field Directorate, Sahyadri Tiger Reserve (STR) which invited reputed organizations such as the UNESCO Category 2 Centre on World Natural Heritage Site Management and Training for Asia-Pacific at Wildlife Institute of India (C2C-WII), The International Union for Conservation of Nature (IUCN), to assist and study the various aspects of research in the Tiger Reserve (abbreviated in the report as TR).

One of the key projects that were assigned to UNESCO Category 2 Centre-WII (C2C- WII) was to come with strategies that will assist the park authorities to understand the status of its world heritage and the benefits derived from them. The approach was to go beyond the intrinsic value of the heritage site and come up with some measurable indicators that can provide objectivity to the implementation of the project. The two imporatant rationale for the study are elaborated below.

Monitoring Outstanding Universal Value

The Outstanding Universal Value (OUV) of a World Heritage Site (WHS) has been loosely defined as *such cultural and/or natural significance which is so exceptional as to transcend national boundaries and to be of common importance for present and future generation of all humanity* (World Heritage Operational Guidelines 2016). The Statement of Outstanding Universal Value (SOUV) is the official statement about a property that is adopted by the World Heritage Committee to clearly define its OUV. The statement encapsulates why the property is of outstanding universal value – how it satisfies the criteria, the requirements of authenticity and integrity, and the protection and management requirement. OUV is therefore, the key reference point for future protection and management of a property. It is also the reference point for monitoring, periodic reporting, state of conservation reporting, potential in danger listing and potential deletion from the World Heritage List. The site elements pertaining to OUV of a natural heritage are usually quantifiable and backed up with strong scientific evidence and hence can be monitored (Badman et.al., 2008).

While, several elements of biodiversity have been well documented and researched for Western Ghats; (a fact that helped its inscription as a world heritage site in 2014), at the same time, the rich repository continues to be explored with new species reported to science (ref. *Nasikabatrachus bhupathi* paper).

The site elements contained in Sahyadri Sub-Cluster are inscribed under criteria IX and X in support of the stated OUV and are described as follows:

Criteria IX: be outstanding examples representing significant on-going ecological and biological processes in the evolution and development of terrestrial, fresh water, coastal and marine ecosystems and communities of plants and animals

Criteria X: contain the most important and significant natural habitats for in-situ conservation of biological diversity, including those containing threatened species of Outstanding Universal Value from the point of view of science or conservation.

Linking OUV to Ecosystem Services

Ecosystem services (ES) have been defined as nature's benefits to people and have been broadly classified into provisioning, supporting, regulating and Cultural services (MEA, 2005). Valuing the benefits provided by nature in monetary terms (termed as Ecosystem Services) highlights their economic importance to decision-makers and investors (Osipova et.al., 2014). The other aspect of this project has been to translate the intrinsic values (as denoted by OUV) of the World Heritage into quantifiable values that can further help in better monitoring and management and garner policy support for the site.

1.3 Justification for the Study

Studies across the globe indicate that biodiversity is an important underlying factor accounting for ES, and today these services in India and other Asian countries are likely to be derived from more intact ecosystems found in Protected Areas (PA).

Downstream, distant large and small-scale agricultural producers, enterprises and urban centers are not the only beneficiaries of PA services. Many low-income agricultural households living around PA are engaged in agriculture, livestock grazing and collection of forest products from such areas. These communities depend for their livelihoods directly and/or indirectly on the numerous environmental services PA provide, such as regulating (food, timber, water, fiber), provisioning (carbon storage, climate regulation, erosion and flood control, pollination), cultural (recreational, aesthetic, spiritual) and supporting (nutrient cycling, water cycle and soil formation) services.

The International Strategy for Disaster Reduction (ISDR) notes that "*protection of vital ecosystem services is fundamental to reducing vulnerability to disasters and strengthening community resilience*". The study is therefore justified on the ground for documentation and assessment of the key ecosystem services provided by Western Ghats (Sahyadri sub-cluster) towards better management of the site and long-term perpetuity of its OUV.

Based on the above, the following objectives of the project evolved as follows.

1.4 Study Objectives

Objective 1 ONE

To assess forest carbon and forest fire occurrence that contribute towards regulating ecosystem services.

Objective 2 TWO

Mapping socio-economic benefits provided by the site to local communities and visitors and possible contribution to provisioning and cultural ecosystem services.

Objective 3 THREE

To suggest an indicator species approach towards monitoring of OUV of World heritage and possible contribution to provisioning ecosystem services.

1.5 Project Duration

The project was spread over a period of 12 months in which more than 70 percent of the time was spent in the field. The overall calendar for the project is summarised below:

Table 1.2 Detailed account of study in Sahyadri sub-cluster from August 2016 to September 2017.

Month	Location	Activity
August 2016	WII, Dehradun	Literature review and guiding dissertations at TISS, Mumbai
September 2016-		

October 2016	Visit to all 4 sub clusters; Kas, Koyna, Chandoli and Radhanagri	Reconaissance visit to study site & opportunistic herpetofauna survey
November 2016	WII, Dehradun	Study design and logistic support
December 2016	Koyana WLS	Training and sensitization of forest frontline staff for world heritage site
January 2017	Kas, STR and Radhanagri WLS	Sampling for Indian giant squirrel, Nilgiri wood pigeon, Koyna toad and Socio-economic surveys in villages.
February 2017		
March 2017	TISS, Mumbai	Training workshop on Disaster Risk Reduction & Heritage sites
April 2017	WII, Dehradun	Data entry and preliminary analysis
May 2017	Kas, STR and Radhanagri WLS	Sampling for Indian giant squirrel, Nilgiri wood pigeon, Koyna toad and Socio-economic surveys in villages.
June 2017		
July 2017		
August 2017	WII, Dehradun	Data entry and analysis and Presentation at XIII Internal Annual Research Seminar
September 2017	WII, Dehradun	Report writing
October 2017- Feb 2018	WII/STR	Report submission


Mass flowering at Kas Plateau, Maharashtra

Chapter Two:

Sahyadri sub-cluster - in the context of Ecosystem Services and Human Well being

2.1 Introduction

In this chapter an exhaustive desktop review of past research carried out in Sahyadri sub-cluster World heritage (SSC-WH henceforth) has been collated as this will help in greater understanding of the values (including OUV) that the site provides. It will also help in narrowing down on the key ecosystem services that can be further mapped through the project. Information pertaining to various stakeholders in the site's protection and management are also provided.

2.2 Study Area

SSC-WH comprises of Radhanagari Wildlife Sanctuary, Chandoli National Park, Koyana Wildlife Sanctuary and the Kas plateau form a discontinuous stretch in a chain of mountain ranges in Maharashtra (Fig 2.1). The area is endowed with rich biodiversity, unique plateau vegetation and occurrence of many plants and animal species endemic to the region. Part of the World Heritage is also the first Tiger Reserve of Western Maharashtra (as declared on 5th January 2010) and 4th Tiger Reserve of Maharashtra State spreading over two Protected Areas those of the Koyana Sanctuary and Chandoli National Park. The total area of the Tiger Reserve is 1165.56 sq km out of which 741.22 sq.kms forms the core and 424.34 sq.kms the buffer of the TR. The area is spread over 4 districts namely, Satara (Mahabaleshvar, Medha, Satara & Patan tahasils), Sangli (Shairala tahasil), Kolhapur (Shahuvadi tahasil) and Ratnagiri (Sangameshvar, Khed tahasils).

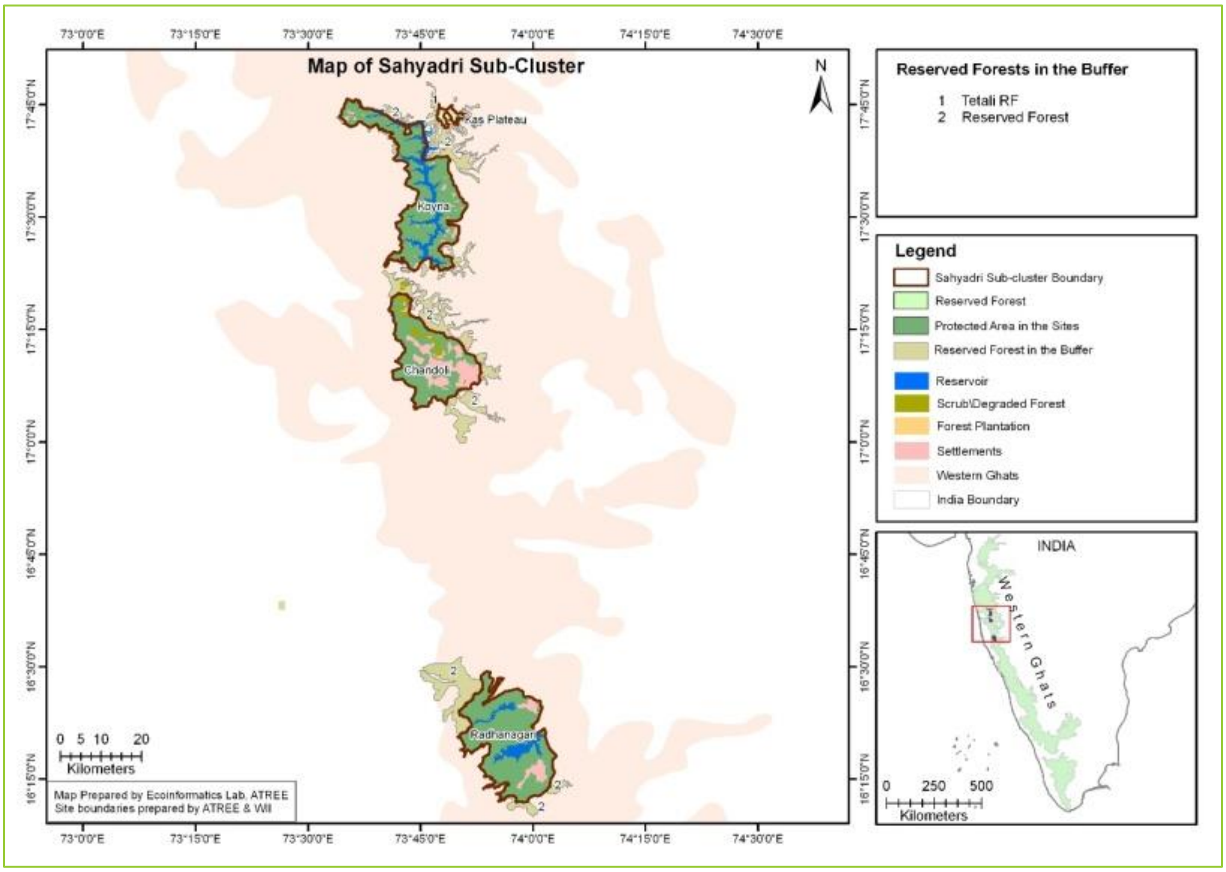


Figure 2.1 Map showing location of Sahyadri sub-cluster; Kas plateau, Chandoli NP, Koyna WLS and Radhanagri WLS in Maharashtra (top to bottom). Source: WII database

Sahyadri hills as a cauldron of endemicity

SSC-WH are an excellent example for diversification, as the volcanic eruptions that formed the Deccan traps during the Late Cretaceous wiped out the then contemporary biota, creating new habitats open for colonization (Widdowson and Cox 1996; Prasad et. al. 2009; Watve 2013). The lineages that dispersed into the Indian subcontinent diversified and gave rise to numerous endemic taxa (Biju et al. 2009; Van Bocxlaer et al. 2009). The unique floral and faunal diversity is a result of the then geological processes that took place in the Indian subcontinent marked by successive episodes of extensive isolation, which have provided ideal settings for this development. By unceasingly providing favourable humid conditions, the subcontinent's southern mountain ranges have served as refugia for old lineages, and hence constitute a unique reservoir of ancient endemism (Roelants et al. 2004).

Due to prevailing specialized conditions, life forms adapted to such conditions may not be able to survive if their niches are disturbed in any way. Similarly, life forms from outside the region may not be able to replace native life forms or colonize due to their inability to adapt to such specialized conditions. This region, when disturbed, thus suffers on two counts. That is why it should be treated as a fragile zone. (Gole 2000).

Unique Physical features

Physical features of SSC-WH are also very important, as the mountain range serves as catchment to all major rivers feeding the entire Indian peninsula. Also, these are the major soil producing areas, supplying soil to downstream which in turn help in agricultural production (Satara district has one of the highest yields in agricultural crop produce, source working Plan Satara). All these special physical features have created unique habitats which have been supporting endemic biodiversity (Ghate et al.1997). Chandoli National Park and Koyana Wildlife Sanctuary is largely mountainous, with very steep precipitous slopes, deep valleys and long stretching lateritic plateaus. It is a stretch of area along the Crest of North Sahyadri Range of Western Ghats forming the catchment of Warana reservoir and Koyana Reservoir. The central portion of Sahyadri Tiger Reserve is occupied by Shivsagar reservoir of Koyana River and Vasant Sagar reservoir of Warana River. The revenue fallow and *Malki* (private) lands included in the Tiger Reserve have scattered bushy tree growth in between and along the banks. The cultivated areas have been turned to grassy meadows/Grasslands (Kulkarni, 2015).

A special note on *sadas* - Islands of biodiversity

The lateritic flat tops of Western Ghats are called as “Plateaus” or “table lands” and locally known as “sadaas”. Plateaus of Kas, Chalkewadi are some of the important sadas. These plateaus possess very characteristic herbaceous ephemeral vegetation. Herbaceous flora of the plateau includes more than 300 species of grasses, *Impatiens, Utricularias, Eriocaulons, Ground orchids, Smithias, Dipcadies, Senecios, Rotala*, *Disophylla* and *Strobilanthes* species etc., (Bachulkar,1996). Deshpande, et. al. (1993) observed that high concentration of endemic species in this part of Western Ghats (Mahabaleshwar and adjoinings), form an ecological boundary between the low-lying plains, Konkan & the Deccan tableland forming an ideal endemic area. Their study pertained to the flora of phytogeographically interesting and floristically rich districts. They had observed that of the 56 genera endemic to Peninsular India, 10 monotypic genera are endemic to Western Ghats and are found in this area. (*Carvia, Dicoelospermum, Erinocarpus, Helicanthes, Indopoa, Moullava, Polyzygus, Pseudodicanthium, Seshagiria, and Trilobachne).* Bachulkar (1996) observed that Vasota fort, Koyana valley (Koyana wildlife sanctuary) and plateaus in the region sustain good number of endemic species. Mahabaleshwar-Khandala range had been recognised as 'hot-spot' in Western Ghats with high concentration of endemic plant species. High flat mountain tops, table lands, escarpments, valleys, strong hill forts and peaks and spurs of Sahayadri provide protected unique habitats for the growth of various kinds of plant species and plant communities. He has studied and recorded 156 families, 680 genera, 1452 species, 10 sub species and 35 varieties, enlisted more than 400 plant species with medicinal value in the Koyana wildlife sanctuary and the Kas plateau in Satara district. 20 plant species which find mention in the Red Data Book as Endangered have been recorded in the area. *(Abutilon ranadei, Aponogeton satarensis, Begonia trichocarpa, Ceropegia jainii, C. noorjahaniae, C. occulata, C. sahyadrica, C. vincaefolia, Decaschistia trilobata, Erinocarpus nimmonnii, Euphorbia panchganensis, Habernaria panchganensis, Iphigenia stellata, I. magnifica, Kalanchoe olivacea, Polyzygus tuberosus, Rotala ritchiei, Seshagiria sahyadrica, Smithia agharkaarii, and Vigna khandalensis).* Bachulkar.et.al (1995), Bachulkar & Yadav (1997), reported new records in the area. Sardesai et.al (2002) made additions to the orchid flora of Maharashtra after studies in the area. Yadav.et.al (1993) reported *Arisaema sahyadricum*, new species from India. Bachulkar and Yadav (1997-98) upon a study reported the endangered endemic taxa of south-western Maharashtra with a detailed account of the existence and floristics analysis of the area. Bachulkar et.al (1995) reported extended distribution of endangered plant species, *Ceropegia jainii*, in Kas and adjoining areas.

Rich floristic compositions

The forests type varied across the entire sub cluster range viz. semi evergreen, mixed moist deciduous, open grasslands and rocky outcrops. The month of September marks the end of monsoons in northern Western Ghats thus, and is the best time to visit the plateaus which are carpeted with endemic flower species such as *Utricularia purpurascens*, *Smithia* sp., *Impatiens oppositifolia*, *Pogostemon deccanensis* and others change colour fortnightly giving a unique look to the landscape.

The sanctuaries are mainly covered by evergreen to semievergreen to moist deciduous forests. Broadly the forest types seen in the P.A. are as follows:

i) Western (Montane) Subtropical Hill Forests - (8.A / C-2): These types of forests are found on the higher ridges of Sahyadri where altitude exceeds 1000mts. The growth is usually stunted, without distinct canopies & with large interspersed blanks.

ii) West Coast Semievergreen Forests - (2.A / C.2): These forests are confined to the valleys where the general height of the trees in the top canopy varies from 12 to 20 mts. The density ranges from 0.5 to 0.7. These forests harbor rich fauna & flora,

iii) Southern Moist Mixed Deciduous Forests - (3B/C.2): This type of forest is seen all along the lower slopes of Sahyadri. The forest is fairly dense with density ranging from 0.5 to 0.8 with natural regeneration of Ain & Shisham.

Koyana wildlife sanctuary forms the northernmost limit to more typical flora and fauna of the evergreen forest biome of western ghats and a few species not so far recorded from other areas in the region while a few others are common here although rare elsewhere. Koyana Wildlife Sanctuary is the only place where climax & near-climax vegetation is plentiful and prospects of adverse anthropogenic influence in the future are minimal (Ghate, 1993). The Koyana reservoir forms the part of the Koyana Sanctuary. Nearly 47% area of Koyana Dam catchment is included in the sanctuary. The Western & Eastern slopes with thick vegetation protect the reservoir from siltation. This benefits the Koyana hydro electricity project. Jagtap Suresh (2004), observed 172 species of plants of medicinal importance in the Medicinal Plants Conservation Area, Nawaja, which include, species rated endangered.

Enigmatic Fauna

The rugged terrain with the rich biodiversity of flora is also known to attract a diverse group of people including the trekkers, wild life lovers, nature lovers, birdwatchers, research scientists, tourists and the educational institutions for its enigmatic fauna. The forests shelter the tiger and other large and charismatic mammals such as leopards, Jungle cats, Jackals along with herbivores like Indian Bison (Gaurs), Sambars, Barking deers, Mouse deers, Sloth bears, Giant squirrel (Shekaru), Common langurs, Hares etc. The reptiles include Monitor lizards, python, cobras and other snakes, etc. The diverse variety of avifauna like Grey Jungle fowls, Parakeets, Eagles, Kites, cormorants, partridges, common peafowl, green pigeons, Indian nightjar, kingfishers, Indian roller, Pied Hornbills, wood peckers, fly catchers and sunbirds are commonly seen in this area. Indian River Tern visits this area in the months of April-May.

A recent discovery of an acquatic snake *Rhabdops acquaticus* is a new addition (Giri et al. 2017) to the repository of unique faunal composition of Shayadri landscape. The snake represents monotypic endemic genus found to be restricted to fresh water streams on lateritic plateaus which are currently facing excessive human pressure.

The region of Northern Western Ghats holds a lot more unexplored habitats and cryptic species diversity that inhabit such areas. Biodiversity profile of Sahyadri still needs to be ascertained as new discoveries are continuously been added in the biodiversity profile of this region.

Threats to biodiversity in Sahyadri sub-cluster

The landscape is variedly degraded and fragmented due to use by local people for centuries old cultivation or as well as modern developmental pressures including commercial form of agriculture within the last few decades. The original forest cover and biodiversity is seen only in pockets of notified protected areas or within semi-protected areas like *Devrais* or scared groves. The landscape is degraded to various seral stages depending on the degree of disturbance and is reflected in six major vegetation classes namely Rocky outcrops, Open grasslands with Scrub, Dense shrubbery, Dwarf canopy forests, Riparian forests and Tall mature forests. Composition of species pertaining to each of these vegetation classes is definite with some overlaps. From an ecological point of view, there is an urgent need to conserve these pockets and provide buffer for them. (Ghate 2014). Shinde (1989) studied the impact of dam construction and agricultural practices on animal diversity in the Koyana catchment.

Mapping Ecosystem Services

Ecosystem services are defined as the services provided by nature. Broadly four types of Ecosystem services have been categorised viz. Provisioning, Regulating, Cultural and supporting services ((MEA, 2005). These services are directly beneficial to the local people and correspond directly to any conservation effort in the landscape.

Sahyadri sub-cluster as well as other Natural world heritage sites in our country support human life by protecting agricultural genetic material (wild cultivars) and providing cheap, clean drinking and irrigation water from forests and Protected Areas (Verma et. al 2015). These PAs not only help in mitigating natural disasters such as floods and cyclonic storms, drought etc. Natural and cultural resources in Protected Areas are important drivers of tourism, supporting local earnings and employment. In addition, these natural landscapes play an important role in ecosystem-based approaches to climate change adaptation and contribute to mitigation by storing and sequestering carbon. Besides conserving the diversity of wild flora and fauna mentioned above, a Tiger Reserve also provides a range of associated economic, social, cultural and spiritual benefits, which are also termed as ‘ecosystem services.’

Table 2.1. Ecosystem services and their symbols in context of Sahyadri sub-cluster (adapted from MEA 2005 and TEEB 2010, Source-GIZ).

1) Provisioning Services- include food, water and other material benefits		**ES in the context of Sahyadri sub-cluster**
Food: Ecosystems provide the conditions for growing food – in wild habitats and in managed agro-ecosystems.		wild fruits, vegetables, mushrooms
Raw materials: Ecosystems provide a great diversity of materials, which can be used for construction and fuel, among other uses.		fuelwood, fodder, thatch and grass
Fresh water: Ecosystems provide surface and groundwater.		groundwater recahrge for irrigation wells, drinking water
Medicinal resources: Many plants are used as traditional medicines and as input for the pharmaceutical industry.		wild medicinal plants
2) Regulating Services- when ecosystems act as regulators e.g. carbon sequestration, ecosystem-based Disaster Risk reduction, disease control etc.		
Local climate and air quality regulation: Trees provide shade and remove pollutants from the atmosphere. Forests influence rainfall.		forests in the dam catchment prevent soil erosion
Carbon sequestration and storage: As trees and plants grow, they remove carbon dioxide from the atmosphere and effectively lock it away in their tissues.		Trees store carbon
Moderation of extreme events: Ecosystems and living organisms create buffers against natural hazards such as floods, storms, and landslides.		watershed protection and fire control
Waste-water treatment: Micro-organisms in soil and in wetlands decompose human and animal waste, as well as many pollutants.		habitat for micro organisms
Erosion prevention and maintenance of soil fertility: Soil erosion is a key factor in the process of land degradation and desertification.		watershed protection

Pollination: Some 87 out of the 115 leading global food crops depend upon animal pollination, including important cash crops such as cocoa and coffee.		habitat for pollinators
Biological control: Ecosystems are important for regulating pests and vector borne diseases.		repository of wild genome
3) Habitat or Supporting Services underpin almost all other services. Ecosystems provide living spaces for plants or animals; they also maintain a diversity of different breeds of plants and animals.		
Habitats for species: Habitats provide everything that an individual plant or animal needs to survive. Migratory species need habitats along their migrating routes.		habitat for wild flora and fauna
Maintenance of genetic diversity: Genetic diversity distinguishes different breeds or races, providing the basis for locally well-adapted cultivars and a gene pool for further developing commercial crops and livestock.		repository of wild genome
4) Cultural Services include the non-material benefits people obtain from contact with ecosystems. They include aesthetic, spiritual and psychological benefits.		
Recreation and mental and physical health: The role of natural landscapes and urban green space for maintaining mental and physical health is increasingly being recognized.		fresh air, water and scenic landscapes
Tourism: Nature tourism provides considerable economic benefits and is a vital source of income for many countries.		tourism and livelihood benefits
Aesthetic appreciation and inspiration for culture, art and design: Language, knowledge and appreciation of the natural environment have been intimately related throughout human history.		nature-based cultural and societal norms (e.g. sacred groves)
Spiritual experience and sense of place: Nature is a common element of all major religions; natural landscapes also form local identity and sense of belonging.		identify of Marathas

Table 2.2 Ecosystem services categorized broadly under four services; Provisioning, Regulation, Cultural and Supporting and their trends in the human use of Ecosystem Services and Enhanced or degradation of the services 15 years back. Upright arrow = Increasing or enhanced; Down arrow = decreasing or degraded; +/- = mixed; NA= not assessed within MA; ≠ = the categories "enhanced or degraded" do not apply. Adapted and modified from Millenium Ecosystem Assessment 2005.

S. No.	Service	Sub-category	Human use	Enhanced/ Degraded	Remarks
1.	**Provisioning Services**				
1.1	Food	Crops	⇧	⇧	Food provision has grown faster than overall population growth of the country.
		Livestock	⇧	⇧	Significant increase in poultry and cattle with limited area devoted to livestock
		Capture fisheries	⇩	⇩	Human use of capture fisheries has declined because of reduced supply or strict regulation in PA, not because of reduced demand.
		Aquaculture	⇧	⇧	Demand and dependence on coastal/marine ecosystem places a burden on cature fisheries.
		Wild plant & animal food products	NA	⇩	Provision of these food sources is declining as natural habitats are under increasing pressure due to exploitation for food, particularly by the poor, at unsustainable levels.
1.2	Fiber	Timber	⇧	+/-	Roughly 40% of the forest area has been lost during the industrial era, and forests continue to be lost in major biodiversity hotspots of India.
		Agriculture fibers	+/-	+/-	Production of some agricultural fibers like cotton and silk has increased while for some has decreased.

		Wood fuel	+/-	⇩	Fuelwood remains the dominant source of domestic fuel in many remote corners of India.
1.3	Genetic resources	Genetic diversity	⇧	⇩	Genetic resources have been lost due to adoption of modern farming practices and loss of traditional cultivars of crop species. Species extinction is other such cause.
1.4	Biochemicals, natural medicine and pharmaceutical s	NA	⇧	⇩	Species extinction and overharvesting of medicinal plants is diminishing the availability of these resources.
1.5	Fresh water	NA	⇧	⇩	Fresh water in rivers provide energy that is exploited through hydropower. The constrcution of dams makes the energy more available to the people. However, pollution and biodiversity loss are major features of modern inland water systems.
2.	**Regulating Services**				
2.1	Air quality regulation	NA	⇧	⇩	The ability of the atmosphere to clesnse itself of pollutants has declined considerably.
2.2	Climate regulation	Global	⇧	⇧	Land cover changes in the past has led to change in albedo, resulting in the warming effect due to assosicated carbon emissions.
		Regional	⇧	⇩	Changes in land cover have affected regional and local climates both psitively and negatively. However, negative effects dominate most. Deforestation & desertification in tropical ecosystems have led to reduced local rainfall.
2.3	Water Regulation	NA	⇧	+/-	Human alterations have severely affected the timing and magnitude

					of runoff, flooding, and aquifer recharge in the ecosystem.
2.4	Erosion regulation	NA	⇧	⇩	Land use changes have accelerated soil degradation and erosion.
2.5	Water purification & waste treatment	NA	⇧	⇩	Factors such as growing population, pollution, loss of wetlands, has decreased the ability of ecosystems to filter and decompose wastes.
2.6	Disease regulation	NA	⇧	+/-	Habitat alterations may increase or decrease the risk of infectious diseases locally.
2.7	Pest regulation	NA	⇧	⇩	Pest control provided by natural enemies has been replaced by the use of pesticides in many agricultural areas. use of pesticides has degraded the capacity of agroecosystems to provided pest control.
2.8	Pollination	NA	⇧	⇩	Decline in abundance of pollinators have resulted in failure to produce seeds or fruits in rare instances, but frequently resulted in fewer seeds or fruits of reduced viability. Losses in populations of specialized pollinators may directly affect reproductive ability of rare plants.
2.9	Natural Hazard regulation	NA	⇧	⇩	Decline in the capacity of ecosystems to buffer form extreme events, has led to loss of life globally and rapidly rising economic losses from natural disasters.
3.	**Cultural Services**				
3.1	Cultural diversity	NA	NA	NA	

3.2	Spiritual and religious values	NA	⇧	⇧	Decline in sacred groves and other such protected areas has been significant. The loss of particular ecosystem attributes (sacred species or sacred forests), combined with social and economic changes, may weaken the spiritual benefits people obtain form ecosystems.
3.3	Knowledge systems	NA	NA	NA	_
3.4	Education values	NA	NA	NA	_
3.5	Inspiration	NA	NA	NA	_
3.6	Aesthetic values	NA	⇧	⇩	Increased urbanization has led to increasing demand for aesthetically pleasing natural landscapes. Reduction in the availability of and access to natural areas for urban residents may have important detrimental effects on public health and economics.
3.7	Social relations	NA	NA	NA	_
3.8	Sense of place	NA	NA	NA	_
3.9	Cultural heritage values	NA	NA	NA	_
3.10	Recreation and ecotourism	NA	⇧	+/-	Naturally occurring features of landcape like dense forests, coastal habitats, coral reefs etc are continuously degraded as resources for recreation.
4.	**Supporting Services**				
4.1	Soil formation	NA	≠	≠	_
	Photosynthesis	NA	≠	≠	_
	Primary production	NA	≠	≠	_

	Nutrient cycling	NA	≠	≠	Large scale changes in nutrient cycling has been observed in recent decade due to inputs from fertilizers, livestock waste, human wastes, and biomass burning. Eutrophication has significantly impaired inland water and coastal sysytems.
	Water cycling	NA	≠	≠	Human alterations to water cycles through strcutural changes on rivers for extraction of water and more recently, climate change.

Chandoli National Park

Chandoli National Park is located in the Sangli, Satara, Kolhapur, and Ratnagiri districts of the state of Maharashtra and is spread across by total area of 317.67 Km^2. It lies between the Koyana and Radhanagari Sanctuaries, and contains pristine patches of semi evergreen forests harboring many endangered species.

It forms and protects many perennial water channels, water holes and the Vasant Sagar Reservoir. The Warna river originates at Patharpunj and a dam has been constructed at the Chandoli village. The entire catchment of the Chandoli dam (Vasant Sagar) reservoir is located within the PA. The Government of Maharashtra, after appreciation of the biological, floral significance of the area, upgraded the Chandoli Wildlife sanctuary (as declared in 1985) into a National Park on 14th May 2004. The relocation of 32 villages from within the sanctuary area has resulted in a habitat conducive for unadulterated development of the protected area. (Salunkhe, and Khot, 2002)

The vegetation according to Champion and Seth's classification belongs to the subgroups:

1) 8A/C2- Western tropical hill forests.

2) 2A/C2 - West coast semi evergreen forests.

3) 3B/C2- Southern moist deciduous forests.

The area supports Semi evergreen forests having remarkably wide range of flora and great variety of fauna. The most common floral species found here in this Protected Area are Anjani

(*Memecylon umbellatum*), Jambhul (*Syzigium cuminii*) Pisa (*Actinodaphaone angustifolia*) etc., “Sadas” or Plateaus at Zolambi, Rundiv are important. These plateaus possess very characteristic herbaceous ephemeral vegetation. Herbaceous flora of the plateau includes more than 300 species of grasses*, Impatiens, Utricularias, Eriocaulons*, Ground orchids, *Smithias, Dipcadies, Senecios, Rotala, Disophylla* and *Strobilanthes* species etc., (Bachulkar 1996; Salunkhe and Khot 2002). The intersperse of the forest and the earlier private lands throws up combinations of dense forest cover patches, interspersed with grass lands, open blanks, sadas, which are known to encourage different types of biodiversity. Some of the main management issues in Chandoli are livestock grazing from forest fringe villages, and the existence of private (*malki*) land inside the park. Windmills near the Park is also an issue especially for bird hit and noise pollution.

The area has got Global and National significance, as it is one of the habitats of the Bengal tiger (*Panthera tigris tigris*). The Indian bison or Gaur, sambar, Panther, Sloth bear, barking deer, Giant squirrel etc., are found in this area. The nests of Giant squirrel are confined to virgin forest of Rundiv, Shidheshwar and Patharpunj villages. Ramnadi a river, and the Sadas on either side to this river provides good breeding ground to Indian guar and other herbivorous animals. (Salunkhe and Khot, 2002). Places of historical and tourist interest include Prachitgad, Kalavantin vihir, Bhairavgad. Scenic points like Kokan darshan, Zolambi sada, virgin forest of Rundiv add to the recreation value of the area. Adjoining areas of interest include town of Battis Shirala, famous for Nagpanchami festival; Kalimata temple at Udgiri village, ancient Valmiki Temple at Paneri village and Naikba temple near Dhebewadi town are important places supporting sacred groves.

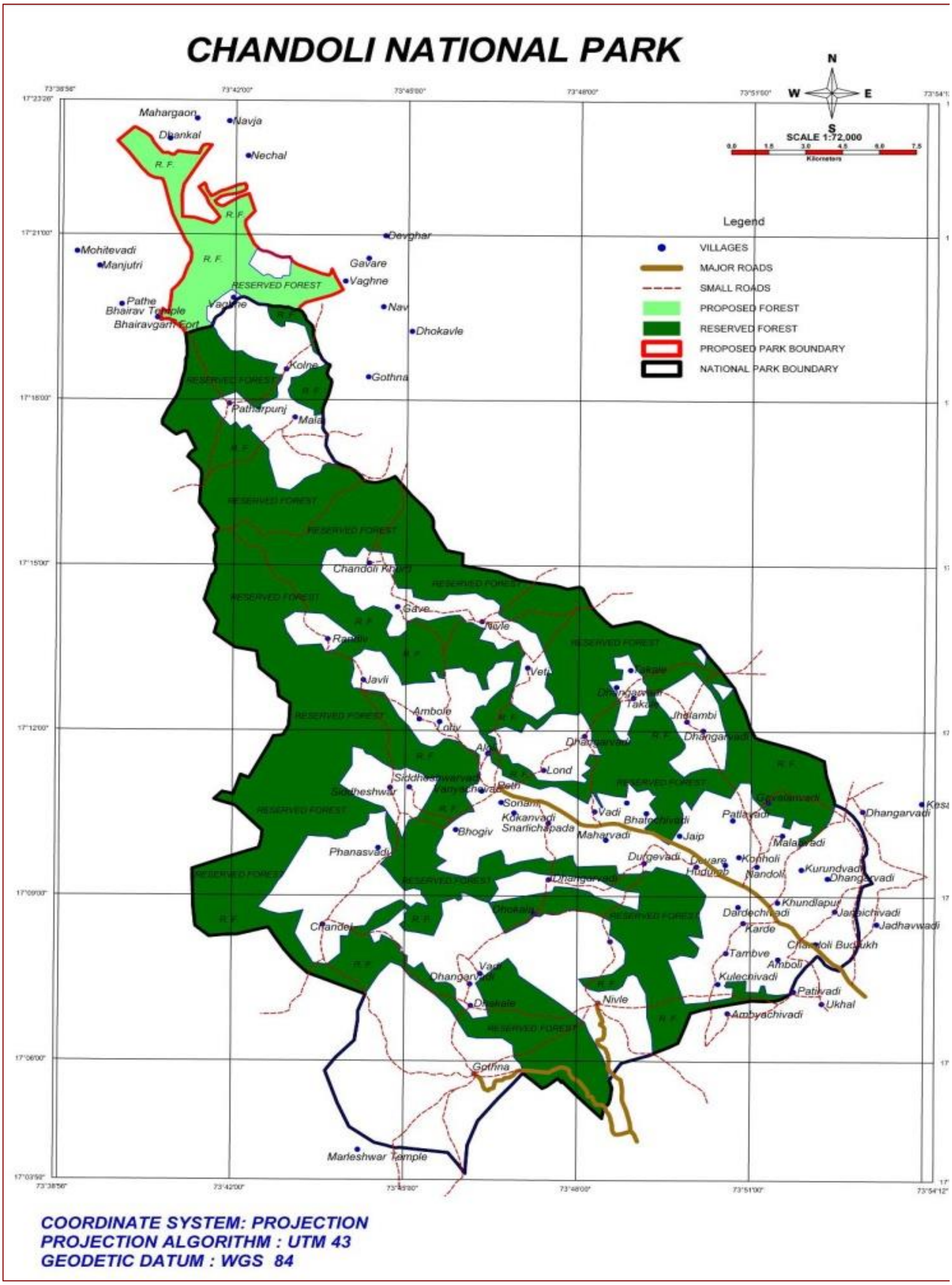


Figure 2.2 Map of Chandoli National Park in Maharashtra, India

Kas Plateau

The Kas Plateau, also known as the Kas Pathar or Kas Sadas, is a biodiversity hotspot known for various types of gregarious wild flowers and numerous species of endemic butterflies that become conspicuous annually in the months of August and September. The name Kas originates from Kasa tree (*Elaeocarpus glandulosus*). The leaves of the tree turn red from green as it matures during the month of March.

Located in Satara district, at an elevation of 1213 MSL, the plateau receives an annual rainfall between 2000 to2500mm annually. The Kas plateau changes the colours after every 15-20 days as the monsoon progresses since June to October. The progress is in terms of yellow colours of *Senecios* and *Smithias,* blue colours of *Utricularias*, pink rosy colours of *Impatiens*, white colours of *Eriocaulons* and *Habanerias* and purple colours of *Strobilanthes* species. Many rare endemic endangered plants like *Ceropegias, Seshagiria, Arisaemas, Decaschistia, Trithuria, Dipcadi etc.,* grow on these plateaus. The panorama of colours makes it a *plateau of flowers* between August-September. More than 850 species of flowering plants have been reported from Kas region. 39 species find mention in the RED DATA book of the total 624, which make it approximately 6% of the Red data species. Of the total area of 1792 hectares under Kas plateau, 1142 hectares is recorded as Government Forest. (Limaye 2004).

Major pressure Kas Plateau is undergoing is due to irresponsible tourism activities like trampling of flower carpet and littering of plastic waste. There are regulations for parking of vehicles, number of vehicles entering the plateau and speed of the vehicles, but enforcement becomes a problem when the tourists come in large numbers.

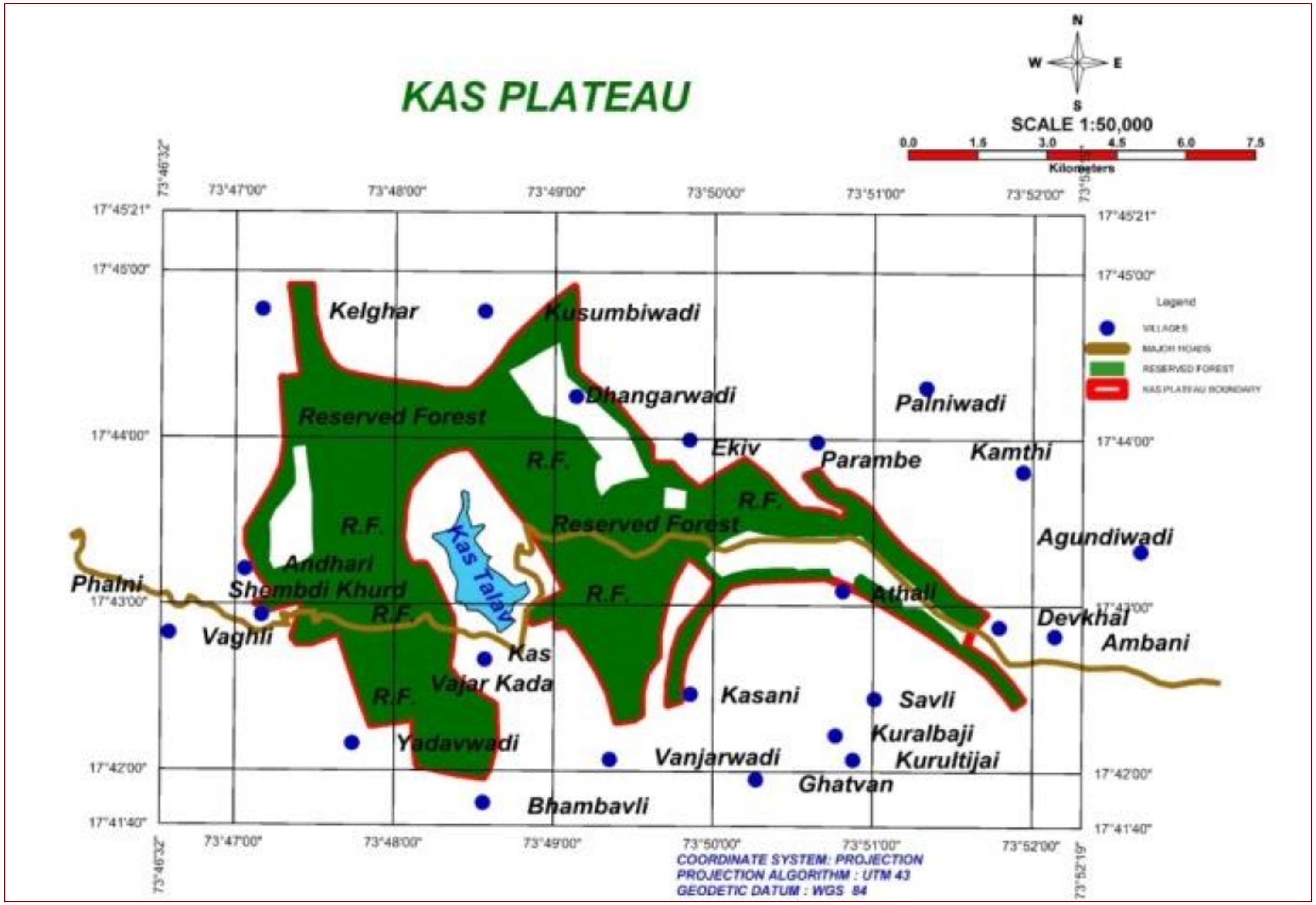


Figure 2.3 Map of Kas plateau in Maharashtra, India.

Koyana Wildlife Sanctuary

Situated in the Sahyadri mountain ranges, Koyana Widlife Sanctuary is rich in bio-diversity and spans over 423.55 sq km. The forest was declared as a Sanctuary in 1985, and only on 5 January 2010 was included as a part of Sahyadri Tiger Reserve.

The forest is along the back water of the dam constructed in 1962 on the river Koyana which originates from Mahabaleshwar, Maharashtra. The backwater is locally known as 'Shivsagar Jalashay'. Koyana Wildlife Sanctuary hosts dense forests all over with diverse flora and fauna, grasslands, and lateritic plateaus.

The rivers Koyana, Kandati and Solashi, originating in the Western Ghats, span the sanctuary. The area around Koyana dam was completed in the early 1960's, and the sanctuary provides an important forested catchment to the dam that has an intsalled capacity of 98 TMC. The structure initially erected, was later expanded in 4 stages and generates hydro-electricity. The IV stage involving Lake Tapping was lauded as a feather in the crown of Maharashtra Irrigation Department at that time when large dams were in vogue. The monolith of the Koyana dam, the hydroelectric generation structures, the Nehru Visitors Information centre continues to attract vistors, although all tourism activity within the dam has been stopped due to security reasons in the last few years.

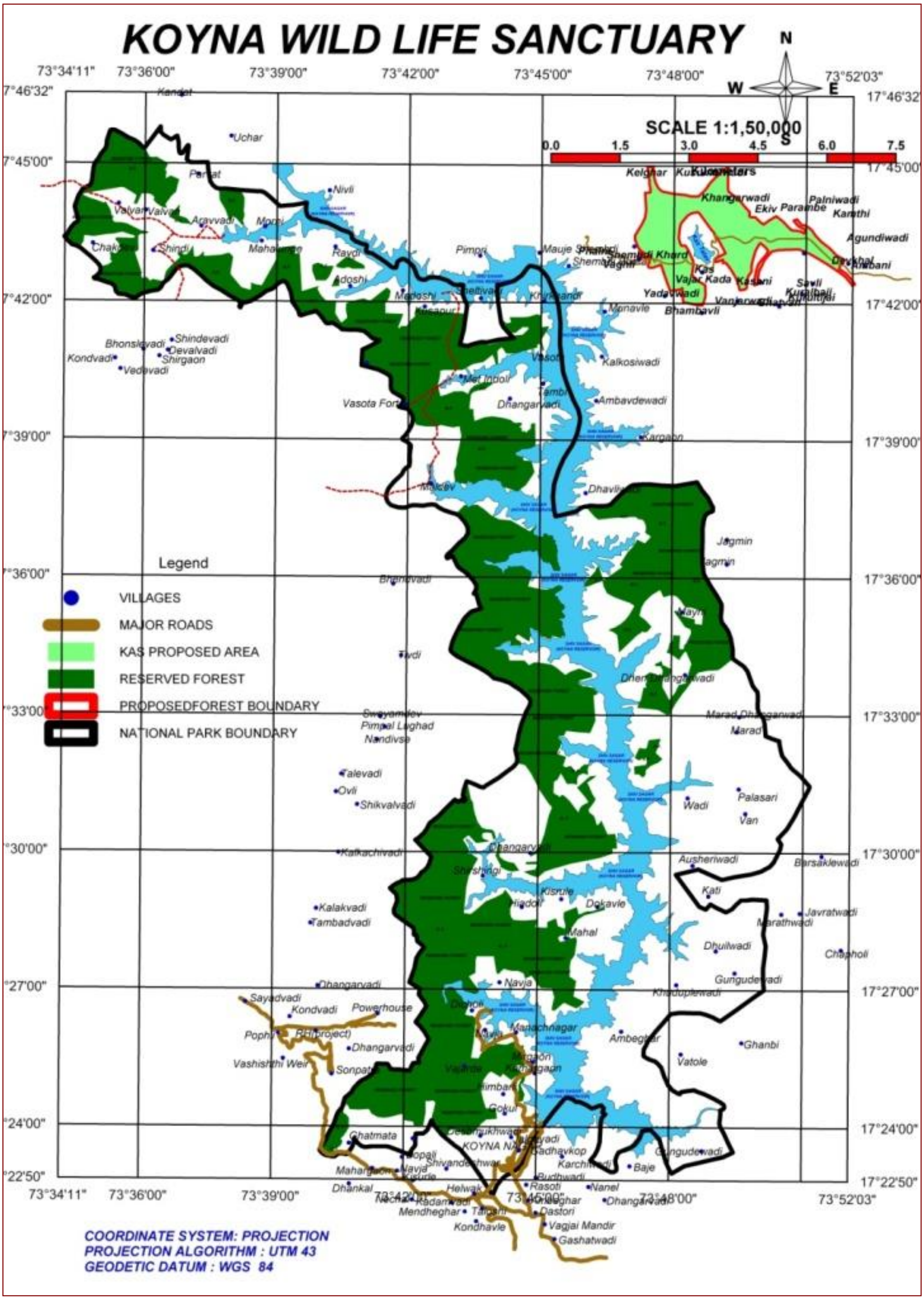


Figure 2.4 Map of Koyna Wildlife Sanctuary, Maharashtra

Radhanagri Wildlife Sanctuary

Radhanagri Wildlife Sanctuary, provides geographic coverage to the typical evergreen forests of Western ghats; supporting large areas under forest restoration, often unexploited for the last couple of decades and hence, often having reached preclimax succession. (Ghate, 1993). The area spreading over 19.16 sq.kms, were notified as Dajipur bison sanctuary in the year 1958, the first sanctuary in Maharashtra; the areas were the shooting reserves of the erstwhile Kolhapur Maharaja. In the year 1985 area of 351.16 sq.km was further notified as Radhanagari Wildlife Sanctuary (including the earlier area). Radhanagari wildlife sanctuary has an altitude ranging between 540 to 955 metres that supports luxuriant rain forest vegetation comprising over 1500 flowering plant species, number of ferns and harbour a variety of wild animals. In westward side of the Sanctuary the dense evergreen or rain forest forms 'climatic climax' vegetation locally known as 'dangs' or 'rai', which take hundreds of years to develop, while eastern parts have semi-evergreen to moist mixed deciduous forests (Bachulkar, 1998). Plateaus of Iderganj, Manbet, are some of the important sadas. The Radhanagari WL sanctuary consists of the catchment area of the two major reservoirs namely "Rajarshi Shahu Sagar" and "Laxmi Sagar" in the Radhanagari Taluka of Kolhapur District. The sanctuary area is traversed by the rivers Bhagavati, Dudhganga, Tulshi, Kallamma and Dirba, which drain out into the Krishna, a major river of the Deccan Peninsula. The vegetation, according to Champion and Seth's classification, belongs to subgroups.

(i) 8A/C2- Western tropical hill forests.

(ii) 2A/C2- West coast semi-evergreen forests.

(iii) 3B/C2- Southern moist deciduous forests.

The sanctuary has diverse flora and fauna and is an important part of the Western Ghats and an ideal habitat of the Indian gaur. The presence of several other endangered animals like the tiger, panther, sloth bear, giant squirrel, mouse deer, barking deer, wild dog and other wildlife species make the sanctuary one of the important protected areas of the Western Ghats. The area supports interesting conservation spots at Patyache Dang, Surungi. Patacha dang is the favourite haunt of the Giant squirrel, Great and Malabar Pied Hornbills (Salunkhe & Sardesai, 2002).

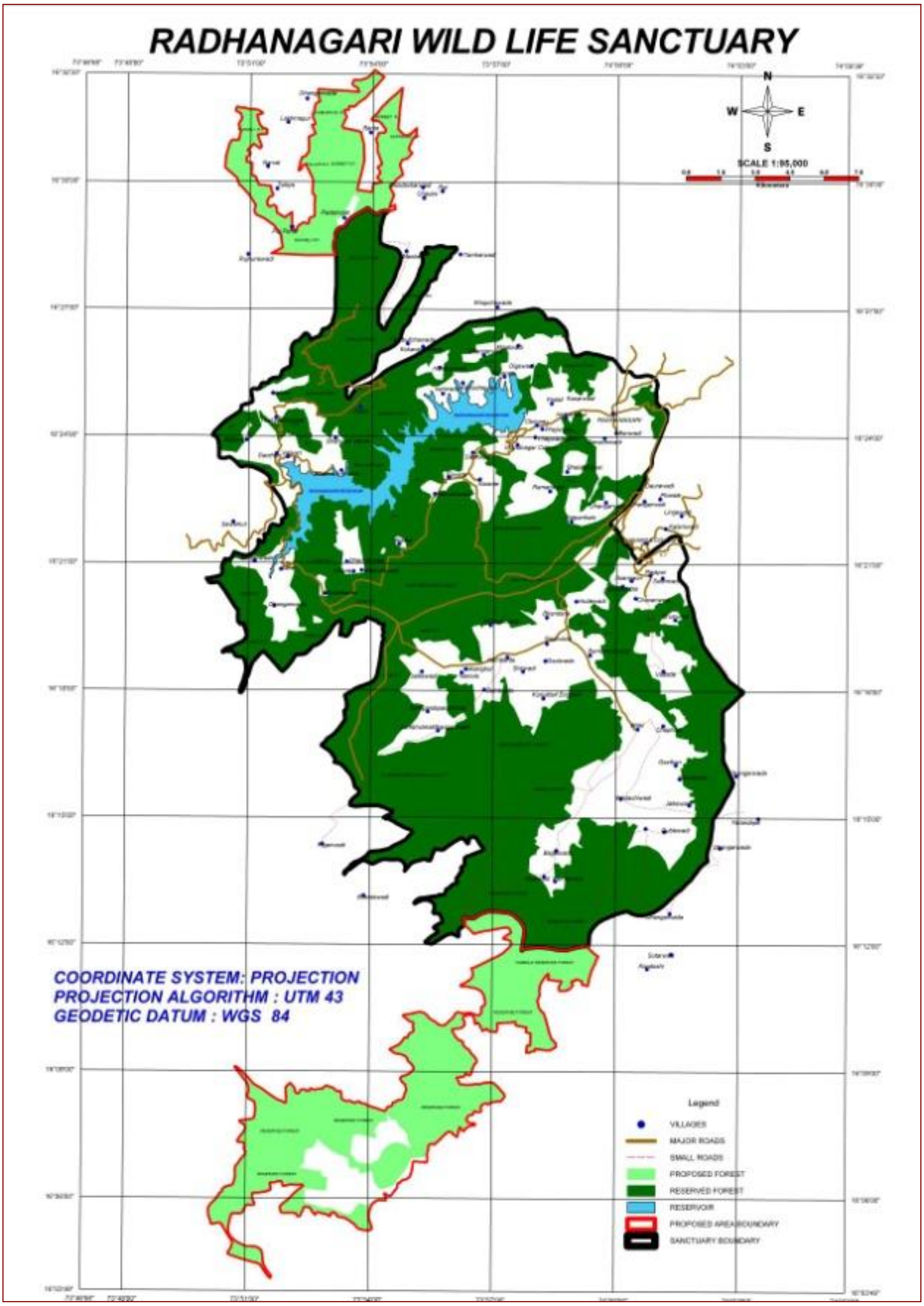


Figure 2.5 Map of Radhanagri Wildlife Sanctuary, Maharashtra

Chapter Three:

An assessment of forest carbon stock for contribution towards regulating ecosystem services

3.1 Introduction

Carbon sequestration is a way to mitigate the accumulation of greenhouse gases in the atmosphere released by the burning of fossil fuels and other anthropogenic activities. Ecosystems keep CO_2 out of the atmosphere by storing the carbon in woods. Among all ecosystem services terrestrial based carbon sequestration and storage is conceivably the most widely recognized. In the study the amount of carbon storage has been assessed in Sahyadri Tiger Reserve, Maharashtra

3.2 Background

A carbon sink may be defined as reservoir that collects and stores carbon containing chemical compound. Ecosystems mostly regulate Earth's climate by adding and removing greenhouse gases (GHG) from the atmosphere. Furthermore, terrestrial ecosystems (e.g., forests, grasslands, peat swamps etc.) collectively store much more carbon than the atmosphere (Lal 2002). Ecosystems keep CO_2 out of the atmosphere by storing the carbon in woods. Subsequently, just storing carbon, many systems also continue to accumulate carbon in plants and soil over time, hence "sequestering" additional carbon each year. Among all ecosystem services terrestrial based carbon sequestration and storage is conceivably the most widely recognized (Stern 2007, Canadell and Raupach 2008). In general managing landscapes for carbon storage and sequestration requires information on where carbon is stored and how much carbon is sequestered or lost over time. Since land managers must choose among sites for protection, harvest, or development, maps of carbon storage and sequestration are ideal for supporting decisions influencing these ecosystem services. Though, trees directly affect the climate change, but are often disregarded because their ecosystem services are not well-understood or quantified. Trees act as a sink for carbon dioxide (CO_2) by fixing carbon during photosynthesis and storing carbon as biomass. On the other hand, local and regional governments are increasingly moving forward with climate mitigation plans that may have important implications for forests. The effectiveness of proposed climate mitigation strategies for reducing atmospheric CO_2 concentrations depends on other land-cover and land-use change (LCLUC) drivers such as fragmentation, development, and agricultural conversion. However, these relationships and the resulting patterns of forest loss and afforestation, carbon sequestration and storage, and wildlife habitat are not well understood. Even for many developing countries where carbon database is either not available or incomplete. There are quite a few conventional methods for quantification of sequestered carbon. However, most of these methods are complicated, expensive and limited in their coverage. Thereafter, remote sensing coupled with ground-based observations can be used not only to generate and disseminate the carbon information but also pinpointing the potential locations for generating carbon credits.

3.3 Objective

The objective of this study was to assess the amount of carbon storage and sequestration in Sahyadri Tiger Reserve. The entire Sahyadri Sub-cluster is not included for this study due to logistic constrain with time and man power.

3.4 Materials and Methods

The vegetation structure in Sahyadri Tiger Resevre is more or less homgogenous and can be classified as medium elevation wet evergreen and southern tropical semi- evergreen forest. However, vegetation near the villages inhabited in the past is of mixed evergreen, moist deciduous and scrub-type with opened up canopies. For the estimation of Carbon stock in STR we constricted to above ground bole biomass of trees as the standing bole biomass is often one of the largest carbon pools compared to other parts of the tree (i.e., leaves, branches and root). On ground vegetation sampling was carried out to assess the biomass of tree (girth size > 10 cm) species. Prior to vegetation sampling tree cover map was generated in ArcGIS 10.3 using landset 8 data. The tree cover map was generated by classifying the satellite image using Unsupervised Classification technique. The algorithm used in unsupervised classification is ISODATA. The final map was reclassed into three classes, i.e tree cover, non-tree cover and waterbodies. The tree cover found in 43% of the area of Sahyadri Tiger Reserve. The non-tree classes consist of scrub, grassland, cropland and built-up (since, we have used buffer boundary of tiger reserve). The same Landsat 8 satellite image is used to generate NDVI (Normalized Difference Vegetation Index) which calculated from the visible and near infra-red light reflected by vegetation. Mathematically NDVI is represented as NIR-VIS/NIR+VIS. The NDVI always ranges from -1 to +1. The -1 represent the no vegetation and +1 represent the highest possible density of green vegetation. In the study area terrain is in accessible as most of the hills are flat –topped with steep slopes, 10 x 10 m plot was laid for the vegetation sampling. Well distributed 29 plots were laid in three different elevation zones i.e., <900 m, 900-1000 m, 1000-1100 m. of Chandoli National Park. Girth size (at 1.33 m) and height was noted for the all the tree species present in the plot.

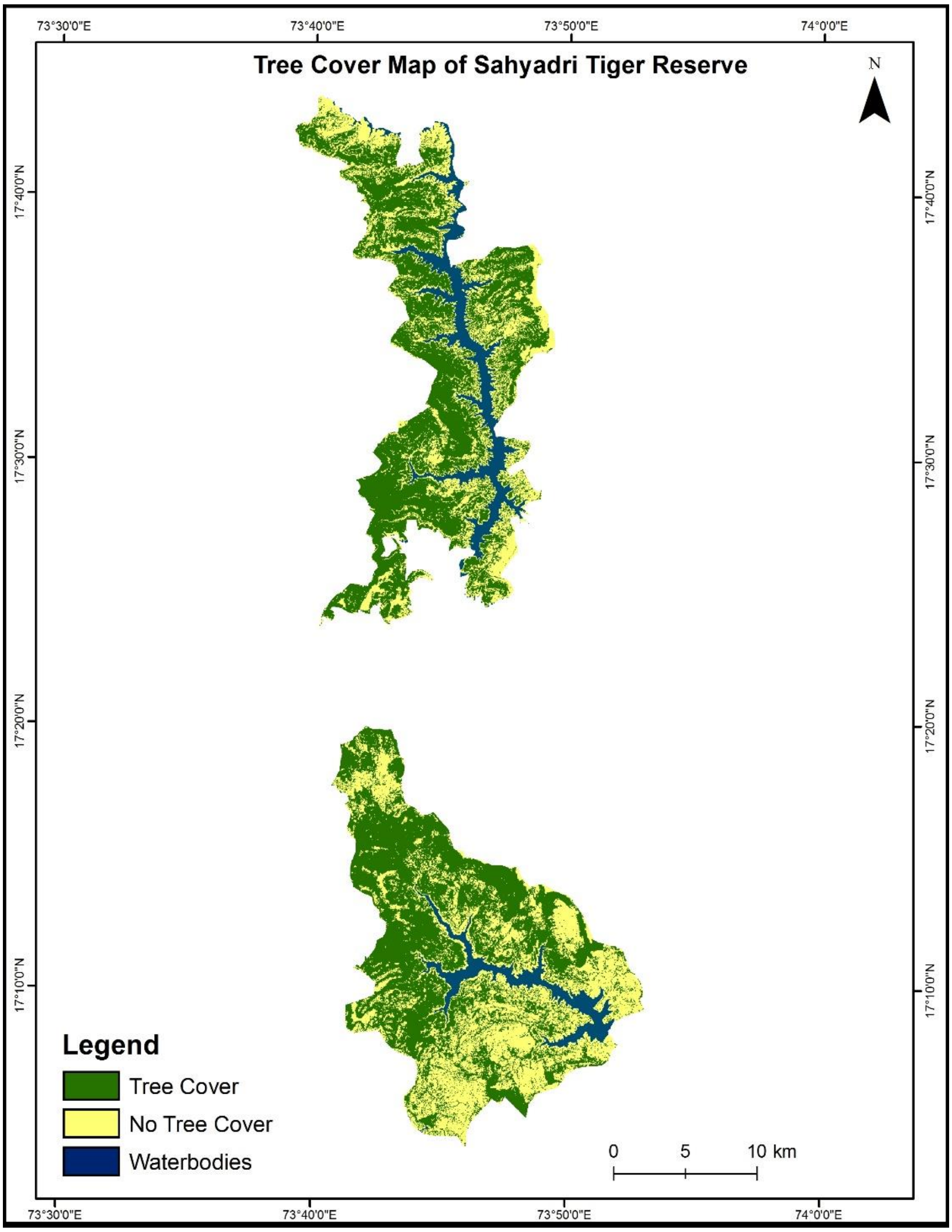


Figure 3.1 Classification of STR in to three major classes: tree cover, no tree cover and waterbody

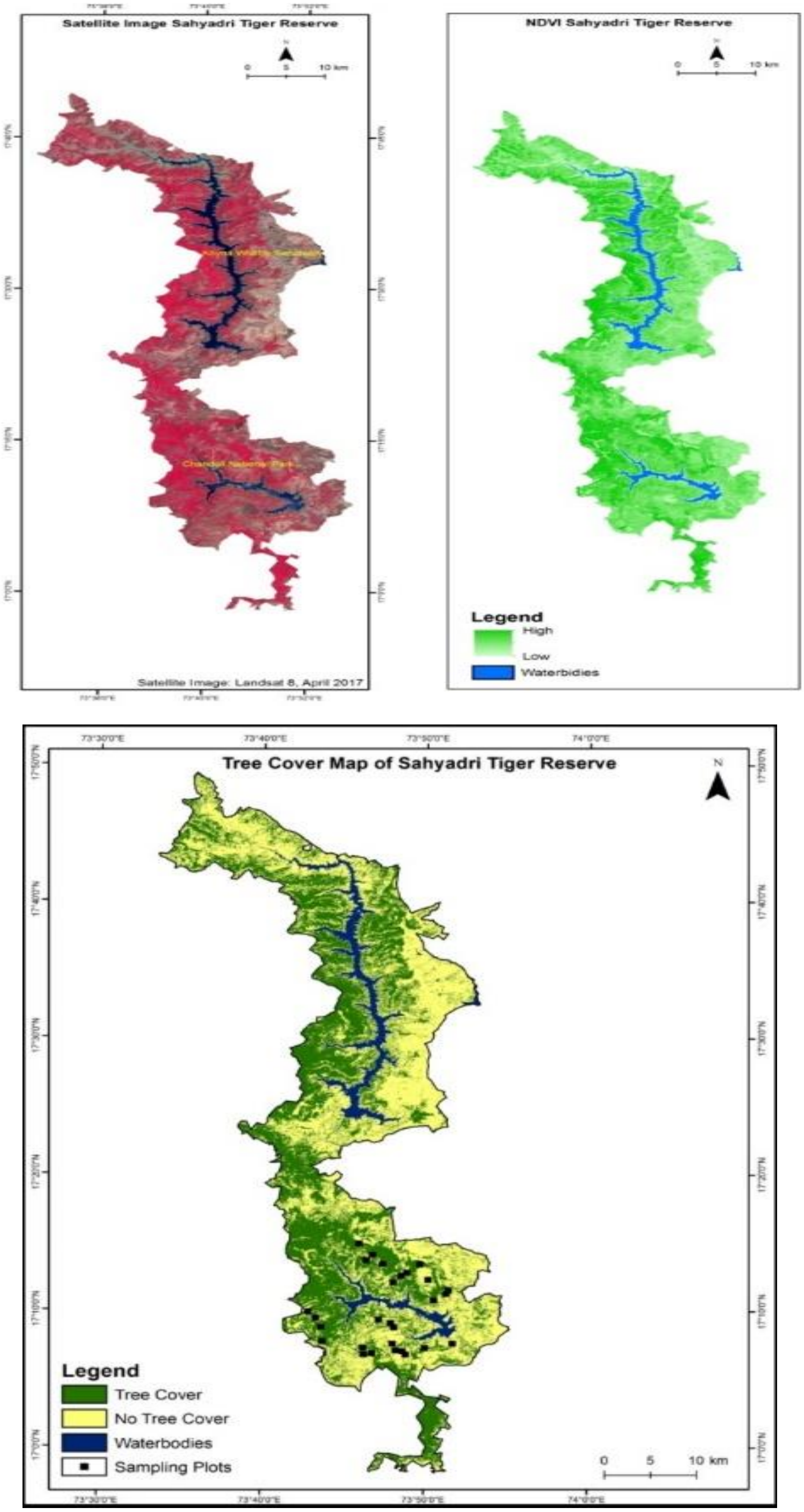


Figure 3.2 Map showing satellite and NDVI imagery of STR (top); vegetation plots and tree cover at STR (bottom)

Volume equations developed by Forest Survey of India (Forest Survey of India, 1996) was used to calculate the volume of individual tree sampled. However, area specific generalized volume equations were also used for all other species for which equations were not available (Kale et al. 2009). Biomass was estimated using equation,

Biomass = volume * specific gravity.

Rajput et al. (1996) was used to obtain the species specific, specific-gravity. For other species for which species-specific, specific gravity was not available an area average specific gravity was used. Plot-wise bole biomass was estimated by accumulation of biomass of all the trees within the plot.

Biomass of tree has direct relationship with amount of carbon present. Intergovernmental Panel on Climate Change (IPCC) reported that the carbon present in biomass is 45% of it (IPCC, 1995). However, earlier Westlake (1963) has observed that there is 47% carbon present in dry biomass. Furthermore, it was found that carbon differs between 45% to 50% asonable for regional level carbon pool estimations (Raghubansi et al., 1990, Kale et al. for different ecosystems and thus considering 47% carbon in the woody biomass is relatively 2009).

Table 3.1 Summary table of studies that have estimated Carbon stock of forests in Western Ghats.

S. No.	Study area	Biomass (t/ha)	Source
1	Kalambaste Private Forest, North Western Ghats situated in Ratnagiri District, Maharashtra, India	73 t/ha to 136 t /ha with average of 106 t/ha.	Patel et al. 2015
2	South-western part of the Karnataka state consisting of Kodagu, Hassan and Mysore districts.	AGB ranged between 7.25 to 287.047 t-dry wt ha-1 across different vegetation types in the region.	Devagiri et al. 2013
3	Uttara Kannada district, Karnataka	Evergreen forest: 381±28.8 t/ha during 2009 and in 2011 379±32.6 t/ha. Deciduous forest: 360±29.0 t/ha during 2009 and 350±29.7 t/ha in 2011	Murthy et al. 2015
4	Gir Reserve Forest, Gujrat	Phytobiomass in Gir Reserve Forest (Dense and Open forest): 65.05 t/ha	Shukla et al. 2005
5	Radhanagri Wildlife Sanctuary	Semievergreen (high elevation): 163.50 (t/ha) Semievergreen (medium elevation): 202.62 (t/ha) Semievergreen (low elevation): 114.87 (t/ha) Mixed moist deciduous (high elevation): 209.25 (t/ha) Mixed moist deciduous (medium elevation): 188.87 (t/ha) Mixed moist deciduous (low elevation): 115.50 (t/ha) Plantation: 112.75 (t/ha) Degraded scrub: 92.50 (t/ha)	Kale et al. 2009
6	Ratnagiri District, Maharashtra	Biomass per hectare ranging from 0.23 to 250.69 t/ha.	Singh & Das 2014

3.5 Results

Sahyadri TR has more or less homgogenous wet evergreen and southern tropical semi-evergreen forest. For the estimation of Carbon stock, we constricted to above ground bole biomass of trees. On ground 77 (10 x 10 m) quadrats were sampled to assess the biomass of tree (girth size > 10 cm) species. Volume equations developed by Forest Survey of India (Forest Survey of India, 1996) was used to calculate the volume of individual tree sampled. However, area specific generalized volume equations were also used for all other species for which equations were not available.

Biomass was estimated using equation, ***Biomass = volume * specific gravity***. Biomass of tree has direct relationship with amount of carbon present. Intergovernmental Panel on Climate Change (IPCC) reported that the carbon present in biomass is 45% of it (IPCC, 1995). However, earlier Westlake (1963) has observed that there is 47% carbon present in dry biomass. The average carbon stock is $\mathbf{94.98_{Mean} \pm 7.67_{SE}}$ t/ha (79.93-110.03 t/ha, at 95% CI). Total tree cover of the STR is 322.56 sq km; hence the estimated carbon pool for STR is **3063966 tons.**

According to the report of The United States Environmental Protection Agency (EPA) 2015, the costs carbon to society increases over time. The report stated that "*every tonne of carbon dioxide we emit into the atmosphere, we sacrifice an average of USD* **$36** *in environmental degradation and negative social impacts. In theory, these should be accounted for in the price of a carbon credit*." Therefore, the estimated carbon credit for the STR is (**3063966** x $36**)** **US$** 110302793.

Table 3.2 Cabon stock calculated for the three ranges: Koyna, Helwak and Chandoli, in Sahyadri Tiger Reserve.

Forest Range	Above Ground Biomass ± SE (t/ha)	Carbon ± SE (t/ha)
Koyna	208 ± 24.71	97 ± 12.29
Helwak	266.81 ± 40.73	125 ± 19.14
Chandoli	147.56 ± 16.88	69.35 ± 7.93
Overall STR	**202.09 ± 16.33**	**94.38 ± 7.67**

3.6 Ecosystem Services and Carbon Sequestration

The importance and value of ecosystem services for mankind is well known (Butler and Oluoch-Kosura, 2006; Costanza et al., 1997; Daily, 1997; de Groot et al., 2002; Harrison et al., 2010). Ecosystems provide four types of service: provisioning (e.g. food), regulating (e.g. water quality regulation, carbon sequestration etc.), cultural (e.g. recreation) and supporting (e.g. nutrient cycling) (MEA, 2005). The relationships between carbon, forests and people are complex and interdependent. Covering about a third of the earth's land surface (just over 4 billion hectares – FAO, 2010) forests play a major role in the global carbon cycle and contain a substantial proportion of the world's terrestrial biodiversity. Deforestation and forest degradation in the tropics and sub-tropics have a large negative impact on terrestrial biodiversity, and thus on the provision of those ecosystem services that are most closely linked to biodiversity.

One of the key supporting service provided by forests is carbon removal from the atmosphere (sequestration) and the long-term storage of this carbon in biomass, dead organic matter and soil carbon pools. Of the global forest carbon stocks, an estimated 55 percent (471 Pg C) is stored in sub tropical forests, of which more than half is stored in biomass (Pan et al., 2011). The role of forests in sequestering carbon is evident when considering that 57 percent of the carbon emitted annually from global fossil fuel use and land-use change is absorbed by land and ocean sinks, cutting in half the rate of increase in atmospheric CO2 concentrations over the past four decades (Le Quéré et al., 2009). Specifically, forests globally are estimated to have contributed a net sink of 1.1 Pg C yr between 1990 and 2007 (Pan et al., 2011).

Today, more than ever, the future of the global forest carbon sink is highly uncertain. The loss of biodiversity, linked to deforestation and forest degradation, could further diminish the ability of forests to effectively provide multiple ecosystem services, including, carbon sequestration. As a result, human being particularly for those most dependent on forests and most vulnerable could be significantly and adversely impacted. The loss of biodiversity could further tip the balance leading to forested regions becoming growing sources of carbon emissions. In this context, efforts to reduce deforestation and forest degradation are of critical value.

Chapter Four:

Forest fire risk assessment and zonation

4. 1 Introduction

Fire is an ecological process that has affected and shaped terrestrial systems and plant communities. Fire resets vegetation successional trajectories, sets up and maintains a dynamic mosaic of different vegetation structures and compositions, and reduces fuel accumulation. Human action disrupts these processes, with consequential fire behaviour and effects outside the range of natural variation (Sugihara et al, 2006).

The worldwide forest fire or wild land fire causes adverse economical, social and ecological effect (Kinnaird et al, 1998 and Butry et al, 2001). The forest fires are considered globally, as one of the major drivers of climate change having deleterious impacts on the earth and environment as studies reveal their significance in producing large amounts of trace gases and aerosol particles, which play a pivotal role in tropospheric chemistry and climate (Hao et al, 1996; Fearnside, 2000 and Crutzen et al, 1990).

4.2 Background

It is reported that almost fiftyfive (55) percent of the forest land is subjected to forest fire causing huge momentary losses and other ecological effects (Gubbi, S., 2003). According to the State of the forest report published by Forest Survey of India (FSI) around 1.45 million hectares of forest land is affected by forest fire annually (FSI, State of the Forest Report, 2001). Earth observation using satellite remote sensing is the only source to detect forest fire worldwide. In the forest area fire being a function of heat, fuel and oxygen, has both anthropogenic and natural origins. Some of the natural causes of forest fire are lightening during or before storms, sparks produced by falling boulders and landslides etc. The anthropogenic causes are more common like deliberately burning of forest for arable land, campfires, domestic ignition, tractors and motor vehicles, cigarettes and matches thrown negligently. Apart from these factors the topology of the area likes elevation, slope, and aspect, climatic parameters like relative humidity, temperature, wind speed and rainfall, along with the fuel type, fuel moisture content and the accessibility to the forests also determines the start and duration, hence the resulting in extent of damage due to forest fire.

Many sensors like AVHRR, ATSR, TRMM VIRS, MODIS (Dwyer, E. et al, 1998; Arino, O. and Rosaz, J., 1999; Giglio, L., 2003; Giglio, L., Descloitres, J., et al, 2003; Prins, E. M., 1998) and the geostationary satellites GOES and MSG (Calle, A., et al, 2006; Giglio, L., Descloitres, J., et al, 2003) are widely used to observe the hotspots of forest fire. Satellite data from MODIS flying on the TERRA and AQUA spacecraft and Visible Infrared Imaging Radiometer Suite data from the Suomi National Polarorbiting Partnership (SNPP-VIIRS) are used for monitoring active forest fire from the long time. The first application of Space technology in forest fire dates from 1960 when several aerial infrared scanners were tested for fire spot detection (Chuvieco and Congalton, 1989). The remote sensing in addition to the forest fire mapping is also used in for developing forest fire risk zonation maps. Forest fire risk zones are locations where a fire is likely to start, and from where it can easily spread to other areas. A precise evaluation of forest fire problems and decision on solutions can only be satisfactory when a fire risk zone mapping is available (Jaiswal et al, 2002). Understanding the behavior of forest fire, the factors that contribute to making an environment fire prone, and the factors that influence fire behavior are essential for forest fire (Chuvieco and Congalton, 1989). The GIS-based model seems to be a reasonably good approach for the conditions in India (Jain., 1996; Roy., 2004). The GIS approach has made it possible to combine several variables in order to establish fire hazard areas. The main factors included in these models are vegetation, fire history, and weather data, which are the critical factors in any fire hazard zonation method (Deeming., 1978).

4.3 Objective

The objective of this study was to map the Forest fire risk zones using geospatial tools in Sahyadri Tiger Reserve, Maharashtra.

4.4 Materials and Methods

Datasets

The major spatial datasets used in the study is the Landsat 8 data of May 2017 which is used to generate the Vegetation type map and Vegetation density Map of the study are. The unsupervised classification technique is used to generate these maps. The Forest Survey of India Forest type map is used to understand the type of forest in the study area. The Shuttle Radar Topographic Mission (SRTM) data of 30 m resolution is used to generate the Slope, Aspect and Elevation maps. The proximity parameters such as distance to roads, distance to settlement are used to understand the influence of these parameters on the forest fire. Daily historical data on the incidences of fires in study area from 2000 till 2017 were obtained from the Fire Information for Resource Management System (FIRMS) (Anonymous 2011) and the Global Fire Information Management System (GFIMS) (FAO 2011). Fire Information for Resource Management System (FIRMS) integrates remote sensing and GIS technologies to deliver global MODIS hotspot/active fire locations to natural resource managers and other stakeholders around the World. FIRMS was developed by the University of Maryland with funds from NASA. FIRMS is currently being transitioned to an operational system at the United Nations Food and Agriculture Organization (UN FAO). FIRMS is primarily aimed at supporting natural resource managers, researchers, planners and policy makers by helping them understand when and where fires occur and delivering the fire information in near real-time and in easy-to-use formats (Christopher, Louis et al., 2006). Each hotspot/active fire location represents the centre of a 1km pixel (approximately) flagged as containing one or more actively burning hotspots/fires within that pixel. The hotspots/fires are detected using data from the MODIS (or Moderate Resolution Imaging Spectroradiometer) instrument, on board NASA's Aqua and Terra satellites, using a specific fire detection algorithm that makes use of the thermal band detection characteristics of the sensor. Shapefiles, text files and kml files were downloaded from FIRMS which contains the fire in formation.

Methods

Landsat 8 data of 30 m spatial resolution is used to generate the base map and other vegetation parameters using unsupervised classification. Unsupervised classification is a method in which the computer searches for natural groupings of similar pixels called clusters. Fewer clusters exist, more pixels within each cluster exist and will vary in terms of spectral signature, and vice versa. In ERDAS unsupervised classification is performed using an algorithm called the Iterative Self-Organizing Data Analysis Technique (ISODATA). Using this algorithm, the analyst input the number of clusters desired and a confidence threshold. The computer will then build clusters iteratively, meaning that with each new iteration, the clusters become more and more refined. The iterations stop when the confidence level (or a maximum number of iterations specified by the user) is reached. In present study the vegetation mapped is classed into eight classes. Elevation information is obtained from Digital Elevation Model (DEM). Slope is one of the important parameters that influence fire behaviour. Fire moves most quickly upward slope and least quickly downward slope (Jaiswal et al., 2002). With increase in angle of slope, fire risk increases. Hence, slope risk zone map has been generated from DEM. Aspect generated using DEM is another important parameter to be considered in fire mapping. Distance from roads and urban areas are important consideration because forest regions are more fire prone where they are located near to roads and high road density. In present study we have used Euclidean distance to understand the influence of road and settlement in forest fire. The Land Use Land Cover map was provided by the Sahyadri forest department.

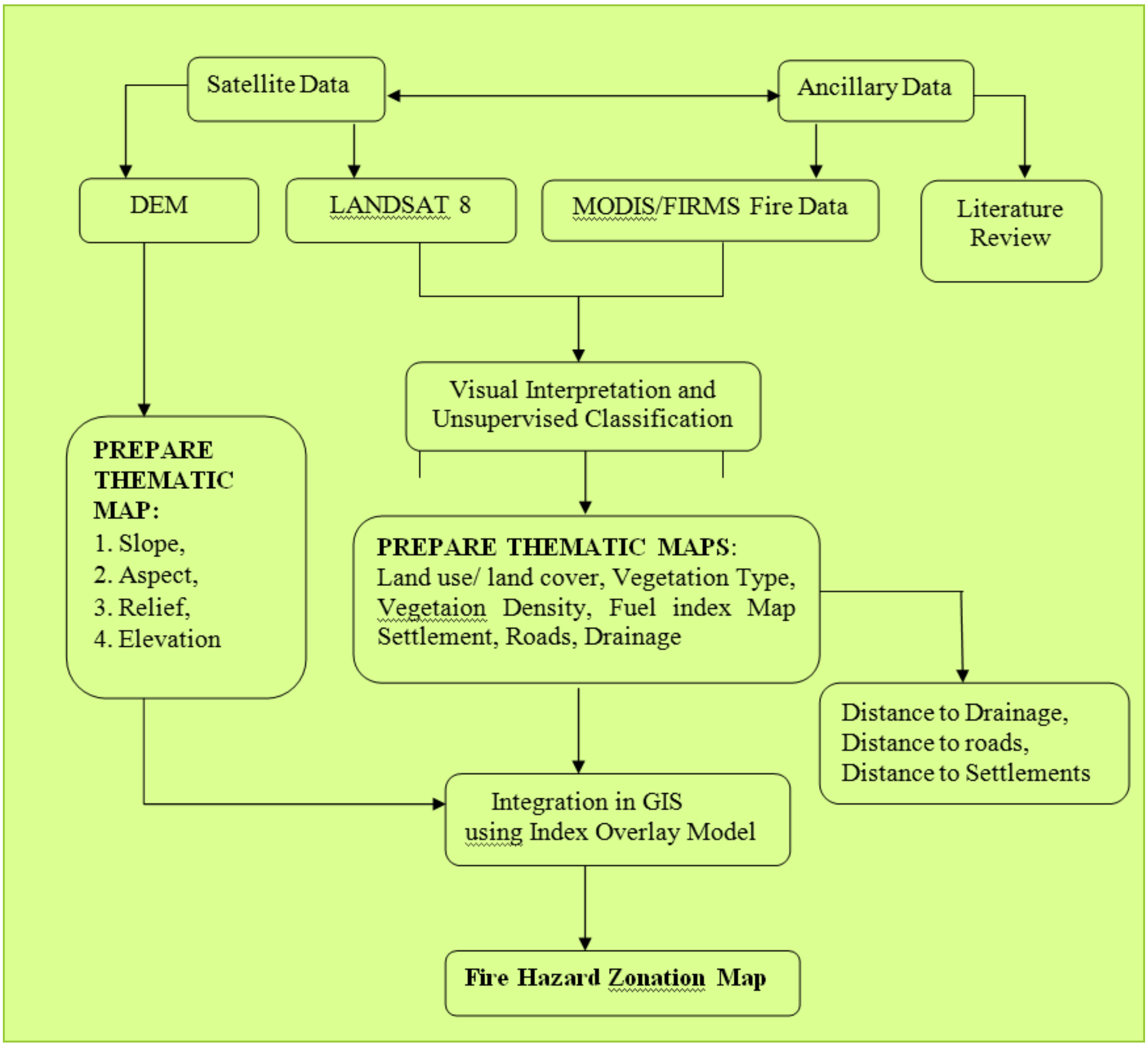


Figure 4.1 Schematic representaion of methodology deployed for forest fire risk zonation in STR

Considering the uniqueness of location, vegetation type and other parameters for the study area has been analyzed separately, each of the theme/parameter has been classified into different classes as shown in table below:

Table 4.1 Thematic layers for fire hazard zonation.

Sr. No.	Parameter	Classes
1	Vegetation	Evergreen/Semievergreen
		Moist Deciduous
		Plantation
		Scrub
2	Vegetation Density	Low
		Medium
		High
3	Slopes (degrees)	0-6^0
		6-11^0
		11-17^0
		23-32^0
		32-64^0
4	Aspect (N/NE/E/SE)	N / NE/ E / SE / SW / S /W / NW
5	Elevation (meters)	343-705
		705-814
		814-918
		918-1030
		1030-1213
6	Distance to Settlements	1000-1500
		1500-2000

		2000-25000
		>2500
7	Distance to Roads	0-50
		50-100
		100-200
		>200
8	Distance to Water bodies	0-100
		100-200
		200-300
		>300
9	Historical data and recent fire events (no. of fire points)	January 2000 to April, 2017
10	Land Use Land Cover	For removal of non-forest class

Model used for generation of Fire Risk Zonation map

Many models have been run for evaluating and generating fire hazard zonation map. At present study Index overlay method is used to prepare the fire risk zonation map. This method is applied where maps are added together in a weighted combination. The steps have been used for index overlay method are following:

- Identification of different thematic maps.
- Conversion of vector maps to grid maps.
- Assigned weights to the different themes.
- Assigned rank or score to the classes in each individual thematic maps, and
- Integration and analysis using IOM.

The following Equation was used for integration of factor maps using index overlay method.

$$S = \sum Sij * Wi / \sum Wi$$

Where:

Wi	=	The weight of ith factor map
Sij	=	The ith spatial class weight of jth factor map
S	=	The spatial unit value in output map

The Value of j depends upon the class actually occurring at the current location. The outcome map is shown by different zone of prospective which further classified into appropriated classes.

In weighted index overlay method, the individual thematic layers assigned weightages as well as their classes are assigned scores on the basis of their relative contribution towards the output. The weights to different themes and scores to different classes of each theme are assigned from 1 to 10, which are shown in tables below. For study purpose the whole Sahyadri Sub-cluster is divided in to two parts, Sahyadri Tiger Reserve and Radhanagri Wildlife Sanctuary.

4.5 Results

In Sahyadri Tiger Reserve the buffer boundary provided by forest department is used in the study. The buffer boundary is used to understand the effect of surrounding area on the risk of fire in the forest. The various scores assigned to the different classes are shown in table below.

Table 4.2 Scores assigned to different classes within thematic layer for fire hazard zonation in STR. The different weights assigned to each theme are shown in table below.

Sr. No.	Parameter	Classes	Scores
1	Vegetation	Evergreen/Semievergreen	7
		Moist Deciduous	8
		Plantation	4
		Scrub	3
2	Vegetation Density	Low	4
		Medium	7
		High	9

3	Slopes (degrees)	$0\text{-}6^0$	2
		$6\text{-}11^0$	3
		$11\text{-}17^0$	4
		$23\text{-}32^0$	5
		$32\text{-}64^0$	7
4	Aspect (N/NE/E/SE)	N / NE/ E / SE / SW / S/W / NW	
5	Elevation (meters)	343-705	1
		705-814	3
		814-918	5
		918-1030	7
		1030-1213	8
6	Distance to Settlements	1000-1500	8
		1500-2000	6
		2000-25000	4
		>2500	1
7	Distance to Roads	0-50	10
		50-100	7
		100-200	4
		>200	2
8	Distance to Water bodies	0-100	2
		100-200	4
		200-300	6
		>300	8

Table 4.3 Weights assigned to different thematic layer for Forest hazard risk mapping

Sr. No.	Parameter	Weights
1	Vegetation	10
2	Vegetation Density	8
3	Slope	6
4	Aspect	6
5	Elevation	6
6	Distance to Settlement	7
7	Distance to Roads	7
8	Distance to Waterbodies	5

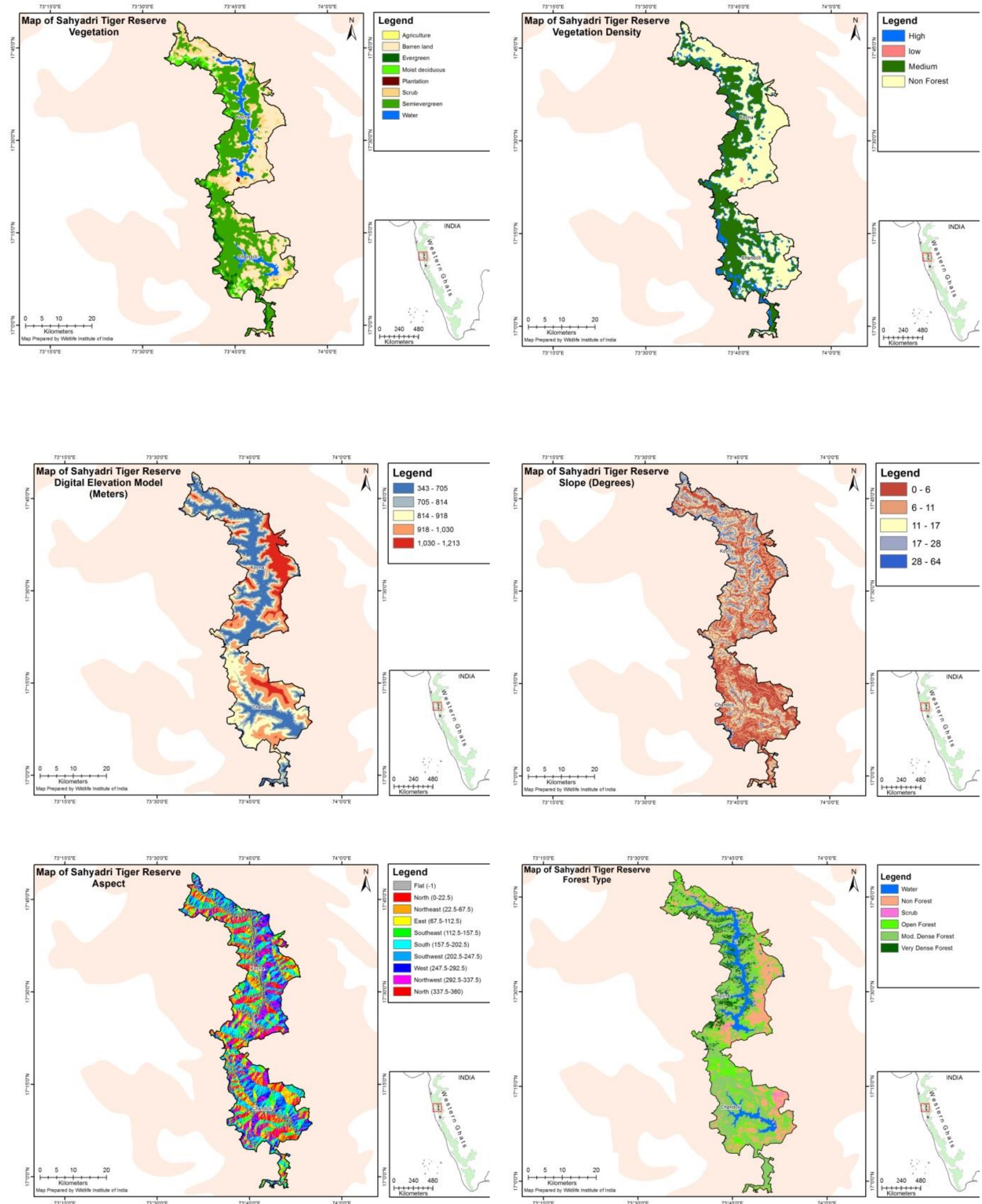


Figure 4.2 Map showing different layers; Vegetation, Vegetation density, DEM, Slope, Aspect and Forest type (top left to bottom right), used in mapping fire hazard zones in STR.

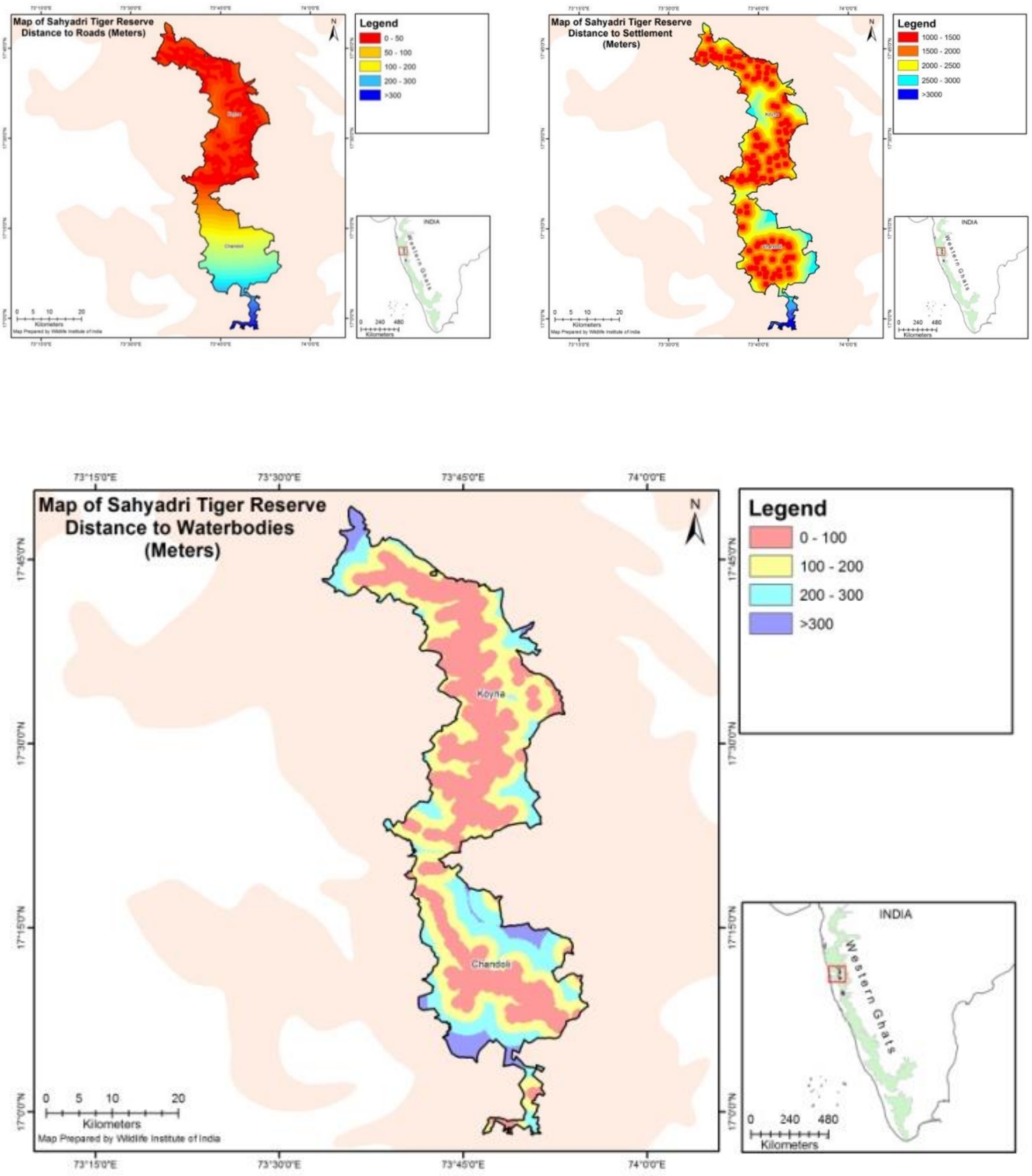


Figure 4.3 Map showing different layers; distance to road (m), distance to settlements (m), and distance to waterbodies (m) (top left to bottom right), used in mapping fire hazard zones in STR.

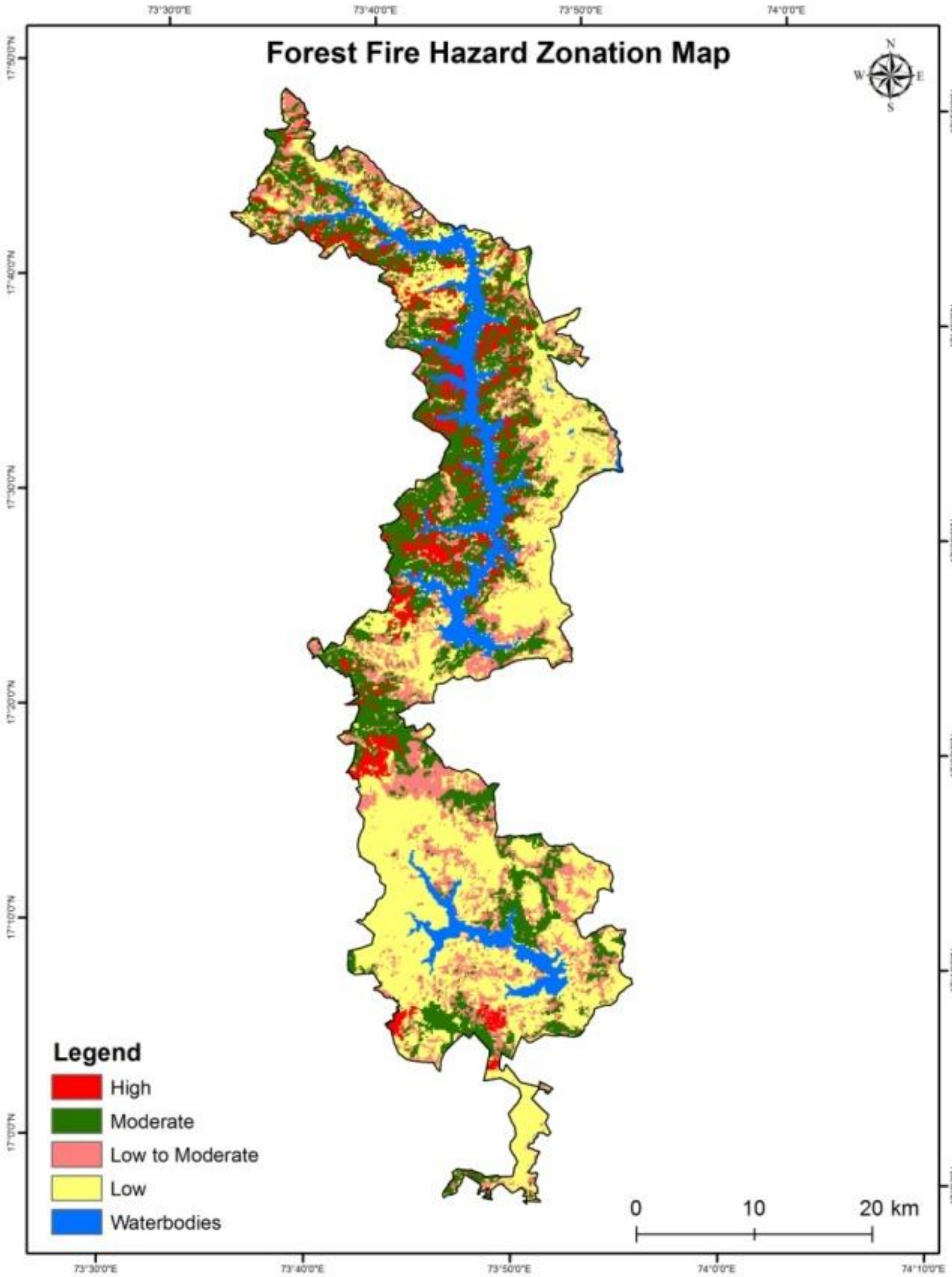


Figure 4.4 Forest Fire Hazard zonation map of Sahyadri Tiger Reserve, Maharashtra.

4.6 Discussion

Settlement, accessibility and vegetation types had played an important role in fire risk zonation modeling. The other variables elevation and slope have comparatively less impacting estimation of fire risk zonation. The proximity parameters like distance to roads, distance to settlement are also very important parameter in the modeling. The area under different fire risk zones is summarized in table given below.

Table 4.4 Area in sq km under fire risk in Sahyadri Tiger Reserve, Maharashtra

Fire Risk	Area (sq.km)
High	82.513
Moderate	286.088
Low to Moderate	203.334
Low	446.145

A further study of risk zonation map with vegetation type map showed that deciduous and senievergreen forest types having high fuel content were falling on high and moderate risk areas where as scrub and plantation were falling on low to moderate and low fire risk areas. High and Moderate fire risk areas were mostly lying along the slopes in northern and central part, whereas eastern parts were falling on low to moderate and low fire risk areas. Fire could thus certainly be averted by taking precautionary measures. This study should prove to be helpful to the Forest Department, as this type of fire risk zone map would enable the department to set up an appropriate fire-fighting infrastructure for the areas more prone to fire damage. Such a map would help in planning the main roads, subsidiary roads, inspection paths, etc. and may lead to a reliable communication and transport system to efficiently fight small and large forest fires. The final forest fire risk model was validated with past fire incidences data that was downloaded from MODIS and Forest Survey of India website. The results of the study showed that out of 103 fire incidences most incidences had occurred in high and moderate risk areas. The fire risk zonation map with fire points are shown in map below.

Fire risk modeling using multi criteria analysis and integrating different layers resulted in developing fire risk assessment of study area. Fire risk index map can be used to prioritize for taking forest fire prevention initiatives at management level. Forest type, density maps and other parameters can be helpful in installation of suitable watch towers for prevention of fire.

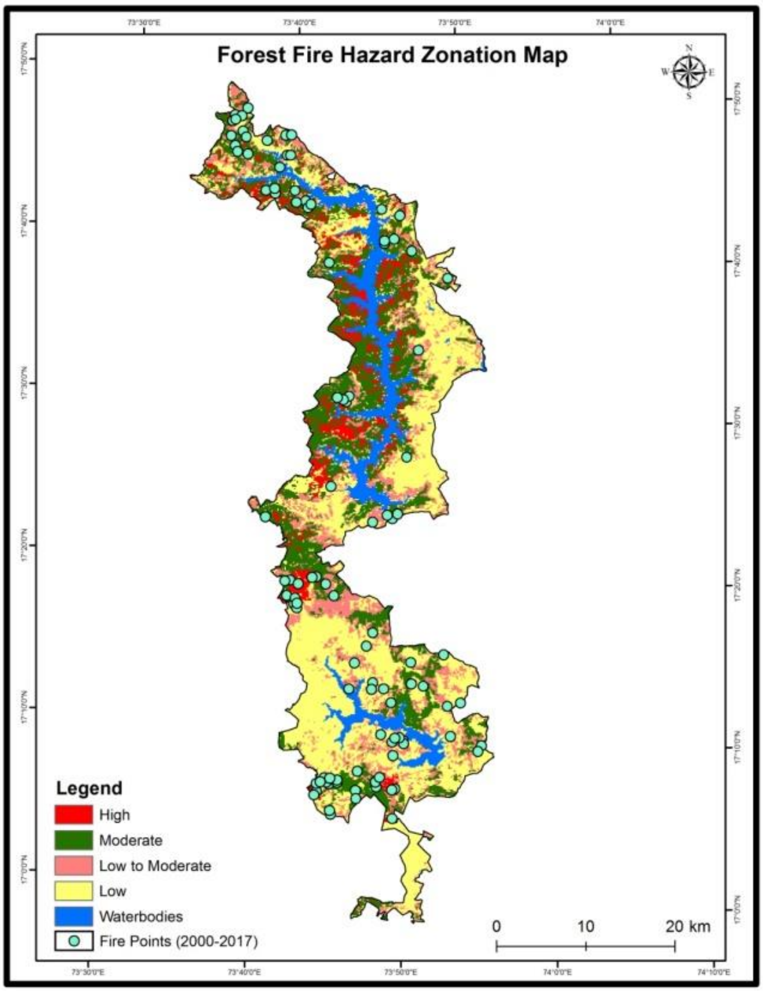


Figure 4.5 Areas under forest fire are shown in the map with 103 fire locations in the past in Sahyadri Tiger Reserve.

Layers generation for slope, altitude and forest density can be used for calculating response time for the disaster. Digital elevation model can be effectively used for studying terrain characteristics and for generating a view shed. The precision in the modeling could be increased by adding more number of variables in the analysis. However, the selection of variables should be based on knowledge base of the area. The areas shown under high, moderate 'fire risk' zones are those areas where fire can be unintentionally caused by human activities, and where fire could thus certainly be averted by taking precautionary measures.

4.7 Ecosystem Services and Forest Fire

Fires are present everywhere on Earth today (Bowman et al., 2009, 2011; Cochrane, 2009, Giglio et al., 2006) and more than 80% of these fires are caused by humans (FAO, 2007). Fires are deliberately set in the tropics as a part of the land management practices (Cochrane, 2003; Eva and Lambin, 2000; Huffman, 2013; Shlisky et al., 2009). These fires severely affect the structure and composition of vegetation communities (Bond and van Wilgen, 1996; Bond et al., 2005) and are responsible for the transformation of large areas of forest to other vegetation formations (Ratnam et al., 2011). Today, many of these areas are maintained in an arrested successional stage whereby the development of forest formations that would emerge in the absence of fire is suspended (Meher-Homji, 2001). In India fire is still seen as the major factor causing forest degradation (Semwal et al., 2003) and as a significant threat to biodiversity conservation and other ecosystem services (Kodandapani et al., 2004, 2008). Therefore, efforts are being made by policy makers, forest managers, and conservationists to prevent forests from burning (Government of India, 1999; MoEF, 2012; Semwal et al., 2003). However, fires set by forest dwellers are often meant for a specific purpose as it ensures that current vegetation forms on stand and at landscape level remain consistent because they produce a flow of specific ecosystem services on which forest dwellers depend.

Chapter Five:

Socio-economic assessment of forest dependency of local communities

5.1 Introduction

Socio-economic assessment is the measure of one's combined economic and social status. The assessment is beneficial for both the local communities and the forest on which they are dependent. Conservationists recognize that many protected areas have limited future prospects without the cooperation and support of local people. Park management has often prioritized keeping local people out, following the view that human activities are incompatible with ecosystem services. Some protected area residents and neighbors have lost their homes and livelihoods as a result.

Information on the growing economic aspirations of communities in the context of local development opportunities need to be studied along with attitudes towards the opportunities afforded by forest produces. Protecting nature for religious reasons is an ancient practice in many traditional societies. in India Sacred groves- community conserved uncut forest vegetation in the name of certain deities or natural or ancestral spirits, exemplify such practice. As a model of community-based resource management, sacred groves have lately gained attention in conservation literature. These systems have recognized as a system that informally forces traditional communities to harvest natural resources in an ecologically sustained fashion (Gadgil, 1985). These systems have largely studied for how property rights regimes governing sacred groves and adjacent properties have changed over time. The social, ethical and legal norms that underlie the governance of traditional sacred groves and the socio-economic drivers in the modern era that have weakened traditional management systems have also been assessed. Being a part of community resource use efficiency, equity and sustainability of the institutional changes were also studied.

There is a paucity of such large-scale studies for the formally protected areas in Indian scenario. As the protected area network provided and conserve a potential forest resources patch. These patches can also be benefitted for the community residing in the areas. The impacts of adoption on economic wellbeing should be assessed. The data gathered from socioeconomic studies, the profitability of forest produces in comparison to alternative sources of agricultural income can be investigated. Additional factors influencing the land use choices of farmers can help to draw observations to identify several factors that emerge repeatedly as sources of conflict in such development.

Socio-economic assessment of forest dependency by the local communities was done in Sahyadri sub-cluster, Western Ghats, Maharashtra. This study will help to understand the benefits provided by forests to the local communities and degree of their dependence on these forest products. As a coin has two sides, communities are getting affected in both the ways- positive and negative because of the particular ecosystem of which they are a part. The study site was recently (2012) described as a world heritage site. Therefore, to check with its status after the inception as a heritage site is another purpose of this study. Is there any effect on the local communities? Are they benefited? An attempt to answer such questions has been done in this particular study.

Due to construction of Chandoli dam [Vasantsagar water reservoir] (initiated in 1976), Koyana dam (initiated in 1956) and Radhanagari dam (initiated in 1907) few of the villages were relocated. After that, with the declaration of Chandoli national park and Koyana wildlife sanctuary remaining few relocated. Now very few villages remaining in the Sahyadri tiger reserve and adjoining areas. To study their socio-economic dependency and to update on their rehabilitation process, this study is performed.

5.2 Background

Local communities are the part of an ecosystem in which they live. Local community' dependency on forest refers to the ecosystem services available in that particular region. An ecosystem is a dynamic complex of microorganism, plant, animal and nonliving environment. Ecosystem services are the benefits people obtain from ecosystem. There are four types of ecosystem services viz. provisioning, regulating, cultural and supporting. The services local communities obtain from an ecosystem are fresh water, food, timber, fiber, fuel, biological products, nutrient and waste management, processing and detoxification, regulation of infectious disease, cultural, spiritual and recreational services, climate regulation etc. (MEA, 2005).

Economic, social and ecological value of ecosystem services was determined (Newcome, 2005). Assessment of ecosystem services was done in India and other countries (Kremen, 2005;

Wallace, 2007). Kremen in 2005 has developed a research agenda to identify the important ecosystem services provided, to determine various aspects of community structure, to assess key environmental factors and to measure the spatio-temporal scale. Sekercioglu in 2010, presented brief overview of ecosystem functions and critical ecosystem services. Mapping of ecosystem services was done for policy support and decision making in European Union (Maes, 2012). Supply and demand sides were also mapped (Garcia-Nieto, 2013) for three types of services including timber, mushroom harvesting and bee keeping as provisioning services, erosion control as a regulating service and nature tourism and recreational hunting as cultural services. Wild edible greens in western Ghats were studied by Narayanan in 2007. Mapping of landscape-land cover (Imam, 2011) and vegetation composition (Kanade, 2008) was done in Chandoli national park, Western Ghats, Maharashtra. Economic valuation of ecosystem services is done in few countries (Fisher, 2011; Groot, 2002; Gurluk, 2006; Pascual, 2010; Sheil, 2002; Wegner, 2011). Local community's dependency on a forest has been studied in India (Adhikari, 2004; Davidar, 2008; Gubbi, 2008; Hegde, 2000; Masozera, 2004; Rao, 2003; Sing, 2015). In India, assessment of ecosystem services of Corbett tiger reserve was done by Badola, 2010 and team. To examine the economic value of few ecosystem services; socio-economic survey, counting of the revenue generated from tourism, estimation of the carbon sequestration and recreational values were carried out. In 2005, Arjunan has assessed the impact of resource extraction on forest vegetation in Mundanthurai Tiger Reserve, southern western Ghats. No. of cut stems and branches were measured and mean extraction pressure for each village was correlated. With the help of vegetation and regeneration analysis it was concluded that unregulated resource extraction has an adverse impact on the forest structure, diversity and regeneration status of the plants. As local communities are getting few of the resources from forest, there are many cases of human-wildlife conflicts. Human-wild pig conflict was studied in five states of India- Madhya Pradesh, Uttar Pradesh, Himachal Pradesh, Uttarakhand and Rajasthan was studied (Chauhan, 2009). Agricultural crop depredation was the main issue associated with this animal. Similar study has been done in Maharashtra for human-leopard conflict (Athreya, 2004) where tolerance level of local people was studied towards the wild carnivore.

5.3 Objective: An assessment of the forest dependency of the local communities in Chandoli National Park, Koyana Wildlife Sanctuary, Kas Reserve Forest area and Radhanagri Wildlife Sanctuary.

Study area

For the survey purpose the study area was divided into five zones- viz. Chandoli range as zone 1, Helwak range - The area connection Chandoli National park and Koyana Wildlife Sanctuary as zone 2, Koyana range as zone 3, Kas plateau (including Bamnoli) range as Zone 4 and Radhanagri range (including Dajipur) as Zone 5.

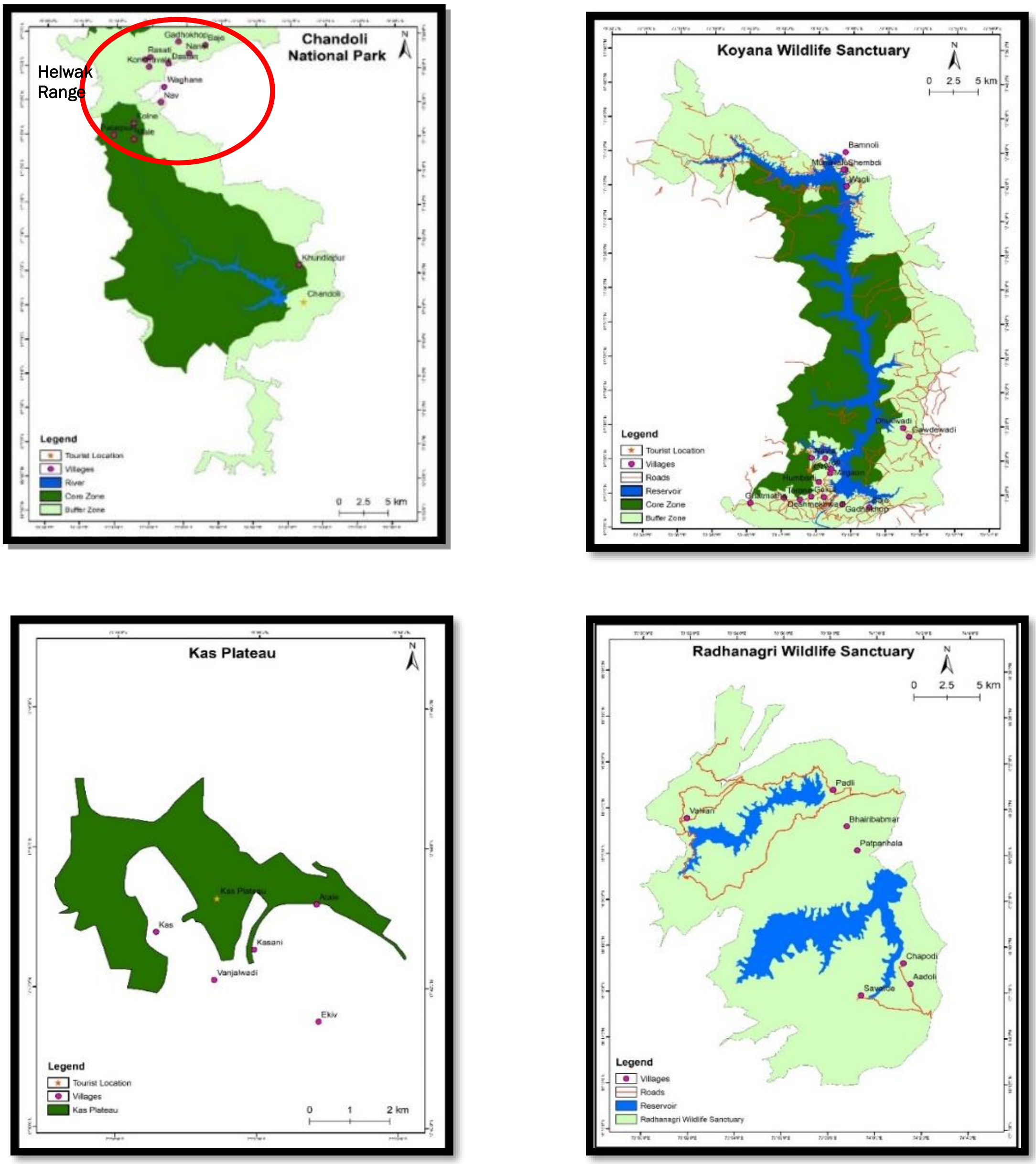


Figure 5.1 Maps of study sites: Chandoli NP, Koyana WLS, Kas plateau, Radhanagri WLS (top left to bottom right).

Methodology

For collecting the information, a detailed questionnaire was prepared which includes three sections- 1) State of village resources, 2) State of water as an ecosystem service and 3) Status of wildlife species. With the help of this questionnaire, household wise information was collected.

Following communities were encountered living in the villages surveyed for socio-economic assessment of local communities-

1) Hindu Maratha
2) Dhangar (Shepherd)
3) Buddha (Gautama Buddha followers)
4) Muslim
5) Christian

In Chandoli range, only one village is present in core zone- Khundlapur Dhangar wada. In Helwak range, there are three villages in core zone- Male, Kolne and Patarpunj. These four villages will be rehabilitated within five to six years (as per the survey). In Koyana range, currently 12 villages are in core zone (from the villages surveyed). The villagers are struggling for declaration of this area into buffer zone. In Radhanagri, seven villages surveyed from buffer zone.

Table 5.1: Details of Villages surveyed over a period of one-year acorss Sahyadri sub-cluster

Sr. no	Zone	Village name	Sample Size	Date of sample
1	Chandoli range	Khundlapur	30	Dec 2016
2	Helwak range	Baje, Dastan, Gadhokhop, Helwak, Kondhavale, Mendheghar, Nanel, Nav, Rasati, Waghane, Male, Kolne, Patarpunj	108	April 2017
3	Koyana range	Deshmukhwadi, Dhuilwadi, Gawdewadi, Ghatmatha, Gokul, Humbarli, Kamargaon, Manai nagar, Mirgaon, Navja, Torane, Van Kusawade	86	May 2017

4	Kas and Bamnoli range	Atale, Ekiv, Kas, Kasani, Wanjlewadi, Bamnoli, Palni	40	April 2017
5	Radhanagari and Dajipur range	Aadoli, Bhairibambar, Chapodi, Padali, Patpanhala, Savarde	60	January 2017

Result

A. State of village resources:

Village resources mainly include agricultural land, crops and livestock.

Provision of Land for Agriculture:

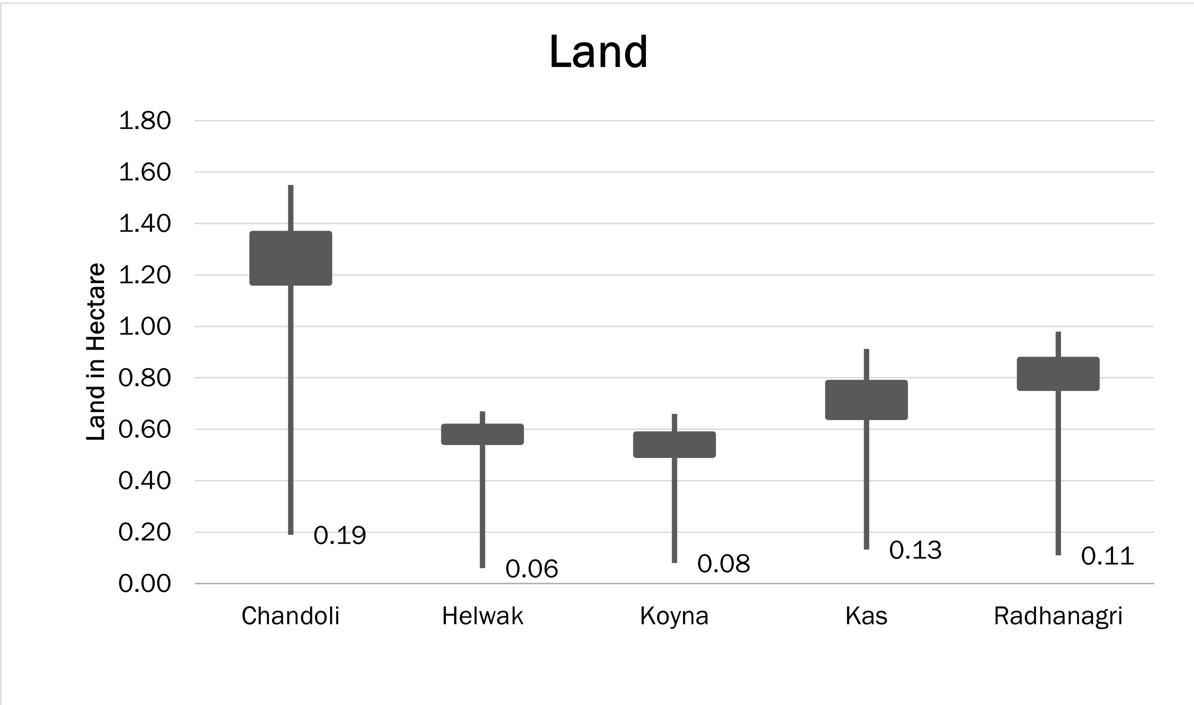


Figure 5.2 Land use by local communities for agriculture

The above graph is showing the "land use" pattern of the five study sites viz. Chandoli, Helwak, Koyana, Kas and Radhanagari. Maximum land is cultivated in Chandoli (1.36 Hectares in 30890 Ha), followed by Radhanagari (0.87 Ha in 28235 Ha), Kas (0.78 in 1142 Ha), Helwak (0.61 Ha in 30890 Ha), Koyana (0.58 Ha in 42355 Ha) respectively. In Chandoli only one village named Khundlapur in core zone was surveyed. Only two crops are cultivated in this area. There are around 60 families and every family has some *Malki* land (Private land) on which they grow rice and finger millet. The reason being less land under cultivation in Koyana might be the inaccurate distribution of it. The land is inadequately divided under forest and *Malki* (Private). They are situated very near to each other so cultivation is difficult to practice in this type of land. In case of Helwak, all the villages are accessible by road, meaning they are situated away from forest compared to other three sites (Chandoli, Koyana, Radhanagari) so on an average 0.61 Ha land is under cultivation and maximum no. of crops are grown in this area.

a) Crop pattern:

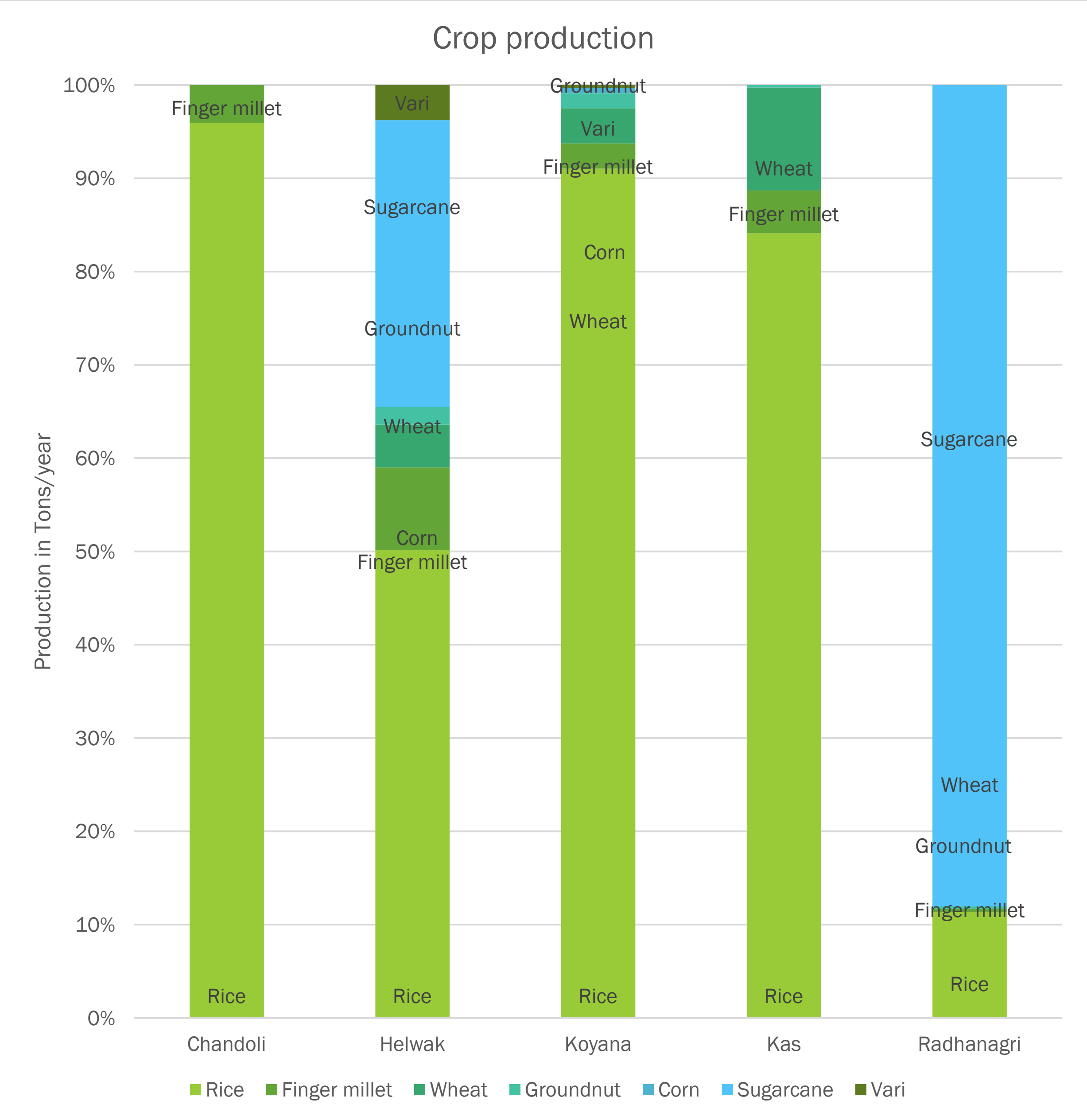


Figure 5.3 Crop production across the four study zones.

From the Socio-economic survey, following crops varieties found to be cultivated in the study area- Rice, Finger millet, Wheat, Ground nut, Corn, Sugarcane & Vari/Bhagar (*Echinochloa* Spp). All the seven varieties of crops grown in Helwak but in Chandoli, only two crops were grown. Only one village is present in core zone of Chandoli, Rest of the villages already been rehabilitated. Animals such as wild boar, Indian gaur causes nuisance to the crops. This might be one of the reasons for a smaller number of crops at Chandoli. Maximum no. of villages from Helwak were easily accessible and were at least 2 km away from forest patches (Ref table 12). Therefore, dependency on forest products is more in case of Chandoli.

Table 5.2: Cropping Pattern (Seasonal calendar)

Location	Crop name	J	F	M	A	M	J	J	A	S	O	N	D
Chandoli	Finger millet												
	Rice												
Helwak	Corn												
	Finger millet												
	Ground nut												
	Rice												
	Sugarcane												
	Vari												
	Wheat												
Koyna	Corn												
	Finger millet												
	Ground nut												
	Rice												
	Vari												
	Wheat												
Kas	Finger millet												
	Ground nut												
	Rice												
	Wheat												
Radhanagari	Finger millet												
	Ground nut												

	Rice												
	Sugarcane												

(Rice: R; Finger millet: F; Wheat: W; Groundnut: G; Corn: C; Sugarcane: S; Vari: V)

The above table is representing the seasonal pattern of crops. Out of seven crops, five are cultivated in the month of January. Rice and sugarcane are the two crops, which require large amount of water; rice is cultivated in the month of June to September. Being a cash crop Sugarcane is being cultivated throughout the year in two localities- Helwak and Radhanagri. All the other crops been cultivated to fulfil family needs.

b) Average Livestock per family:

Table 5.3: Average livestock per family (* Figures shows Mean ± SE)

	Chandoli	Helwak	Koyana	Kas	Radhanagri
Buffalo	2.16 ± 0.26	0.7 ± 0.31	0.53 ± 0.10	0.60 ± 0.17	1.05 ± 0.14
Cow	1.16 ± 0.20	0.75 ± 0.16	0.47 ± 0.14	1.18 ± 0.35	0.27 ± 0.11
Ox	0.2 ± 0.07	0.57 ± 0.09	0.48 ± 0.08	0.90 ± 0.15	0.62 ± 0.12
Goat	1.16 ± 1.16	0	0.09 ± 0.09	0.25 ± 0.15	0.13 ± 0.10
Total	3.7 ± 0.43	2.02 ± 0.45	1.59 ± 0.22	2.93 ± 0.41	2.07 ± 0.24

The above table is showing approximate number of livestock per family in a village. In Chandoli local people gets supplementary income from milk production (Rs. 30/- to 40/- per liter). Koyana showed less number of livestock due to improper distribution of land resulting lack of grazing land. Grazing was allowed on Kas plateau. But after declaration of heritage site in 2012, it has banned officially.

5.4 Provisioning of Food from Forests

Wild resources were recorded and categorized as wild edible plants, medicinal plants, NTFP and Fuelwood.

Table 5.4: Resources obtained from forest ecosystem

Scientific name	Local name	Part used/Uses	Wild edible plants	Medicinal plants	Fuel-wood	NTFP
Plant based resources						
Acorus calamus	Vekhand	Head pain cold		+		
Adhatoda vassica	Adulsaa	Cough cold		+		
Alstonia scholaris	Saatveen	-		+		
Arisaema murrayi	Pandhara sapkanda			+		
Artocarpus integrefolia	Phanas	Fruits consumed	+			
Asparagus racemosus	Shatavari	prevention and treatment of gastric ulcers and dyspepsia		+		
Butea monosperma	Palas	Flowers on kidney stone		+		
Canarium strictum	Dhoop			+		
Cardia dichotoma	Bhokri	Leaves consumed as vegetable	+			
Carissa carandus	Karwand	Fruits consumed	+			
Cassia tora	Takla	Leaves consumed as vegetable	+			
Celosia argentia	Kurdu	Leaves consumed as vegetable	+			
Clerodendrum serratum	Bharangi	Leaves consumed as vegetable	+			

Cretaeva religiosa	Waivarna	Leaves consumed as vegetable	+			
Dioscorea pentaphylla	Shendwal	Flowers consumed as vegetable	+			
Eclipta prostate	Mhaka	Juice of leaves on Fever		+		
Garcinia indica	Kokam	Fruits used	+			
Gloriosa superba	Kalalavi	Use don't know		+		
Gmelina arborea	Shivan	Leaves on arthritis		+		
Lannea coromandelica	-				+	
Lantana camara	Ghaneri	Juice extracted from Leaves to stop blood flow		+		
Mangifera indica	Aamba	Fruits consumed	+			
Merremia umbellate	Motiya	Leaves	+			
Murraya koengii	Kadipatta	Leaves used in food preparation		+		
Nothapodytes nimmoniana	Narkya	Cancer		+		
Olea dioica	-				+	
Phyllanthus emblica	Aawla	Fruits eaten either raw or in cooked form	+			
Smithia sensitive	Naal	Leaves consumed as vegetable	+			
Syzygium cumini	Jambhul	Fruits consumed	+			
Wrightia tinctorial	Kudya	Leaves consumed as vegetable	+			
Animal based resources						
Apis cirana	Sateri	Honey				+
Apis dorsata	Aagya	Honey				+

Channa morulis	-	Fish consumed	+			
Puntius sahyadrensis	-	Dominant species in landscape	+			
Sperata seenghala	-	Fish consumed	+			
Tor khudree	Kharshee	Fish consumed	+			

5.5 Dependency of locals on forest reseource

Figure 5.4 *Nachni* crop (Raagi) used for daily consumption

Figure 5.5 A traditional raincoat - made out of localy available raw materials.

Figure 5.6 People’s dependency on honey and other such forest produce.

Figure 5.7 People’s dependency on wild fruits and other such forest produce.

A) Details of food resource gathered from forests

1. Fish: According to more than 90% people in Helwak and Koyana ranges, there is no change in the no. of fishes in water bodies. More than 70% people in Chandoli and Radhanagri range are of the same opinion. The reason being, majority of people do not go for fishing because of the regulations of forest department. They usually buy fishes from market. Very few people practice fishing in Koyana and Bamnoli range (as per the survey).

2. Medicinal plants: Availability of medicinal plants has decreased in all the sites. Elderly people were knowing about these plants but they did not share the knowledge with anybody. Now a day new generation know about very few medicinal plants and their uses. Another reason for decreased use is most of the people go for allopathic. However, when asked about the results/outcome of the medicines, majority of them think that Ayurveda was better.

3. Wild fruits and vegetables: Use of wild fruits and vegetables have decreased in all the study sites because of regulations of forest department, villagers do not go inside the protected area for collecting wild fruits and vegetables.

4. Wild meat: According to more than 90% villagers in Chandoli, Helwak, Koyana and Radhanagri ranges, they do not consume wild meat. Therefore, the use of it has decreased. Due to strict regulations of forest department, poaching has banned. In Kas and Bamnoli ranges, more than 75% people have the same opinion.

5. Fodder: According to more than 60% people in all the ranges, there is no change in availability of fodder as people store it in large amount for the cattle.

B) Fiber

1. Construction material: Construction material like bamboo and thatch do not show any change. In Radhanagri, most of the people do not have bamboo plantation in their *malki* (private land) therefor there is no readily available construction material, according to around 50% villagers.

2. Fuelwood: According to 100% people in Chandoli and around 62% people in Kas and Bamnoli range, dependency of the people on the fuel wood has decreased. The reason might be the regulations of forest department due to which villagers cannot go inside the protected area to bring fuel wood and forest department has provided LPG to the villagers inside core zone of Chandoli range. In case of Kas, village development committee has provided LPG and solar lamps to the villagers. However, there is no change observed in Helwak, Koyana and Radhanagri.

C) Drinking Water

Drinking water: The graph is showing that according to how many people the drinking water availability has decreased. Blue color in the graph indicates the drinking water. In Helwak and Koyana it has decreased according to more than 80% of people.

Irrigation water: More than 80% people in Helwak and Koyana have an opinion that the irrigation water has decreased in last 4-5 years. The reason being people are migrating towards cities and majority of them do not do farming. Therefor they do not require irrigation and there is scarcity of water in the month of April and May.

Flood control: There is no change observed in flood control in Helwak, Koyana, Kas and Radhanagri according to more than 80% people. The area is very less prone to floods so flood control mechanism is not required.

Table 5.5 Trend in the forest resources and services (D: Decreased I: Increased N: No change).

Forest resources and Services	Chandoli			Helwak			Koyana			Kas			Radhanagri		
	D	I	N	D	I	N	D	I	N	D	I	N	D	I	N
Fish availability	20	6.7	**73.3**	0.9	0	**99.1**	3.5	1.2	**95.3**	40	5	**55**	8.3	3.3	**88.3**
Medicinal plants availability	**80**	0	20	**73.1**	0	25.9	**91.9**	1.2	7.0	**65**	0	35	**88.3**	3.3	8.3
Wild fruits and vegetables availability	**56.7**	6.7	36.7	**63**	1.9	35.2	**74.4**	1.2	24.4	**50**	2.5	47.5	**90**	0	10
Wild meat availability	**100**	0	0	**99.1**	0	0.9	**97.7**	0	2.3	**77.5**	0	22.5	**98.3**	0	1.7
Fodder availability	26.7	3.3	**70**	0.9	0	**99.1**	4.7	0	**95.3**	12.5	2.5	**85**	10	0	**90**
Construction material availability	6.7	0	**93.3**	1.9	0	**98.1**	0	0	**100**	35	0	**65**	**50**	1.7	48.3
Fuelwood dependency	**100**	0	0	10.2	0	**89.8**	12.8	0	**87.2**	**62.5**	2.5	35	10	0	**90**
Drinking water availability	13.3	3.3	**83.3**	**60.2**	0	39.8	**60.5**	0	39.5	35	17.5	**47.5**	40	3.3	**56.7**
Irrigation water availability	**80**	0	20	**85.2**	0	14.8	**97.7**	0	2.3	**75**	0	25	**80**	1.7	18.3
Flood control	23.3	3.3	**73.3**	0	0	**100**	0	0	**100**	0	17.5	**82.5**	3.3	6.7	**90**
Religious values	3.3	**86.7**	10	0	8.3	**91.7**	0	19.8	**80.2**	7.5	40	**52.5**	0	21.7	**78.3**
Tourism	6.7	0	**93.3**	3.7	16.7	**79.6**	1.2	**61.6**	37.2	5	**80**	15	5	**70**	25

Figure 5.8 Maximum no. of local people usually buy salt-water fishes from the market. wild fishing is more or less stopped due to regulations and awareness.

5.6 Forest as a source of Cutural and spiritual beliefs

Religious values: Religious values for villagers include temples and sacred groves in the village. All the villages from these areas are remotely placed and thus change in belief system has not been observed. There is no change in these values at Helwak, Koyana, Kas and Radhanagri.

Tourism: According to more than 60% people in Koyana, Kas and Radhanagri, tourism has increased since they have defined tourism locations. Koyana has Ozarde waterfall, Radhanagri has Gagangiri maharaj math (temple) and Kas is famous for wild varieties of flowers therefor tourism has increased since the inscription of world heritage site in 2012 (as per the survey). In case of Chandoli and Helwak there are no such defined locations so there is no change in the no. of people visiting these places since last 5-6 years. In case of Chandoli, there is only one resort to stay and two are under construction. This might be another reason, because in case of Koyana and Kas more accommodation facilities are available.

Driver of ecosystem change / threat analysis:

Few of the major reasons of change (driver) in the forest area identified. Following tables shows the change according to the villagers. Siltation, river cutting, deforestation, overexploitation, sewage, invasive, erosion and landslide, chemical poisoning, hunting, habitat degradation, grazing, lopping, fire and pollution these are the factors affecting the state of an ecosystem in some or the other way.

Table 5.6: Threat analysis (Chandoli range)

Chandoli	Change				
%	**Very high**	**High**	**Neutral**	**Low**	**Very low**
Siltation	0.00	0.00	33.33	6.67	**60.00**
River cutting	0.00	6.67	36.67	0.00	**56.67**
Deforestation	26.67	**43.33**	6.67	16.67	6.67
Overexploitation	10.00	6.67	**66.67**	10.00	6.67
Sewage	0.00	0.00	**80.00**	3.33	16.67
Invasive	0.00	0.00	**80.00**	3.33	16.67
Erosion landslide	0.00	3.33	**66.67**	6.67	23.33
Chemical poisoning	0.00	0.00	**86.67**	0.00	13.33
Hunting	0.00	0.00	**90.00**	0.00	10.00

Habitat degradation	26.67	13.33	**40.00**	3.33	16.67
Grazing	33.33	**46.67**	16.67	0.00	3.33
Lopping	10.00	33.33	**50.00**	3.33	3.33
Fire	13.33	**30.00**	30.00	6.67	20.00
Pollution	3.33	0.00	**76.67**	3.33	16.67

Table 5.7: Threat analysis (Helwak range).

Helwak	**Change**				
%	**Very high**	**High**	**Neutral**	**Low**	**Very low**
Siltation	0.00	3.70	**90.74**	3.70	1.85
River cutting	0.00	0.00	**99.07**	0.93	0.00
Deforestation	0.00	3.70	0.00	**49.07**	47.22
Overexploitation	0.00	0.00	43.52	4.63	**51.85**
Sewage	0.00	0.00	**90.74**	2.78	6.48
Invasive	0.00	**44.44**	8.33	21.30	25.93
Erosion landslide	0.00	1.85	1.85	27.78	**68.52**
Chemical poisoning	0.00	0.00	**99.07**	0.00	0.93
Hunting	0.00	0.00	**100.00**	0.00	0.00
Habitat degradation	0.00	0.93	7.41	**51.85**	39.81
Grazing	0.00	1.85	0.93	19.44	**77.78**
Lopping	0.00	1.85	15.74	6.48	**75.93**
Fire	3.70	**42.59**	1.85	37.96	13.89
Pollution	0.00	0.00	**99.07**	0.00	0.93

Table 5.8: Threat analysis (Koyana range)

Koyana	**Change**				
%	**Very high**	**High**	**Neutral**	**Low**	**Very low**
Siltation	0.00	1.16	**94.19**	4.65	0.00
River cutting	0.00	0.00	**100.00**	0.00	0.00
Deforestation	0.00	0.00	0.00	**68.60**	31.40
Overexploitation	0.00	0.00	**79.07**	3.49	17.44
Sewage	0.00	0.00	**93.02**	1.16	5.81
Invasive	0.00	38.37	0.00	**39.53**	22.09

Erosion landslide	0.00	0.00	3.49	10.47	**86.05**
Chemical poisoning	0.00	0.00	**98.84**	0.00	1.16
Hunting	0.00	0.00	**100.00**	0.00	0.00
Habitat degradation	0.00	2.33	2.33	**74.42**	20.93
Grazing	0.00	3.49	1.16	26.74	**68.60**
Lopping	0.00	0.00	5.81	8.14	**86.05**
Fire	0.00	**65.12**	0.00	22.09	12.79
Pollution	0.00	0.00	**98.84**	0.00	1.16

Table 5.9: Threat analysis (Kas range)

Kas	**Change**				
%	**Very high**	**High**	**Neutral**	**Low**	**Very low**
Siltation	0.00	20.00	**37.50**	22.50	20.00
River cutting	0.00	0.00	**77.50**	0.00	22.50
Deforestation	0.00	10.00	15.00	**40.00**	35.00
Overexploitation	0.00	2.50	32.50	0.00	**65.00**
Sewage	0.00	2.50	**47.50**	7.50	42.50
Invasive	7.50	15.00	27.50	**27.50**	22.50
Erosion landslide	10.00	12.50	17.50	**35.00**	25.00
Chemical poisoning	0.00	2.50	**67.50**	5.00	25.00
Hunting	2.50	0.00	**60.00**	5.00	32.50
Habitat degradation	2.50	5.00	30.00	22.50	**40.00**
Grazing	0.00	12.50	20.00	**50.00**	17.50
Lopping	0.00	7.50	30.00	12.50	**50.00**
Fire	2.50	**47.50**	5.00	37.50	7.50
Pollution	0.00	5.00	**42.50**	17.50	35.00

Table 5.10: Threat analysis (Radhanagri range)

Radhanagri	**Change**				
%	**Very high**	**High**	**Neutral**	**Low**	**Very low**
Siltation	3.33	5.00	**78.33**	8.33	5.00
River cutting	0.00	0.00	**90.00**	0.00	10.00
Deforestation	0.00	10.00	3.33	**45.00**	41.67
Overexploitation	0.00	0.00	**75.00**	3.33	21.67

Sewage	0.00	1.67	**70.00**	1.67	26.67
Invasive	5.00	15.00	**43.33**	11.67	25.00
Erosion landslide	0.00	0.00	**51.67**	15.00	33.33
Chemical poisoning	0.00	1.67	**71.67**	11.67	15.00
Hunting	0.00	0.00	**93.33**	0.00	6.67
Habitat degradation	0.00	16.67	6.67	**51.67**	25.00
Grazing	0.00	16.67	8.33	**38.33**	36.67
Lopping	0.00	6.67	25.00	21.67	**46.67**
Fire	0.00	**35.00**	11.67	28.33	25.00
Pollution	0.00	1.67	**81.67**	1.67	15.00

According to the survey, Siltation is neutral in all the sites except Chandoli where very low siltation has observed but it does not directly affect the households. River cutting has also observed in very low amount in Chandoli. Deforestation was high in case of Chandoli and low at other four sites. Overexploitation is very low in Helwak and Kas. Rest of the places it is neutral. Sewage is neutral at all the study sites. Invasive species are high in Helwak, low in Kas and Koyana. Soil erosion and landslides are very low in Helwak and Koyana and low in Kas. Use of chemical fertilizers is neutral at all the sites. No hunting has observed at all the sites. Habitat degradation is low at Radhanagri, Koyana and Helwak and very low at Kas. Grazing pressure is high in Chandoli, very low in Helwak, Koyana and low in Kas and Radhanagri. Lopping in very low at all the four sites except Chandoli where it is neutral. Fire is high and pollution is neutral at all the sites.

Chandoli has maximum no. of livestock per family therefore; the grazing pressure has more compared to any other sites. Forest fire frequency is high at all the study sites. Due to deciduous forest and presence of grasslands in these areas, occurrences of fire are more. In addition, tourists visiting these places might be responsible for fire, according to the locals.

Figure 5.9 Forest fire is a major threat at all the study sites (top);
Garbage is a problem in many villages (bottom)

5.7 A broad sketch on the Village and community profile

Table 5.11 Village profile

Study sites	No. of villages sampled	Location of the villages		Main occupation of villages	Alternate income source	Human-animal conflicts	Threats/ Natural calamities
		Core	Buffer				
Chandoli	1	1	0	Agriculture	Dairy	Gaur, wild pig	Drought, fire, flood, landslide
Helwak	13	3	10	Agriculture	Dairy, Sugarcane	Gaur, languor, leopard, peafowl wild dog, wild pig	drought, earthquake excess rainfall, fire, flood, landslide.
Koyana	12	12	0	Agriculture	Dairy, daily wages	Gaur, languor, leopard, wild pig	Earthquake excess rainfall, fire, landslide
Kas	10	0	10	Agriculture	Tourism,	Gaur, leopard, macaque, peafowl, wild pig	Drought, fire, flood, landslide, Siltation.
Radhanagri	7	0	7	Agriculture	Sugarcane	Elephant gaur, languor, leopard, macaque, peafowl, wild pig, wild dog,	Drought, excess rainfall, fire, landslide

Zone 1: Chandoli range

Village name: Khundlapur (Core zone, Chandoli National Park)

Introduction: Khundlapur village has situated 1 km away from the Khundlapur check-post and around 500 m away from the forest. Actual village has already rehabilitated, only Dhangarwada containing 55 families with population of 370 is remaining. This is the only village in core of Chandoli, rest of them have rehabilitated. More than 90% people depends on farming as the main occupation. Rice is the major crop in this area. All people have their own land for farming. This village has a primary school.

Main forest dependancy: Stream is the main water source for this village. People are dependent on forest for fuelwood. Though they have the LPG connections from forest department but because of the high rates of gas refilling they are reluctant to use that. People consume fruits like Jamun (Syzygium), Karvand (Carrisa) Etc. and wild vegetables like Shendwal, Naal, Tarli, Kurdu, Umbar, Alambi (Mushrooms). More than 90% people depend on allopathy. Very few of them have knowledge about medicinal plants but they do not use it. 10 percent villagers know about Ayurveda medicines for cattle. People believe that Ayurveda is more effective than Allopathy.

Threats: Landslide, flood, drought and fire has observed in this area. These lead to loss of farmlands, livestock etc. No. of leopards, wild boars and Indian gaurs have been increased since last 10-12 years. These species negatively affect livelihood of people. Wild boar and Indian gaur destroy their farms and people get very less compensation for the loss. However, on the other side gaur has a religious importance. According to people, this animal has shivlinga on its forehead. Gaur is thus, considered as a vehicle of lord Shiva. For the rehabilitation, this village has divided into 3 parties. Three different sites have chosen for this Viz. Bhiur, Aetgaon and Karungli. Initially all the villagers selected Bhiur but forest department was not agreeing for the rehabilitation so now there are only two places. People should choose one of them.

Culture and traditions: There is one Hanuman temple inside this village. There are various programs at the time of Hanuman Jayanti (birth of lord Hanuman). Darubandi Pooja (awareness program about alcohol prohibition) also takes place.

Figure 5.9: Khundlapur village, Chandoli range- Villagers still use fuel wood for cooking (top); Villagers get some amount by supplying milk to the dairy in Manadur village (bottom)

Zone 2: Helwak range

Villages: Baje, Dastan, Gadhokhop, Helwak, Kondhavale, Mendheghar, Nanel, Nav, Rasati, Waghane (Buffer zone, Helwak range)

Introduction: Village Baje and Gadhokhop are rehabilitated in 1956, Dastan in 1967 and Waghane in 1971. Mendheghar had originally located at the same place, therefore no rehabilitation took place. More than 80% people in Baje, Dastan and Gadhokhop practice agriculture and have livestock. Therefore, income from milk is one of the financial sources for the villagers. Rice, wheat and raagi are main crops. Shamaprasad Mukharji Yojna has proposed in Gadhokhop and Rasati but it did not work out. Helwak has more developed compared to other villages in this range. Only 20% people in Kondhavale use LPG gas for cooking, rest depends on fuelwood. In Mendheghar, less than 20% people have farming as a main occupation. Rest of the people have gone outside for jobs. Some of them work on daily wages. In Nanel, less than 30% and in Nav and Waghane more than 50% people practice agriculture and that of around 20% has livestock. Some people lost their lands in road construction.

Main forest dependancy: Koyana River and Streams are the main water source for these villages. Scarcity of water has observed in the month of March and May. Farming has practiced only in rainy season. People are dependent on forest for fuelwood, food etc. Village Mendheghar is less dependent on forest as they have LPG and very less livestock. People from Baje, Gadhokhop, Kondhavale consume wild vegetables such as Shendwal, kurdu, Patri, Bharangi, Talli, Waghchouda, Fatkure, Bhokari, Naal, Kurdu, Kusumba, Alambi (Mushroom) etc. Villagers from Baje, Dastan, Helwak and Mendheghar do not have information about medicinal properties of plants so nobody uses it but people think it is better than allopathy.

Threats: Excess rainfall, fire, earthquake, drought and landslide are the natural calamities observed here. There were two earthquakes in 1967 and 1993, that caused a lot of damage of Rasati their farms and houses gets affected due to these calamities. No. of leopard, Indian gaur, wild boar, languor, Indian peafowl has increased causing tremendous loss for villagers and their farmlands. Because of this reason, many people have left farming.

Villages: Kolne, Male, Patarpunj (Core zone, Helwak range)

Introduction: These three villages are in core zone of Helwak range. The rehabilitation proposal has passed in 1974 but still there is no rehabilitation. More than 80% villagers depend on farming as a main occupation and around 50% have livestock. Main crops are rice, finger millet and wheat. There is one tourist location nearby named Bhairavgadh. Forest department asked these three villages (Male, Kolne and Patarpunj) to look after the tourism but these villages are not ready for this.

Main forest dependancy: Main water source for this village is Koyana River, streams and wells. They have enough water for drinking and other domestic purposes but not for irrigation. They think that due to earthquakes water level has decreased. In Kolne and Patarpunj, people used to consume fruits from forest but now a day they only consume some wild vegetables such as Shendwal, Rajgira, Waghchouda, Kurdu, Alambi (mushrooms) etc. Some of them know about medicinal plants but nobody uses it. In spite of being very close to the forest, people from Male village do not consume fruits and wild vegetables. They also do not have information about medicinal properties of flora around them, but they think that Ayurveda medicine is better than allopathy.

Threats: Main natural calamities faced by these villages are earthquake, landslide, flood and fire. They also have fire problem. Earthquake has reported 2-3 times a year. In rainy season electricity problem arises. Sometimes there is no electricity at all. No. of leopard, wild boar and Indian gaur have been increased which causes tremendous loss for the people. With these, no. of wild dogs is also increasing and tiger and spotted dear have been disappeared from the nearby forest, according to the villagers.

Zone 3: Koyana range

Villages: Deshmukhwadi, Dhuilwadi, Gawdewadi, Ghatmatha, Gokul, Humbarli, Kamargaon, Manai nagar, Mirgaon, Navja, Torne, Van Kusawade (Core zone, Koyana range)

Introduction: All the villages are in core zone of Koyana range of Koyana WLS. Deshmukhwadi, Ghatmatha, Kamargaon, Manai nagar, Mirgaon, Navja, Torne and Van Kusawade have rehabilitated because of Koyana dam construction in 1955. Navja and Manai nagar lost around 465-acre land for dam and road construction but did not get any compensation for that. For Ghatmatha, rehabilitation has done at five different places. Maximum no. of people had gone to Thane district and only around 15-20% people, stayed back- one of the parts is Kusawade Ghatmatha. Around 60 to 70% people have farming as their main occupation from which around 40% has their own land. Now a day villagers grow rice, wheat, raagi and Vari in their farms. Around 15% among them do farming on someone else’s land. People do not grow any vegetables in their farms. Villagers get some income from milk dairies. In few of the villages such as Navja, Torne, Van Kusawade more than 80% people left farming and around

50% does not have livestock. They have very little information about medicinal plants and now a day nobody uses it. There is a tourist place very near to Navja village- Ozarde waterfall, though villages earn nominal profit. Villagers from Gokul were not ready to give information as they have many problems with forest department. They think that if we and our animals (cattle) are not allowed to go inside forest for grazing then forest department's animals and beat guards are not allowed to come inside our village. Villagers are very aggressive against forest department. In Manai nagar, Kamargaon, Mirgaon, and Navja, more than 50-60% people left farming because of wild animals and rest of the people grow rice crop only. They do not grow any vegetable in the farm.

Main forest dependancy: Koyana dam, well and small streams coming from the forest are the main sources of water for villagers. There is enough water for drinking and other domestic purposes but not for irrigation. Fishing has banned so people buy and consume salt-water fishes from Chiplun or Patan market. People are dependent on forest only for fuelwood. Rest of the things like fruits, vegetables they buy from market. People from few of the villages consume fruits such as jamun (Syzygium) and Karwand (Carrisa), wild vegetables such as Shendwal, Waghchouda, Paat, Talli, Patri, Kurdu, Murud, Naal etc. and honey. They do not have information about medicinal plants but they still think that use of medicinal plants is better than today's allopathy. They use few of the medicinal plants such as Hirda, Behda, Adulsa, Tulsi, Korfad, and Mehndi on cough; Ramata for wound healing; katri, Nigad on swelling. People who know about medicinal plants do not share the information with any villager. They just provide the medicine. Therefor most of the people prefer allopathy in spite of economic loss. People from maximum villages do not consume any wild vegetable or fruit from forest. Very less dependency on forest has observed. Only for fuelwood, people depend on forest. There is one tourist place nearby- Ozarde waterfalls. In rainy season lot of people visit here. 4 years ago the entry fee was collected by villagers because the land belongs to them but now a day all the money is collected by forest department so no profit to the villagers. They face many problems due to tourists.

Threats: Excess rainfall, earthquake, landslides and fire natural calamities faced by the villagers. There were two huge earthquakes in the year 1967 and 1994, which caused tremendous loss for them. Many of the villagers had to rebuild their houses. There are some natural waterholes inside forest; villagers want to use that water for domestic purposes. They need another electricity line, Gayran for cattle etc. and they want permission to take out forest produce at least for home use. There are some small temples inside forest. People need the permission for repair and rebuilding of those temples. No of leopard, wild boar, languor, Indian gaur and peafowl have been increased which is harmful for their livestock and crops.. Due to

Nehru garden and Ozarde waterfall, tourists passes by the village, which is sometimes troublesome to the villagers. According to them, the land of Ozarde waterfall belongs to two villages Navja and Manai nagar but they do not get any profit from tourists. Forest. Unemployment and improper roads are the biggest problem faced by the villagers. Because of the declaration of tiger reserve, the road construction has banned.

Zone 4: Kas & Bamnoli

Village name: Atale, Ekiv, Kas, Kasani, Vanjlewadi (Kas range)

Introduction: These villages practice farming. Main crops are rice and wheat. People don’t grow any vegetable in their farms.

Main forest dependancy: Main water source for these villages is stream. There is enough water for drinking and other domestic purposes except April and May. Rain water is used for irrigation. Sometimes they also use well’s water. People consume wild vegetables such as Sakruba, Shendwal, Naal, Alambi (Mushrooms) etc.

Threats: Siltation, landslide, drought and flood are the main calamities reported here. Sometimes because of tourists, fire also occur. It causes loss to the farmlands. Wild boar and Indian gaur have increased which causes bad effects on the farmlands.

Bamnoli range

Village name: Bamnoli, Munawale, Waghli, Shembdi, Padali (Bamnoli range)

Introduction: In above mentioned villages, people practice farming and the main crops are rice, wheat and raagi.

Main forest dependancy: Main water source for this village is stream coming from forest. In off-seasons water comes through boar well. People consume wild vegetables such as Sakaroba, Kurdu, Shendwal, Bhokari and fruits like Syzygium, Carissa etc. also many of the wild vegetables. Use of medicinal plants has decreased.

Threats: Main problems here are landslides and fire. No. of peafowl, leopard, wild boar and gaur has increased which causes problem for the farms. Around 80% people wanted rehabilitation.

Figure 5.10: Helwak range- Water storage in Gadhokhop village (top);
Water storage in Rasati village (bottom)

Figure 5.11: Helwak range- Temple near Patarpunj village in core zone (top); A temple in Waghane village in buffer zone (bottom), people from nearby villages visit the temples

Figure 5.12: Koyana range- Water as a provisioning service,
A woman from Dhuilwadi village bringing water from the stream at the backside of the village (top); Villagers from Kamargaon filling tap water (bottom)

Figure 5.13: Koyana range- Storage of fuel wood in Ghatmatha (top) and Gawdewadi village (bottom)

Figure 5.14: Bamnoli range- Fish as an importnat food resource

Tor khudree (top) and *Sperata seenghala* (bottom) fresh water fishes.

Zone 5: Radhanagari & Dajipur

Village name: Aadoli, Bhairibambar, Banachi wadi, Chapodi, Padali, Patpanhala (Radhanagari range); Savarde (Dajipur range)

Introduction: Aadoli is situated 1.5 km away from the forest camp. It has two parts- Main Village and Adsulwadi. People practice agriculture and have livestock. Main crops are Rice and sugarcane. People get income from this cash crop and also from dairy. They grow few vegetables in the farms, for e.g. Brinjal.

Main forest dependancy: Main water source for these villages are streams, Radhanagri dam and lake. People consume wild vegetables such as Patri, Kurdu, Shendwal, Murud etc. and fruits such as Syzygium, Carrisa etc. Most of the people don't know about medicinal properties of plants so nobody uses it. People still think that this medicine is better than allopathy. Few years back villagers used to collect honey but now ths has also stopped.

Threats: Landslides and fire are observed here. No. of wild pig, gaur, macaque, languor, wild dog has increased which causes lot of problems to the villagers. According to villagers' fox and vulture have disappeared from the forest. People need rehabilitation due to conflict with gaur. They say that if this problem would have been resolved then they will happily stay here. Indian gaur is one of the reasons of rehabilitation. There are no proper roads for transportation.

5.8 Human-Wildlife Conflict

Human–wildlife conflict refers to the interaction between wild animals and people and the resultant negative impact on people or their resources, or wild animals or their habitat. Let us understand the conflict in all the five zones.

Zone 1- Chandoli: In Chandoli, No. of leopards and wild boars have increased. Wild boar destroys the farmlands of villagers. Leopard attack on villager has not been reported in Chandoli, according to Khundlapur villagers. However, many of them have spotted a leopard many times. Recently (Jan/2017) one leopard seen in Pune city, Maharashtra has been released in Chandoli. Few months back, a Black panther was spotted near Janicha aamba (A place in Nandoli beat, Chandoli)

Zone 2- Helwak: In Helwak, the no of Indian gaur has increased, according to people. In summer months, they do not get water at high altitude so they come down in search of water. This leads to conflict and unprovoked attacks some times.

Zone 3- Koyana: In Koyana, no. of wild pig (*Sus scrofa*) and Gaur (*Bos guarus)* has increased. Due to inappropriately divided land cover pattern, people have a different view for wild animals. They think that, 'if forest department does not allow our cattle to enter their area then why would we allow the wild animals to enter in our *Malki* land (Private land)?' Around 25 years ago, a tiger killed one lady from nearby village. But the reports of leopard attacking a goat or dog are not so regular. In fact, very few attacks have been reported.

Zone 4- Kas: On Kas plateau, barking dear, wild boar, gaur is in good number. Villagers mainly complained about the increase in no. of wild boar and Indian gaur. These animals destroy their farmlands. There is no change in no. of leopards is as it is and no attack reported.

Zone 5- Radhanagari: Dajipur (A part of Radhanagari Wildlife Sanctuary) is famous for Indian gaur. So they are found in huge numbers. With this, wild boars are also found here. According to people, no. of tigers in Radhanagari has decreased.

Human-wildlife conflict might also depend on the distance of a village from the protected area boundary.

Table 5.12: Villages surveyed and avergae proximity from forest

Zone	Village name	Avg Distance from park boundary (Km)
Chandoli	Khundlapur	Inside the Park
Helwak	Mendheghar	2.6
	Nav	2.3
	Rasati	2.7
	Waghane	3.4
	Kondhavale	3.4
	Nanel	3.3
	Dastan	4.2
	Gadhokhop	2.6
	Baje	2.1
	Male	Inside the park

	Kolne	Inside the park
	Patarpunj	Inside the park
Koyana	Kamargaon	Inside the park
	Mirgaon	Inside the park
	Manai nagar	Inside the park
	Navja	Inside the park
	Ghatmatha	Inside the park
	Van Kusawade	Inside the park
	Torane	Inside the park
	Dhuilwadi	Inside the park
	Gawdewadi	Inside the park
	Deshmukhwadi	Inside the park
	Humbarli	Inside the park
	Gokul	Inside the park
Kas	Kas	-
	Ekiv	-
	Vanjlewadi	-
	Atale	-
	Kasani	-
	Bamnoli	1
	Shembdi	4
	Waghli	2
	Munawale	2
	Palni	1.5

Radhanagari	Patpanhala	0.2
	Bhairibambar	0.5
	Aadoli	1.5
	Chapodi	1
	Savarde	0.2
	Padali	0.4
	Valvan	2

5.9 Discussion

The present study focused on identification of natural resources and the extent of local community dependancy on forest ecosystem. Few of the drivers that regulate the provisioning of food, water, flood control and recreation under regulating and culturalservices were attempted. Decrease in dependency on the forest resources was observed in community. In general there was a gradual decrease in the dependency of local communities on forest resources. The availability of resources such as wild vegetables and fruits, medicinal plants, extraction of honey has largely decreased due to enforcement of forest departments' rules and regulations. Similarly, people from STR have been regulated by forest department to go inside after the declaration of tiger reserve. The creation of Chandoli NP has positive impacts on the protection of biodiversity but the impacts on local communities are predominantly negative (Kouwenhoven, 2010).

Few threats to the ecosystem such as over-grazing, fire were identified. Grazing pressure was high at Chandoli National park. According to a study by Mehta, 2012 in Chandoli, Koyna and Radhanagri, the grazing pressure was comparatively low (2007-09) but now a day due to increased number of livestock in Chandoli (3.7 ± 0.43- No. of livestock per family) the pressure is high. Forest fires is another threat to Sahyadri tiger reserve, Kas and Radhanagri. It has been a part of western Ghats ecosystem for many thousands of years (Gadgil and Chandran, 1988). As per the present study, forest fire frequency has increased. The reason according to locals is increased tourism. Tourism is the only entity which is showing increased trend at Koyana, Kas and Radhanagri. Tourism in Chandoli also showed increase (Bhandare, unpublished) but in case of the current study in STR there was no change in tourism at Chandoli. The reason being, when compared to the other three sites, they have a defined tourist location or presence of something that attracts tourists- Ozarde waterfall at Koyana, Lateritic plateau in Kas harbors ephemeral flush vegetation which is tourists' attraction. Gagangiri maharaj temple situated in Radhanagri is also a tourist place. It includes Dajipur ranges which is famous for gaur. Apart from wildlife as prime interests these areas showed unique landscapes, frequently been visited by tourists.

Chapter Six:

An assessment of tourism benefits to local communities

6.1 Introduction

Tourism has been of great importance for the local communities residing near tourists' places. It has both positive and negative economic, social and psychological impacts. Positive impacts such as economic growth, psychological relaxation and negative impacts such as increasing pressure on existing infrastructure, disrupting existing cultural assets etc.

Protected areas around the world are becoming popular tourist destinations along with the rapid growth of nature-based tourism or ecotourism (Ceballos-Lascurain, 1996). Potential benefits of tourism in protected area include revenue collection for the maintenance of natural resources, contribution to economic and social development, funding the development of infrastructure and services, providing jobs, generating income, education etc. Conserving natural resources in protected areas will not be easily achieved without local support (Stoll-Kleemann & O'riordan, 2002; Wells & Brandon, 1992). So, for improvisation in conservation management strategies for protected areas, involvement of local communities becomes mandatory. Sharing tourism benefits can help to achieve active participation of local communities, so that the community will be willing to share the responsibility of conserving the natural resources (Brandon, 1996). Tourism is expected to benefit the locals by bringing in economic opportunities, improving living standards, promoting agricultural products, and facilitating cultural preservation.

Tourism can involve and affect local residents without being driven and controlled by the community. The later situation might be desired, but the former situation needs to be addressed. On some global level efforts are already being made to enhance involvement of local communities in the tourism industry. However, experience to date has thrown up many limitations and challenges (Caroline & Roe, 1998).

Thus, Participatory approach will help to determine Strategic priorities and action programs to protect and enhance the area's natural and cultural heritage, for and through tourism, and to protect it from excessive tourism development. The tourism strategy should be planned in such a way that it will seek to ensure the tourism support and does not reduce the quality of life of local residents. This will also help to increase benefits from tourism to the local economy and will have a positive impact on various economic sectors. A well-managed and permanent forum for sustainable development of tourism in and around the protected area is essential for an effectively structured process.

6.2 Background

'Tourism' is the temporary, short-term movement of people to destination outside the places where they normally live or work and their activities during the stay at each destination. It includes movements for all purposes (Feuler,1905). The thinking behind the establishment of protected areas developed rapidly. The IUCN (1994) classification system for protected areas, which takes biodiversity conservation as its starting point, though it also recognizes the importance of other protected area objectives such as recreation and tourism. The economic impact of tourism in protected areas emphasizes their community, regional and national importance. Protected areas do not offer a single, homogenous level of 'protection'. It has many and different management objectives. There is wide agreement that much more needs to be done to improve the effectiveness of protected area management (Hockings, 2000). It is important therefore that, when tourism takes place, management frameworks and strategies are put in place to ensure that it supports and maintains protected area natural and cultural values. Previous literature has identified shifts away from nature-based recreation in wealthy countries (United States, Japan) over the last two decades (Pergams & Zaradic 2008). Balmford et al. (2009) found increasing visitors to protected areas (PAs) in 15 of 20 countries, with rapid increases in less-wealthy countries tied to international tourist visitation. These studies focus on tourism generated from industrialized economies. Karanth and Defries in 2010 have examined trends and patterns in nature-based tourism and tourist infrastructure in these PAs and attitudes and practices of tourist facilities (resources use, economic opportunities). The conservation benefits from nature-based tourism to either PAs or local people is debatable (Lindberg et al. 1996; Kiss 2004; West & Carrier 2004; Nash 2009; Sims 2010). Some research (King & Stewart 1996; Willkie & Carpenter 2002; Lindsey et al. 2006) suggested improvisation in local livelihoods, park management, and conservation by nature-based tourism that also helps in reducing pressures on forest resources. Communities close to parks getting benefited (Bookbinder et al. 1998; Nagendra et al. 2005; Spiteri & Nepal 2008; Andam et al. 2010). However, according to few studies (Archebald & Naughton-Treves 2001; Stem et al. 2003; Charnley 2005; Bandyopadhyay & Tembo 2010) local communities are devoid of tourism benefits. Even the involvement of communities in PA management decisions about tourism was also not observed. Critics question sustainability of tourism revenues, and lack of benefit sharing with local communities (Stone & Wall 2004; Arjunan et al. 2006; Waylen et al. 2009). Previous literature has identified negative impacts of tourism activities on biological resources in PAs (due to resource extraction, overharvesting, hunting, harassment of animals) and the physical environment (increased fire frequency, soil compaction, water pollution, introduction of invasive species and pathogens, Charnley 2005; Kruger 2005). Others found tourism-generated revenues may be insufficient to sustain PA conservation and management efforts (Naidoo & Adamowicz 2005). There exists significant debate about the benefits and costs of tourism in conservation.

The wild life protection act, 1972 and the National Tiger Conservation Authority provided the guidelines for tiger conservation and tourism. ‘Tourism’ in the context of Tiger Reserves is contemplated as “ecotourism” and as ecologically sustainable nature-tourism. This is emerging as an important component of tourism industry. It is having sustainable, equitable, community-based effort for improving the living standards of local, host communities living on the fringes of tiger reserves. Ecotourism is proposed to benefit the host community in accordance with tiger reserve specific Tourism Plan forming part of the Tiger Conservation Plan, subject to regulation as per carrying capacity, with a focus on buffer areas.

However, tourism is not directly an ecosystem service, opportunities for recreation and ecotourism is the cultural ecosystem service (MEA, 2005; TEEB, 2010). Nahuelhual, 2013 has mapped recreation and ecotourism as a cultural ecosystem service in Southern Chile. They proposed a methodological framework that uses geographical information system to map these two services. Though India has a great potential of tourism (Mishra, 2011); Karanth in 2012, showed that the direct economic opportunities due to tourism for the locals are minimal compared to its’ neighboring countries such as Nepal. Scheyvens studied relation between tourism and empowerment of local communities in 1999.

As per Maharashtra tourism policy report in 2016, it is the third largest state in India and the leader in the country with respect to foreign tourists’ arrival (20.8%) and domestic tourism visits (7.2%). The rich heritage, trade, culture, history and growing economy have become major attractions for the tourists. Poria in 2011 has studied Basilica in Israel- religious site after its declaration as world heritage. Sahyadri tiger reserve, Radhanagri wildlife sanctuary and Kas plateau were recently (2012) described as world heritage site by UNESCO. Satara forest department has observed increase in tourism activities at the Kas plateau since 2012.

Now a days, countries are more focused on tourism development. Tourism potential of many locations has been studied- Sunshine coast, Australia (Gursoy, 2009); Murshidabad district, west Bengal (Mamun, 2012); Matheran, Maharashtra (Patwardhan, 2007). Patil in 2011 has studied the tourism potential from Maharashtra state- Salher fort, Sahyadri ranges, Nashik. The objective was to find the role of stakeholder in sustainable tourism and ecofriendly development. Tourist's satisfaction is the most relevant factor for the development of tourism. (Gade, 2016) calculated the satisfaction index of tourists visiting Radhanagri Wildlife Sanctuary, Kolhapur. Author has stated that tourists' views about destination, personal safety, transportation etc. are important for the tourism development at the destination. If the tourists are satisfied with the facilities, then they are willing to pay for it. Tourists' willingness to pay was studies in India and other countries (Barnes, 1999; Spash, 2006). Hadker, 1996 for Borivali National Park, Mumbai, and Maharashtra, has done same study. Hadker has found that, maximum decision-making members in Mumbai are willing to pay for maintaining and preservation environmental amenities.

The tourism at particular site has an impact on the site environment as well as the local communities living there. Manoj et al, 2016 has studied the impact of tourism on village Kumbalangi in Ernakulum district of central Kerala- the first model tourism village in India. It is a successful example for rural tourism. Similar studies have been done in Namibia (Ashley, 2000) and Varanasi (Das, 2009). Das also studied both the positive and negative impacts of tourism on the ecosystem. Forest based tourism has positive effects on local communities (Kausar, 2015).

Ecotourism is considered as a conservation strategy in Maharashtra (Shelar, 2016). According to the author, activities like trekking, bird watching, wildlife tourism helps the government to improve the management of natural resources. There is a unique relationship between conservation and tourism- while tourists enjoy nature and other recreational services, locals help them in getting the facilities and earn income from that. It is beneficial for both. With this, tourism also has a significant potential for peace building in local communities (Chauhan, 2008). Therefore, tourism plays a crucial role for local communities- both ecologically and economically. The Indian National Wildlife Action Plan states that ecotourism benefits must be shared with local communities (Tiger Task Force 2005). Similar to other PAs worldwide, tourism revenue in India has rarely been directed towards improving conservation efforts or supporting local people (Wells 1993; Sandbrook 2010). This will require sharing of benefits with local people and building support among private enterprises for conservation initiatives.

6.3 Objective

An assessment of the tourism benefits to local communities living in the fringes of Chandoli, Koyana and Kas.

6.4 Study area

In the study, total 3 tourism locations were surveyed- 1) Chandoli NP 2) Ozarde waterfall, Koyana WLS and 3) Kas plateau, Satara.

1) Chandoli National Park: Chandoli NP is a part of Sahyadri Tiger Reserve situated in four districts of Maharashtra- Satara, Sangli, Ratnagiri and Kolhapur. There are many tourists' attractions nearby but tourists usually come to visit the park and Chandoli dam. Inside the park, there are points like Janicha aamba (An ancient mango tree), watch-tower etc. Same like Kas plateau, Zolambi plateau is also there but tourists are not allowed on that. 2) Ozarde waterfall, Koyana wildlife sanctuary: This waterfall is in Core zone of Koyana Wildlife Sanctuary- Navja beat. This place hardly finds a mention on internet compared to its more popular siblings. Surrounded by thick forest it is an ideal location for one-day picnic. The best season to visit is from July to October. There are various places to visit around it- Nehru garden, Koyana dam etc. Most of the people coming to visit this waterfall are from Karad, Patan, Pune, Ichalkaranki, Phaltan, Umbraj, Satara, Chiplun, Kolhapur, Baramati, Islampur; also Mumbai, Sangli, Miraj etc. Tourists from outside India also visit this place (US). Maximum revenue is collected in the month of July and August (Rainy season). 3) Kas plateau, Satara: This place is quite famous compared to above two places. Kas was declared as World Heritage Site by UNESCO in 2012. Since then people started visiting this place. This plateau is situated 30 km away from Satara, Maharashtra and popular for wild flower species. The best season to visit Kas is from August to October. People coming to Kas are from Mumbai, Thane, Pune, Ratnagiri, Sangli, Satara, Buldhana, Patan, Karad, Kolhapur, Shendre etc. Tourists from outside India also visit this place. There are many other places to visit- Bamnoli, Chalkewadi plateau, Thoseghar waterfall, Sajjangad fort, Mahabaleshwar, Vasota fort, Raigad fort, Lonawala, Matheran, Wajrai waterfall etc. Maximum revenue was collected in 2016 at Kas plateau.

Figure 6.1: Chandoli National Park.

Figure 6.2: Ozarde waterfall, Koyana WLS

Figure 6.3: Kas plateau, Satara

6.5 Methodology

Three different questionnaires were prepared for the information collection-

1) Tourists
2) Local resort owners
3) Forest department/NGOs

Questionnaire for tourists contained information like Education qualification, no. of individuals accompanied, monthly gross income, no. of visits, duration and place of stay, whether aware about UNESCO site, which element want to see etc. The purpose is to gain information on the current scenario which in turn will help improve the tourism facilities.

Table 6.1: Details of survey

Zone	Sample size (#)	Date sampled
Chandoli	10	2nd – 5th July 2017
Koyana	90	7th – 9th July 2017
Kas	200	22nd - 23rd July 2017

Questionnaire for resorts contained information about their accommodation rates, facilities provided by them etc. For the forest department, questions like revenue generated from tourism, facilities provided by the forest department etc. were asked.

6.6 Results

The basic information of tourists visiting the three tourism sites was collected. This helps to understand the socio-economic status of tourists. Their awareness about the world heritage site and willingness to pay might depend on following things.

Table 6.2: Information of tourists visiting the locations

Parameter (%)	Category	Chandoli	Koyana	Kas
Education qualification of tourists	High	20	17	47
	Low	80	83	54
Monthly income of tourists	High	40	18	29
	Low	60	82	72
Group size	Large	0	20	20
	Small	100	80	80
Frequency of visits	Frequent	10	38	31

	Not frequent	90	62	69
Duration of stay	Not staying or 1 day	100	1	6
	>1 day	0	99	94
	Commercial	30	19	32
Accommodation	Non commercial	0	2	8
UNESCO WHS awareness	Yes	40	38	60
	No	60	62	40

'High' category of education qualification includes the post-graduates. 'Low' category includes graduates and below that. It might or might not affect the awareness level of tourists though. 'High' economic class of tourists indicate monthly income more than Rs. 50,000/-. The economic class might affect 'willingness to pay' by tourists. Maximum no. of people visiting Chandoli and Koyana are in group of 1 to 5. In case of Kas, they visit in group of 6 to 10 and almost all come with their personal car. According to the above table, first timers are more in all the three places. They get the information online or through someone from their family or friend circle.

Maximum no. of people doesn't stay as they make a day visit. In Chandoli there is only one resort- Chandoli Resort. Other two are under construction. Chandoli resort is situated near Jadhav wadi check-post. It is very beautifully developed. Forest department and government officials also stays here. According to tourists, the rates are expensive, so there should be another resort in cheap rates.

Those who don't stay, have no idea about the rates. In Koyana 14% people think that the rates are affordable. In case of Koyana there are many resorts near Humbarli village, so tourists actually have a choice to stay. Just like Koyana, Kas also has lot of resorts. Initially it was not permitted. Now the construction has started and no. has increased.

UNESCO: Only in case of Kas, maximum no. of people aware of the place as a UNESCO World heritage site. In fact, after its inscription of world heritage site, no. of tourists has increased a lot (As per the records of Satara forest department).

Table 6.3: Awareness regarding Entry fee.

Information about entry fee		Chandoli	Koyana	Kas
Aware about the entry fees?	Yes	10	90	94
	No	90	10	6
Would you like to pay additional fees?	Yes	90	86.67	68.5
	No	10	13.33	34.5
Should not charge at all		0	3.33	21.5
Just right		50	58.89	38.5
Expensive		0	24.44	17
Cheap		0	2.22	13
Don't know		50	11.11	10

The entry fees for Chandoli is Rs. 30/- only. As it was mentioned above, the tourism season is from October to May. Only in these months' tourists are allowed to go inside the park. Those who know about the entry fees, think that it is just right.

In Koyana, the entry fees for Ozarde waterfall is Rs. 30/- only. Most of the people think that it is just right. Very few think that forest department should not charge the fees at all. Only 1% people think that they should increase the fees.

In Kas, 94% people are aware of the entry fees. But as it was an off-season, so entry fees were not there. Satara forest department do not take the entry fees in off-season.

Table 6.4: Perspective of tourists towards services available in Chandoli, Koyana and Kas.

Chandoli						
Rate the following (%)	***Excellent***	***Good***	***Average***	***Poor***	***Very poor***	***Don't know***
Tourism facility (stay)	20	**40**	0	10	0	30
Access to place	0	**60**	30	10	0	0
Availability of local guides	0	30	20	0	0	**50**
Cleanliness	**50**	10	30	10	0	0
Tourism activities (trekking, birding)	0	0	**50**	10	0	40

Koyana	***Excellent***	***Good***	***Average***	***Poor***	***Very poor***	***Don't know***
Tourism facility (stay)	11.11	27.78	23.33	5.56	1.11	**31.11**
Access to place	8.89	**53.33**	32.22	4.44	1.11	0.00
Availability of local guides	0.00	0.00	1.11	5.56	7.78	**85.56**
Cleanliness	16.67	**50.00**	22.22	3.33	2.22	5.56
Tourism activities (trekking, birding)	1.11	2.22	25.56	2.22	1.11	**67.78**

Kas	***Excellent***	***Good***	***Average***	***Poor***	***Very poor***	***Don't know***
Tourism facility (stay)	16	**38**	21	11.5	11.5	2
Access to place	11.5	**33**	28.5	16	11	0
Availability of local guides	0	15	18.5	**39.5**	19.5	7.5
Cleanliness	7.5	18	20	24.5	**28**	2
Tourism activities (trekking, birding)	3.5	18.5	**21.5**	19	**21.5**	16

In Chandoli, maximum people say that the stay and access to place is good. They don't know about availability of local guides, because the guides from the forest department are not well trained. Cleanliness is excellent and Tourism activities are average. In Koyana, according to tourists, Tourism facility and access to place is good. People are not satisfied with the local guides. However, there is no security inside, a place from where one gets closest view of the

Ozarde waterfall. People also complaint about the road which goes till the waterfall. No proper toilet facilities are available here. First aid kit should be there in the booking office.

Suggestions by tourists-

Chandoli-

1) Road widening and road safety.
2) Information boards on both sides of the road.
3) More tourists' vehicles for safari should be available. They need to be pollution free.
4) Support from local politicians should be there. Revenue should be used for the betterment of local communities.
5) Local people should be trained as guides.

Koyana-

1) Medicinal kits should be available at the check-post for tourists.
2) Cigarettes should be banned.
3) Tourists park their vehicles in private land of local villagers, therefor there should be proper parking management.
4) Forest guards should also be there near the waterfall if in case of any accident.
5) Need tourists' accommodation near waterfall.

Kas-

1) As it is a world heritage site, the fencing on the plateau should be removed.
2) Ambulance should be available.
3) Limited people should be sent on the plateau- only online bookings.
4) Alcohol should be banned on the site.
5) Dustbins should be placed after every 200 m.
6) Security should be improved.
7) Police station should be there at Kas Lake.
8) Kas samitee people should have some uniform.

Figure 6.4: Vehicular conveyance destroying the beauty of Kas plateau.

Figure 6.5: Irresponsible tourists at Kas plateau and Kas lake

An Assessment of Willingness to pay for Conservation:

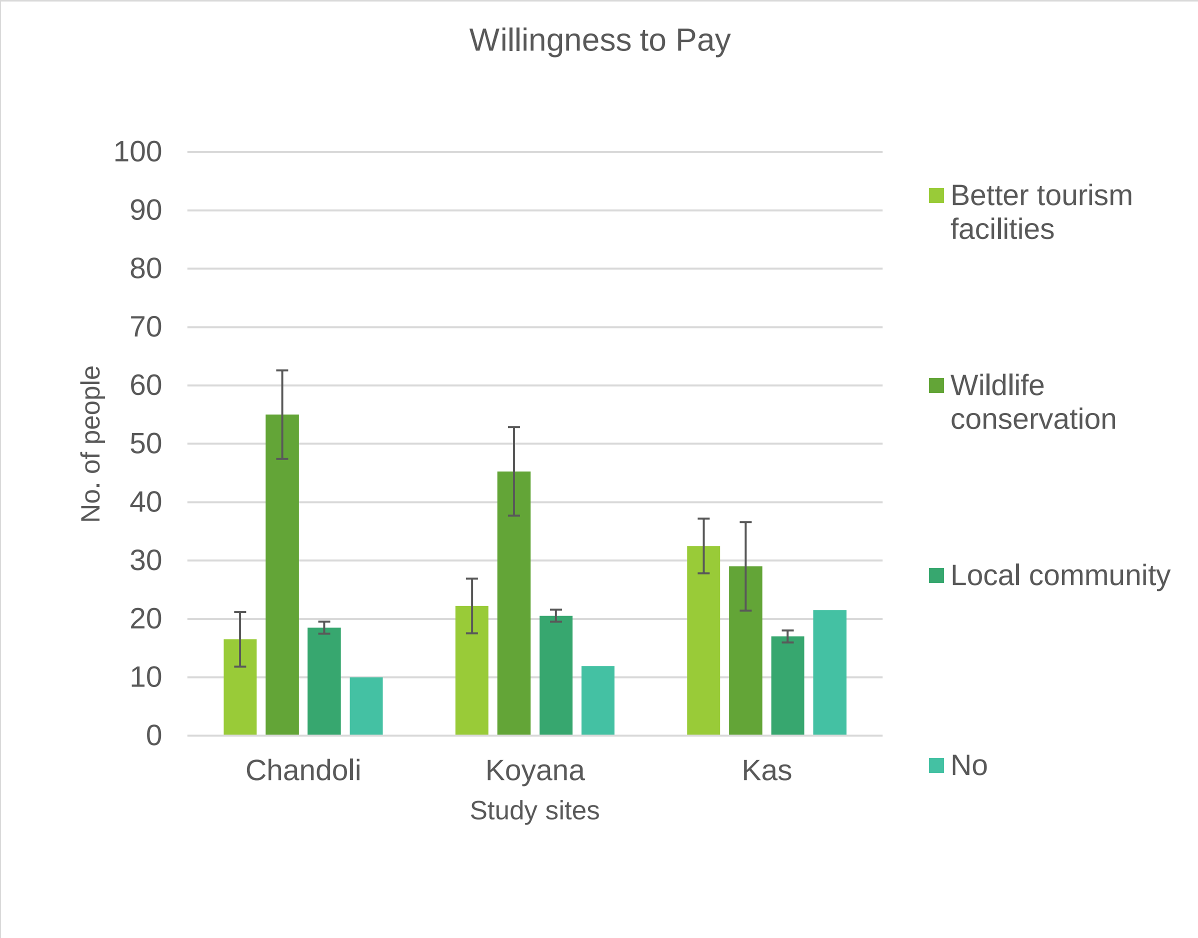


Figure 5.6 Willingness to pay by tourists visiting Chandoli, Koyna and Kas.

Tourists' willingness to pay was determined for better tourism facilities, wildlife conservation and local community. Above graph represents that in Chandoli and Koyana tourists are willing to pay more for wildlife conservation. In Kas, they want to pay more for better tourism facilities followed by wildlife conservation. Compared to Chandoli (10%) and Koyana (11.94%) tourists who are not willing to pay are more in Kas (21.5%).

Many resorts are present in Koyna (15) and Kas (40). Only one resort is there in Chandoli. Therefore, compared to Chandoli, tourism at Koyana and Kas is more developed. Bamnoli is a part of Koyana WLS having tourism locations like Vasota fort. Village Bamnoli is situated around 40 km away from Kas plateau.

Resort information at study sites:

Table 6.5: Detailed information of resorts

Study site	No. of resorts surveyed	People working	Belongs to (city/village)	Total price /person /day(Rs.)	Services provided	Drawbacks of tourists
Chandoli	1	14	Manadur	3000	Restaurant, jungle safari, tourism package	Bring alcohol
Koyana	6	73	Patan, Koyna nagar, Navja, Humbarli, Gokul, Mirgaon, Rasati	2500	Conference hall, restaurant, jungle safari, tourism package	Noisy, bring alcohol, unaware of what to expect from the place
Bamnoli	3	7	Bamnoli, Pavshewadi, Palni	1500	Conference hall, restaurant, tourism package	Leave behind waste, bring alcohol
Kas	10	50	Satara, Kas, Kasani, Ekiv	2000	Conference hall, restaurant, guide	Noisy, leave behind waste, bring alcohol

Perception of Forest department on tourism:

Sahyadri Tiger Reserve: This includes Chandoli, Koyana, Helwak and Bamnoli ranges. Around 350-400 people work in Chandoli and Koyana. Key mandate is tourism and revenue. Maximum no. of people belongs to Satara, Sangli and Kolhapur. Main tourism facilities managed are Tourism area, Awareness programs and Cooperation with tourists. Main tourism locations managed by this forest department are Janicha aamba (Chandoli), Ozarde waterfall and Ramban nature trail (Koyana), Vasota fort etc.

Entry fees for all the places keep changing. Recently for Chandoli NP and Ozarde waterfall entry fees are Rs. 30/- only. The facilities provided by FD are Interpretation Centre, Guides and Souvenir shops. According to the Forest Department, the tourists are noisy, they leave behind waste, bring alcohol and create ruckus and some people are totally unaware of what to expect from place. Tourists wants to see Tiger, Leopard, Gaur, Sloth bear, Birds, Rare trees, flowers, butterflies and beauty of landscape into the wild. Most of them do not know about Koyana toad and Malabar giant squirrel. According to Forest department, the entry fees for the park are just right and Road & access, availability of local guides are average. Implementation of rules and activities like trekking, bird watching are good and information material is good in case of Chandoli and Koyana.

Table 6.6: Revenue generated at Chandoli NP

Sr. No.	Years	Revenue (Rs. In lakhs)
1.	2007-08	0.35
2.	2008-09	0.36
3.	2009-10	0.65
4.	2010-11	1.07
5.	2011-12	1.27

Table 6.7: Revenue collected by Koyana forest department

Year	2014	2015	2016	2017
Month	**Revenue (Rs. In lakhs)**			
Jan	-	0.11	0.01	0.13
Feb	-	0.06	0.01	-
Mar	-	0.02	0.01	0.02
Apr	0.09	-	0.04	-
May	0.11	-	0.02	-
Jun	0.07	0.66	0.23	-
Jul	1.07	1.99	6.48	-
Aug	1.96	3.17	0.58	-
Sep	0.62	0.47	0.45	-
Oct	0.13	0.34	0.46	-
Nov	0.18	0.02	0.14	-
Dec	0.13	0.02	-	-

Helwak range: Around 42 people work in Helwak. Key mandate is religious. Maximum no. of people belongs to Patan city and nearby villages like Dastan, Rasati etc. Main tourism location managed by this forest depart is Bhairavnath temple.

Entry fee is Rs. 30/- only. (Vehicle- Rs. 150/- Child- Rs. 15/- and Guide- Rs. 100/- only). The facilities provided by FD is Guide. According to the Forest Department, the tourists bring alcohol and create ruckus but very few people do this because it's a temple. People mostly visit this place for religious purposes. Tourists wants to see Gaur, Sloth bear and Sambar into the wild. Most of them don't know about Koyana toad and Malabar giant squirrel. According to Forest department, the entry fees for the temple are just right. Road & access, Implementation of rules Activities like trekking, bird watching and information material are poor and local guides are not trained properly.

Revenue collected by Helwak range office includes entrée fee, guide fee and vehicle fee.

Table 6.8: Revenue collected by Helwak range office

Year	**2015**	**2016**	**2017**
Month	**Revenue (Rs. In lakhs)**		
Jan	-	0.05	0.06
Feb	-	-	0.07
Mar	-	0.07	-
Apr	-	0.04	-
May	0.09	0.04	-
Jun	0.02	0.01	-
Jul	-	-	-
Aug	-	-	-
Sep	-	-	-
Oct	0.03	-	-
Nov	0.08	0.05	-
Dec	0.08	0.10	-

Bamnoli range: Around 27 people work in Bamnoli. Key mandate is capacity building. Tourism in Vasota fort should increase. Maximum no. of people belongs to Satara district. Main tourism locations managed by this forest depart are Vasota fort, Nageshwar temple, Parvat, Chakdeo, Mahimgad, Shembdi math etc.

Entry fee is Rs. 30/- only. (College student- Rs. 20/- Vehicle- Rs. 150/- Camera fee- Rs. 50/- and Guide- Rs. 300/- only). The facilities provided by FD are Souvenir shops and guides. According to the Forest Department, there are no complaints from tourists. Tourists want to see Tiger, Leopard, Malabar giant squirrel, Sloth bear and almost every animal including Amphibians and reptiles into the wild. According to the Forest department, the entry fees are very cheap. Road & access is average. Availability of local guides, implementation of rules, activities like trekking, bird watching and information material are good. Vasota fort is closed for tourists between 16 June to 15 October. The entrée fees were started since 2001-02. Tent facility by forest department was started from 2005-06. Camera fees were started since 2012-13 and guide system was started from 2013-14.

In Bamnoli, maximum revenue is collected in the month of December.

Table 6.9: Revenue collected by Bamnoli range office

Year	2014	2015	2016	2017
Months	**Revenue (Rs. In lakhs)**			
Jan	0.41	-	0.95	-
Feb	0.61	-	0.64	0.86
Mar	0.35	-	0.59	0.69
Apr	0.34	0.53	0.29	0.27
May	-	0.22	0.07	0.19
Jun	-	0.09	0.02	0.01
Jul	-	-	-	-
Aug	-	-	-	-
Sep	-	-	-	-
Oct	-	0.50	0.22	-
Nov	-	0.91	0.84	-
Dec	-	1.06	1.39	-

Radhanagari wildlife sanctuary: Around 60 people work in Bamnoli. Key mandate is to promote ecotourism to conserve forest. FD need the protection of Biodiversity. Maximum no. of people belongs Radhanagari and nearby villages. Main tourism locations managed by this forest department are Rautwadi waterfall, Thakyacha wada, Konkan darshan and two dams.

Entry fee is Rs. 30/- only. The facilities provided by FD are Interpretation Centre, Jungle safari and Tourism package. According to the Forest Department, tourists leave behind waste. Tourists wants to see Tiger, Leopard, Gaur, Rare trees, flowers, butterflies and beauty of nature the most. They don’t know about sloth bear, Koyana toad and Nilgiri wood pigeon. According to the Forest department, the entry fees are very cheap. Road & access and activities like trekking, bird watching are good. Availability of local guides, and implementation of rules are average and information material is poor.

Kas plateau: Kas tourism officially started since 2012 (when the site was declared as world heritage site). The entrée fees till 2015 was Rs. 10/- per head. Since 2016 Satara forest department has increased the fees as Rs. 100/- per head.

Total 4 villages were included in the Village Development Committee at Kas plateau (Kas, Ekiv, Atale, Kasani). Now they have included two more villages. Therefore, these six villages will be getting the benefits from tourism revenue. From the VDC, villagers are getting LPG and solar lamps.

Table 6.10: Revenue collected by Satara forest department- Kas tourism

Year	Revenue (Rs. In lakhs)
2010	0.06
2011	0.14
2012	11.64
2013	18.53
2014	14.36
2015	21.38
2016	116.38

Perception of NGOs and Tourism agencies on tourism:

1) Paryavaran Dakshata Mandal, Thane

Total manpower of the NGO is 25. Key mandate is educational awareness on environment. Main tourism facilities managed are Local nature trails for students and professionals, Nature camps for professionals and enthusiastic.

Table 6.11: Revenue (in lakhs) collected by NGO (Paryavaran Dakshata Mandal, Thane)

Year	PDM	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2014	Revenue	-	-	-	-	-	-	0.12	-	0.45	0.45	-	-
2015		-	-	-	-	-	-	-	-	0.45	0.45	-	-
2016		-	-	-	-	-	-	-	-	0.45	0.24	-	-

Services provided by NGO are boarding facility, food, guides and tourism package. According to the tour operator, tourists are totally unaware of what to expect from the place. They have the intention for picnic. Here they want to see Frogs, toads and reptiles, birds, rare trees, flowers, butterflies, beauty of the landscape etc. The entry fees are just right and all the facilities like road and access, availability of local guides, implementation of rules, activities such as trekking, bird watching, information materials are poor.

2) Vihang Travels, Mumbai

Total manpower of the tourism industry is 3. Area of operation is all over Maharashtra including Kas plateau. Main tourism facilities managed are Package tours including transportation, accommodation and food, safari in various national parks, sanctuaries and reserves.

Table 6.12 Revenue (in lakhs) collected by tourism industry (Vihang travels, Mumbai)

Year	Vihang	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2014	Revenue	-	-	-	-	-	-	-	-	1	-	-	-
2015	Revenue	-	-	-	-	-	-	-	-	0.88	-	-	-
2016	Revenue	-	-	-	-	-	-	-	-	0.48	-	-	-

According to the tour operator, tourists are totally unaware of what to expect from the place. They leave behind waste, bring alcohol and create ruckus. Here they want to see Tiger, Leopard, Gaur, Malabar giant squirrel, Frogs, birds, rare trees, flowers, butterflies and beauty of the landscape etc. The entry fees are just right. Facilities like road and access is good. Availability of local guides is average. Implementation of rules is poor. Activities such as trekking, bird watching and information materials are not being provided.

6.7 Discussion

Comparative analysis of Tourists, Resorts and Forest department:

Chandoli National Park: In Chandoli, resort owners have a complaint against tourists saying that they bring alcohol and create ruckus. Majority of tourists and resort owners think that the entry fees are just right. But people think that the rates of resorts are expensive.

Table 6.13 Quality assessment of services at Chandoli National Park

Services (Chandoli)	Tourist	Resort owner	Forest department
Road and access	Good	Good	Good
Availability of local guides	Poor	Poor	Good
Implementation of rules	Excellent	Good	Good
Activities	Average	Good	Good
Information material	Poor	Good	Good

Koyana Wildlife Sanctuary: In Koyana, resort owners have complaints such as noisy, bring alcohol and totally unaware of what to expect from the place. Majority of tourists and resort owners think that the entrée fees are just right.

Table 6.14 Quality assessment of services at Koyna Wildlife Sanctuary

Services (Koyana)	Tourist	Resort owner	Forest department
Road and access	Good	Poor	Average
Availability of local guides	Poor	Very poor	Average
Implementation of rules	Good	Average	Good
Activities	Average	Poor	Good
Information material	Poor	Very poor	Poor

Kas plateau: In Kas, resort owners have complaints such as noisy, leave behind waste, bring alcohol etc. Majority of resort owners think that the entrée fees are expensive, but tourists think that the entrée fees are just right.

Table 6.15 Quality assessment of services at Kas Plateau

Services (Kas)	Tourist	Resort owner	Forest department	NGO
Road and access	Good	Average	Average	Poor
Availability of local guides	Poor	Average	Good	Poor
Implementation of rules	Very poor	Average	Good	Poor
Activities	Average	Average	Good	Poor
Information material	Poor	Average	Good	Poor

Perception of tourists, forest department and resort owners towards tourism was studied in this particular study. Above three tables represent the opinions of the stakeholders in Chandoli, Koyana and Kas. These views are helpful for getting the information that which of the services need improvement. Tourism will be beneficial for both the local communities and tourists if the carrying capacity of that place is maintained. Kas is an example of not taking care of the carrying capacity on the plateau. A study by (Patil, 2008) was done on environmental carrying capacity and tourism development in Maharashtra at two sites. Author explained why it is important to maintain a carrying capacity of any place. Tourism experience, accommodation and transport of tourists as well as biodiversity of that place are adversely affected by beyond carrying capacity tourism.

The attitude towards conservation of nature is measured by individuals' willingness to pay. A study by (Bhandari, 2009) showed that willingness to pay is determined by the level of education and income of tourists. In the current study, there is no correlation observed in education qualification of tourists and awareness about the UNESCO site. There is no correlation as well in the monthly income of a tourist and their willingness to pay for the better tourism facilities, wildlife management and local communities. Direct economic benefits due to tourism are observed at Kas plateau. In case of Chandoli and Koyana, all the local people are not getting any benefits. Few of the people have resorts and hotels for the tourists. Only those are getting income from tourism. Rest of the people are not dependent on tourism as one of the incomes. A study by Hampton in 2005, examined relationships among host communities, their local heritage sites and tourism management structures. Author suggested that involvement of local people in the tourism management will be beneficial for the conservation of that particular site. If the local people get benefited from the tourism, then they are concerned about the conservation of that place.

WHS designation has brought both positive and negative impacts upon local communities in/around WHS (Jimura 2011). It caused the shift of local industry from the mixture of agriculture, construction and forestry, which had been declining, to tourism, and enhanced the level of local people's pride. On the other hand, it caused the invasion of tourists into local people's life, weakened the feel and spirit of local communities, which led to a split between the WHS and its surrounding areas. Moreover, ironically, the level of conservation seems to have decreased after WHS designation, despite a WHS status. A policy was framed in 2012 allowing only 200 vehicles a day on Kaas Pathar, as the plateau is locally known. A parking lot was also planned at the base of the hill. But since the road leads to Kaas and Bamnoli villages, as also the popular tourist hill-town of Mahabaleshwar, any attempt by the short-staffed forest department to curtail the entry of vehicles proved futile. In fact, until three years ago, cars even used to drive over the flower beds, until environmentalists had fences put up. “Vegetation trampling is the biggest threat faced by the plateau. Added to this, there is a lot of solid waste generation and pollution due to growing tourism,” says Agarwa Tourism at Kas has been impacted in three ways

1. The first factor is the scale and pace of tourism development since WHS designation. Overall, tourism development since the designation has been too large and too rapid in both good and bad terms. This tourism development includes an increase in the number of businesses, and more variety of businesses, as well as an increase in the number of tourists.

2. The second factor is the level of appeal of a WHS status for domestic tourists as most tourists visiting in/around WHS Ogi-machi are Japanese. 3. The third factor is local people's attitudes to wards conservation of the cultural environment and a WHS status. Most local people still do not understand the significance of the cultural environment, especially the surroundings of gassho-style houses, and what a WHS status means.

Chapter Seven:

Indicator species approach- A potential method for monitoring Outstanding Universal Values of Sahyadri Tiger Reserve and Radhanagri Wildlife Sanctuary

Ecosystem is one of the many factors that affect human well being, making it challenging to assess linkages between humans and the services provided by ecosystem, Various methods are available to assess ecosystem condition and trends, and support policy decisions that involve tradeoffs among ecosystem services. Some of them are; a) Inventories of Ecosystem Components, b) Use of remote sensing and Geographic Information Systems, c) Numerical simulation models, d) Indigenous, traditional and local knowledge, and e) Indicators of ecosystem condition and services (Millennium Ecosystem Assessment 2005). In this chapter we have focussed exclusively on Indicator species approach to assess the ecosystem condition and its effect on services like that of water.

7.1 Indicator Species Approach

Animal species have been used for indicators for decades to collect information about the many regions. Vertebrate are used as potential indicator species to look at population trends and habitat quality (Landreset et al. 1988).

Indicator species are those that show a measurable change or response to any environmental change. Indicator species are also known as sentinel organisms, i.e. organisms which are ideal for biomonitoring. Such species do not die off immediately; rather show a considerable decline in their population.

The concept and use of indicators, particularly indicator species, has received increasing attention for application in ecologically sustainable forest management (Landres et al., 1988; Noss, 1990; McKenney et al., 1994). The concept is potentially important given the impossibility of managing the huge array of taxa that inhabit forest ecosystems (Margules and Lindenmayer, 1996).

An indicator species defines a trait or characteristic of the environment. Indicator species can be among the most sensitive species in a region for changes in the environment, and sometimes act as an early warning. For long term monitoring of the Outstanding Universal Values (OUVs) of Sahyadri Tiger Reserve, we chose locally abundant species, whose biology is well known, from three different taxa as indicators of ecosystem.

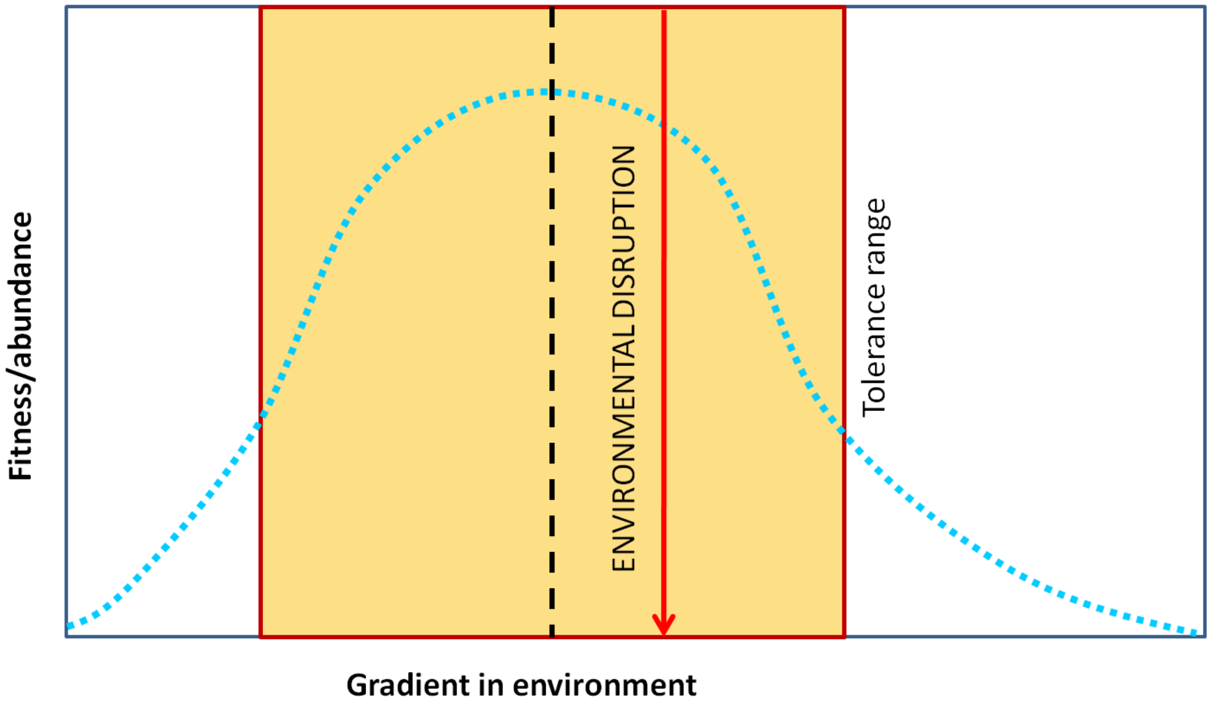


Figure 6.1 Response of an Indicator species to Environmental changes

In this chapter we have focussed on three groups; Malabar Giant Squirrel (Mammal), Nilgiri Wood Pigeon (Bird) and Koyana toad and Amboli toad (Amphibian) that are selected as ‘candidate indicators’ that support ecosystem services in direct and indirect ways. The species selected have an IUCN status varying from Least concern (for Indian giant squirrel), Vulnerable (for Nilgiri woodpigeon), Endangered (for Koyna toad), to critically endangered (for Amboli toad), but the current population status of the four selected species is declining (as per IUCN red data list). This is the first attempt to use species as potential indicator value of the ecosystem services in a World Heritage Site in India.

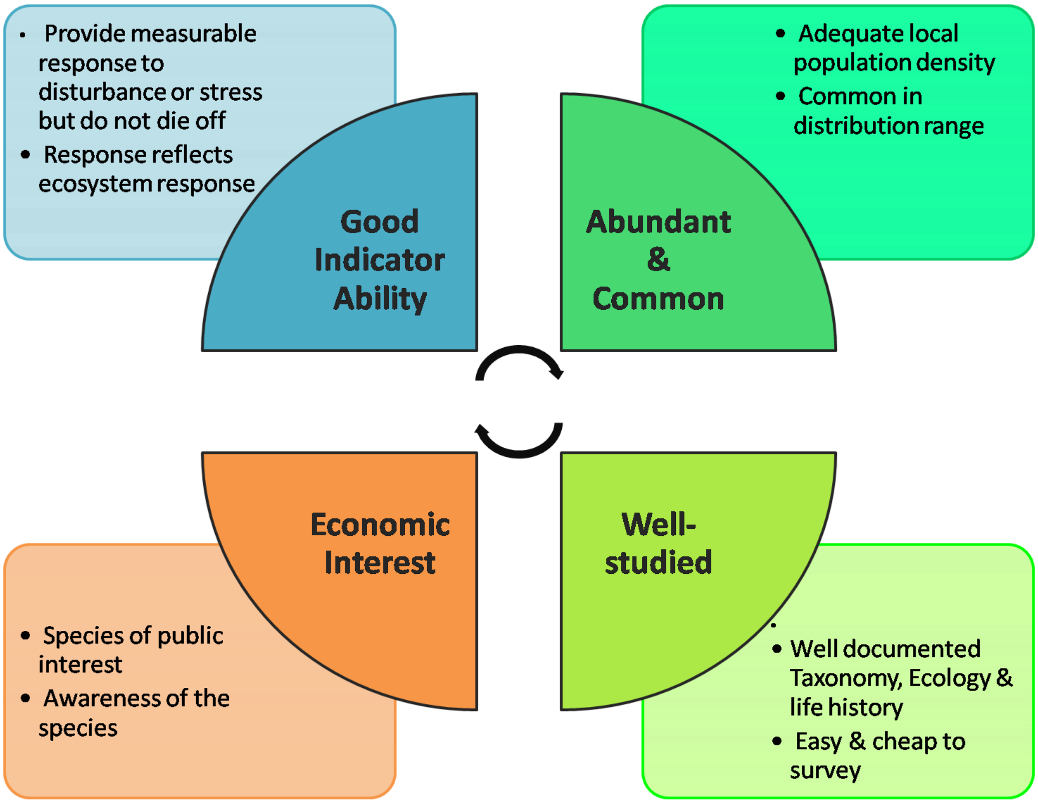


Figure 7.2 Characteristics of Biological Indicators. Source: Holt & Miller 2011

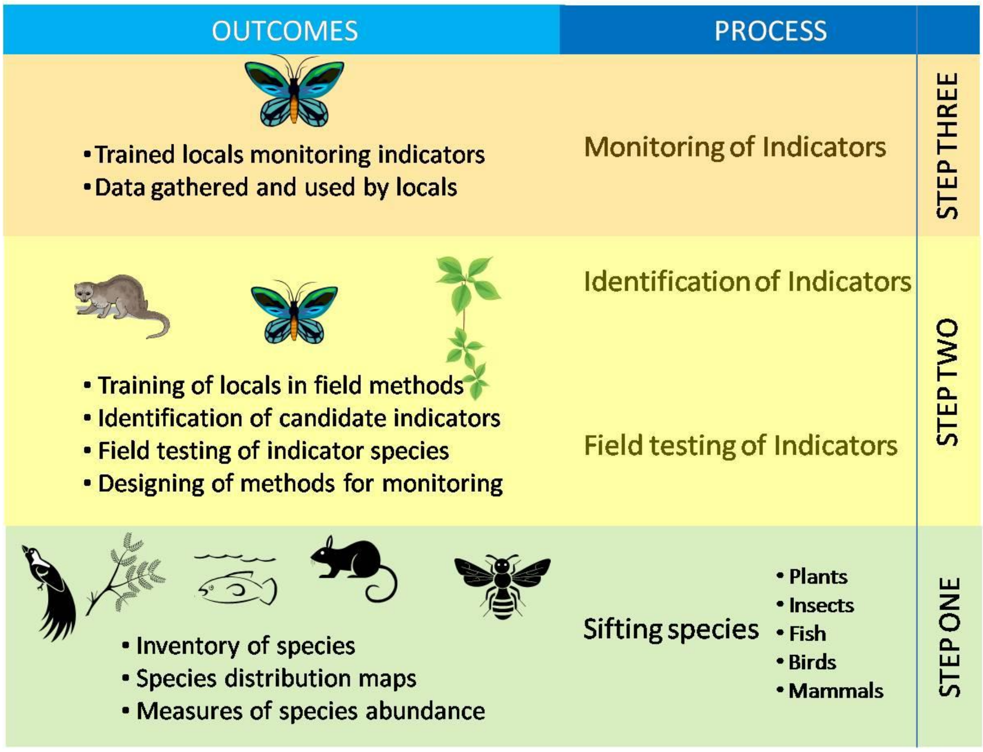


Figure 7.3 Framework for identification of Biological Indicator Species

7.2 Indian Giant Squirrel - *Ratufa indica indica*

Classification

Local Name – Shekru

Kingdom – Animalia

Phylum – Chordata

Class – Mammalia

Order – Rodentia

Family – Sciuridae

Genus – *Ratufa*

Figure 7.4 *Ratufa indica indica* (Indian giant squirrel)

Conservation Status – Schedule – II, according to wildlife (Protection) act, 1972 and classified as Least Concern (LC) by the IUCN.

Distribution

The Indian giant squirrel is endemic to India. They found in deciduous and most evergreen forests of peninsular India. They also found in Satpura hill range of Madhya Pradesh and Maharashtra.

Habit and habitat

The Indian giant squirrel, or Malabar giant squirrel, (*Ratufa indica*) is a large tree squirrel species genus *Ratufa* native to India (Abdulali and Daniel 1952). It is a large-bodied diurnal, arboreal, and herbivorous squirrel found in South Asia. It is called 'Shekru' in Marathi and is state animal of Maharashtra.

The species is endemic to deciduous, mixed deciduous, and moist evergreen forests of peninsular India, reaching as far north as the Satpura hill range of Madhya Pradesh.

Indian giant squirrel is omnivorous, they feed on fruits, flowers, nuts, bark, bird eggs, and insects. They prefer tall profusely branched trees for the construction of nests. It generally stays high in the forest canopy, rarely leaving the trees. Using its long tail for stability, this squirrel can leap from tree to tree. The Giant Squirrel's large tails used for balancing, and allowing it to move quickly, running and jumping on surprisingly thin branches very high in the forest.

Behaviour and Ecology

The species is shy in nature and is found living alone or in pairs. They travel from tree to tree with jumps of up to 6 meters. They are mostly active in the early hours of the morning and in the evening, and resting in the midday. They build large globe-shaped nests of twigs and leaves, placing them as possible in the trees. They also used tree holes as shelter. An individual will often have 2 to 5 nests in a small area of forest which are used as sleeping quarters, with one being used specifically for giving birth and nursing the young. Breeding occurs throughout the year, or several times during the year. Males actively compete for females during the breeding season and pairs may remain associated for longer periods of time. Average number of offsprings is 1 or 2. The gestation period is between 29 to 35 days. The average lifespan of Indian giant squirrel is 20 years.

The species is not tolerant of habitat degradation and does not occur in plantations. It is found to occupy high canopy (Molur et *a*l. 2005). The age of first reproduction for a female is around three years, four years for a male. Age of last reproduction is about 12 years in the wild (older females observed with pups).

Threats

Indian giant squirrel is a Schedule – II animal, according to wildlife (Protection) act, 1972 and classified as Least Concern (LC) by the IUCN (Molur 2016). Habitat degradation due to expansion of agro-industry based large-scale and small-scale plantation, monoculture plantation, clear felling, selective logging, construction of dam, hunting for local consumption have been observed to be the major threats for this species throughout its range (Molur et al. 2005).

7.3 Nilgiri Wood Pigeon, *Columba elphinstonii*

Classification

Kingdom: Animalia

Phylum: Chordata

Class: Aves

Order: Columbiformes

Family: Columbidae

Genus: *Columba*

Species: *C. elphinstonii*

Figure 7 *Columba elphinstonii* (Nilgiri Woodpigeon)

Distribution

Columba elphinstonii is endemic to the hill-ranges of the Western Ghats, south-west India, occurring from north-west Maharashtra south, through Karnataka and Goa, to southern Kerala and western Tamil Nadu.

The species is evolutionarily close to the Ceylon woodpigeon *Columba torringtoni* and the ashy wood pigeon *Columba pulchricollis* which form a clade that is basal within the Old-World genus *Columba*.

Habit and Habitat

The Nilgiri wood pigeon (*Columba elphinstonii*) is large pigeon found in the moist deciduous forests to moist evergreen and semi-evergreen forest, including densely wooded ravines and hollows ("sholas") of the Western Ghat, India. They are mainly frugivorous and forage in the canopy of dense hill forests. They are best identified in the field by their large size, dark colours and the distinctive checkerboard pattern on their nape.

Behaviour and ecology

Nilgiri wood pigeons are usually seen singly, in pairs or in small groups, feeding almost entirely in the trees but sometimes descending to the ground to forage on fallen fruits. Although feeding mainly on fruits they have been recorded taking small snails and other invertebrates. The breeding season is March to July during which time they make a flimsy platform of twigs and lay a single white egg which is usually visible from below the nest. They feed on large fruits and may play an important role in dispersal of the seeds of many forest trees. Fruits of the family Lauraceae are particularly favoured and most of their food is gathered by gleaning on the outer twigs of the middle and upper canopy. They have been recorded ingesting soil that may provide mineral nutrients or aid digestion. They often make movements within the forest according to the fruiting seasons of their favourite trees. Their call is a loud langur-like low-frequency hooting "who" followed by a series of deep "who-who-who" notes.

Threats

This pigeon qualifies as Vulnerable owing to its small, declining population which is a consequence of the widespread destruction of its forest habitat. It was once considered common and widespread, but has undergone a major decline, which is thought to be continuing owing to on-going forest loss (The Birdlife International Red Data Book 2001).

7.4 Xanthophryne spp.

Classification

Kingdom: Animalia

Phylum: Chordata

Class: Amphibia

Order: Anura

Family: Bufonidae

Genus: *Xanthophryne*

Species: *X. Koyanaensis* and *X. tigerinus*

Distribution

Derived from two Greek words, 'xanthos' meaning yellow, and 'phryne' meaning toad. The two species in the genus have only been reported from the northern part (Maharashtra) of the Western Ghats of India and are considered as point endemic species.

Xanthophryne Koyanayensis (commonly known as Chrome-yellow toad, Koyana toad) is a species of toad in the family Bufonidae. It is endemic to the Western Ghats of India where it is known from Koyana and adjoining areas in the Maharashtra state. Type locality is Shivaji Sagar lake at Satara district, in Koyana.

Xanthophryne tigerina, commonly known as the Amboli toad, is a species of frog. It is endemic to the Western Ghats of India and known only from the vicinity of Amboli in Maharashtra.

Figure 8 *Xanthophryne koynaensis* (Koyna toad)

Figure 10 *Xanthophryne tigerina* (Amboli toad)

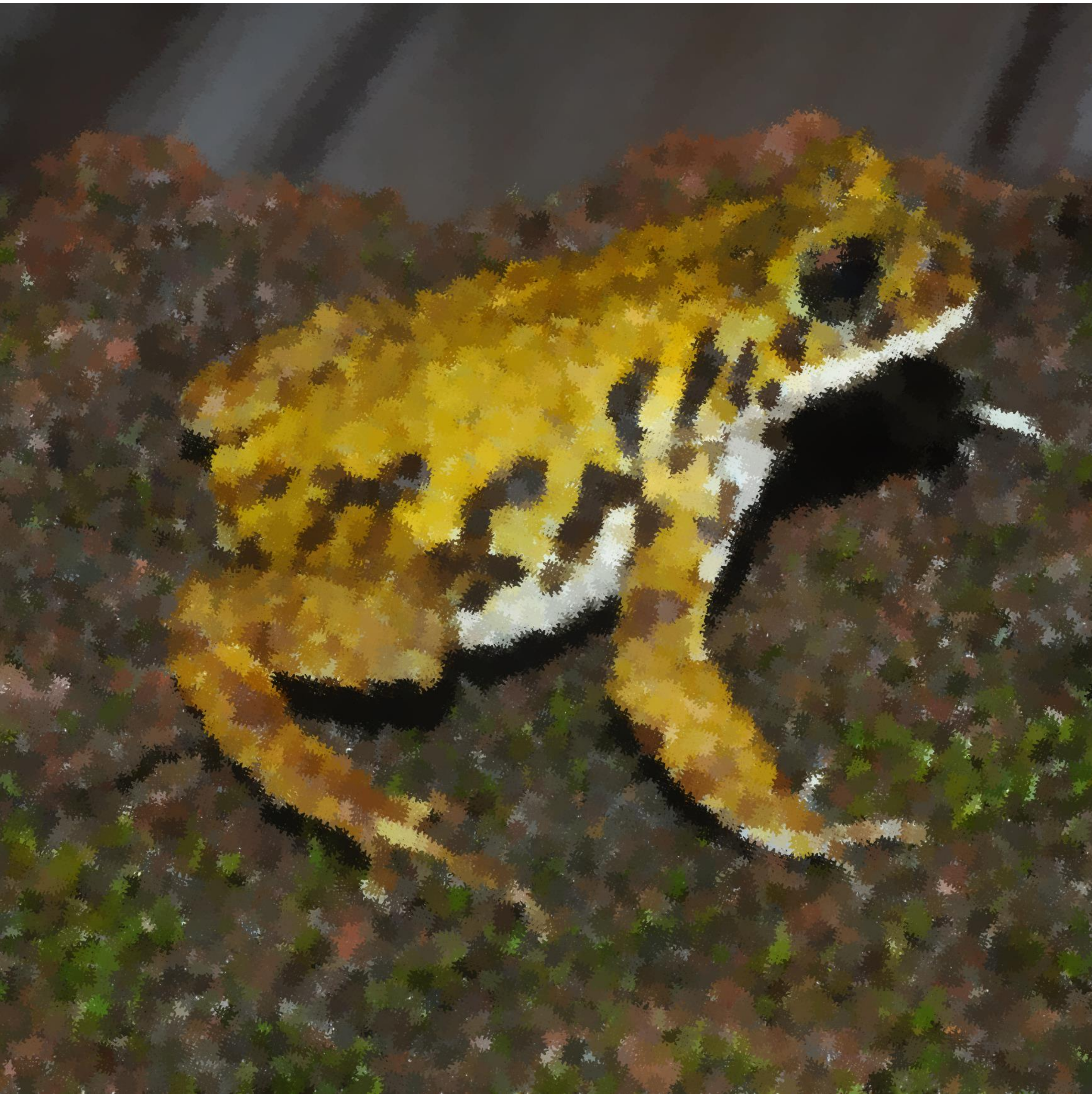
7.5 Indicator Species Approach in Management

The indicator species concept can make an important contribution to biodiversity conservation because of the impossibility of monitoring all taxa in species-rich forest environments. However, the concept needs to be tested by validating relationships between an indicator species and entities for which it is hypothesized to be indicative. Long-term monitoring is thus critical for assessing the indicator species to adapt best approaches to conservation in protected and unprotected forests. Indicator species approach can be helpful in following ways:

1. Stand level management strategies to create and maintain key structural and floristic attributes that form critical habitat components for wildlife (e.g. large living and dead trees),

2. Landscape level strategies to ensure the maintenance of landscape heterogeneity and connectivity, such as the establishment of networks of riparian protection zones and wildlife corridors

3. Landscape and regional level management involving the identification of potential sites for conservation. While the importance of monitoring is often discussed, more programs are needed to gather the data needed to inform the development of ecologically sustainable forest management practices.



Chapter Eight:

Monitoring OUV trends of Indicator species and Supporting Ecosystem services

The Western Ghats or 'Sahyadris' is home to some very unique flora and fauna. The biodiversity and terrestrial ecosystem of the Sahyadri and peninsular Indian landscape, are highly diverse supporting livelihoods providing invaluable ecosystem services and sustain millions of people in the world's highest concentration of humans in a biodiversity hotspot.

The Sahyadris is witnessing rapid developmental activities leading t habitat disturbance and degradation. Factors such as pollution due to industrial and agro expansion and tourism related development is shrinking more and more pristine habitats throughout the range. It is time now to get aware of such causes, find ways to reduce them and ensure continued survival of the unique living organisms found nowhere else other than the Sahyadris.

Aim of this chapter is to bring the consolidated results of methods deployed for assessing Indicator value of the selected vertebrate species as 'Candidate Indicators' in Sahyadri Tiger Reserve for long term monitoring of their population.

8.1 Objectives

I. Species distribution modeling for Indian Giant Squirrel, *Ratufa indica indica* and Nilgiri Wood Pigeon, *Columba elphinstonii* in Sahyadri Tiger Reserve and Radhanagri Wildlife Sanctuary fr long term monitoring of the species.

II. Individual identification of endemic toads in genus *Xanthophryne*. in Sahyadri Tiger Reserve and Radhanagri Wildlife Sanctuary for long term monitoring of amphibian populations.

8. 1.1 Objective I: Species distribution modelling of Malabar Giant Squirrel and Nilgiri Wood Pigeon

Data Collection

The locations for the two species *Ratufa indica* and *Columba elphinstonii* were collected by walking line transects in each beat of the study site. Apart from this, randomized walks were conducted on the forest trails, mostly during morning hours, i.e between 7:00 hrs to 10:00 hrs. Opportunistic evening surveys were also conducted based on the logistics and field conditions. Presence only data was collected for both the study species.

GPS etrex 10 was used to record coordinates for presence data for the two study species.

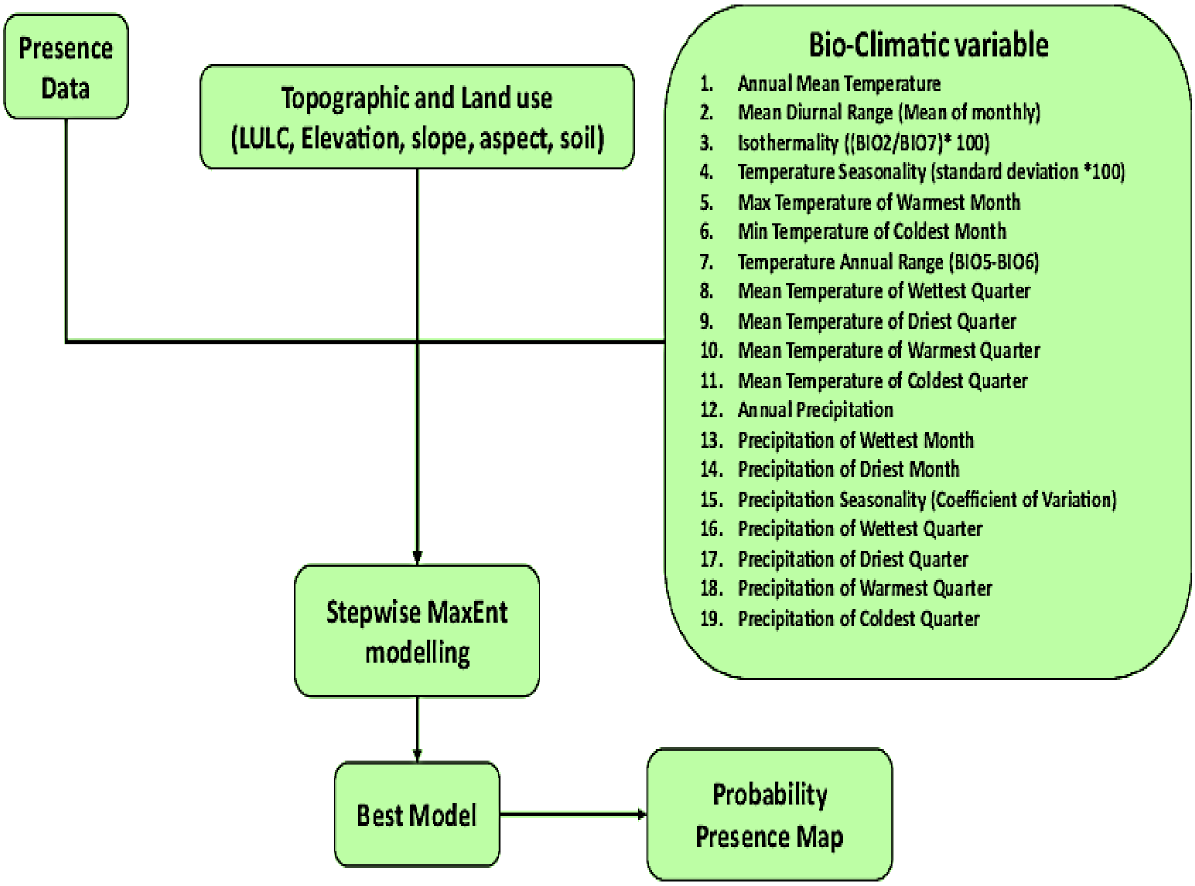


Figure 8.1 Flow diagram elaborating stepwise analysis for Species distribution modeling of *R. i. indica* and *C. elphinstonii*

Analysis

Species distribution and modelling suitable habitat are progressively more important subjects in ecology and conservation. In general, models provide a measure of the probability of presence, which can be used to define species spatial occurrence (Graham et al. 2004), assess impacts of climate and habitat change and enlighten conservation planning (Arau´jo& Williams 2000). In the recent past, species distribution models turn out to be one of the most recurrent tasks in conservation. In addition to that SDMs are becoming more accepted since most of the SDMs do not necessitate absence data (Jime´nez-Valverde, Lobo &Hortal 2008). Apparently, collecting data on population is much more complex task than simply recording the presence of the species in a particular area.

Availability of suitable habitat most often determines the patterns of distribution of the particular species (Coulon *et al*., 2004). As a result of discontinuity in suitable habitat, most species occur patchily across its distribution range (Koopman, 2007). Moreover, endemic species are restricted to specific areas with most being habitat specialists. Western Ghats in India, one of such hot spot for the endemic flora and fauna and recognized as a UNESCO's World Heritage Site. However, in the northern parts of Western Ghats the forest loss is relatively more compare to southern Western Ghats (Panigrahy et al. 2010, Northern Western Ghats State Report 2010). Rapid urbanization due to increase in developmental projects for highways, railways, power plants and mines have cleared away the forest cover in the region (Mehta and Kulkarni 2010, Northern Western Ghats State Report 2010). Despite that, Northern Western Ghats of Maharashtra play a vital role in the Zoogeography of India as it is in the forefront of the entire Western Ghats. However, unlike southern counterpart, the Maharashtra part of Western Ghats has not paid much attention from the researcher community possibly owing to its drier and fragmented landscape. The Western Ghats of Maharashtra are called 'Sahyadris,' containing four site elements in the state of Mahrastra. The Radhanagari Wildlife Sanctuary, Chandoli National Park, Koyana Wildlife Sanctuary and the Kas plateau form part of this Sahyadri sub-cluster with a total area of 1026.22 sq km. while Koyana wildlife sanctuary forms the northernmost limit to more typical flora and fauna of the evergreen forest biome of Western Ghats. In the present study we try to investigate the distribution patterns of two endemic species (Malabar Giant Squirrel *Ratufaindicaindica* and Nilgiri Wood Pigeon *Columba elphinstonii*) which address the canopy connectivity and fragmentation; as both the species prefer mid and upper canopy. The Nilgiri Wood Pigeon a canopy dwelling frugivorous bird and occupy a huge elevation gradient from ~50 m to 2000 m asl (Rasmussen & Anderton, 2012). There were few limited studies which address distribution and habitat preference of the species and only handful record of the species from northern Western Ghats (Gole, 1994a, b, 1998; Mahabal*et al*., 2011; Taware*et al*., 2012). Decline of this endemic species was reported by the IUCN due to loss of forest cover, shifting cultivation, collection of timber for fuel wood collection (Birdlife International, 2012). Similarly, Malabar giant squirrel is endemic to Western Ghats and reliant on the canopy connectedness for its survival. Apart from that, *R. indica* has five recognized subspecies distinguished on the basis of their pelage colour (Moore and Tate 1965). Here in our study we are specifically interested on the *Ratufaindicaindica*as this subspecies restricted its distribution in the Sahyadri-Konkan region of Maharashtra, Goa and northern parts of Karnataka Western Ghats (Prater 1980). The goal of habitat monitoring of the mentioned species is to track changes in the amount of habitat or quality of habitat in Sahyadri sub cluster which is also a part of the UNESCO's World Heritage Site part of Western Ghats.

Methods

Input data

We used 333 occurrence data of Malabar Giant Squirrel (collected by forest department year and present survey) after spatial filter of 2 km which comprises of presence location of both Sahyadri Tiger Reserve and Radhanagri Wildlife Sanctuary. However, for Nilgiri Wood Pigeon we used presence location provided by Koparde et al. (2016) from STR.

Environmental variable

To characterize landscape in the Sahyadrisubclusters, we drew fine-resolution Normalized Difference Vegetation Index (NDVI; UMD, 2001). Since NDVI provides an index to photosynthetic mass, which incorporates index over annual cycles, indicative of vegetation type, seasonality, and land use et al. 2002; Scharlemann et al. 2008). We used all 46, 16-day composite coverages for 2012–2013 NDVI data layers. To reduce the effect of multicollinearity in the distribution model we simplify the environmental space into fewer orthogonal dimensions using principal component analysis. For the model building we used 12 principal components which shows 90% of variation) along with the elevation data.

Model calibration

We used Maxent (version 3.4 k) to develop the distribution models, because of the robust nature and broad adoption of this algorithm (Elith et al. 2006). we used default settings for parameters such as prevalence, regularization multiplier, and density of background sampling, but created multiple replicate models and explored the implications of different combinations of environmental variables.

For both the species 25% of the data set was used to test the model accuracy and calibration. However, in case of NiIgiri Wood Pigeon we also validated the accuracy of our model using data collected from the present survey. Allouche et al. (2006) found that the theoretical and empirical evidence that kappa, one of the most widely used measures of model performance in ecology, has serious limitations that make it unsuitable for such applications. Hence, True Skill Statistics (TSS = Sensitivity + Specificity -1) which accounts for both sensitivity and specificity is therefore better suited than kappa for measuring performance of a method (Allouche et al. 2006).

Results

Malabar Giant Squirrel

Table 8.1 Jacknife results for Malabar giant squirrel

Malabar Giant squirrel (*Ratufa indica indica*)	
Over all accuracy	0.91
Sensitivity	0.98
specificity	0.91
TSS	0.90
AUC	0.78

Nilgiri Wood Pigeon

Table 8.2 Jacknife results for Nilgiri wood pigeon

Nilgiri wood pigeon (*Columba elphinstonii*)	
Over all accuracy	0.567946
Sensitivity	1
Specificity	0.5676
TSS	0.5676
AUC	0.88

Discussion

A species in an ecosystem contributes to biodiversity in terms of its genetic diversity and unhindered gene flow in the population and are classified as provisioning services of the ecosystem. The current distribution of both the common species (Indian giant squirrel and Nilgiri wood pigeon) clearly acts as an early warning to the managers to enact and implement strategies for protection of forest patches and conduct yearly census for long term monitoring of their population.

The forest department at Sahyadri Tiger Reserve and Radhanagri Wildlife Sanctuary is conducting a yearly census for *R. i. indica* past 2 years. For census of Indian squirrel, the forest guards walk line transects and forest trails so as to document direct sighting data and collect data on nests of this species. However, a monitoring protocol still needs to be put in place for estimation of population for bird diversity and population level studies in Sahyadri sub cluster.

The results of Species distribution modeling for *R. i. indica* and *C. elphinstonii* show a highly patchy distribution. The most suitable habitats are along the riparian forest patches, thus indicating the importance of clean water in an ecosystem and services provided by water; and the dense canopy patches also show suitable habitat for both species. Reason for the patchiness is due to the highly fragmented landscape undergoing continuous human pressures due to developmental activities; constructions of dams, wind mills, mining, road network, human settlements. The fragmented occurrence of sentinel species within the PA (with several locations outside) indicates the urgency to restore and maintain the connectivity between the PAs for long term survival of such species.

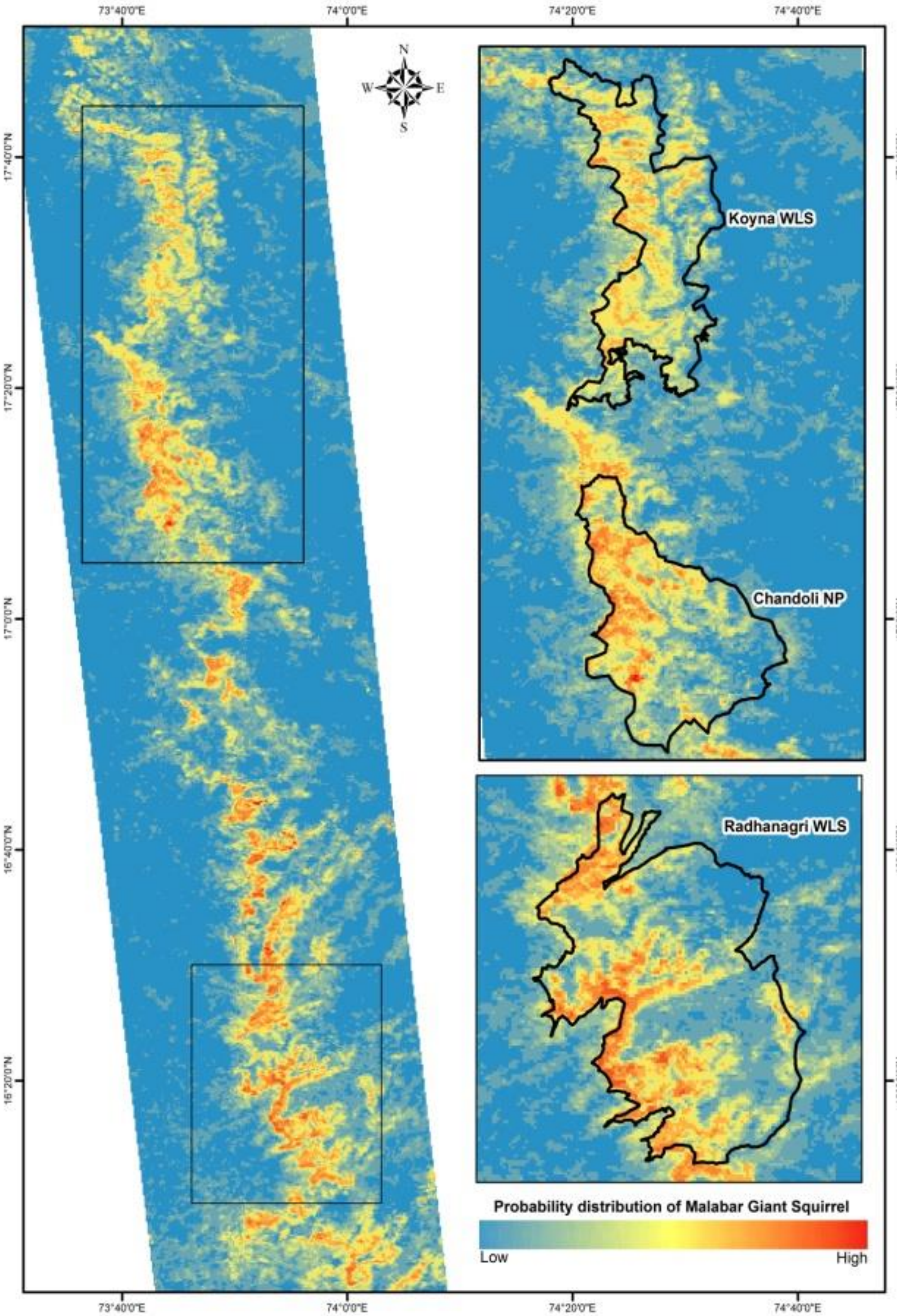


Figure 8.2 Probability distribution for Indian Giant Squirrel using MaxEnt modeling

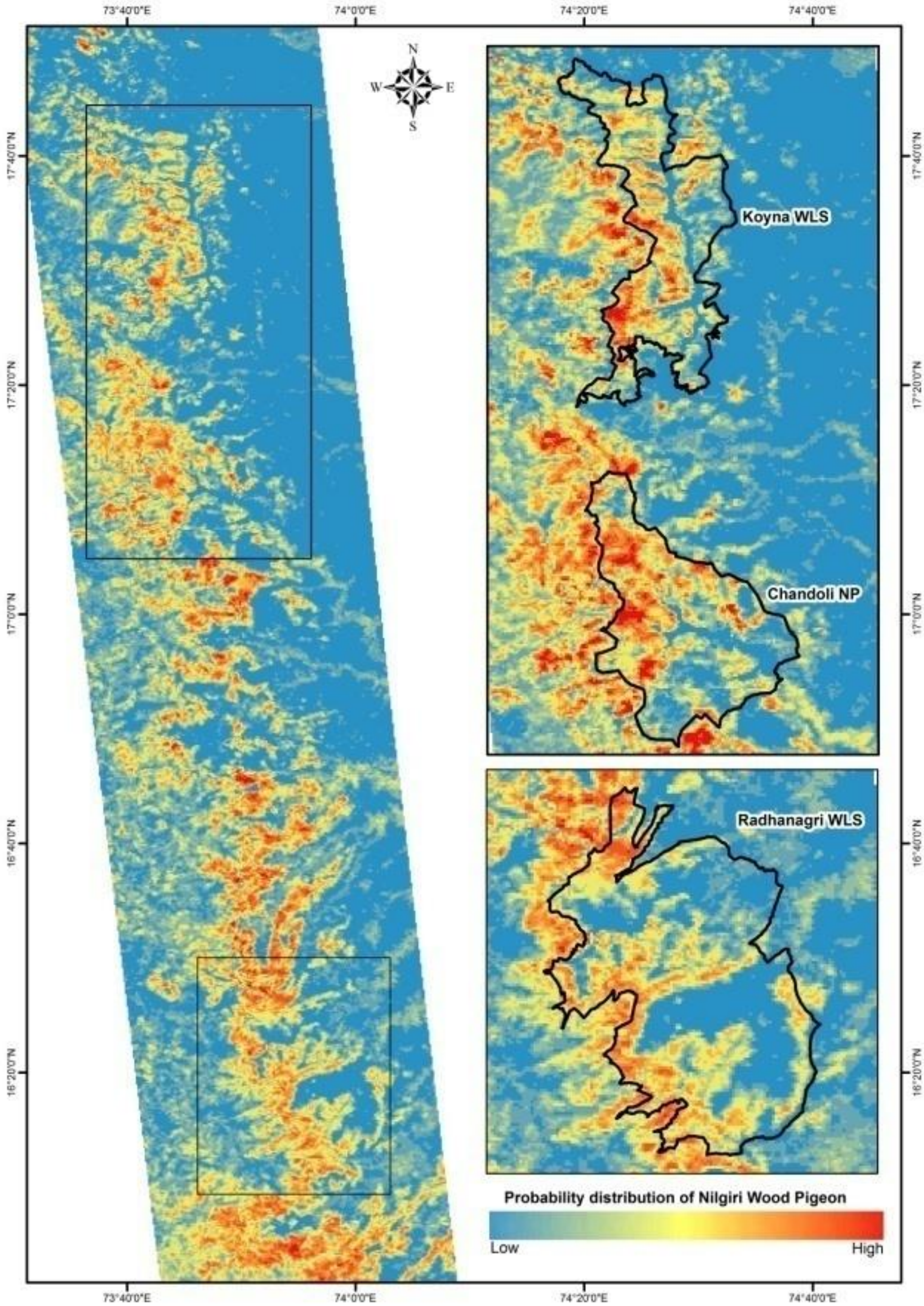


Figure 8.3 Probability distribution for Nilgiri Wood Pigeon using MaxEnt modeling

Recommendations

We propose some recommendations for maintaining diversity of species, Indicator species or otherwise, in fragmented landscape like Sahyadri Tiger Reserve and Radhanagri Wildlife Sanctuary.

1. Conduct a landscape level analysis for a longer duration to determine the pattern of habitats and connections at multiple spatial scales. Relating these factors to the native/endemic/indicator species in the landscape could help identify the major, non-fragmented blocks of habitat and if natural connections between habitats needs maintenance or restoration!

2. Evaluate the landscape of interest (Sahyadri sub-cluster) within a larger context from Western Ghats perspective. As Western Ghats is a Natural World Heritage site, and Sahyadri sub-cluster forms the Northern most limit, it is important to set conservation goals of this landscape at regional, national, and global scale.

3. Avoid any further fragmentation or isolation of natural areas. Development (dams, wind mills), resource extraction (bauxite mining) activities should be clustered and minimized so that large blocks of natural habitat remain intact.

4. Do not ignore the small fragments while conserving large, non-fragmented patches of habitat. Smaller areas are often useful as habitat for some species and as stepping stones for animal movement. Such areas may also be the last refuges for many species for maintenance of species population or may also act as sources for recolonization in a highly fragmented landscape (Turner and Corlett 1996).

5. Sahyadri sub-cluster is a matrix of different habitat types from private land holdings, villages, agriculture fields, wind mills, dams to severely fragmented patches of forests. In such scenario, do not write off non-forested cover as ‘non-habitat’ as animals do not understand human made boundaries. Opportunities do exist to maintain habitat conditions in such landscape matrix that may meet needs of native species in the region.

6. Try and manoeuvre human activities away from critical wildlife movement areas. This will help minimize edge effects around the remaining natural areas. This can be done by dedicating buffer zones to low intensity human use.

7. Ecotoursim may bring in a lot of economy to a National Park or Sanctuary. But it also brings in pollution, disturbance, non-native species which may impact the native species directly or indirectly. A regulated and directed tourism in specified areas (may not include all buffer areas and should also depend on species distribution) should be adopted for achieving ends of eco and tourism. Well trained staff should be deployed for such activities in the protected area. This will give jobs to many and also spread awareness among tourists.

8. Maintain native vegetation along streams, roadside, powerlines, and other corridor strips or fragmented areas of forest to minimize edge effects and human disturbance.

9. Northern Western Ghats has broadly dry deciduous, semi evergreen and evergreen forests. Mostly dominated by dry patches of forests, these fragments may suffer from fire regimes and often effect species occurrence and distribution. Active management is needed to maintain the native species of flora and fauna inhabiting these fragments.

10. Identification of potential corridor habitats for indicators; indicating contiguous arboreal habitat (species such as Ratufa indica indica), indicating dense canopy (species such as *Columba ephistonii*) and other criteria depicting health of the ecosystem, is a must. Although the species is fairly common across Western Ghats, it does not assure its long-term survival if no intervention is done for monitoring of indicator wildlife populations.

Implications for Managers and Decision-makers

Species distribution models are flexible tools which can be used to guide management and have direct implications in formulations of policies. In particular, distribution models can aid with individual species management plans and also identify potential habitat refugia and key regions for protection or corridors. For example, SDM's can be used to predict the value of future reserve areas and plan species translocations. However, lack of information on basic biology and ecology can impede SDM's for some rare and understudied species, and thus effort should be made to increase field studies on such species. Greater biological knowledge of species can also aid in the use of more robust mechanistic models. When used in combination with assessments of demographic viability (extinction risk) and spatial structuring of populations within the landscape (e.g. metapopulations), SDM's can be used for ranking alternative management options for climate change adaptation, and for conservation prioritisation.

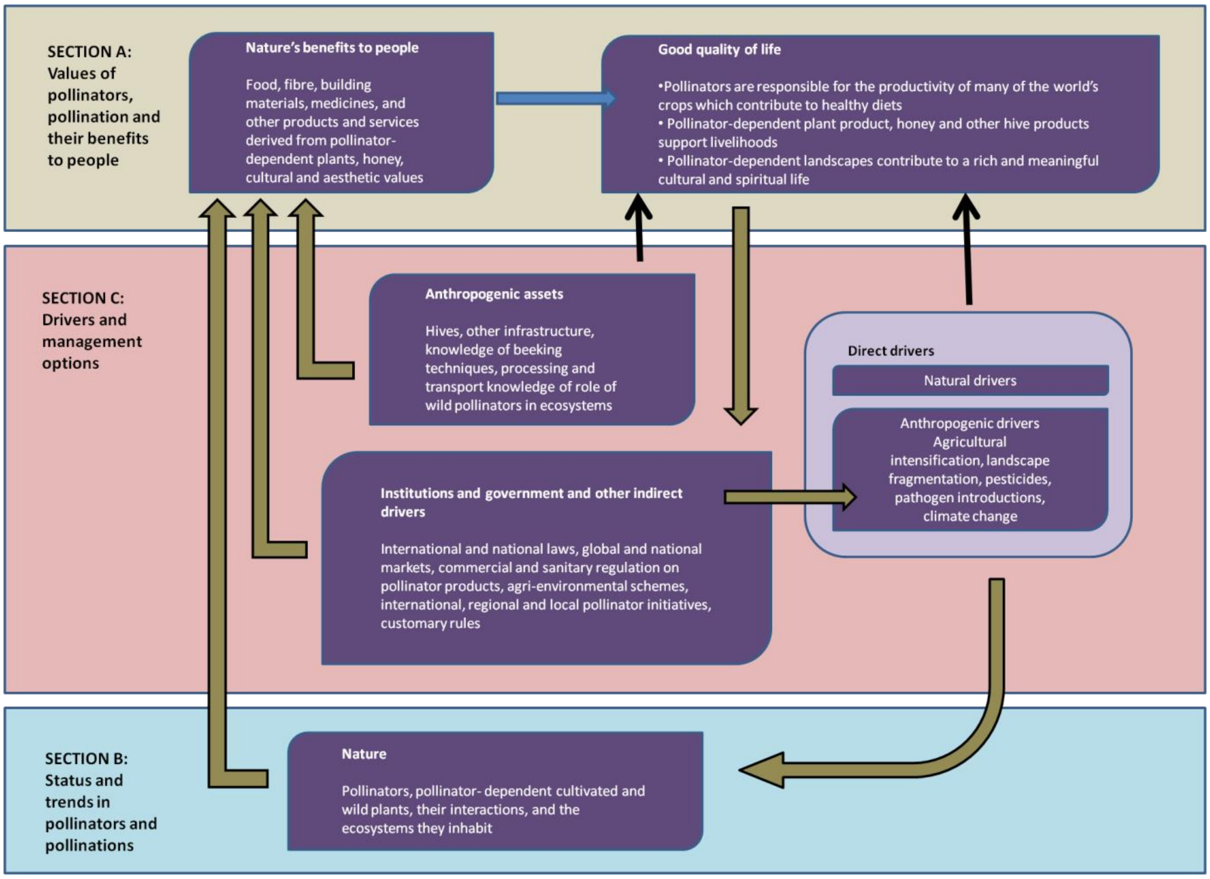


Figure 8.4 Illustration of the core concepts of pollinators useful for policymakers. Boxes represent main elements in nature and society and their relationships; thick arrows denote influence between elements; thin arrows denote links that are acknowledged as important, but are not the main focus.

8.1.2 Objective II. Individual Identification technique for *Xanthophryne* genus

The tropical semi-evergreen forests of the Western Ghats biodiversity hotspot have a rich assemblage of herpetofauna, especially amphibians (Daniels 1992; Bossuyt et al. 2004; Gunawardene et al. 2007). Although the ecology and behaviour of most anurans from the Western Ghats is largely unknown, many unique and extraordinary behaviours and adaptations in amphibians parallel this high amphibian diversity (Kunte 2004; Preininger et al. 2013; Gaitonde and Giri 2014; Crump 2015; Seshadri et al. 2015; Senevirathne et al. 2016). The Western Ghats region is tremendously diverse across length in climate, rainfall pattern, elevation, geology, topography, biota and landscape features (Prasad et al. 2009; Watve 2013). Many endemic anurans (frogs and toads) of the Western Ghats have narrow distributions and some are point endemics due to geographical barriers, specific niche requirements and habitat specialization (Vasudevan et al. 2001; Naniwadekar and Vasudevan 2006; Gunawardene et al. 2007; Van Bocxlaer et al. 2012). Toads are widely distributed and have attained a nearly cosmopolitan distribution (Pramuk et al. 2008; Van Bocxlaer et al. 2010). Their characteristic features, such as the parotoid glands, exotrophic tadpoles, large clutch size and ability to reproduce mostly throughout the year even in degraded habitats, have contributed to their success and enabled them to disperse, resulting in wide distributions (Saidapur 2001; Van Bocxlaer et al. 2010).

True toads (Bufonidae) arrived in India after the drifting Indian plate collided with Asia, facilitating biotic exchange with Laurasia (Van Bocxlaer et al. 2009). The lineages that dispersed into the Indian subcontinent diversified and gave rise to numerous endemic taxa (Biju et al. 2009; Van Bocxlaer et al. 2009). The northern Western Ghats turned out to be an excellent opportunity for diversification, as the volcanic eruptions that formed the Deccan traps during the Late Cretaceous wiped out the then contemporary biota, creating new habitats open for colonization (Widdowson and Cox 1996; Prasad et al. 2009; Watve 2013). One of the specialized genera that arose from the diversification of ancient lineages is the recently described genus *Xanthophryne* Biju, Van Bocxlaer, Giri, Loader and Bossuyt, 2009 (Biju et al. 2009). It is endemic to the northern Western Ghats and contains the sister species, *Xanthophryne Koyanayensis* (Soman, 1963) from Koyana and Xanthophryne tigerina Biju, Van Bocxlaer, Giri, Loader and Bossuyt, 2009 from Amboli, Maharashtra, India (Biju et al. 2009). Both species specialize on natural rocky outcrops, which are large expanses of exposed lateritic rock that host unique and fragile ecosystems with a large proportion of endemic flora and fauna (Watve 2013). Hence, they are integral landscapes that substantially contribute to the high levels of endemism in the Western Ghats biodiversity hotspot (Watve 2013). The rocky outcrops are patchily distributed and have cliffs at the edges and/or are surrounded by forests and have been aptly described as 'terrestrial habitat islands' (Watve 2013). The distinct microhabitat on rocky outcrops and their isolation exposes organisms to novel pressures that may lead to unique adaptations. An understanding of the biology of these toads will be useful – how they are specialized to a highly seasonal environment and the strategies they employ to overcome numerous biotic and abiotic challenges.

The study reports both the species of Xanthophryne; X. koyanayensis and *X. tigerinus* from Sahyadri Tiger Reserve. Earlier reported from Amboli, *X. tigerinus* is the first record from the protected area.

Xanthophryne can be distinguished from other bufonid genera by the combination of the following characters: small-sized adults (male SVL 26.5-32.9, N = 12; female SVL 33.3-35.3, N = 3) having light brown dorsum with a suffusion of dull chrome-yellow; head with discontinuous and weak canthal and preorbital ridges on the anterior part, flanks and sides of the abdomen have chrome-yellow patches, or sometimes 2-4 continuous bands; tympanum indistinct, rather weak parotoid glands; toes and fingers without webbing, tips rounded; eggs in clutches. Xanthophryne can be characterized in a phylogenetic framework as the most inclusive clade that contains *Bufo Koyanayensis* Soman, 1963 but not *Bufo melanostictus* Schneider, 1799 and *Bufo kelaartii* Günther, 1858.

The two species can be identified based on the differences in their morphological characters. Xanthophryne tigerinus can be distinguished from *X. Koyanayensis* by the following combination of characters: (1) medium size, male adult SVL 27.8-32.9, female adult SVL 33.3-35.3; (2) body rather elongate; (3) presence of discontinuous canthal and preorbital ridges; (4) stripes on lateral and dorsal side; (5) absence of webbing between fingers and toes.

Xanthophryne tigerinus (Add Figure) differs from X. Koyanayensis (Add Figure) by the presence of a denser arrangement of granular projections with horny spinules on dorsal and lateral parts of head, back and flank; more prominent canthal and preorbital ridges; snout longer than eye length (SL 4.0 ± 0.3 mm, EL 3.4 ± 0.5 mm, N = 5, male) vs. snout shorter than eye length (SL 3.3 ± 0.3 mm, EL 4.3 ± 0.2 mm, N = 7, male); shank longer than thigh (ShL 11.5 ± 0.6 mm, TL 9.9 ± 0.4 mm, N = 5, males) vs. shank about equal to thigh (ShL 11.1 ± 0.7 mm, TL 11.1 ± 0.8 mm, N = 7, male); foot length longer than shank and thigh (FOL 12.8 ± 0.6, N = 5, male) vs. equal to shank and thigh (FOL 11.2 ± 0.7, N = 7, male).

Data collection

Amphibians are obligate to their specific micro habitat. Similar case is with *Xanthophryne* sp. This species of toad has evolved on the lateritic, rocky plateaus that form a perfect microhabitat for the toads by providing them with water puddles for breeding during monsoons, lateritic rocks as refuge and insects to feed.

Minimum one plateau from each range; Bamnoli, Chandoli, Dhebewadi, Koyana and Radhanagri and Dajipur, were surveyed for the presence of the species in non-rainy and rainy seasons.

Xanthophryne sp. have a distinct lateral pattern, similar to stripes found in tigers, thus we recorded photographic shots of the species for individual identification based on unique body patterns.

The toads were photographed using Nikon DSLR with tamron macrolens of 90 mm. Lateral and dorsal shots were taken of each toad at a minimum distance of 10-15 cm. We also collected morphometric data (Snout vent length, Snout length, Tibia length, Eye diameter) using Mitutoyo vernier calliper (having precision of 0.01 mm) which can be used as a potential tool for population level studies over long term (see Appendix). Put hygrometer model and Pesolawt.

We recorded a total of 151 individuals of *Xanthophryne tigerinus* on Zohlambi (N=101) and Valmiki plateau (N=50) which form part of Chandoli National Park. For *Xanthophryne koyanaensis* we recorded 35 individuals from Dicholi plateau of KoyanaWilldife Sanctuary.

Analysis

A dataset with 453 photographs for *Xanthophryne tigerinus* was used for individual identification using Hotspotter software. This software is fast and fairly accurate for indentifying individual animals based on their body markings. Photos of *X. Koyanaensis* were not used as the species doesn'tshow a distinct marking on its lateral sides. However, dorsal warts may be used for the purpose of identification of individual toads.

What is Hotspotter?

HotSpotter is a fast and accurate algorithm software foridentifying individual animals against a labelled database. It is not species specific and has been applied to a variety of animal such as zebras, giraffes, leopards, and lionfish.

How Hotspotter works?

The software analyses the images using two approaches, both based on extracting and matching keypoints or "hotspots". The first approach tests each new queryimage sequentially against each database image, generating a score for each database image in isolation, andranking the results. The second, building on recent techniques for instance recognition, matches the query imageagainst the database using a fast nearestneighbor search. Ituses a competitive scoring mechanism derived from the Local Naive Bayes Nearest Neighbor algorithm recently proposed for category recognition (ref).

HotSpotter uses in each image, a region of interest (ROI) and orientation to generate a chip. Within these chips HotSpotter computesits hotspots—elliptical regions centered on points of interest that HotSpotter automatically detects. Two chipshaving enough hotspot similarity will be matched successfully by HotSpotter

Getting started with Hotspotter

The data for 151 individuals was analysed using the following steps:

1. Open hotspotter software
2. Go to ‘File’. Select ‘New Database’ [Ctrl +N]

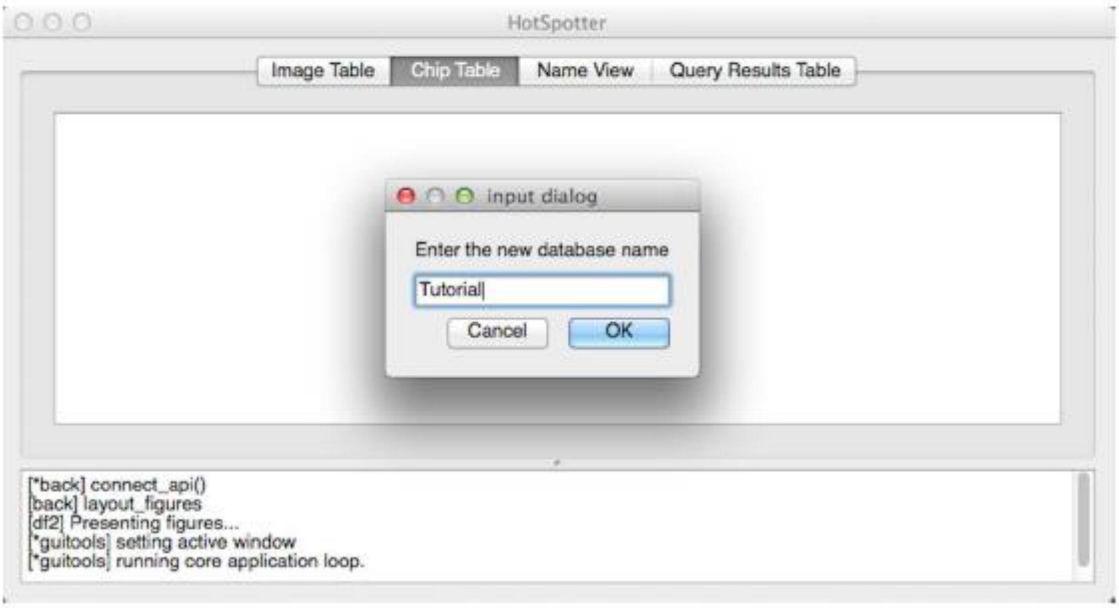


Figure 8.5 setting the directory for using Hotspotter

3. Select the working directory
4. Import images by selecting File->Import images. The imported images can be seen under ‘Image Table’.

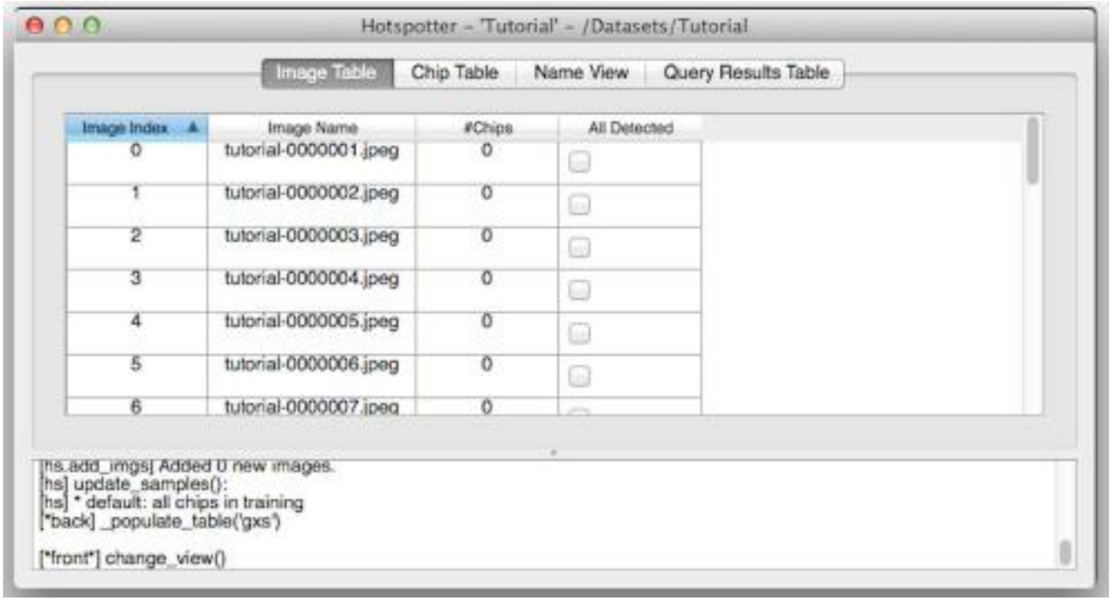


Figure 8.6 Assigning region of Interest (ROI)

5. Assign a region of interest (ROI) and an orientation to each animal image. The sub-image extracted from an ROI is called a "chip". Under 'Image table', select each image and click on 'Actions'-> Add Chip [A].

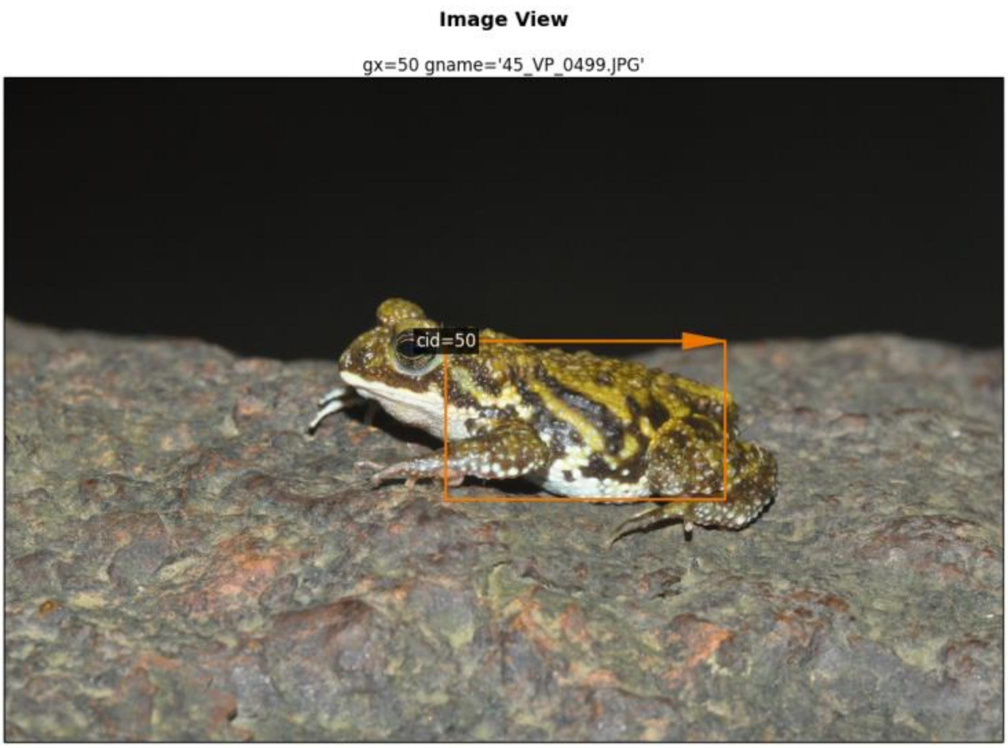


Figure 8.7 Image view in Hotspotter window

Figure 8.8 Chip view in Hotspotter window**.**

6. For reselecting ROI, use Actions -> Reselect ROI [R].
7. For deleting a chip use Actions -> Delete Chip
8. Sometimes the photos may need to be oriented as they may not be at the same axis as other photos. To reorient the photo use Actions -> Reselect orientation [O]

Figure 8.9 Selecting region of Interest for reorientation

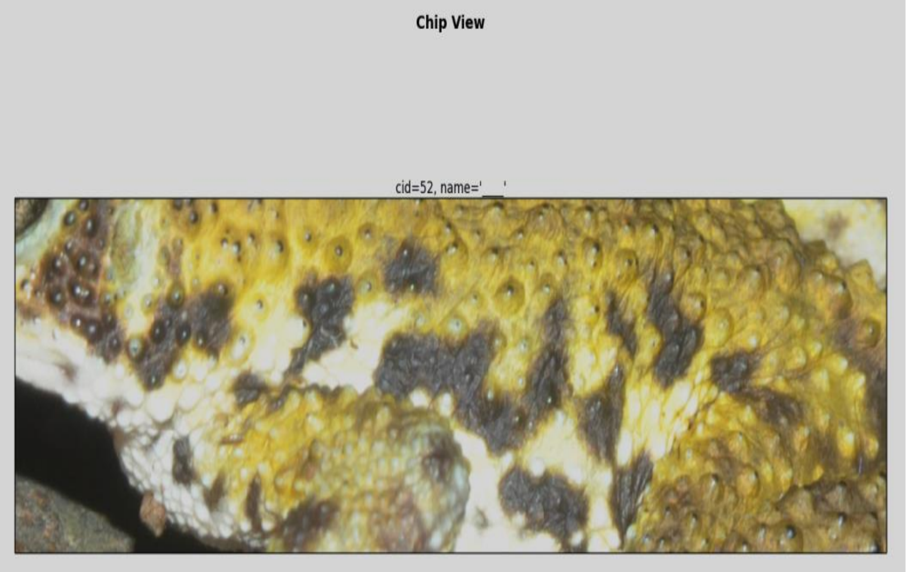


Figure 8.10 Reoriented chip view

9. When all the chips are made out of the imported images, a query is run by selecting a desired chip. Actions -> Query [Q]. This command quickly finds similar chips in the database. HotSpotter then automatically ranks the chips inorder of similarity and highlights the portions of the image that it identifies as being most similar to each other.

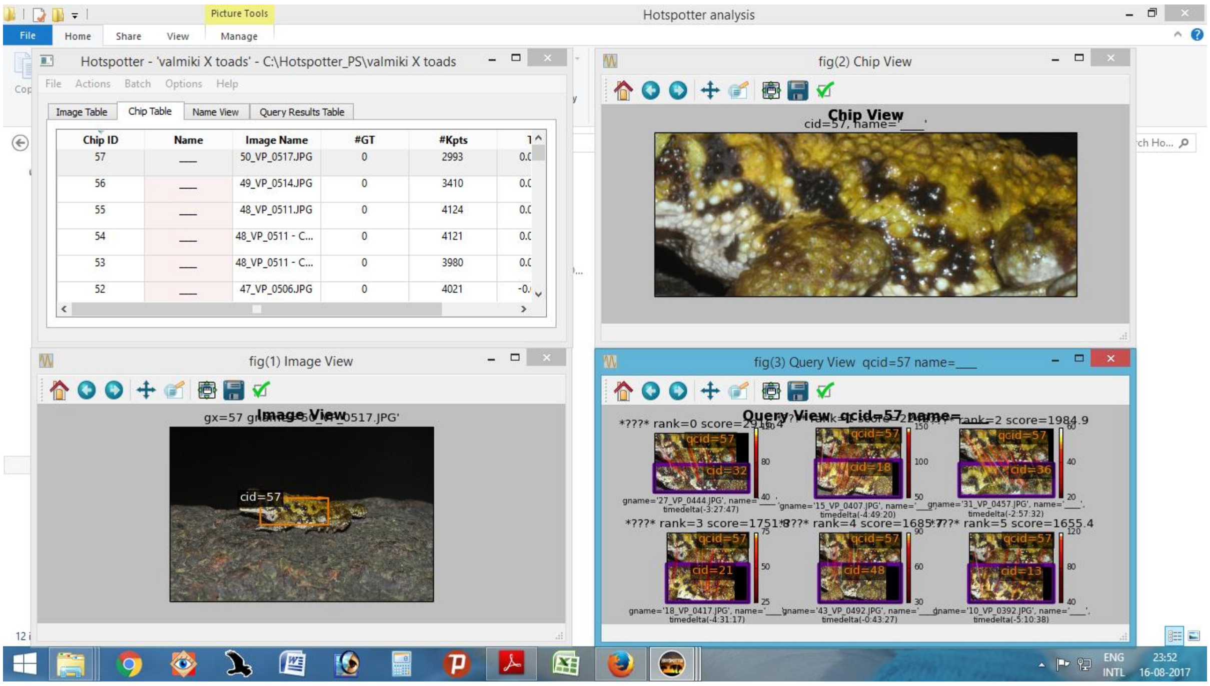


Figure 8.11 Result window in Hotspotter

Results

Chips in order of similarity that it identifies as being most similar with a dataset using replicate photos of the Query chip. If two chips are highly identical, the results of the query would look similar to image below. The rank generated by the software would be very high ranging above lakh (the rank may vary depending on the variation in dataset). However, similarity between two images does not confirm if the two individuals are same. This is where role of ranking of similarity between two images comes into play. Higher the ranking of two chips, more likely the chips belong to similar individuals.

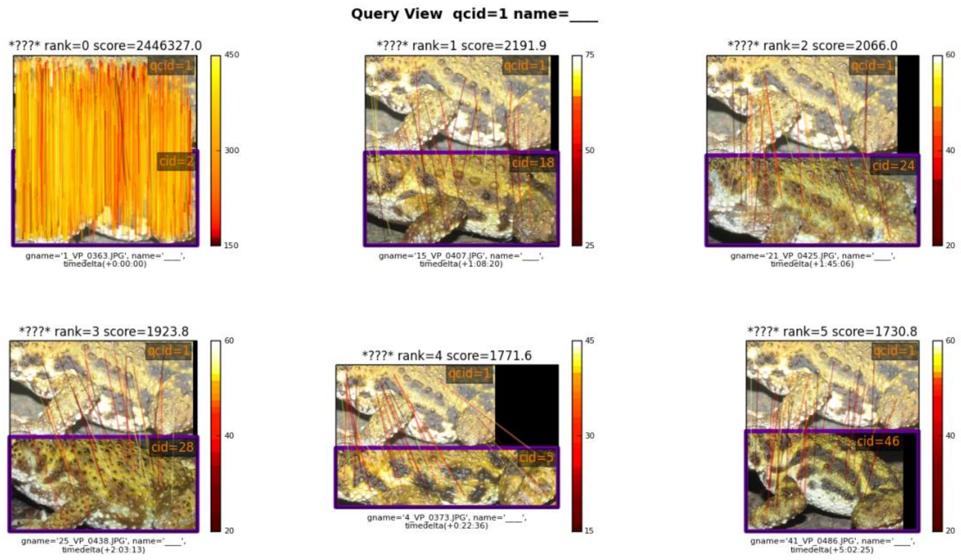


Figure 8.12 Chips in order of similarity that it identifies as being most similar with a dataset using replicate photos of the Query chip

Chips in order of similarity that it identifies as being most similar with a dataset using no replicate photos of the Query chip. If two chips are less identical, the results of the query would look similar to image below. The rank generated by the software would be very low ranging between thousands (the rank may vary depending on the variation in dataset).

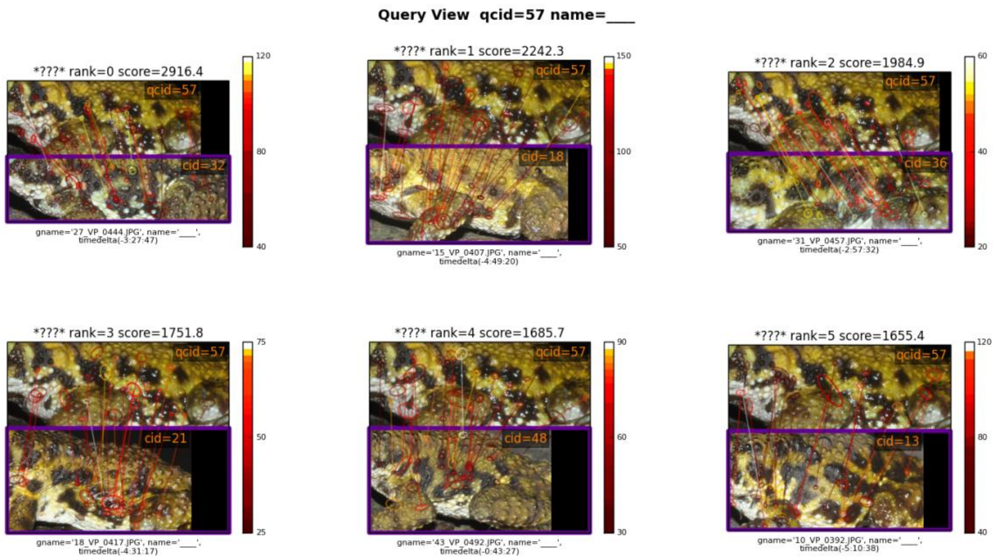


Figure 8.13 Chips in order of similarity that it identifies as being most similar with a dataset using no replicate photos of the Query chip

Discussion

During dry season no individuals of *Xanthophryne* were recorded from plateau and elsewhere. However, in monsoons, we found hundreds of toads on the plateau during our field visit between 1- 15 September, 2016 and 27 June – 13 July, 2017. We did not observe any breeding pair during our study period but we did record photographic evidence of tadpoles and metamorphs on and around plateau.

*Xanthophryne Koyanaensis*has been previously reported from buffer areas of Koyana WLS (Biju 2001; Gaitonde et al. 2016). This is the first record from the core zone of the WLS.*Xanthophryne tigerinus* however is a new record for Sahyadri Tiger Reserve as it has been reported only from Amboli (S. D. Biju pers. comm. 2011).

This study proposes to the forest department to incorporate simple yet informative techniques for sampling of lesser known groups like reptiles and amphibians, as is felt needful for big cats. Hotspotter and similar softwares like WILD ID and Stripe spotter, Mark, R, Capture can help as potential tools for monitoring of species populations provided the field data is collected and maintained meticulously.

Such data can give fairly good idea of habitat utilization and migration patterns of amphibians and other lesser taxa over long term. The softwarecan serve a helpful to in mark recapture of endemic species to Sahyadri sub-cluster.

Recommendations

During the study period we have sampled various habitats for presence of Xanthophryne sp. which is a point endemic species to Northern Western Ghats. We suggest a monitoring protocol for sampling of point endemics in Sahydari Tiger Reserve and Radhanagri Wildlife Sanctuary.

1. It is very important to identify potential sites for sampling of the species. In case of *Xanthophryne* sp. they prefer lateritic plateaus for breeding. For sampling of other endemic amphibians, streams (seasonal and perennial), ponds or small pools, and other wetland areas can act as potential sites for sampling of the species.

2. Monsoons are best time to look out for amphibians and other herpetofauna. Rains mark the beginning of breeding of most amphibian species. An intensive sampling in each beat for a week during rains can give a wonderful data on population of a species. During non-rainy seasons the sampling may be continued so as to have a long-term database on seasonal distribution of target species.

3. Night surveys are best as the activity period of this vertebrate group is nocturnal in behavior.

4. A group of dedicated staff to look out for smaller or lesser known group is needed. It is always better to have 4-5 people as a group in each beat during the sampling sessions.

5. The team should be equipped with the following instruments in order to collect all the microhabitat parameters required to access the habitat quality for an amphibian;

    a. GPS for recording coordinates (latitude and longitude) to know where the species/ individual of the species is found

    b. Hygrometer to record the environmental readings such as air temperature, air moisture, wind velocity, wind speed, surface temperature where the individual is found.

c. Vernier caliper to take morphometric measurements of amphibians (Snout to vent length, Snout length, tibia length, Eye diameter). Please refer appendix I for morphometric measurements taken during the study period for *Xanthophryne* cf. *tigerinus*.

d. Pesola weight to weigh amphibians

e. Cloth bags and zip lock pouches for collecting individuals (only for measurements) in case of mark recapture of an amphibian/reptile population

f. Torch is a must when you go out in field. High beam torches are an essential field gear. One can also sight amphibians, lizards and other herps using eye shine method using a focused beam torch.

Implications for Managers and Decision-makers

Not only Western Ghats, but also the other parts of the Maharashtra State are suffering from habitat loss which is a major threat to the amphibian populations. A new possible threat that is coming up is the habitat loss by erection of wind mills (personal observations). Species such as *Xanthophryne koyanayensis*, *Xanthophryne tigerinus* as well as other species *Nyctibatrachus danieli*, which are inhabitants of the plateaus, are subjected to this threat. Currently, plateaus in and around Sahyadri Tiger Reserve and Radhanagri Wildlife Sanctuary, which are inhabited by *Xanthophryne koyanayensis*, *Nyctibatrachus danieli* and *Indotyphlus maharashtraensis* are been covered by windmills. Further, during our recent survey in June-July 2017, we have also noticed the amphibian limb deformities in few individuals of *Xanthophryne* from Koyana Wildlife Sanctuary. Padhye and Ghatke (2012) also recorded amphibian limb deformities from different areas in at least 6 different species in plateau dwelling amphibians. This may be due to some parasite attack, as is known from elsewhere in the world (Johnson and Sutherland 2003), that is considered as an emerging threat to amphibians (Kiesecker et al. 2004). This could also be due to chemicals or pollutants (human induced, such as unregulated tourism) that cause abnormal development. Gurushankara et al. (2007) have studied morphological abnormalities in natural populations 240 Fauna of Maharashtra, State Fauna Series, 20 of common frogs inhabiting agro-ecosystems of central Western Ghats. On this background, it is requested that detailed study of these emerging threats to amphibian population is urgently required.

Table 8.3 Capacity-building requirements for the development and use of scenarios and models of biodiversity and ecosystem services.

ACTIVITY	CAPACITY-BUILDING REQUIREMENTS
Stakeholder engagement	Processes and human capacity to facilitate engagement with multiple stakeholders, including holders of traditional and local knowledge
Problem definition	Capacity to translate policy or management needs into appropriate scenarios and models
Scenario analysis	Capacity to participate in the development and use of scenarios to explore possible futures and in policy and management interventions
Modelling	Capacity to participate in the development and use of models to translate scenarios into expected consequences for biodiversity and ecosystem services
Decision-making for policy and management	Capacity to integrate outputs from scenario analysis and modelling into decision-making
Accessing data, information and knowledge	Data accessibility Infrastructure and database managements Tools for data synthesis and extrapolation Standardization of formats and software compatibility Human resources and skill base to contribute to access, manage and update database Tools and processes to incorporate local data and knowledge

8. 2 Other Herpetofauna of Sahyadri Sub-cluster

Overview

Herpetology, study of reptiles and amphibians, is a science that is more than two hundred years old. Herpetology started with taxonomy and species description based on morphological characteristics during pre-independence era (up to 1947) and continued similar trend for a few decades after post independence as well.

This field got its best contributions during British period in the form of most reliable and most widely referred book, "The Fauna of British India" by Malcolm A. Smith. This book is the most comprehensive taxonomic compilation of Indian reptiles till date.

Now is the 'modern era' for herpetology and additional to taxonomy and species description, the science now deals with a range of disciplines such as Biogeography, Evolution, Behaviour, Phylogenetics and Species and Community ecology.

Herpetofaunal diversity is rich but poorly documented. One of the major challenges in Herpetofaunal studies is the enigma of 'Cryptic diversity'. This is evident from the fact that number of herpetofaunal species had almost doubled in number in last ten years. This suggests that enormous diversity of herpetofauna still needs documentation particularly in hotspot regions of biodiversity ie. North East India and the Western Ghats.

Endemicity in Western Ghats

The Western Ghats has a high proportion of endemic species. If an animal or plant species' natural home or habitat is restricted to one particular area or space on the globe, it is known as an endemic species. For example, *Calotes elliotі* commonly known as Elliot's forest lizard is endemic to the Western Ghats and the list goes on. The greatest number of endemics in the Western Ghats is found among the amphibians (78%) followed by reptiles (66%).

We have elucidated in this chapter, the records of herpetofauna during our one year of study period, conducted in September 2016 till July 2017. The findings give an insight into the endemicity of herpetofauna in Northern Western Ghats.

A table of the species encountered during the field visit is described along with a brief taxonomic note for each of the species found. Some interesting pictures of the cryptic group of amphibians and reptiles is also provided for reference.

AMPHIBIANS

Genus *Indirana*

Frogs of this genus are distributed in central and Southern India. So far the whole genus is endemic to India. This genus currently contains 14 species. We have encountered this particular species in Chandoli range. The individuals were found in a stream habitat during day time. Taxonomic identity at species level is yet to be ascertained.

Genus Nyctibatrachus

Frogs of this genus belongs to Nyctibatrachidae and are distributed in Western Ghats from Southern Gujarat to Tamil Nadu. A very specious genus that contains 35 species from India. We have encountered this particular species in Chandoli range. The individuals were found in a stream habitat during day time. The individual was sighted with all the tadpole stages in a water puddle under leaf litter. From Maharashtra, species such as *Nyctibatrachus humayuni* has been reported. However, taxonomic identity at species level is yet to be ascertained.

Genus *Euphlyctis*

Frogs of this genus belong to family Dicroglossidae. This genus contains 8 species distributed in Central Asia, South and South-east Asia. *Euphlyctis cyanaphlyctis*is a widespread species distributed all across Indian sub-continent and inhabits both lentic and lotic ecosystem. However, this species is considered to be a cryptic species. During the study, we have encounterd this species in Radhanagri WLS inhabiting water body on a plateau at an elevation of ~1000 m.

Genus *Raorchestes*

Frogs of this genus belong to family Rhachophoridae. Forgs of this genus are distributed from Southern India to North east and further south east Asia. The genus contains 62 species with highest level of endemicity in the region. During the study, we have encountered this species in a stream habitat in Chandoli National Park during day time survey.

Genus *Xanthophryne*

Toads of this genus belong to family Bufonidae. Toads of this genus are endemic to Western Ghats in Maharashtra, India. There are two species in this genus; *Xanthophrynetigerina* and *XanthophryneKoyanaensis*. Both species are recorded during the study period from Chandoli and Koyana. 151 toads of *X. tigerina* and 35 of *X. Koyanaensis* were recorded during our field visit in monsoons between 27 June-13 July 2017.

REPTILES

Snakes

Naja naja

This species belongs to family Elapidae which contains venomous proteroglyph snakes such as *Calliophis, Bungarus, Ophiophagus, Sinomicrurus*. This is a widespread species in India and is regarded as one of the dangerously venomous big four in the county. Present record is based on a shed skin found on a plateau in Chandoli National Park.

Echis carinatus

The species belongs to family Viperidae and is among the big four venomous snakes in India. This species is distributed widely in India except extreme north and Northeast India. The species is particularly in Northern Western Ghats and central India landscape. We encountered this species on a plateau in Chandoli National Park, hiding under a rock during day time.

Amphiesma beddomei

This species belongs to family Natricidae. The distribution of this species include Maharashtra, Karnataka, Tamil Nadu and Kerala and thus is an endemic snake species to Western Ghats. We have encountered this species along the river bank on moist sand in Koyana WLS.

Amphiesma stolatum

This species belongs to family Natricidae. The distribution of this species is widespread that includes South and South East Asia including Taiwan and China. We have photographed this species in Koyana WLS while it was swimming across the backwaters.

Eryx whitakeri

This species belongs to family Boidae and is endemic to South west India. This species is closely related to widespread *Eryxconicus* from which it differs in having less or no keel on head scales. We have encountered juvenile of this species while an afternoon survey on a plateau in Chandoli National Park.

Python molurus

Commonly known as Indian Rock Python, the species belongs to familyPythonidae. The species is found throughout India (except the islands) up to 2000 m above sea level. We encountered a female python (ca. 2 m) basking/lying out in the open, during a rainy morning along a natural forest trail, in Koyana Wildlife Sanctuary.

Macropisthodon plumbicolor

Commonly known as Green keelback, the species falls in the Family Natricidae. Green keelbacks are found in whole of the mainland except the east coast Ganges valley and the extrteme Northwest in India. It is a common species in arts of Maharashtra found up to 2000 m. we observed 2 individuals of the species during our field survey in Radhanagri and Dhebewadi ranges of Radhanagri WLS and Chandoli NP respectively.

Lizards

Hemidactylus sp 1

The species belongs to Family Gekkonidae characterized by granular scales, divided lamellae under toes, vertical elliptical pupil without eyelid. The family is highly specious with 143 species so far known from the world. Northern Western Ghats and parts of central India are particularly rich in *Rupicolous*, *Hemidactylus* species such as *Hemidactylus graniticolus, Hemidactylus gujaratensis, Hemidactylus prashadi* and *Hemidactylus sataraensis.* The species is found to be restricted in the plateau formations of Chandoli and Radhanagri WLS. The individuals of this species were found under rocks in day time. We also observed gravid females of this species in the month of Decemeber 2016 – January 2017 along with eggs of clutch size two.

Hemidactylus sp 2

Also from Family Gekkonidae characterized by granular scales, divided lamellae under toes, vertical elliptical pupil without eyelid, differ from the above species in having a distinctly smaller body size, less granular and less prominent flank on both sides. This species is found to be restricted along the riparian habitats in Chandoli National Park.

Cnemaspis sp.

This genus also belongs to family Gekkonidae and is specious with 121 species known around the world. This genus has discontinuous distribution that includes Western Ghats, North east India and South East Asia. The species in the genus are remarkable in having round pupil, digits without lamellae and diurnal in activity, also known as 'day geckos'. Majority of the species are endemic to Western Ghats. The species was found along a forest trail in Radhanagri Wildlife Sanctuary, under a rock during day time.

Lygosoma lineata

The species belongs to family Scincidae. Members of this genus are characterised by slender shiny body, smooth scales (keeled or not keeled), and small or degenerated limbs. The genus contains 29 species all across the world. *Lygosoma lineata* is distributed in Northern Western Ghats, Tamil Nadu, Karnataka, record from Jharkhand needs confirmation. The species was found in Radhanagri Wildlife Sanctuary in soil cracks under rocks during day time survey.

Lygosoma sp

This species differs from L. lineata in having a robust body with absence of characteristic lines along the length of the body. We found this species during a day time survey on a plateau in Chandoli National Park. Two individuals of this species were found under a rock, one of them was a gravid female

Calotes versicolor

The species belongs to family Agamidae. The genus contains 26 species across the globe of which *Calotes versicolor* is the most widely distributed species, perianthropic species. The species is distributed in Central, South and South East Asia. The species is also considered as cryptic and new species are described from Myanmar from this complex. We have observed the individuals of this species on a plateau in Chandoli NP including several areas in Dhebewadi range.

Calotes sp 2

We have recorded a juvenile of genus *Calotes* during day time in Koyana WLS on boulders along river bank. Due to only photographic record from a distance and the individual being a juvenile, the taxonomic identification at species level not certain.

Calotes rouxii

The species belongs to family Agamidae.*Calotes rouxii* is a diurnal, semi-arboreal insectivore, it can be seen in moist evergreen forests, dry deciduous forests, tropical dry scrub and secondary forests. Despite being a widely distributed species, very little data exists on the population status of this species. We documented 3 individuals of the species in Chandoli National Park and Radhanagri Wildlife Sanctuary.

Ophisops cf. *beddomei*

The species belongs to family Lacertidae. Members of this genus are characterized by heavily keeled dorsal scales, ventral scales smooth and equal sized, symmetrical head scales with osteoderms. The genus contains 8 species in the world. The one that we observed is *O*. cf. *Beddomei* which is distributed from Gujarat all the way to Western Ghats. High level of morphological diversity can be seen this species group across their geographical range indicating their cryptic nature. The species was found in plateau habitats of Chandoli NP and Radhanagri WL

Table 8.4 Detailed description of Herpetofauna encountered during the one-year study period with their IUCN status, pppulation trends, threat status and ecosystem services provided by each of them.

S. No.	Species	Common Name	Locality recorded during study	Date of record	Sampling method	Population as per IUCN)	IUCN Status	Conservation measures	Conservation threats	Ecosystem service Indicator	Remarks
1	*Euphlyctus cyanophlyctis*	Indian skipper frog	Radhanagri WLS	7-Jan-17	Nightsurvey is stagnant pools or wetlands	Stable	LC	Widespread, perianthropic species. Schedule IV.	Prolonged drought, desiccation and fragmentation of wetlands	Biomass contribution in Freshwater eosystem	A cryptic species complex, found in marshes, pools and various other wetlands within a variety of habitat types. Adults are generally found basking at the edge of the waterbodies and males call from within the water. The species breeds, and the larvae develop, in suitable waterbodies. The species may be found in modified habitats, usually where suitable wetland habitat is available. The species ranges throughout much of South Asia including southern Afghanistan and Sri Lanka. It is also present in southeastern Iran (this is the westernmost part of its range).
2	*Hydrophylax bahuvistara*	Fungid frog	Radhanagri WLS	3-Jul-17	Night survey in wetlands and/or forsted patches near t water bodies	Stable	LC	As the species is fund in many PA it is protected by national legislation.	Aquatic pollution (agricultural and domestic), severe droughts and wildfires	Genetic resource and ecosystem integrity	This species is present throughout much of the Western Ghats, and also in the Eastern Ghats of India. It has a wide altitudinal range being found from sea level to 1,500m asl. It is a terrestrial species adapted to a wide variety of habitats including semi-evergreen moist deciduous forest, plantations, agricultural

S. No.	Species	Common Name	Locality recorded during study	Date of record	Sampling method	Population as per IUCN)	IUCN Status	Conservation measures	Conservation threats	Ecosystem service Indicator	Remarks
											fields and rural gardens. Breeding takes place in temporary ponds and other waterbodies.
3	*Nyctibatrachus humayuni*	Bombay Night frog	Radhanagri WLS	9-Jan-17	Night survey along stream/ and or seasonal wetlands with riparian vegetation	Decreasing	Vulnerable	No specific conservation measures in place for this species.	Land conversion, water pollution by agrochemicals, the siltation of streams, construction of roads and unregulated tourism	Ecosystem Integrity and genetic resource	This species is endemic to the Western Ghats of Maharashtra State in India. It has an altitudinal range of 200-1,200m asl. It occurs in torrential hill streams in riparian habitat of tropical moist evergreen and semi-evergreen forest. It has also been collected from disturbed forest edge habitats. They are often found inhabiting crevices between rocks in the streams. It presumably breeds by larval development in streams.
4	*Xanthphryne koynaensis*	Koyna toad	Koyna WLS	11-Jul-17	Night survey on lateritic plateau during monsoons	Decreasing	Endangered	No specific conservation measures in place for this species. Further research is needed into the range and breeding biology of	Habitat fragmentation, water pollution, and unregulted tourism	Flagship species, genetic resource, recreational importance	This is a terrestrial toad of moist to wet evergreen forest, and dry riparian grassland. Its breeding has not been recorded, but it presumably takes place in water, probably in streams, by larval development. This species is known only from two localities (Koyna and Aboli) in the Western Ghats of Maharashtra, India at elevations between 900 and 1,200m asl.

S. No.	Species	Common Name	Locality recorded during study	Date of record	Sampling method	Population as per IUCN)	IUCN Status	Conservation measures	Conservation threats	Ecosystem service Indicator	Remarks
								this species.			
5	*Xanthphryne tigerinus*	Amboli toad	Chandoli NP	6-Jul-17	Night survey at lateritic plateau during monsoons	Decreasing	Critically endangered	No conservation actions are currently known for this species, and until now it was not known to occur in any protected areas. This is the first record of this species from inside a PA.	Protection of its fragmented forest habitat is necessary. More information is needed on this species' distribution, population status, natural history and threats.	Flagship species, genetic resource, recreational importance	This species is known only from the type locality, Amboli (at 720 m asl), Maharashtra state, in the Western Ghats of India (Biju et al. 2009). It is a terrestrial species found near disturbed evergreen forest patches (Biju et al. 2009) and plantations (S.D. Biju pers. comm. December 2010). Egg clutch size varies between 30-35 eggs, and eggs are laid in temporary puddles on laterite rocks (Biju et al. 2009). The species appears to be tolerant of some habitat modification since it occurs near disturbed forests; however, the extent of this tolerance is unknown.
6	*Naja Naja*	Indian cobra	Chandoli NP	30-Dec-16	Visual Encounter Survey	No status by IUCN	No status by IUCN	No specific conservation measures in place for this species. It is listed under the CITES treaty	It is hunted for its distinctive hood markings for cmmercial use and/or is killed by people due to issues of snake bite.	Rodent Pest Control, Medicine from Venom	It occurs in wild forest and in cultivated areas distributed all acrss the mainand India (excluding the northeast). This is one of four common venomous snakes of medical importance in India. It is responsible for 10,000 bite mortalities in India each year. Deaths are common because

S. No.	Species	Common Name	Locality recorded during study	Date of record	Sampling method	Population as per IUCN)	IUCN Status	Conservation measures	Conservation threats	Ecosystem service Indicator	Remarks
								(Appendix ii) because it closely resembles other species that are threatened and in need of protection.			this species likes to live in rice paddies. They have a "spectacle" marking on the back of the hood. They're most active during the night and they are good swimmers and climbers. The feed on a variety of animals, including mammals, birds, lizards, and other snakes. Their venom is neurotoxic. The Indian Cobra is hunted by carnivorous mammals and birds of prey.
7	*Echis carinatus*	Saw scaled viper	Chandoli NP	31-Dec-16	Visual Encounter Survey	No status by IUCN	No status by IUCN	Wildlife Protection Act (1972): Schedule 2	Habitat destruction, killing due to its venom potency and road kills	Rodent Pest Control, Medicine from Venom	Saw-scaled Viper is the only Echis species found all across Peninsular India and is member of famous Big Four venomous snakes of medical importance in India. Saw-scaled Viper is a nocturnal species which remains active from late evening to late nights for foraging and other life activities. Activity usually terrestrial but climbs on scrub vegetation for basking. Found both in moderate elevation and plains. Distributed in variety of forests including deserts, semi-deserts, rainforest, scrub forest, mixed, dry and moist deciduous forest, grassland etc. Habitat includes dry open

S. No.	Species	Common Name	Locality recorded during study	Date of record	Sampling method	Population as per IUCN)	IUCN Status	Conservation measures	Conservation threats	Ecosystem service Indicator	Remarks
											lands, agricultural field, scrubs, rocky terrain, open plains etc. Hides in mounds, holes, piles, caves, cracks, dense leaf litters, rocks etc. Feeds on small rodents, geckos, other snakes, insects including scorpions.
8	*Amphiesma beddomei*	Nilgiri Keelback	Koyna WLS	2-Dec-16	Visual Encounter Survey	Unknown	LC	There are no known species-specific conservation measures in place for this species. Further survey work is needed to understand its biology, ecology, population status and trends.	Mining activities, pesticide use and road kills	Ecostsyem integrity	The species is endemic to the Western Ghats of India, from south of Mahabaleshwar, Satara District, Maharashtra to Bonacaud Estate, Kerala (Smith 1943, Whitaker and Captain 2004, S.P. Vijayakumar pers. obs.). It is found at elevations between 60 and 1,000 m asl.
9	*Amphiesma stolatum*	Buff-striped keelback	Koyna WLS	1-Dec-16	Visual Encounter Survey	No status by IUCN	No status by IUCN	Schedule IV	Road kill mortality, loss of moist vegetation and decline in population of	Ecostsyem integrity	Striped Keelback is a diurnal and terrestrial species which shows activity during day time of moderate temperature. Found in whole of Indian mainland including North and

S. No.	Species	Common Name	Locality recorded during study	Date of record	Sampling method	Population as per IUCN)	IUCN Status	Conservation measures	Conservation threats	Ecosystem service Indicator	Remarks
									amphibians as its mainly a toad & frog feeder.		North-east states. Not found in Islands. Behavior shy and non-offensive. Feeds mainly on toads and frogs. Also feeds on small rodents. Habitat includes moist, mixed and dry deciduous forests, wetlands, grasslands of plains and moderate elevations. Lives in moist vegetation of agricultural lands, gardens, open forests etc. Hides in dense bushes, under leaf litters, grass, rocky cracks etc.
10	*Python molurus*	Indian Rock Pythn	Koyna WLS	9-Jul-17	Visual Encounter Survey	No status by IUCN	Near threatened	Schedule 1	Road kill mortality; killing due to conflict in agricltural fields and around water bodies due to its large size; misdentification and confusion with venomous species, habitat loss.	Majot predator in Koyna landscpe that overlap dietary niche with tiger and leopard.	Indian Rock Python is one of the most famous and one of the largest growing snake of India. It Endemic to Indian subcontinentIndia and inabitats mixed & dry deciduous forests, mangroves, grasslands, rainforests and semi-deserts. lives in dense vegetation, agricultural land's edge, rocky hills; prefers water body for activity. Indian Rock Python is a nocturnal species but can be seen at day time also during basking and opportunistic foraging on prey animals. Activity usually terrestrial but climbs well to good heights and can stay there for roosting.

S. No.	Species	Common Name	Locality recorded during study	Date of record	Sampling method	Population as per IUCN)	IUCN Status	Conservation measures	Conservation threats	Ecosystem service Indicator	Remarks
											Behavior usually non-offensive and try to escape to hide in natural surrounding
11	*Macropisthodon plumbicolor*	Green keelback	Chandoli NP & Radhanagri WLS	3-Jul-17	Visual Encounter Survey	No status by IUCN	No status by IUCN	No conservation actions are currently known for this species.	Unknown. We observed road kills of this species in Chandoli NP which may be a potential threat t the species.	ecosystem integrity	Also called as the Lead Keelback, the species is distributed across India (Maharashtra, Kerala, Tamil Nadu, Andhra Pradesh, Karnataka), Sri Lanka, and Pakistan, mostly found in hillsrather than plains.
12	*Eryx whitakeri*	Whitaker's sandBoa	Chandoli NP	28-Dec-16	Visual Encounter Survey	No status by IUCN	No status by IUCN	Indian Wildlife (Protection) Act of 1972: Schedule-IV	Threats includes road kills and destruction of hills of Western Ghats causing population decline. Unintentional killing is done during agricultural and other digging activities as it’s a burrower.	Rodent pest control and ecosystem heterogenity	Whitaker's Boa is an endemic species found in almost whole of Western Ghat's moderate elevations. Habitat includes hilly or highland agricultural fields, gardens, unused lands having sandy soil, deep cracks and rat holes. Hides in cracks, mounds, under wooden logs, rat holes, brick piles, rock piles. Activity is nocturnal and burrowing preferring dry and sandy soil. Can be seen at day time while foraging and preying. Feeds on lizards, rodents and birds. Kills its prey by constriction method.
13	*Lygosoma lineata*	Lined supple skink	Radhanagri WLS	9-Jan-17	Visual Encounter Survey	Unknown	Least concern	There are no known species-	Anthropogenic activities that include	Species diversity and heterogenity	*L. lineata* is endemic to India where it is a widely distributed species found in Western

S. No.	Species	Common Name	Locality recorded during study	Date of record	Sampling method	Population as per IUCN)	IUCN Status	Conservation measures	Conservation threats	Ecosystem service Indicator	Remarks
								specific conservation measures in place	expansion of human settlements, encroachment of forest land, increased human activity, garbage and/or pollution, forest fires.		Ghats of Gujarat, Maharashtra and Karnataka, but is not common anywhere within its range. These lizards can be found in a variety of habitats including hilly areas, coastal forests, grassland patches, scrublands, gardens, and can also be seen among large boulders. Animals actively forage near termite mounds in cooler parts of the day, feeding on small insects such as termites and flies (including mosquitoes). One record exists of a member of this species feeding on the blindsnake Ramphotyphlops braminus (Mirza et al. 2010). Animals mostly shelter beneath rocks or woody material, or within leaf litter.
14	*Ophisops cf. beddomei*	Beddome's snake-eye	Chandoli NP & Radhanagri WLS	5-Jan-17	Visual Encounter Survey	Unknown	Least concern	There are no known species-specific conservation measures in place. Research is needed to better determine	The main threat to this species is stone quarrying leading to decline in habitat quality.	Important indicators in preservation of microhabitats such as rocky habitats	It is endemic to India, where it is restricted to the Western Ghats with the exception of a single locality in the Eastern Ghats (Dutta and Acharjyo 1997, Das and Bauer 2000, Vyas 2003). It has an estimated extent of occurrence of 27,196 km2. This species occurs at elevations between 200 and 1,000 m asl. This diurnal,

S. No.	Species	Common Name	Locality recorded during study	Date of record	Sampling method	Populat ion as per IUCN)	IUCN Status	Conservati on measures	Conservation threats	Ecosystem service Indicator	Remarks
								the distribution , population size and threats.			ground dwelling lizard has been found in grassland habitat and in varied forest types, including moist deciduous and semi-evergreen forests, mixed semi-evergreen forests, and both dry and wet mixed deciduous forests. In all of these areas it prefers to live among rocky boulders, where it has been observed feeding on insects.
15	*Calotes versicolor*	Garden lizard	Chandoli NP	30-Dec-16	Visual Encounter Survey and/or Night survey using eye shine method	No status by IUCN	No status by IUCN	No known specific conservatio n measures in place for this species.	Human activities and urban development. Yet taxonmic studies need to be done on this widespread species which may have sme genetic divergence.	Ecosystem integiry and biomass contribution	Calotes versicolor occupies a wide geographic range and is considered the most widespread species of its genus. Its range extends from southeastern Iran and Afghanistan east to Indo-China and south to Sri Lanka, Sumatra, and northern peninsular Malaysia. The lizard is incredible adaptable, thrives in human-altered environments, and is even able to survive in urban areas (Enge and Krysko 2004). *Calotes versicolor* prey mainly on insects but also feed on smaller invertebrates, such as rodents and lizards (Enge and Krysko 2004).

S. No.	Species	Common Name	Locality recorded during study	Date of record	Sampling method	Population as per IUCN)	IUCN Status	Conservation measures	Conservation threats	Ecosystem service Indicator	Remarks
16	*Calotes rouxii*	Roux's forest calotes	Chandoli NP, Koyna WLS & Radhanagri WLS	3-Jul-17	Visual Encounter Survey and/or Night survey using eye shine method	Stable	Least concern	No known specific conservation measures in place for this species.	Conversion of lowland forests to agriculture throughout its distribution.	Ecosystem Integrity	Calotes rouxii is a diurnal, semi-arboreal insectivore, seen in moist evergreen forests, dry deciduous forests, tropical dry scrub and secondary forests.Species is endemic to India and is widely distributed in many localities in the Western Ghats of Gujarat, Maharashtra, Goa, Karnataka, Kerala and Tamil Nadu, and Eastern Ghats (Srinivasulu and Das 2008, Manthey 2008). This species occurs at elevations between 100 and 900 m asl.
17	*Hemidactylus maculatus*	Spotted leaf-toad gecko	Koyna WLS	18-May-17	Visual Encounter Survey and/or Night survey using eye shine method	Unknown	Least concern	There are no known species-specific conservation measures in place. Research is needed to better determine the distribution, population size and threats.	Anthropogenic activities including tourism related, infrastructure development and shifting agriculture practices.	Composition of Ecologicl community	Hemidactylus maculatus is an Indian endemic. It is distributed in both the Eastern and Western Ghats and in some parts of peninsular India (Smith 1935). This gecko is locally abundant in many parts of its range, but there is no information on population trends. This largely rupiculous gecko has been recorded from dry deciduous, moist deciduous and wet evergreen forests, but is occasionally recorded on trees in other habitats and in houses.

S. No.	Species	Common Name	Locality recorded during study	Date of record	Sampling method	Population as per IUCN)	IUCN Status	Conservation measures	Conservation threats	Ecosystem service Indicator	Remarks
18	*Geckoella deccanensis*	Gunther's Indian Gecko	Koyna WLS & Radhanagri WLS	19-May-17	Visual Encounter Survey and/or Night survey using eye shine method	Unknown	Least concern	There are no known species-specific conservation measures in place. Research is needed to better determine the distribution, population size and threats.	Cconversion of forested tracts for agriculture, pesticide use, and tourist-related development	Composition of Ecologicl community	Geckoella deccanensis is endemic to the northern Western Ghats south to Belgaum with an extent of occurrence of greater than 40,000 km². They are found from tropical deciduous and semi evergreen forest patches. It is a nocturnal gecko, mostly observed on forest floor or tree bark (Bauer and Giri 2004).

Chapter Nine:

Conclusion and way forward

This study hasin its short duration attempted to identify the assessment tools that can be applied in the World Heritage context, and provide guidance to site managers and government agencies. It is expected that this help them better understand how to develop and undertake ecosystem services assessments in order to maximise some services without impacting on a site's Outstanding Universal Value. It has also identified who benefits from ecosystem services and how, and shed light on how threats affect these services.

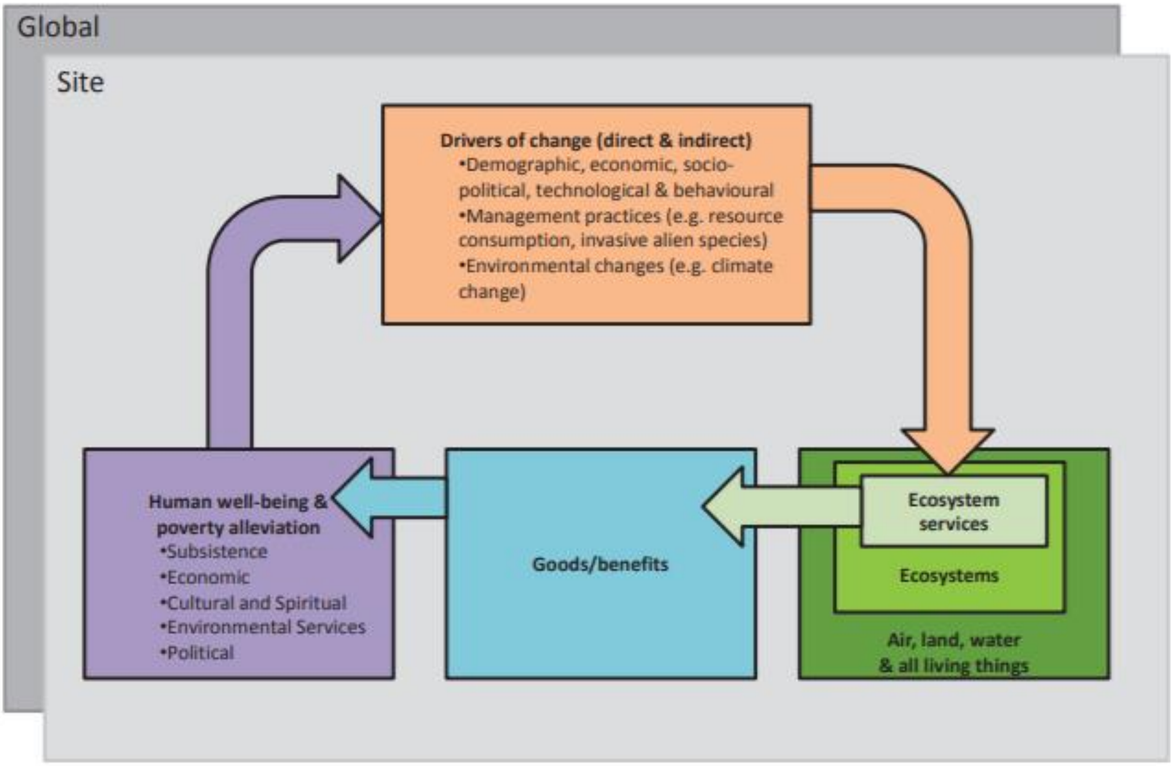


Figure 9.1 Conceptual framework for the analysis of ecosystem services and benefits provide by natural World Heritage sites at the global and site scales. Source: adapted from the UK National Ecosystem Assessment (UK NEA, 2011, Osipova et.al., 2014).

This study successfully demonstrated the OUV of the World heritage sites that is well preserved through a judicous mix of regulatory and conservation measures.

In terms of natural resources availability to the local communities, It was clearly demonstrated that Sahyadri sub-cluster can provide important water resources that significantly contribute towards human well-being through providing water to: allow basic subsistence needs to be met; increase agricultural production through permitting irrigation; and generate electricity through powering hydroelectric generators. Additionally, water resources can enhance tourism, thus indirectly allowing a population to generate an income from the water resources. Often the direct beneficiaries of these water services live outside the boundaries of the World Heritage site itself. Maintaining water-related services requires careful planning given the large size of watersheds and the many factors that can influence water quality.

The site can also play an important role in mitigating the impacts of natural disasters through the delivery of regulating services which can reduce people's exposure to natural hazards such as fire and drought (Millennium Ecosystem Assessment, 2005). Evidence suggests that it is more cost effective to invest in risk prevention than to fund post-disaster recovery by preserving the delivery of disaster mitigating ecosystem services rather than attempting to recreate them once an ecosystem's capacity to provide these services has been reduced through degradation (UNESCO et al., 2010). Intact ecosystems are better able to deliver the ecosystem services they provide, such as flood mitigation, and to withstand hazardous events.

Cultural and spiritual values of natural sites shape people's relationships not only in social and in a religious life but also with the landscapes they inhabit. The socio-cultural significance of sacred site in and around Sahyadri played a pivotal role in the lives of local communities. Failing to recognise this socio-cultural and spiritual significance can exacerbate misunderstandings of ontological differences and jeopardize the management of these areas. Similarly, Tourism played an important role in further enhancing this feature altough there were several key learnings too which can be considered while maangeing such as site (Watve, 2016) . Nature-based tourism initiatives can also facilitate local empowerment and encourage local communities to take responsibility for the long-term conservation of their natural assets. While it is important to recognize the benefits tourism can bring to the conservation of World Heritage Sites, it is equally important to acknowledge that this is not a one-size-fits-all approach and that negative impacts can result from mismanagement. Poorly managed tourism can compromise the integrity of a site, as well as its Outstanding Universal Value, and potentially create negative socio-cultural implications (Osipova et.al., 2014).

The study also demonstrated that monitoring certain taxa such as endemic species are very useful for linking Ecosystem Services to conservation. Indicators are not only relevant and able to convey the message of the consequences of biodiversity loss but must also be based on accepted methods that reflect the aspects of biodiversity involved and the service that is of interest, capture the often non-linear and multi-scale relationships between ecosystems and the benefits that they provide, and be convertible into economic terms.

Ecosystem and biodiversity indicators serve multiple purposes which can broadly be categorized into three key functions: (1) tracking performance; (2) monitoring the consequences of alternative policies; and (3) scientific exploration (Failing & Gregory 2003). Indicators are defined here as variables indicating something of interest or relevance to policy- or decision-makers with some logical connection to the object or the process being measured. They reflect, in an unambiguous and usually quantitative way, the status, causes (drivers) or outcome of the process or object (Ash et al. 2009). Indicators simplify and quantify information so that it can be easily communicated and intuitively understood, allowing policy- and decision-makers to base their decisions on evidence (Layke 2009).

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ANNEXURE

Dissertations conducted by Students of Tata Institute of Social Sciences, Mumbai

A Framework for Strategic Environmental Assessment (SEA) For Kaas Plateau with respect to Tourism

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TISS
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List of acronyms and abbreviations

BSI	**Botanical Survey of India**
EIA	**Environmental Impact Assessment**
FD	**Forest Department**
IUCN	**International Union for Conservation of Nature**
JFMC	**Joint Forest Management Committee**
NGO	**Non-Governmental Organization**
PPP	**Policy Planning Program**
SEA	**Strategic Environmental Assessment**
SIA	**Strategic Impact Assessment**
UNESCO	**United Nations Educational, Scientific and Cultural Organisation**
WHS	**World Heritage Site**

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Introduction

Biodiversity

> *"Biological diversity means the full range of variety and variability within and among living organisms and the ecological complexes in which they occur, and encompasses ecosystem or community diversity, species diversity, and genetic diversity"* (Jenson *etal*, 1990).

India contains a great wealth of biological diversity in its forests, its wetlands and in its marine areas. Overall there are total 868741 animal species present (Alfred, 1998) and approximately 45000 plants species (BSI, 1994) present in India. These species are distributed throughout in variety of biomes.

Various biogeographic zones represent variety of different habitats and ecosystems in them. Many species also differ from other species due to their habitat preferences and needs. Thus lot of endemism is also observed in these species. All the species have adapted themselves according to their habitats.

Habitats can be simply defined as an ecological or environmental area that is inhabited by a particular species of animal, plant, or other type of organism. It is the natural environment in which an organism lives, or the physical environment that surrounds (influences and is utilized by) a species population.

Western Ghats is one of the hotspot present in India. It runs from Gujarat to the southern peninsular tip. It covers approximately1, 59,000 sq. km area and is highly rich its biodiversity. They form the major tropical evergreen forests found in India (Rodgers and Panwar, 1988).There are currently15 national parks in the Western Ghats with a total area of 2,073 sq. km (equivalent to 1.3% of the region) and 52 wildlife sanctuaries covering an area of about 13,595sqkm(Emiliyamma and Palot, 2012). These protected areas have a variety of habitats in which serve as a home for many plant and animal species.

Rock outcrops

Rock outcrops are one type of a special habitat present in India. In the Western Ghats rocky plateaus belonging to the category of rock outcrop habitat are prominent feature of the region. Variety of life forms are based and adapted for such habitats and a lot of variations can be observed in the species distribution in these habitats. An example of it is the Kaas plateau.

Rock outcrops is a recognized habitat category under IUCN habitat classification. They are generally defined as portions of exposed bedrock protruding above the soil level due to geological activities. They include various landforms ranging like cliffs, isolated hills and platforms with diverse geology. Wiser & White (1999) identified rock outcrops as distinct from the surrounding areas by having on average 55% ground surface of exposed rock while S.Porembski & W. Barthlott, have stressed on the naturally formed or primary outcrops whichare exposed due to geological reasons such as volcanism weathering etc. (Porembski andBarthlott, 2000). Open rocky areas in the form of naturally exposed plateaus are components of the landscape in Western Ghats, but are under heavy anthropogenic disturbances(Porembski, 2007).

The uniqueness of rock outcrops from the surrounding is a major factor which leads to plant and animals diversity hence; they have been described as “Terrestrial Habitat Island” and the microhabitats on them as “Islands upon Islands”(Porembski et al. 2000).

Rocky outcrop habitats are less studied habitats. Only few scientists have studied these unique habitats. As they form the terrestrial islands, the plant species have adapted themselves for specific micro habitats. High level of endemism can also be seen in such type of habitats as they are so isolated.

Various unique micro habitats are also present in such habitats such as vegetation of rock crevices, vegetation of ephemeral pools, ephemeral flush vegetation etc. the vegetation of the rocky plateaus is mainly dominated by the herb species irrespective of the rock type (Watve, 2007). Adaptation to insectivorous diet can be observed by the plant species present in the EFV (Porembski and Watve 2005). The soil density on the plateaus differs a lot in its depth. The soil depression factor differs from area to area on a plateau. Various rock types are also present on these outcrops. These factors decide the fate of species on a large scale. Temperature also plays an important role on the outcrop habitat. (Watve and Thakur2006). Thus due to such varied microhabitats a lot of animal and plant diversity is observed with a high level of endemism.

These rock outcrop habitats are subjected to variety of threats such as grazing, farming, tourism, mining, developments of wind farms etc. which leads to destruction of such unique habitats.

The primary division of rocky plateau is made on the substrate as the lateritic plateaus (lateriticmesas/ ferricretes) and the basaltic plateaus (basalt mesas) in India.

Ferricrete (lateritic plateaus)

Watve (2013) said that Ferricretes are platforms of laterite rock present in the Maharashtra region. Ferricretes are commonly known as "tablelands" owing to the wide flat or undulating rock surfaces surrounded by steep edges. In Marathi language these ferricretes are referred as "SADAS".

Hardly any studies have been performed on the plateaus of Maharashtra. In 2003-06 Dr. Aparna Watve did a study on the plateaus of northern Western Ghats. Even if small studies were taking place mostly they studied the floral aspect. The faunal aspect was grossly neglected except for certain taxa like caecilians (Giri, 2004). Nowadays studies are being carried out on the fauna of plateau. That is why less data about these diverse taxa is available. But new discoveries are starting to take place which mainly contribute the reptiles and amphibian species and some invertebrates like scorpions. (Giri 2003, 2004, 2008; Chikane 2012; Mirza 2013).

Climate is the key factor for such habitats. The species are mainly adapted due to the climatic conditions. Monsoon is the main season in which many species can be seen. Many herbs and shrubs flower in this season of the year. Rest of the year dry conditions is present. That is why many plant species complete their life cycles in monsoon season and remain dormant in rest of the seasons. Rainfall variations can also be observed during each year. Faunal activity is also dominant in this season due to high availability of food.

Due to such climatic conditions such variety of micro habitats are present which shows high adaptation and endemism in species. But in Maharashtra such ferricretes are subjected to high destruction and degradation due to various anthropogenic activities like uncontrolled pleasure tourism, grazing, mining, wind farming, collection of species, horse riding, artificial fires and more. Facing many of these problems is the current scene on **Kaas plateau** which is situated near the city of Satara.

World Natural Heritage Sites (WHS) are places on Earth that have Outstanding Universal Value. As these sites are considered precious for present and future generations, they deserve collective efforts for conservation and management. WHS are also exposed to Natural and Man-made disasters which threaten their integrity and have negative socio-cultural and economic impacts. The loss or deterioration of these outstanding properties would negatively impact the national and local communities, both for their cultural importance as a source of identity and of information on the past, and for their socio-economic value. Experience, moreover, has demonstrated that the conservation of cultural heritage and the transmission of traditional technology, skills, and local knowledge systems, are not just important, i.e. for their intrinsic historic, artistic or scientific significance, but because they may contribute fundamentally to sustainable development, including the mitigation of disasters. Heritage-sensitive practices, in fact, can assist in significantly reducing the impact of disasters, before, during and after they have taken place.

The State of Maharashtra is known for its unique biodiversity & hill ranges such as Western Ghats. One such unique biodiverse ecosystem in Maharashtra is ‘Kaas Plateau’. Kaas plateau is wonderful, eye-catching creation of nature nestled in Sahyadri Hill range of Western Ghats. It has significant ecological as well as tourism value. In the month of August and September, the whole plateau looks like a carpet of flowers colored with various shades of green, yellow, pink, purple etc. Due to this it attracts lakhs of tourists, scientists and nature lovers. The value of Kaas is noticed not only at state level but also globally. Kaas got the tag of World Natural Heritage Site in June 2012 by the United Nations Educational Scientific and Cultural Organization (UNESCO) & this brought Kaas plateau in limelight.

The SIA is used as a multidisciplinary tool which is an evolved form of the Environmental Impact Assessment [EIA] for the Policy, Planning or Program [PPP] level, this tool is deployed at the onset of any project, failing of which gives rise to various problems involving to different questions after a project is been implemented, working with the institute would equip me with the tool which I could use in the future. By implementing it before the projects starts will reduce the risk of the failure of the project.

Kaas is the home to large species of flora of them a part is also endemic. Under the current scenario it is found to be one of the vulnerable areas in spite of being a WHS. Intervention of tourist in the area makes the flora vulnerable again the tourism industry of the area is also needed for the development of the area as a huge part of income is generated from it. Thus keeping the two extremes in mind and developing a SIA for the area is a challenge.

Aims & Objectives

Aim: To design a framework of Strategic Environmental Assessment and provide guidelines for future conservation of Kaas plateau's biodiversity, Satara, Maharashtra.

Strategic objectives & issues and vision:

- Restore, rejuvenate and ensure a socially and environmentally balanced plateau.
- Promote an environmentally sustainable development plan
- Conserve the heritage site by implementing a model for eco-tourism
- Create a financially sustainable efficient governance model.

Study Area

Out of all the plateaus present in Maharashtra Kaas plateau is the most studied plateau out of all plateaus in Maharashtra locally known as "Valley of flowers of Maharashtra".The Kaas plateau is located 25 Km west of the Satara town. It is located about 25 kms east of the Crestline area of the Northern Western Ghats in Satara district. The main tableland of Kaas is located roughly between 17°45'21.95"N, 73°47'29.13"E to 17°43'36.50"N, 73°50'56.51"E.The highest point is around 1240m ASL. The area is also famous for the Kaas Lake (built 100 years ago) and an old water supply system can be seen which supplies water to Satara town since the British period. The plateau is spread over approximately 3.5387 sq. kms area. The plateau is directly accessible as a road goes directly from Satara city to Kaas plateau. The road ends at Bamnoli village which is also a tourist spot situated on the banks of Koyna backwaters. Another untarred road, passing over the main part of the plateau goes towards Sahyadrinagar and then up to Mahabaleshwar. This is known as "Shivaji's Rajmarg".Many villages are present surrounding the plateau from which the important villages considered in JFMC are Kaas, Ekiv, Kasani, Atali. A lake is present on this route which is famous for its Nymphaea sps. Many perennial springs originate from kaas plateau and supply water to many villages present at the base of plateau.The surrounding villages are dependent on the streams and water percolating from the plateau tops. The plateau and the surrounding area play important role as catchment area for water storage (Batra Puja pers. comm., 2012). Climate and temperature also plays a significant role in changing the biodiversityof the plateau seasonally. The lowest temperature can get up to 4° to 6°C in the winters while it can increase up to 55°C in the summers (Thakur and Watve, 2006).

Kaas Lake is also a famous tourist spot attracting thousands of tourists. After visiting the plateau many people move to lake to enjoy the beauty of it. It is a typical picnic spot for the tourist having a beautiful view. A lot of garbage and beer bottles can be seen on the lake. (*Pers. comm. Apeksha Patil, 2012*).

The biodiversity of this plateau have been studied by many scientists for many years. Many floral species are described from this plateau like *Aponogeton sataraensis* (Yadav S.R, 1992). This species is found endemic to the Satara district. Many species of plants are also newly described like *Eriocaulon epedunculatum* (Yadav andPotdar, 2005).Recently scientists have also studied the small bryophytes like liverworts and hornworts with a good number of species density and population (Bagawan and Kore, 2011). Many new species of insects like *Kashmirobia* (Konstantinov, 2006) are being described. Many lesser fauna like reptiles, spiders' etc add to the list of the species. New species of spider *Idiops kaasensis* (Mirza, 2013) was discovered lately. Checklist of reptiles was also published which indicated a high species diversity (Chikane and Bhosale, 2012). With such new discoveries scientists are now studying these plateaus in deep sense. Many field guide books about kaas are published by scientists like Shrikant Ingalharikar and Dr. Sandeep Shrotri.The vegetation and biodiversity values of the Kaas plateau as a representative site of the threatened rocky plateau habitat has been discussed by Watve (2003, 2007, 2009 2010, and 2013).

Due to such high biodiversity and many more factors kaas plateau was crowned as "**WORLD NATURAL HERITAGE SITE**" on 2^{nd} JULY 2012 by UNESCO. As this area is now declared as WHS there is a possibility that things may change accordingly. Tourism is the main field which may affect due to this title. Tourists visit kaas plateau in large number. They are also said to be the source of garbage in that area (*Pers. comm. Apeksha Patil*, 2012). Heavy tourist activity includes heavy trampling of the area which can cause a lot of destruction of the area. The amount of hotel activity may increase due to tourism. There is a possibility that this title may cause positive or negative consequences on the tourism behavior. Tourism may increase suddenly as foreign crowd may be attracted towards it. Decrease in tourism can also be observed if the area get properly managed and planned. Kaas plateau is present under the jurisdiction of forest department (FD). It can be seen that FD has not made any special provisions for the plateau. The attitude of FD is same for this site as it is for any other protected area and no special preference is given on the arrangements. No as such framework is present with the FD for conservation of the site. Previously many threats were also observed by this plateau other than tourism issues. But they were completely ignored at that time as nobody cared. The plateau can be seen completely dry during the season other than rainy season. So a general outlook of the people is that it is a wasteland. These were some of the issues which were primarily identified for the project as these were the important threats faced by the plateau.

Kaas plateau was the area selected for the study as it was observed that the area was facing lots of disturbances like uncontrolled tourism, trampling, waste etc. The working plan of the Forest Department (FD) was seen to be incorrectly implemented and did not make a good conservation provision. A management plan was also practiced by FD, but it was observed that all the activities conducted by the FD were for the control of the tourism and not for conservation purpose of biodiversity. The biodiversity was indirectly getting affected even though tourism was being managed. It was important to provide a structure which will directly conserve the unique biodiversity of the area. So this project was undertaken in order to provide various guidelines and a SEA model so that conservation of biodiversity of kaas plateau can be managed for a long term.

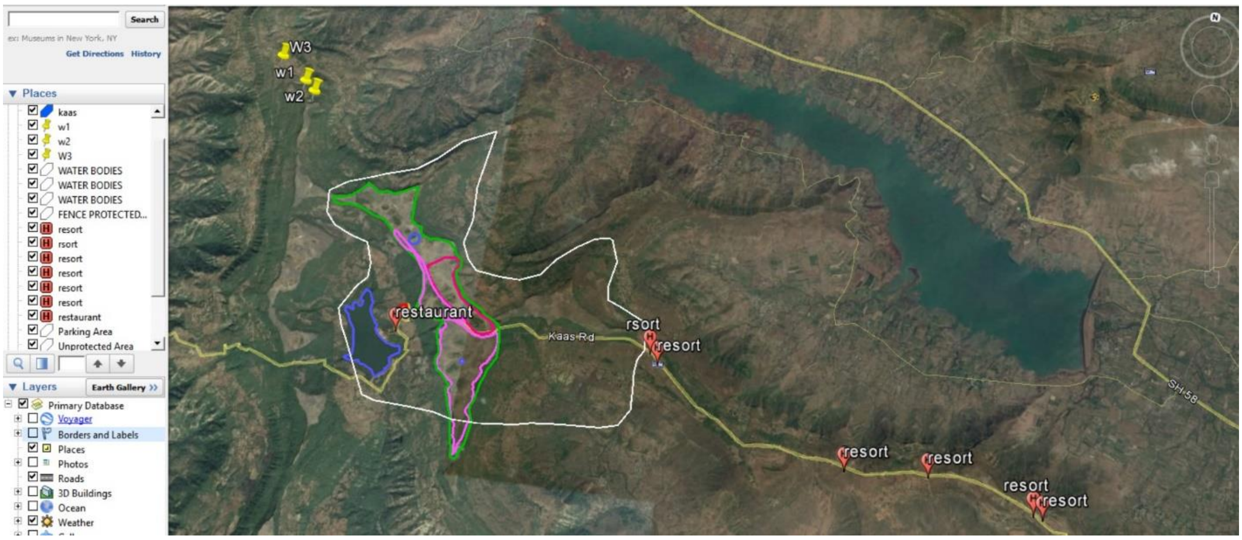


Fig. 1: Google Earth image of Kaas Plateau.

Step by Step tasks to framework an SEA for Kaas Plateau w.r.t. Tourism.

TASK 1: Screening

Screening is a process to determine whether an SEA is needed or not. Regulatory guidance may sometimes be available to aid the process. In the absence of a legislation mandating SEA, other criteria should be developed for assessing the process of screening. Some of these criteria that can be considered include: location of the project area, sensitivity of the environment likely to be affected (presence of protected/rare species of flora or fauna, valuable ecosystem services being lost) or any adverse impacts that the project actions may cause.

The stage of screening process marks the beginning for the SEA. In this step we basically argue about the validation of doing an SEA. In the case of Kaas plateau, the SEA should definitely be made for the tourism industry prevalent. The existing tourism management plan is not efficient enough to cater to the negative impacts that are being prevalent in this WHS. To develop a perfect SEA would lead to a decrease in the trampling of the flowers by the tourist which will result in conservation of the endemic flora species. To preserve a WHS many other aspects should also be looked upon without compromising on the development of the area. The lack of policy to cater the pollution is leading to the damage of the biodiversity of the WHS. The growth of illegal construction and illegal possession of land in WHS implies the definite needs for the SEA. Thus a framework for SEA becomes very crucial when it comes to the conservation of biodiversity of Kaas. The lack of policy for the conservation of the area makes it highly vulnerable.

TASK 2: Setting objectives and scope of assessment

The scoping stage basically sets a framework of environmental objectives and targets against which the predicted environmental impacts are tested.

Scoping determines:

- **The likely geographic and temporal extent and level of details of assessment required**
- **Information to be included in the SEA**
- **Boundaries of baseline information and data needed**
- **Identify gaps in available information that need to be plugged for conducting the scoping and subsequent assessments**
- **Environmental, social and economic problems, objectives and obligations**

- **Suitable methods and techniques to be used for assessment**
- **Potential stakeholders and participants to be involved in various SEA stages**

Object of assessment: Study the tourist's impact on the heritage site. Study the Tourism and developmental policies of the region for conservation of the heritage site.

Strategic objectives & issues and vision:

- Restore, rejuvenate and ensure a socially and environmentally balanced plateau.
- Promote an environmentally sustainable development plan
- Conserve the heritage site by implementing a model for eco-tourism
- Create a financially sustainable efficient governance model.

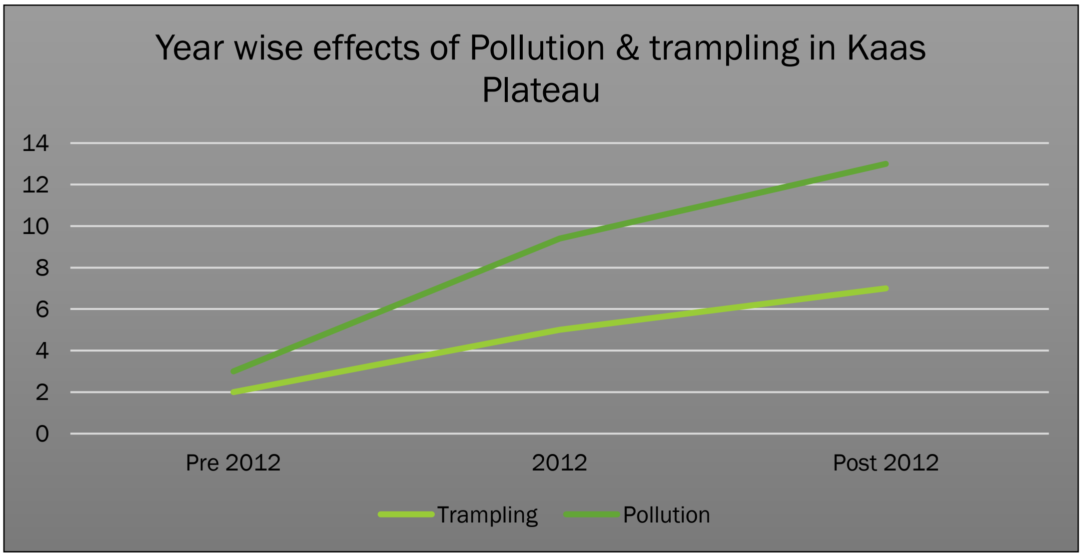
Table 1: Environmental, social and economic issues caused due to development projects on temporal and geographical scale.

Key Issues	Temporal Scale			Geographical Scale		
	Short term	Medium term	Long term	Local	Regional	Inter-state
ENVIRONMENTAL ISSUES						
Trampling			*			*
Air pollution(Oxides of Carbon, nitrogen & Sulphur)			*	*		
Solid waste management		*		*		
Wind mills			*		*	
Hydroelectric power plant			*			*
Human-wildlife conflict			*	*		
Noise pollution			*	*		
Resorts/ hotels			*		*	
ECONOMIC ISSUES						
Livelihood			*	*		
Restricted tourist activities		*		*		
Land holdings			*	*		
Income		*				*
SOCIAL ISSUES						
Migration		*				*
Health			*	*		

Task 3: Establishment of baseline data

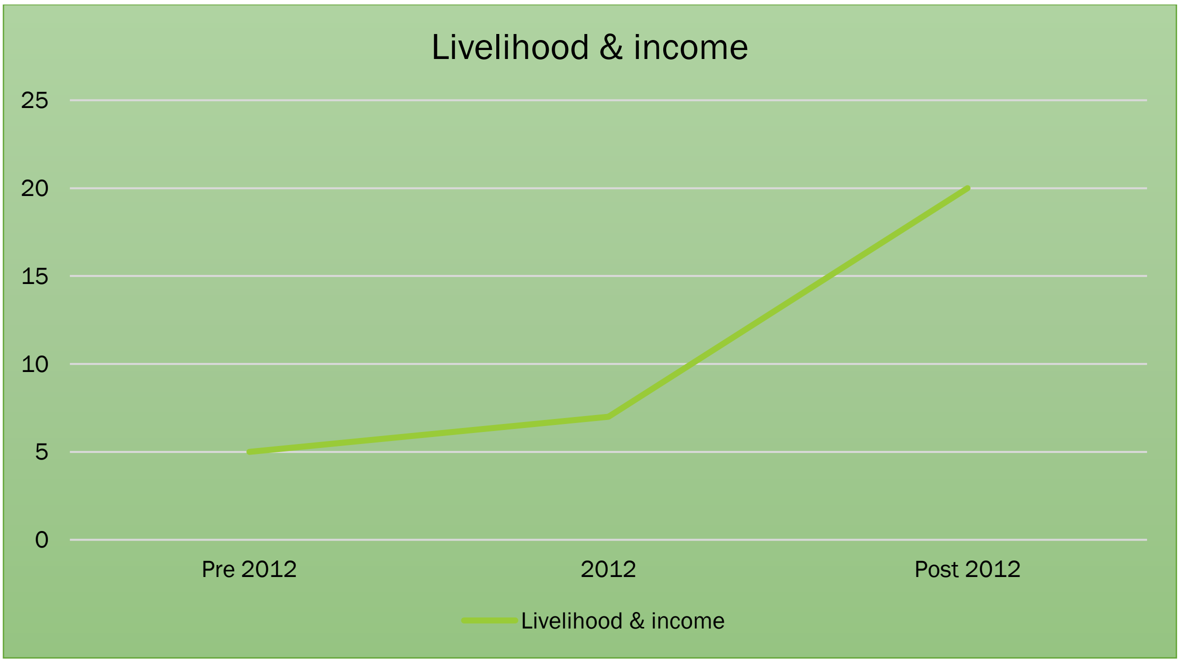
Baseline data refers to the background information on the biophysical, social and economic settings of the region under consideration. Both primary (field samplings, interviews, surveys, consultations) and secondary (reports, research literature) sources of information are used. Baseline data is collected to provide a description of the current status and trends of environmental and social factors of a given region against which predicted changes can be compared and evaluated in terms of significance.

Trampling & pollution: The increased pressure of tourist in the area is a concern for the ecological values of it. The presence of endemic flora species of the plateau is known to all but the lack of management policies is forcing the extinction of those. Although the number of visit of tourist is restricted but the negative effects of the visit is seen to be increasing with the time. Although no baseline data of the trampling and pollution effects are found but the loss of the species are evident of it. Trampling by tourist is something which is destroying most of the flower species. Trourist visiting the place are combined of aware and unaware population about the value of the WHS. But still the difference in their act is not noticed leading to the increase in damage. If we consider pollution, mainly air & sound pollution is prevalent there which is afftecting the plateau. The motor vehicles passing over the Pathar (where the flowers are prevalent) region increases the air pollution leading to the decrease in species. The sound pollution made by the vehicles forces the pollinating birds & insects to leave the area for survival which again impacts the WHS.



*The figures are not exact due to unavailability of numerical data.

Livelihood & income generation: The livelihood of the population drastically changed after the region has been announced a WHS. The habitants was previously dependent on the agriculture but with time the agriculture got totally dismissed and they have been substituted by tourism industry. Before 2012 the main source of income for the people was agriculture but after the announcement of WHS the livelihood of the people changed. After the announcement and different policies the human-wildlife-conflict increased as well which totally destroyed the agriculture of the region. People are now mostly dependent on the tourism industry which is negatively affecting the universal values of the plateau. A huge number of temporary migration is also found.



* The figures are not exact due to unavailability of numerical data.

Task 4: Analysis of proposed development objectives

Table 2: Current tourism management plan by fd with relation to biodiversity.

MANAGEMENT ACTIONS	IMPACTS ON BIODIVERSITY DIRECT/INDIRECT	
	Positive	Negative
1) Formation of Joint Forest Management Committee	Indirectly help in conservation of Biodiversity.	None
2) Tickets/ online booking	None	None
3) Fencing the plateau	Reduction of trampling, collection of species and garbage	Destruction of aesthetic beauty and difficulty for animals to cross
4) Facility of parking/ no parking zone on the plateau	None	Kaas lake was crowded as all vehicles were directed which caused pollution there.
5) Nature guides/ field guides	Awareness	None
6) Introduction of fine for plucking of flowers and throwing garbage	Biodiversity was not harmed	Was not monitoried properly. So collection and throwing of garbage did take place
7) Introduction of dustbins on the plateau	Reduction in garbage pollution.	None
8) Shuttle bus service	None	None
9) Division of plateau into four parts	Tourist equally divided in	Carrying capacity was

	sections to reduce load on a single area.	not evaluated and trampling was caused to a certain extent.
10) Money collected by JFMC was used in the development of villages	None	None
11) No grazing zone on plateau during the tourist season	Reduction of threat of grazing.	None

Showing positive and negative impacts of current management plan of FD.

Table 3: Guidelines for long term conservation

	NATURAL FACTORS		
IMPACTS	PLANTS	ANIMALS	HABITATS
Tourism	Yes	May be	Yes
Grazing	May be	No	May be
Fires			
artificial	Yes	Yes	Yes
natural	Yes	Yes	May be
Land use			
roads	Yes	No	Yes
resorts	Yes	Yes	Yes
flex	May be	No	May be
windmills	Yes	Yes	Yes
mining	Yes	Yes	Yes
garbage dumping	May be	No	Yes
agriculture	Yes	Yes	Yes
Plan of FD			
fencing	No	No	No
no parking zone	No relation	No relation	No relation

dustbins	No	No	May be
bus services	No relation	No relation	No relation
no grazing	May be	May be	May be

➢ **SUGGESTIONS FOR LONG TERM CONSERVATION OF THE AREA**

- Respect the area.
- Map the important species which are of key significance and need protection.
- Study the carrying capacity of the area to understand things like grazing, tourism etc.
- Proper linkage between waste pickers and scrap collectors should be formed.
- Maintain the current website regularly.
- The total number of people in a particular section should be limited as per the results from carrying capacity.
- Study the activity of fauna in the area.
- Plan community participation for better conservation.
- Consult local people, local NGOs and experts from various fields before planning of any policy.
- Public consultation should be done regularly and its report should be made available.
- Spread awareness in tourist through ads or posting information on website.
- High security should be made available during the season and also on Kaas Lake.
- Security should be present 24 by7 throughout the year.
- Prepare the walking trail routes taking into account the significant species.
- Monitor the area regularly through detailed studies.

➢ GUIDELINES FOR CONSERVATION OF BIODIVERSITY OF PLATEAU

- To understand complex biodiversity of plateau scientific studies are recommended as per needs like interlinkages between species, various ecosystem processes, study of indicator species, plant and pollinator relationships etc.

- Indicator species should be identified and mapping should be done by overlapping the species are with the threats present in that area.

- Any management action should be based on proper scientific studies.

- Management of the area should be implemented by professional management agencies.

- A legal body should be formed which will deal with all the management aspects of the plateau. The legal body should consist of Management experts, Area planners, Biodiversity specialists (ecologists, biologists, and managers), representative of local community(political) and District collector or any of his representatives.

- Monitoring and studies should be carried out regularly and a legal status to the area should be provided.

- Proper respect to biodiversity should be spread through awareness techniques.

Suggestions:

Limiting tourist activities:

Tourist activities should be limited to certain areas where the impact of such activities is less or can be minimized by using certain measures. The number of tourists in Kaas are manageable but the destruction of species due to trampling and other human activities needs to be kept in check. Use of the proper pathways is a must. It was observed that many-a-times people to do not use the pathways. This leads to trampling of the flower species. This can be minimized by making people aware of the importance of the species of flowers. Also developing proper pathways, if possible tiled pathways, maybe a solution.

Stringent laws for housing/ hotel:

Laws for the housing places and hotels within the perimeter of the area should be stricter in implementation. The application of these laws should also be checked. It should be made sure that the hotel owners conform to the present laws. Regular checks and audits can be performed to make sure they are followed. Measures to tackle the waste generation of these hotels need to be revamped.

Manpower needed:

More skilled man power is needed so that the tourists can be directed and informed about the expected conduct in the area. People with the knowledge about the area are also needed to inform people about the importance of conservation of the area. Tourists hardly know what World Heritage Site means. Thus people are needed more to inform than to protect the area. If the importance of the area can be sufficiently communicated to the tourists, they would themselves help in protecting the area and conserve the species in Kaas.

Vehicles and Parking:

Vehicles are the immediate threat to the ecosystem in Kaas. The pollution from these vehicles is polluting the area. Moreover, the way to parking is via the Kaas Pathar area. This can and should be moved to a location before the pathar area towards Satara. This will ensure that the pristine environment is conserved. This will also ensure the proper management of tourists in the area.

Alternate Route for State buses:

The alternative route which goes through Kasani and Ghatwan villages should be developed. The traffic should be redirected to that route so as to reduce the pressure on the road via the plateau area. This will increase the travel time but will substantially reduce the negative impact of vehicles passing the area.

Alternate Livelihood for the locals:

The shifting of parking space from inside to outside the plateau area can also help in giving the locals a way of earning their livelihood. Those people who cannot practice agriculture can then engage in activities like helping the tourists to reach the area from the parking space and vice versa. The transportation medium can be the electric vehicles which will also help in mitigating the adverse effects of pollution from the vehicles.

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Traditional Knowledge and its Rols in Eco-DRR and Biodiversity Conservation Strategies as adopted by people residing in the Bamnoli Range of Sahyadri Tiger Reserve

Image: Devrai of village Aarav

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Wildlife Institute of India

United Nations Educational, Scientific and Cultural Organization

UNESCO Category 2 Centre

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Lastly, I would like to thank all the villagers residing in the vicinity of the Sahyadri Tiger Reserve.

Introduction:

Local communities encounter various hazards and disasters regularly in their life. Their knowledge of mitigating the impact of any hazard or to adapt themselves to any hazard is invaluable. Their knowledge is often considered inferior to the knowledge provide by the scientific community and often on some aspect there are differences among them. Scientific knowledge is still struggling to reach to the grass root level, where the vulnerability is often highest and here local knowledge and beliefs strengthen the community's resilience and coping power to the hazard which they encounter regularly. This knowledge is often lost or forgot in this fast moving modernised world where indigenous knowledge is considered sub-standard. But since this knowledge has helped various indigenous communities to survive various hazards from generations there has been arguments and calls for increase for the documentation and acceptance of this knowledge worldwide.

Literature review on Traditional knowledge:

Though there is no particular defined definition of traditional or indigenous knowledge, many scholars and researchers has tried to bring out the idea and importance of this knowledge set. Traditional or indigenous knowledge is the pool of knowledge, passed down generations, gained through the knowledge of environment which is revealed through intuitions, dreams or visions (Agrawal, 1995). This knowledge is attained through community i.e. the local people's interaction with the nature. This knowledge has helped local communities all over the world to survive for generations (Iloka, 2016). The traditional knowledge evolves with generations and changes they experience with their encounter with the nature. Traditional knowledge empowers the community and helps them in tackling problems and this empowerment enhances their developmental process (Iloka, 2016). Traditional knowledge and practices are widely used by the communities in the developing countries in field of medicine, agriculture, food production, engineering and ecological management of natural resources (Domfeh, 2007). Traditional knowledge is widely ignored due to lack of proper documentation and as it is considered inferior to the scientific knowledge.

Traditional knowledge in Eco-DRR and Biodiversity conservation:

This traditional indigenous knowledge which the community inherits from the past generations helps them to cope up with several hazards (Hiwasaki, 2014). Though, this knowledge is not accepted much and is underappreciated but from last two decades the importance of this knowledge set has received lot of attention worldwide.

But, with reference to Hyogo Framework for Action- Priority 3, and the current Sendai Framework for Disaster Risk Reduction much importance is given on inclusion of traditional community knowledge into developmental plans for disaster risk reduction and development of the local community.

Study objectives and Justification:

The primary objective of the study is to document the lost, available or new traditional knowledge and practices of the people residing in the buffer zone of the Sahyadri Tiger Reserve, and to relate these knowledge, practices and skill with the Eco- Disaster Risk Reduction. Since the communities has been residing in the vicinity of the forest much before it was declare as a tiger reserve. So the study aims to majorly document the traditional knowledge associated to Disaster Risk Reduction and Biodiversity conservation.

As discussed earlier, there is an increase call on utilisation of local community knowledge to mitigate hazards, or to structure developmental plans incorporating disaster risk reduction inherited from traditional knowledge (Mercer, 2012). There is a need to integrate traditional knowledge of mitigation and adaptation into the DRR and Developmental plans, since this knowledge has helped them to survive generations (Nyong, 2007). To document and accept the traditional knowledge of DRR and biodiversity conservation is a road to community empowerment and development in this 21st century. One cannot desire of development at the local community level without empowering the community and this local empowerment comes with use of traditional local knowledge which leads to increased community participation and their awareness for disaster risk reduction. Thus, on broader picture, the inclusion of traditional knowledge plays an important role in complete community development.

Study area:

The study area for the above-mentioned aim is a cluster of 8 villages which falls under the buffer zone and protected buffer zone area of Bamnoli Range of Sahyadri Tiger Reserve. The villages i.e. Waghavale, Nivli, Lamaj, Uchat and Kandat are in buffer zone while the villages Aarav, Valvan and Shindi are in protected buffer area.

Image: Google earth image of the study area

Sanctuary, National park and Tiger Reserve:

According to wildlife protection act 1972 government declared “sanctuary as any area comprised within any reserve forest or any part of the territorial waters, which is considered by the State Government to be of adequate ecological, faunal, geomorphological, natural or zoological significance for the purpose of protecting, propagating or developing wildlife or its environment, is to be included in a sanctuary”.

With reference to sanctuary they have also described National park as a “Whenever it appears to the State Government that an area, whether within a sanctuary or not, is, by reason of its ecological, fauna, floral, geomorphological, or zoological association or importance, needed to be constituted as a National Park for the purpose of protection & propagating or developing wildlife therein or its environment, it may, by notification, declare its intention to constitute such area as a National Park”. A Tiger Reserve is a critical habitat mainly for tigers under the GOI Project Tiger initiated in1973. It has several layers for the protection and conservation of the animal. A Tiger Reserve has core area, a protected area and an additional layer of buffer zone for protection.

A buffer zone serves to provide an additional layer of protection to a Wildlife Protected Area. The concept of a buffer zone was first included in the *Operational Guidelines for the implementation of the World Heritage Convention* in 1977. In context of India The national wildlife action plan NWAP 2002-2016 Indicates that *“areas outsides the protected areas* *network are often vital ecological corridor links and must be protected to prevent isolation of fragments of biodiversity which will not survive in the long run".*

The villages under study falls under the second and third layer of the Sahyadri Tiger reserve and thus there are various restrictions on the villagers as well as certain advantages of various programmes run by Forest department. After the WEEP report on the Western Ghats biodiversity many restrictions have been imposed on the villagers. Which has there repercussions on the traditional activities of the village.

More importantly most of the traditional practices in the village has been forgotten, as the villages have been relocated and rehabilitated during the construction of Koyna dam while modernisation and restrictions due to forest department has acted as a catalyst.

Methodology:

A suitable methodology has been followed to undertake the present study. It comprises of the mix of quantitative and qualitative research - collection, analysis and interpretation of data, the design of sample, interview schedule and use of secondary data. This sample is of diverse background, the tools like household surveys and focus on group discussions were to collect the primary data from the sample. Sampling methodology was purposive random sampling. With sample size of 24, 3 from each village. For the study, interviews has been conducted with youth and the elderly, belonging to various community and caste. The emphasis was on the *"Dhangar gavli" "Maratha" & "Jangam" samaj* communities, which are native to the area.

Image: Gavli people rearing their cattle and an elderly talking about their traditional practices

Results and Discussions:

Housing: The traditional structure of housing is made from the building materials available in the village and forest. A typical house in every village were kuttcha house having thatched roof, made up of multiple layer of dried vegetation tied together and the walls are made up of mixture of mud and cattle dung. But now due to regular required maintenance and forest restrictions the roof of the most of the houses are made up of kiln tiles, but the structure is more or less similar. From inside the house is supported by frame and pillars made from trunks of *sag (teak)* or *khair (senegalia catechu)* trees. Bamboo is also used sometimes to build the frame. The structure of the house is such, that it is rain and storm resistant, since the area receives high rainfall. The wooden frame and thatched roof makes the house earthquake resilient, as tremors are regularly felt in the vicinity. The mud wall are protected against heavy rains by layer of dried vegetation during monsoon. Usually a house requires repair every 7-8 years.

Image: A traditional & conventional village house.

The house has a separate areas designated for storage of grains and seeds, cattle, cooking. The house is suitably ventilated and the fire space in the house is located such that in case of fire damaged can be minimised. The fire also keeps the house warm in during monsoon and winter.

The traditional engineering knowledge involved in the activity of house making is perfect, villagers acknowledge almost all the hazards they are prone to and tries to accommodate mitigating efforts for all hazards. All the materials required for making a conventional house is available in forest, the family is solely engaged in house building process. So, no external support for materials, services or labour is required.

Image: Places designated for grains and cattle.

Lifestyle: People of these villages recognises heavy rains as a particular hazard effecting their life and property constantly, their houses which are very well resilient to rains, they use "*irl"* to protect themselves during heavy rain. *Irl* is a poncho like garment made up of bamboo woven in cloth. This garment protects their upper portion of their body. These days people use plastic sheets instead of bamboo between the cloths, as plastic is easily available and better rain resistant than bamboo. This *irl* is very effective in heavy rains, it is made locally at home and can be reused and maintained easily.

Image: dhangar gavli men wearing conventional Irl

Agriculture:

Traditionally livelihood activity of the people is agriculture & they are habitual of taking single crop in a year i.e. paddy/rice *(Bhat)*, few farmers also take crop as ragi (millet) known as *nachni* and *"vari"* a type of rice.

Field preparation: After the removal of weed, which is mostly done manually (sometimes cattle are used), farmer spreads a thick layer of dried *"Nirguda"* or Vitex negundo leaves on the field and they cover it with a thin layer of soil. This is then burnt and then farmer proceeds with the next activity for sowing the seed. The *nirguda* leaves known for its fumigation and disinfectant properties removes rest of the weed and it also acts as a fertilizer and insecticide for the crop, as per villagers. This was practiced mostly once every 7-8 years and then the land is abandoned for 3-4 years. Now in present time farmers use chemical fertilizer along with this practice but they no longer abandon the land (which is near to their village). People also acknowledge using decomposed tobacco leaves as insecticide, sometimes they used to mix the leaves with mixture of water and jaggery. They used to sprinkle this mixture 1:4 (tobacco leaves water and water) on the field for pest control thus to prevent insect infestation. Cattle dung was widely used as traditional manure.

The use of traditional methods of weed management, use *nirguda or tobacco* leaves as insecticide and disinfectant and use of cattle dung as manure, not only reduces the input cost of the crop but also is indigenous in nature reducing the dependency of farmers on the expensive chemicals. As now the world is recognizing the value of organic crops and farmers are motivated to practice organic farming. Traditional farming methods were themselves organic in nature and thus must be supported throughout.

Agricultural predictions: the knowledge of local people on the prediction of rainfall on the basis of past occurrences or due to unusual weather patterns is impeccable. They can predict the amount (high, moderate or low) of rainfall one or two months before the monsoon. This is due to their knowledge of past experiences. They sow and harvest their crop according to the nakshatras, which is commonly known as agro-astronomy, though there are no much scientific viability of their habit in this world of climate change.

Irrigation: Traditionally and presently, almost all the agricultural land is dependent on monsoon, either on gravity water or direct rain. Traditionally from generations people have made gullies from the hills directly to their field to irrigate the field. To prevent soil erosion and to hold the water for the paddy, bunds are constructed using rocks on the boundary of the field. In the case of heavy rain they remove the rock as per requirement so that the excess water flows downstream. In case of less rainfall they divert the other gullies to their field for more water.

Image: A typical irrigation gully and wall at the end of the village near reservoir to prevent soil erosion

Traditionally these farmers were not sowing crops in multiple area, but due to their relocation after the Koyna dam project they got fields in multiple areas, though it is difficult of them to keep an eye on all fields, this has also turned out be an advantage for them. In case of crop damage due to any reason, insect infestation or due to trespassing of wild animals, they do not suffer total crop loss. They also take multiple crop so that in case of one crop failure the other crop survives.

To prevent soil erosion and gully erosion they have planted trees around the border of the field and along the embankments, these trees are mostly bamboo and few tree are of items which are consumed regularly in the household. They also use small walls which works as bunds to hold water and to prevent soil erosion.

Storage and preservation: For storage and preservation purpose they make a container using bamboo, this container can be of varied size and shape, but at most of the places this container was cylindrical. At the bottom of the container they lay down a thick layer of ash, which is produced at their home daily after cooking, above this layer they applied a layer of *nirguda* leaves and then they fill the container with the harvest. There are multiple layers of *nirguda* leaves in the container applied at regular difference. In case of crop failure due to any reason, they have a storage for up to 3-4 years and people do not remember, when they ran out of storage. People also don't acknowledge severe drought condition in the area.

Image: A traditional grain storage mechanism using ash and leaves of nirguda protected from above with plastic sheets.

Image: two different types of containers made of bamboo, used to store and preserve grains

The containers are homemade, and use of ash and *nirguda* leaves for preservation, similar to other things, it also reduces the cost and dependency of the local people on the outside world.

Natural resource management:

Natural resource conservation is vital for forest and biodiversity sustainability and this is the core area where indigenous traditional knowledge is invaluable. From generations the forest is properly divided among the villages, and no one from other village was allowed to access the forest and take goods, from the forest assigned to particular village, this was some kind of property right system they followed from generations, also certain area around *"Parvat"* is declared sacred, and no villager used to cut trees or hunt or take their animals for grazing in this area of the forest. Similarly, in the forest designated to every village, a certain area is again declared as *"devrai"* meaning land of god i.e. it is also considered to be sacred. People do not use or access these sacred forest areas for any reason. These area acts a nucleus for biodiversity balance for every village, and on the broader scale for the whole forest.

Similarly, for sustainable use of forest, villagers used to strategically divide the forest such that, no trees are cut more than once and also no area of forest is accessed twice for the same good in the same time period (cycle). For this purpose villagers used to go to a certain section of forest, for forest produce and next time they will go to another area and allow the previous area to grow till the next cycle. By these methods no forest area was exploited instead, it was a traditional art of sustainable forest management amongst the villagers.

Now presently hunting is an unlawful offence, but elderly of the village acknowledge that they used hunt wild boar only on the nights of village feast, for family gatherings and feast they used to hunt *"bhakel"* i.e. barking deer, as it is small in size and thus no meat is wasted next day.

People don't do fishing activity during monsoon as it is the breeding period for the fishes and they acknowledge the importance of this period for aquatic sustenance. For consumption purpose they used an equipment "*koin"* instead of using fishnets to catch fishes, *koin* is a fish trapping equipment made up of multiple concentric rings made up of bamboo, which used to catch big fishes as small fishes can easily move out of the trap.

The idea and logic of declaring certain area of forest as sacred *"devrai*" is impeccable as it supports and sustains the nature and forest without any human interference. The regular changes for collection of forest produce also gives time to forest to regrow. It is no doubt that the knowledge of the local about their forest and its management is as good as the today's logical approach of laws and restrictions. But the population growth and developmental plans had led to extinction of this knowledge, people recognises most of the traditional practices and facts about natural resource conservation and management but no longer practice it.

Conclusion and Suggestions:

People are exposed to numerous hazards and just scientific knowledge is not sufficient to mitigate all hazards at the basic community level. And thus community's traditional knowledge is required to be incorporated in the developmental plans. The integration of traditional knowledge with the scientific knowledge will result in the evolved and efficient Disaster Risk Reduction for both the community and the nature. Though communities approach of biodiversity conservation was viable in the past but due to Illegal smuggling and over exploitation of forest goods certain laws and restrictions are required to be imposed. But their practices of natural resource management or conservation was impeccable and this has led to the sustenance and existence of forest from several centuries.

The sustainability of community, their habitat, various government projects and of environment all together depends on how community interact with the nature, and their interaction with the nature from past many decades suggest that their knowledge and experiences with the nature and their habitat has been effective in past and if integrated, accordingly, with formal laws and plans it will result in enhanced and sustainable development of the community and the environment.

Somehow, this modernised world and the modern education system is responsible for the extinction of traditional indigenous knowledge, and without the external support of the modern world it would be difficult to revive this knowledge. The traditional knowledge of the locals must be thoroughly documented by VEDC (Village-Eco Development Committee) and then this sound knowledge should be referred for any decentralised development plans. At school level in the village, children must be taught the importance of this knowledge and this knowledge must be accepted as a core of survival and existence of the people in the study area. Thus, this knowledge must have its space in developmental plans, study reports, educational books and most importantly in minds of the people outside the study area.

Annexure

Questionnaire:

Basic information:

1) Household no:- Village:

2) Respondent name:- Age:

3) Family members

Name of household members	Relation to head of family	Age	Education	Occupation male/female	Lives in	Income

4) Cast and Sub Cast:-

5) Type of House:- Kaccha / Pucca / Own/rented/ other

6) Drinking water facility:- Yes / NO (Well/ hand pump/ spring/ ……………………)
Period of drinking water scarcity if any:

7) Elecricity supply: YES/NO Duration/day:

(B) Livelihood information

1) Land Owned:

Irrigated: Non-irrigated:

Have you sold land in last 5 years? How much?

2) Livestock owned and numbers

Cows: Bullocks: Buffalo: Goat:

Other:

Traditional/Indigenous Practices: (Various folk songs, saying and stories.)

1. Housing and lifestyle
    1.1. Rain resistant attire/ warm clothing
    1.2. Living style during heavy rains or uncertain weather conditions
    1.3. Rain/storm resilient/resistant
    1.4. Earthquake resilient/resistant
    1.5. Flood or waterlogging resilient
    1.6. Resilient of Settlements in landslide prone areas
    1.7. Fire space (for cooking and other purposes)
    1.8. Ventilation and air flow
    1.9. Place designated for
        1.9.1. Fossil fuel/wood
        1.9.2. Grains and seeds
        1.9.3. Cattle
        1.9.4. Important material
2. In agriculture:
    2.1. Crops grown
        2.1.1. No of crops
        2.1.2. Type
        2.1.3. Season
        2.1.4. period
        2.1.5. For sale/consumption
        2.1.6. Average yield per year
    2.2. Storage/preservation (Technique and Duration)
        2.2.1. Harvest
        2.2.2. Seeds
        2.2.3. Type of granary
    2.3. Soil and land
        2.3.1. Conservation techniques
        2.3.2. Treatment techniques
        2.3.3. Preventing soil erosion
        2.3.4. Preventing gully erosion
    2.4. Pest control mechanism
    2.5. Weed management
    2.6. Preparation of field
    2.7. Traditional Manures and fertilizers
    2.8. Agricultural predictions
        2.8.1. On the basis of past occurrences
        2.8.2. On the basis of unusual weather patterns.
        2.8.3. On the basis of nakshatras
        2.8.4. On the basis of traditional meteorological knowledge
        2.8.5. Prediction of flood or less/high rainfall.
    2.9. Multiple area and cropping mechanism
        2.9.1. If yes (then WHY?) for both (area/cropping)
        2.9.2. For survival in case of one crop failure

2.9.3. For survival in case of damage due to wild animals
2.9.4. For survival in case of damage due to insect infestation.
2.10. Traditional knowledge
2.10.1. Water conservation and harvesting
2.10.2. Drought management
2.10.3. Survival strategies in case of famine or total crop loss.
2.11. Traditional Irrigation technique
2.12. Traditional flood management or prevention of crop failure in case of heavy rainfall
2.13. Traditional technique to save a crop in case of less rainfall.

3. Medical knowledge
    3.1. As preventive measures
    3.2. For basic health problems
    3.3. Measures taken to keep cattle healthy.
    3.4. Veterinary knowledge for cattle or goats etc.
    3.5. Resilience to snake bite and traditional measures for snake bite.
    3.6. Measure taken after any animal or insect attack/bite/sting/
    3.7. Any other knowledge of indigenous medicinal plant
4. Measures taken to avoid human-animal conflict.

5. Alternate livelihood practices (current or earlier)
    5.1. Collection of forest produce
        5.1.1. Type
        5.1.2. Place of collection
        5.1.3. Readymade or any further processing required
        5.1.4. Problems and challenges
        5.1.5. Market and sale.
    5.2. Type(if other)
    5.3. Dependency on forest
    5.4. Challenges
    5.5. Coping mechanism
6. Livestock rearing purpose: farming/ dairy/ meat or any other
    6.1. How many are stall fed:
    6.2. Grazing area:
    6.3. Problems faced:
    6.4. Coping mechanism
7. Traditional knowledge of natural resource management.
8. Traditional knowledge for
    8.1. Predict presence of wild animal
    8.2. Keeping or Moving that animal away
    8.3. Signalling the community about the wild animal
9. Traditional knowledge of Disaster management

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Review on World Heritage Sites and Tiger Reserve with special reference to impacts of DRR policy in Western Ghats (Sahyadri Sub-cluster)

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United Nations
Educational, Scientific and
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Contents

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Introduction

"Natural heritage": natural features consisting of physical and biological formations or groups of such formations, which are of outstanding universal value from the aesthetic or scientific point of view; geological and physiographical formations and precisely delineated areas which constitute the habitat of threatened species of animals and plants of outstanding universal value from the point of view of science or conservation; natural sites or precisely delineated natural areas of outstanding universal value from the point of view of science, conservation or natural beauty. (Article 2, Convention Concerning the Protection of the World Cultural and Natural Heritage, 1972)

To be included on the World Heritage List, sites must be of outstanding universal value and meet at least one out of ten selection criteria. These criteria are explained in the "Operational Guidelines for the implementation of the World Heritage Convention" (The World Heritage Committee, the main body in charge of the implementation of the Convention, has developed precise criteria for the inscription of properties on the World Heritage List and for the provision of international assistance under the World Heritage Fund. These are all included in a document entitled "Operational Guidelines for the Implementation of the World Heritage Convention") which, besides the text of the Convention (The Convention concerning the Protection of World Cultural and Natural Heritage was adopted by the General Conference of UNESCO on 16 November 1972), is the main working tool on World Heritage. The criteria are regularly revised by the Committee to reflect the evolution of the World Heritage concept itself. Until the end of 2004, World Heritage sites were selected on the basis of six cultural and four natural criteria. Now with the adoption of the revised Operational Guidelines by UNESCO; for the Implementation of the World Heritage Convention, only one set of ten criteria exists (UNESCO, World Heritage List Nominations)

India has 7 natural heritage sites. These are as follows:

1. Kaziranga National Park, Assam (1985)
2. Keoladeo National Park, Rajasthan (1985)
3. Manas Wildlife Sanctuary, Assam (1985)
4. Nanda Devi and Valley of Flowers National Parks, Uttarakhand (1988)
5. Sundarbans National Park, West Bengal (1987)

6. Western Ghats of Maharashtra (2012)
7. Great Himalayan National Park Conservation Area, Himachal Pradesh (2014)

This Study focuses on sites from the Western Ghats. Western Ghats are selected as Natural Heritage site on the basis of following Criteria

Criterion (ix): The Western Ghats region demonstrates speciation related to the breakup of the ancient landmass of Gondwanaland in the early Jurassic period; secondly to the formation of India into an isolated landmass and the thirdly to the Indian landmass being pushed together with Eurasia. Together with favourable weather patterns and a high gradient being present in the Ghats, high speciation has resulted.

Criterion (x): The Western Ghats contain exceptional levels of plant and animal diversity and endemicity for a continental area. In particular, the level of endemicity for some of the 4-5,000 plant species recorded in the Ghats is very high: of the nearly 650 tree species found in the Western Ghats, 352 (54%) are endemic. Animal diversity is also exceptional, with amphibians (up to 179 species, 65% endemic), reptiles (157 species, 62% endemic), and fishes (219 species, 53% endemic). Invertebrate biodiversity, once better known, is likely also to be very high (with some 80% of tiger beetles endemic). A number of flagship mammals occur in the property, including parts of the single largest population of globally threatened landscape species such as the Asian Elephant, Gaur and Tiger. Endangered species such as the lion-tailed Macaque, Nilgiri Tahr and Nilgiri Langur are unique to the area. The property is also key to the conservation of a number of threatened habitats, such as unique seasonally mass-flowering wildflower meadows, Shola forests and Myristica swamps (UNESCO, world Heritage List, 2012)

Amongst the Western Ghats, four areas from Maharashtra Sahyadri Sub-Cluster were selected as World Heritage Sites namely ‘Kaas Plateau’, Dist. Satara, ‘Koyna Wildlife Sanctuary’, Dist. Satara, ‘Chandoli National Park’, Dist. Sangli, ‘Radhanagari Wildlife Sanctuary’, Dist. Kolhapur. Amongst this 4, Kaas Plateau & Koyna Wildlife Sanctuary sites were visited during the field visit.

Kaas Plateau

Kaas Plateau fits into following 2 criteria and therefore it is selected as Natural Heritage Site.

(iX) To be outstanding examples representing significant on-going ecological and biological processes in the evolution and development of terrestrial, fresh water, coastal and marine ecosystems and communities of plants and animals;

(X) To contain the most important and significant natural habitats for in-situ conservation of biological diversity, including those containing threatened species of outstanding universal value from the point of view of science or conservation.

Kaas Plateau is situated in the central part of Deccan plateau of Maharashtra, in Satara District. It is high hill plateau and grassland which turn into a 'valley of flowers' during monsoon season, in the month of August. Kaas Plateau has more than 150 or more types of flowers, shrubs and grasses. Major portion of the Kaas Plateau is a reserve forest. It is well known tourist destination and serious damage to the ecosystem has been observed due to increased tourist activity, major collection by the botanists and reason like climate change.

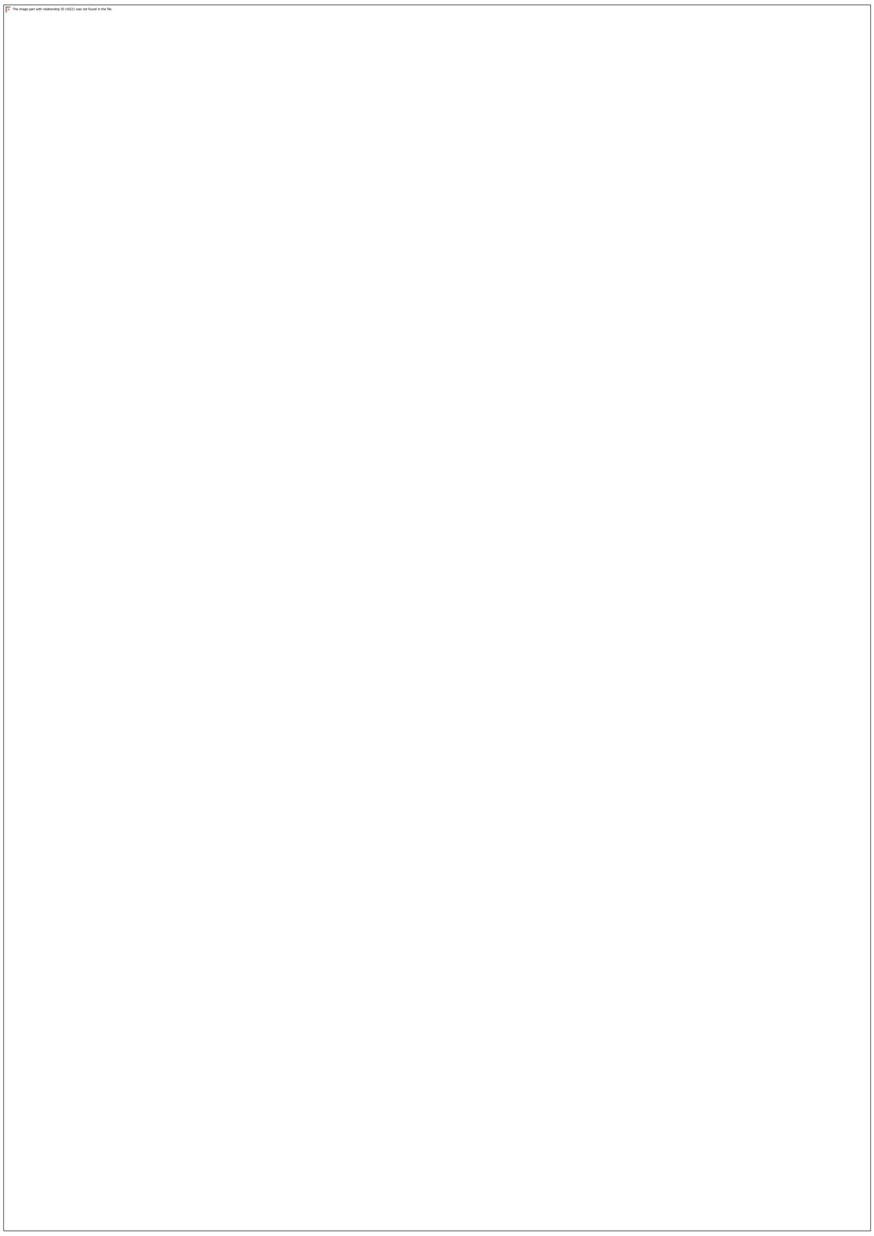
Kaas Plateau was formed by volcanic activities and is covered by a thin soil cover as a result of which, no vegetation thrives in the region. This area comes under very high rainfall zone. Due to this, the flora and fauna of the region is unique and endemic. Its unique ecological features make Kaas one of the hotspots of biodiversity.

Currently Flora of Kaas is becoming endangered mainly due to the anthropogenic activities like tourism and other human interferences. 38 endangered species are listed from Kaas. The endemic ecosystem of Kaas has already been declared as under threat and needs utmost protection (D.D. Shenai, 2013)

Koyana Wildlife Sanctuary

Koyna Wildlife Sanctuary is part of Sahyadri Tiger Reserve as well as Natural Heritage Site also. Koyana wildlife sanctuary includes Eastern and Western catchments of Koyana dam, which is a major hydro-electric project center in the western Maharashtra. The Sanctuary is well protected by the large extent of Shivasagar reservoir and steep Slopes of western Ghats on both the sides. This protected area is connected by a vegetal cover corridor of Chandoli and Radhanagari wildlife sanctuaries in south. The average altitute is 897 M. above MSL. The mean annual rainfall is 5500 mm. Koyana wildlife sanctuary is located in Satara District of Maharashtra state. The total area of notified sanctuary is 423.55 sq.kms. Koyna Wildlife Sanctuary was formed in the year 1985, as a part of Project Tiger which was initiated to protect the precious specious of tigers in India. The park was declared as the Northern part of Sahyadri Tiger Reserve in the year 2010.

The forest types are southern tropical evergreen forests and southern moist mixed deciduous forest. Dominant species are Anjani, Jambul, Hirda, Awala, Pisa, Ain, Kinjal, Amba, Kumbha, Bhoma, Chandala, Katak, Nana, Umbar, Jambha, Gela, Bibba etc. Karvi is found almost all over the area. Climbers such as Shikekai, Garambi are quite frequent. Shrubs species and Medicinal plants such as Karvand, Vagati, Ranmiri, Tamalpati, Toran, Dhayati, Kadipatta, Narkya, Murudsheng, etc. with small quantity of Bamboo are also found Quite a large no. of ephemerals, bulbs of seasonal plants are found.



Kumudini (Pan Bhopli)

Many sites around the globe are vulnerable to natural as well as man-made disasters. There are no significant policies for the world natural heritage sites. At the same time local disaster risk reduction policies may or may not justify the special needs of these special locations. So main focus of my study was on multiple designation areas - impacts on DRR policy with special reference to Sahyadri Tiger Reserve and World Heritage Site

Literature Review:

Defining the concept 'policy' is somewhat difficult: this is because we do not know precisely what a policy is (Page, 2006). Cunningham (1963, p.229) argued that "policy is rather like an elephant – you can recognize it when you see it, but cannot easily define it". Hill (2005) argues that policies can be identified as a decision, but more often it involves a group of decisions, or what may be seen as little more than an orientation. Therefore, it is hard to identify particular occasions when policy is made. Policies are also always connected to existing policies. It is important to recognize that a policy exists within a context of many other policies, and that they all impact and influence each other. There are various policies applicable to STR and WHS.

The Wildlife Protection Act, 1972, provides for protection to listed species of flora and fauna and establishes a network of ecologically-important protected areas. The Act consists of 60 Sections and VI Schedules- divided into Eight Chapters. The Wildlife Protection Act, 1972 empowers the central and state governments to declare any area a wildlife sanctuary, national park or closed area. There is a blanket ban on carrying out any industrial activity inside these protected areas. It provides for authorities to administer and implement the Act; regulate the hunting of wild animals; protect specified plants, sanctuaries, national parks and closed areas; restrict trade or commerce in wild animals or animal articles; and miscellaneous matters. The Act prohibits hunting of animals except with permission of authorized officer when an animal has become dangerous to human life or property or as disabled or diseased as to be beyond recovery. The Act underwent many amendments. An amendment to the Act in 1982, introduced provisions permitting the capture and transportation of wild animals for the scientific management of animal population. An amendment in the year 1991 resulted in the insertion of the special chapters dealing with the protection of specified plants and the regulation of zoos. This also recognized the needs of tribal and forest dwellers and changes were introduced to advance their welfare. The near-total prohibition on hunting was made more effective by the Amendment Act of 1991. Widespread changes have been made by the Wildlife (Protection)

Amendment Act, 2002 and a new chapter has been incorporated as Chapter VI-A to deal with the forfeiture of property derived from illegal hunting and trade. Further, this amendment Act also introduced the concept of co-operative management through conservation reserve management committee and community reserve committees.

The Wildlife Protection Act 1972 provides for four different categories of protected areas: Sanctuaries, national parks, conservation reserves and community reserves. The first two are managed by the Forest Department, the latter by the Forest Department in cooperation with local communities. The process of declaring a Wildlife Sanctuary is laid down in the Wildlife Protection Act 1972. Before the Wildlife Protection Act amendment 1991, a State Government could declare a Wildlife Sanctuary, without first notifying the people living that specific area of this plan. After the 1991 amendment, the State Government first has to declare its intention to declare a Wildlife Sanctuary in a notification (section 18). After this, the Collector (a district official) needs to proclaim the sanctuary to all villages in the area and investigate the existence of any claims or rights of people over the land that is included in the sanctuary (sections 19 – 23). The Collector needs to admit or reject the claims. If the claims are admitted the collector needs to exclude the land from the sanctuary, acquire the lands or rights, or allow continuation of the rights (in consultation with the Chief Wild Life Warden) (sections 24 – 26). The latter means that it can be decided by the Collector and the Chief Wild Life Warden that people are allowed to continue live inside a Wildlife Sanctuary. After all the admitted land rights are excluded, acquired or allowed to continue, a final notification will declare the area as a Wildlife Sanctuary (section 26). Within a sanctuary, no wildlife or forest produce may be can be hurt or destroyed. Collection of forest produce is restricted and may only be used for subsistence. Grazing is allowed.

A National Park can be declared under section 35, and follows the same procedure as a wildlife sanctuary. But in the case of national parks the Collector cannot allow the continuation of rights and thus needs to extinguish all rights (section 35 (3)). This means that no people are allowed to live inside the national park. A national park has more restrictions on the use of the natural resources than a wildlife sanctuary: no human interference is allowed in the park (unless of the purpose of park management). The collection of forest produce and grazing are not allowed.

The Wildlife Protection Amendment Act, 2006 allowed for the creation of the National Tiger Conservation Authority (NTCA). The NTCA has the authority to create Tiger Reserves. Unlike a Wildlife Sanctuary and the National Park, the Tiger Reserve is not described into detail in the

Act: the procedures and restrictions are laid down in the guidelines written by the NTCA. A state government submits a proposal to create a Tiger Reserve. After the NTCA recommends the creation of a Tiger Reserve, a State Government can notify the creation of a Tiger Reserve. Existing rights need to be inquired, and communities can be relocated if other forms of coexistence are deemed impossible. A Tiger Reserve needs a “core” area: an area without any human interference. The core area of a Tiger Reserve has the same restrictions as a National Park (Task Force Tiger, 2005). The Tiger Reserve is considered to offer the highest level of protection of all protected areas (Davidar *et al.*, 2007).

The Environment Protection Act 1986, Section 3(2)(v) of the Act empowers the central government to take all such measures that it deems necessary to protect and improve the quality of the environment and prevent environmental pollution. It allows for the restriction of areas in which certain developmental activities can be prohibited. Further section 5(1) of the Environment (Protection) Rules (EPR), 1986, specifies certain criteria like topographic and climatic features of an area, biological diversity of the area, environmentally compatible land use, extensive cultivation, proximity to the protected areas, etc. that can be considered while prohibiting or restricting certain operations in different areas.

Forest Vehicle taking VIP people inside protected area

The National Forest Policy 1988 lays out the guidance for the Ministry of Forests and Environment (and Forest Departments) on national and state level. It aims to create environmental stability, and sets the objective to have a minimum of one-third of the land area of India under forest or tree cover (section 4.1).

The Maharashtra Project Affected Persons Rehabilitation Act 1976 (and 1986) grants persons who have to be relocated due to irrigation projects, such as the construction of dams, the right to be compensated for their losses with new lands and civic amenities at their new lands (section 10 (1) and (2)). These civic amenities include access to water, schools, electricity, infrastructure, sanitation facilities and agriculture or grazing lands (if they had these in their original villages). This Act 1976 (and 1986) only applies to people affected by irrigation projects.

The Project Affected Persons Rehabilitation Act 1999 also applies to 19 other categories of projects besides irrigation projects, such as the creation of Wildlife Sanctuaries or National Parks. The 1999 Act came into force in the year 2000. Relocation and rehabilitation are not the same. Rehabilitation refers to more than only physically relocating people: it aims to improve or at least regain the standard of living of the people from prior to their relocation (Hemadri *et al.*, 1999).

The Protection of Forest Rights Act 2006 (also known as the Scheduled Tribes Act) came into force in January 2008. The Act gives the right to communities who have been living in forests for generations to use of those forests lands and the forest resources. They are allowed to collect forest resources and use or sell them.

National policy on disaster management 2009 aims at Promoting a culture of prevention, preparedness and resilience at all levels through knowledge, innovation and education. Encouraging mitigation measures based on technology, traditional wisdom and environmental sustainability. Mainstreaming disaster management into the developmental planning process. Establishing institutional and techno-legal frameworks to create an enabling regulatory environment and a compliance regime. Ensuring efficient mechanism for identification, assessment and monitoring of disaster risks. Developing contemporary forecasting and early warning systems backed by responsive and fail-safe communication with information technology support. Ensuring efficient response and relief with a caring approach towards the needs of the vulnerable sections of the society. Undertaking reconstruction as an opportunity to build disaster resilient structures and habitat for ensuring safer living; and Promoting a productive and proactive partnership with the media for disaster management.

The International Strategy for Disaster Reduction (ISDR) notes: “protection of vital ecosystem services is fundamental to reducing vulnerability to disasters and strengthening community resilience”. The Sahyadri Tiger Reserve landscape provides space for overspill of water and attenuates flood situation since it houses the Koyna Dam and the Chandoli Dam. The forests on steep slopes stabilizes soil and loose rock thereby preventing landslides. As the Sahyadri Tiger Reserve is managed as per the sanctioned Tiger Conservation Plan by the Government of India, the ban on grazing and trampling reduces the process of desertification. Various management interventions viz. maintenance of meadows, clearance of fire lines, soil and water conservation measures, strengthening of existing natural water holes and rehabilitation of people from the core zone are some of the activities executed in the Sahyadri Tiger Reserve which directly plays a pivotal role in Disaster Risk Reduction and Climate Change (Ben, 2016)

Signboard on road

The standard list of threats/factors affecting the Outstanding Universal Value of World Heritage properties consists of a series of 14 primary factors, this list is published by the UNESCO which needs to be discuss in context of study area; HRVC Analysis of villages is necessary to design a Village Disaster Management Plan which will thoroughly give idea of situation of that place.

1. Building and Development: Housing, Commercial development, major visitors accommodation and associated infrastructure, interpretive and visitation facilities.

2. Transport Infrastructure: ground transport, air transport, marine transport, effects arising from use of transportation, underground transport

3. Utilities or service Infrastructure: Water infrastructure, Renewable energy, Non-renewable energy, Localised utility.

4. Pollution: Marine water pollution, Ground water pollution, Surface water pollution, Air pollution, Solid waste, Excess energy.

5. Biological resource: Fishing/ Collecting aquatic resources, Aquaculture, Land conversion, Grazing of domesticated animals, Crop production, Commercial wild plant collection, commercial hunting, Forestry/Wood production
6. Physical resource extraction: Mining, Quarrying, Oil & Gas, Water extraction.
7. Local conditions affecting physical fabric: Wind, Humidity, temperature, light, dust, water, pests, micro-organism.
8. Social/cultural usage of heritage: Ritual& associative uses, Indigenous hunting, gathering & collecting, Changes in traditional ways of life & knowledge system, Identity social cohesion, changes in local population & community, Impacts of tourism.
9. Other Human activities: Illegal activities, Deliberate destruction of heritage, Military training, war, terrorism, civil unrest.
10. Climate change & severe weather events: Storms, flooding, Drought, Desertification, changes to oceanic waters, temperature changes.
11. Sudden ecological & geological events: Volcanic eruption, earthquake, Tsunami, Avalanche, landslide, Erosion & Siltation, fire.
12. Invasive/ Alien species or Hyper abundant species: Translocated, Alien terrestrial, Alien fresh water, Alien Marine water, Hyper abundant, Modified genetic material.
13. Management 7 institutional factor: Management plan, Legal framework, Low impact research/ monitoring activities, Governance, High impact research, Human resources, Financial resources.
14. Any additional factor not already covered in the list.


Landslide prone area

Objective:

- To understand the current policies and Framework applicable to Wildlife sanctuaries, Tiger Reserve and World Natural Heritage Site; collectively analyze the role of each policy and framework in implementing the particular mechanism at these sites.
- To work on the gaps for convergence of DRR framework/policy.

Justification for the study:

Heritage is usually not taken into account in global statistics concerning disaster risks, cultural and natural properties are increasingly affected by events which are less and less 'natural' in their dynamics, if not in their cause. The progressive loss of these properties as a result of floods, mudslides, fire, earthquakes, civil unrest and other hazards has become a major concern, partly because of the significant role that heritage plays in contributing to social cohesion and sustainable development, particularly at times of stress. In the face of these challenges, the number of World Heritage properties that have developed a proper disaster risk reduction plan is surprisingly low.

This is often due to a series of misperceptions. On the one hand, there is a widespread belief that disasters are events beyond human will and control, against which little can be done. On the other hand, heritage managers and policy-makers tend to concentrate their attention and resources on what they perceive as the real priorities for their properties, i.e. pressure from development and the daily wear and tear of sites as a result of slow, cumulative processes that can be 'seen'. Finally, and somewhat ironically, the vulnerability of heritage properties to disasters is normally recognized after a catastrophic event has taken place – including by the media and donor community – when it is often too late. The reality, of course, is different. Disasters are the combined product of hazards and vulnerabilities resulting from the complex interaction of numerous interlocking factors, many of which are very much within human control. It is therefore possible to prevent them, or at least considerably reduce their effects, by strengthening the resilience of the assets to be safeguarded. In general, moreover, the impact of a single disaster on cultural and natural properties far outstrips the deterioration caused by long-term, progressive decay and may sometimes lead to their complete obliteration. Often, therefore, disaster risks constitute the most urgent priority that heritage managers should address. (Managing Disaster Risks for World Heritage_Resource Manual, 2010)

Climate change is impacting our glacial reserves, water balance, agriculture, forestry, coastal ecology, bio-diversity and human and animal health. The Western Ghats today are being rapidly degraded due to various land use changes that have occurred in the recent past. Apart from the traditional impacts from farming, grazing and fire there are newer changes in land use that are leading to biodiversity losses. This includes deforestation due to mining, roads, dams, resorts and industrialization. Changing existing wilderness areas into intensive agriculture, urbanization and industry in Maharashtra, Gujarat and Goa has altered the natural ecological attributes over the last several decades. This has not spared the Western Ghats where dams, roads and other economic development programs have led to new forms of land use. World Heritage properties, as with all heritage properties, are exposed to natural and human-made disasters which threaten their integrity and may compromise their values. The loss or deterioration of these outstanding properties can negatively impact national and local communities, both for their cultural importance as a source of information on the past and identity, and for their socioeconomic value. The special requirements of sustainable development in areas that are ecologically fragile such as the Western Ghats finds little place in current planning processes. While the Western Ghats in the southern states have been better studied, the ranges of the northern sector have been neglected. The two ecosystems vary widely and suffer from different human impacts.

Unfortunately, most World Heritage properties, particularly in developing areas of the world, do not have any established policy, plan of process for managing risks associated with potential disasters. Existing national and local disaster preparedness mechanisms, moreover, usually do not take into account the significance of these sites and do not include heritage expertise in their operations. As a result, hundreds of sites are virtually defenceless with respect to potential disasters (Bandarin, 2008)

Now a day's managing the pace of development and at the same time maintaining the natural value of our sites is necessary. Growing demand for energy have led to more than 1000 windmills in the Koyna site, similarly increase in tourism sector is boosting the number of visitors to Kaas Plateau and other Natural Heritage Sites which have fragile ecosystem ultimately disturbing those areas. Policies, frameworks and programmes are there but addition, alteration and strengthening them to achieve sustainability is need of hour.

According to thematic surveys addressed to site managers from 959 UNESCO natural sites, which UNESCO has undertaken, at least 25% of all biosphere reserves, 46% of world heritage natural sites and 60% of UNESCO global geoparks are exposed to at least one type of natural hazard that may turn into a disaster and threaten a site's integrity. In terms of population, it was estimated that more than 300 million inhabitants are vulnerable to natural hazards at these sites. (Pavlova, 2016)

Study Areas:

The Western Ghats are internationally recognized as a region of immense global importance for the conservation of biological diversity, besides containing areas of high geological, cultural and aesthetic values. The Ghats traverse the States of Kerala, Tamil Nadu, Karnataka, Goa, Maharashtra and Gujarat. These mountains cover an area of around 140,000 km² in a 1,600 km long stretch. A significant characteristic of the Western Ghats is the exceptionally high level of biological diversity and endemism. This mountain chain is recognized as one of the world's eight hottest hotspots of biological diversity along with Sri Lanka. The forests of the Western Ghats include some of the best representatives of non-equatorial tropical evergreen forests in the world. (UNESCO, world Heritage List, 2012)

The Lateritic plateaus are at an elevation of 1200 MSL. The rainfall received is between 2000 to2500mm annually. The plateau changes the colours after every 15-20 days as the monsoon progresses since June to October. The progress is in terms of yellow colours of *Senecios* and *Smithias*, blue colours of *Utricularias*, pink rosy colours of *Impatiens*, white colours of *Eriocaulons* and *Habanerias* and purple colours of *Strobilanthes* species. Many rare endemic endangered plants like *Ceropegias, Seshagiria, Arisaemas, Decaschistia, Trithuria, Dipcadi etc.*, grow on these plateau. The panorama of colours makes it a *plateau of flowers – Kaas Plateau* between August-September. More than 850 species of flowering plants have been reported from the region. 39 species find mention in the RED DATA book of the total 624, which make it approximately 6% of the Red data species.

The presence of hills creates major precipitation gradients that strongly influence regional climate, hydrology and the distribution of vegetation types and endemic plants (Pascal, 1988; Gadgil and Meher-Homji, 1990). The importance of the Western Ghats as a hot spot of diversity is well known. It is a stretch of area along the Crest of North Sahyadri Range of Western Ghats forming the catchment of Warana reservoir and Koyana Reservoir. Western Ghats area of India is considered an important biodiversity hot spot. It is of home to several endemic, rare and endangered plant species. These forests contain many threatened species such as Garambi, Ranjaiphal, Dhup, Rose wood (Shisham) etc. Wild animals Tiger, Leopard, Sloth Bear, Indian giant squirrel (Shekaru), Indian Gaur (Bisons), Sambar, Barking deer, Wild Boars, Porcupines, Wild dogs, Mouse deer, Four Horned Antelope etc. are the inhabitants of the area.

Tiger Project

A Project called “Project Tiger” has been formulated by the Government of India. Each tiger reserve shall have a core area in which work envisaged by the Project only shall be done to the exclusion of all other work. Thus in this core area there will be no forestry operation, collection of minor forest produces, bamboo extraction, grazing of domestic cattle and any human interference including tourism. The residual area in every reserve can, however, be used for wild life oriented forestry purposes.

Sahyadri Tiger Reserve is one of the important tiger reserve area of the State. The Sahyadri Tiger Reserve is located in the Sahyadri Ranges of the Western Ghats of Maharashtra. These ranges from a common boundary between Maharashtra, Karnataka and Goa. These areas constitute rich evergreen, semi-evergreen and moist deciduous forests. It is the first Tiger Reserve of Western Maharashtra and 4th Tiger Reserve of Maharashtra State spreading over two Protected Areas those of the Koyana Sanctuary and Chandoli National Park of 741.22 sq.kms. and adjoining area in the landscape 424.34 sq.kms.

Total Area: 1,166 km^2 (450 sq. mi)

Core Area: 600.12 km^2 (231.71 sq. mi)

Buffer Area: 565 km^2 (218 sq. mi)

The area is spread over 4 districts namely, Satara (Mahabaleshwar, Medha, Satara & Patan tahasils), Sangli (Shairala tahasil), Kolhapur (Shahuvadi tahasil) and Ratnagiri (Sangameshvar, Khed tahasils). The number of tigers in the reserve is low as they do not breed here mainly due to issues like poor prey base in the Koyna wildlife sanctuary and weak links in the corridor connecting the reserve with the source tiger population down south.

Tigers suffer from lack of enough prey at Koyna due to poaching, although the base at Chandoli now has good numbers. Authorities have now stepped up protection activities to prevent poaching as a result of which 35 people have been arrested for illegal hunting in this year.

To resolve the prey issue, authorities also plan to release herbivores in the tiger project so that there is enough to feed on. There is plan to introduce sambar deer, which is the most preferred prey of the tigers, and spotted deer from the Katraj zoo to build up the prey base before translocating the tigers. This will help create a healthy ecosystem for the big cats.

The Chandrapur territorial circle, in which Bramhapuri falls, has around 55 adult tigers plus sub-adults, which is the second highest number in Maharashtra. This is beyond its carrying capacity and leads to man-animal conflict and territorial fights between animals. This led officials to propose moving a few tigers from here to other rich landscapes where the tiger population was low. The Central India province is different from the Western Ghats. It has to be examine if the tigers from Bramhapuri can adapt to this terrain which is highly wooded and hilly.

Sahyadri Tiger Reserve falls in Biogeographic Zone 5B of Western Ghats and is situated in the Central Sahyadri Range. The entire Sahyadri Tiger Reserve is mountainous, with very steep precipitous slopes, deep valleys and long stretching lateritic plateaus. The central portion of Sahyadri Tiger Reserve is occupied by Shivsagar reservoir of Koyana River and Vasant Sagar reservoir of Warana River. Floristic compositions of the Sahyadri Tiger Reserve represent the following Forest types.

1) 2.A/C.2–West coast Semi Evergreen Forests
2) 8.A. / C.2 – Western (Montane) Subtropical Hill Forests
3) 3. B / C.2 – Southern Moist Mixed Deciduous Forests.

The forts like Vasota, Bahirgad, Mahimangad and Jangali Jaigad have historical importance. The trekkers visit these areas for trekking and for enjoying the scenic beauty of Western Ghats. The devotees in fair weather often visit the religious temples at Nageshwar, Parvat. Considering the uniqueness of nature of this area and the presence of tigers, it needs to be declared as Critical Tiger Habitat. The area falls in biogeographic province 5 b of Western Ghats along the crest of Sahyadri Range.

The total area of Sahyadri Tiger Reserve is undulating with steep escarpments along western boundary. The most distinct feature of the Tiger Reserve is the presence of numerous barren rocky and lateritic plateaus, locally called "Sadas" with less perennial vegetation and over hanging cliffs on the edges and numerous fallen boulders with dense thorny vegetation and small caves. Most of the area prevails dense Semi evergreen forests having remarkably wide range of flora and great variety of fauna. The most common floral species found here in this Protected Area are Anjani (Memecylon umbellatum), Jambhul (Syzigium cumini) Pisa (Actinodaphaone angustifolia) etc.

The revenue wasteland and Malki lands included in the Tiger Reserve have scattered bushy tree growth in between and along nalla banks. The cultivated areas turned to grassy meadows/Grasslands. The area has Global and National significance as it is one of the habitats of the tigers, Panthera Tigris, Gaur, sambar, Leopard, Sloth bear, Barking deer, Giant squirrel etc. are found in this area. The Endangered, Endemic, threatened birds of the area are enclosed herewith for perusal. It is home for Horn bills, and many other endemic Birds.


Great Hornbill

The nests of Giant squirrel are confined to virgin forest of Rundiv, Shidheshwar and Patharpunj villages. Ramnadi and the Sadas on either side to this river provides good breeding ground to Indian gaur and other herbivorous animals. Water bodies, open lands, Dense forest and Sadas makes this Protected Area an ideal ecological habitat for wildlife endemic to Western Ghats. The breeding grounds of Indian River Tern are found in Chandoli National Park and Koyana Sanctuary. Crocodile breeding is also noticed recently in Chandoli National Park. The Blue finned Mahasheer fish are present in the Koyana waters. They survive only in pure waters and in undisturbed areas.

The Western Ghats are also recognized as a centre for origin of several cultivated plants, the progenitors of pepper, cardamom, ginger, turmeric, mangoes, jackfruit, ragi and variety of millets. The Western Ghats provide habitat for several orchid species and also house a variety of medicinal plants. The region is also rich in iron, manganese and bauxite ores.

Sahyadri Tiger Reserve is the only place where climax & near-climax vegetation is plentiful and prospects of adverse anthropogenic influence in the future are minimal. The area is bestowed with several biogeographical peculiarities. Climax evergreen formations of higher elevations have been wiped out or highly degraded everywhere in Western Maharashtra except in tiger reserve area, where this type still occupies substantial area. The area is relatively undisturbed as compared to other regions in western Maharashtra giving refuge to Species facing local extinction

Sadas: Recent studies on the rocky outcrops (‘sadas’) on such plateaus, has led to observe that they support a natural herbaceous vegetation complex, adapted to survive in adverse conditions. Watve.A (2003), observed that due to the Cyanobacterial crust on the rocky outcrops, Lichens, desiccation tolerant Ferns, varied mosses occur abundantly on such rocky outcrops. Further observations have revealed that members of Poaceae abound in such microclimates, with insectivorous plants present dominantly. The natural herbaceous vegetation surviving in stressful conditions has a unique presence in this part of the Southern Sahyadri plateau, a phenomenon not observed elsewhere in the Western Ghats. Porembskrkii.S and A. Watve (2003), further observe that such rocky outcrops which were neglected hitherto, need to be given due emphasis. They have labelled them as Islands of Biodiversity.

20 plant species which find mention in the Red Data Book as Endangered have been recorded in the area. (Abutilon ranadei, Aponogeton satarensis, Begonia trichocarpa, Ceropegia jainii, C.noorjahaniae, C.occulata, C.sahyadrica, C.vincaefolia, Decaschistia trilobata, Erinocarpus nimmonnii, Euphorbia panchganensis, Habernaria panchganensis, Iphigenia stellata, I.magnifica, Kalanchoe olivacea, Polyzygus tuberosus, Rotala ritchiei, Seshagiria sahyadrica, Smithia agharkaarii, and Vigna khandalensis)

Methodology:

Secondary data was collected & reviewed initially from the available data sources i.e. Internet, Library and with the government offices. To verify current practice at the site against the historical record or on paper information; on-field visit was conducted. Methodology adopted on field visit to Koyna Wildlife Sanctuary was transit walk, observation, interaction with local people and forest personnel.

During my field visit it was festival time so the people from villages who are migrated to Mumbai, Pune for better employment opportunities were also there in village for holidays so their views were also listened during the individual village meetings and all 16 village's meeting. Field visit to Kaas Plateau was also very helpful to gain the knowledge of current activities going on the Plateau.

At both the places unstructured interviews were conducted. Reason of this visit was to gather primary source data from people who are currently living or engaged in the efforts for Natural Heritage Site, Sahyadri Tiger Reserve and related issues were interviewed. To achieve the desired objectives Case studies, review of existing policies, statistical analysis has helped a lot.

Result & Discussions:

Conservationists in the recent years view local peoples support for protected areas management as an important element of biodiversity conservation. This is often linked to the direct benefits, which local communities get from the protected areas. These benefits could be in the form of biomass resources, park funds diverted to local villages by JFMC and revenue from wildlife tourism. There are a very few studies which have attempted to study the direct relationship between benefits from wildlife tourism and local support for conservation.

In India, wildlife tourism is restricted, and mostly controlled by state and private agencies. Wildlife conservation policy does not view tourism in protected areas as a source of revenue for the local communities. There is need to examines the local people's attitudes towards wildlife tourism, Conservation of Sites and the impact of benefits from tourism on the local support for Sahyadri Tiger Reserve (STR) and Kaas Plateau (WHS). STR will become popular for tourism where protected areas will be increasingly visited and where local support for wildlife tourism has not been started adequately. Local people are mostly positive towards tourism because employment opportunities in that area is very less and they are ready to support for conservation as well. But there is need to create aware that more tourism benefits are possible from a well-conserved protected area; this is especially necessary in villages near to Kaas Plateau where excessive tourism is becoming threat to Natural Heritage Site. Some of the main problems are the unequal distribution of tourism benefits, lack of local's involvement in tourism and sustainable development. There is a need to clearly address these issues, so that protected areas may get the support of local people and local people get the support of protected areas, which may lead to sustainable development.

Communities and local people judge risk whether it is a natural hazard (e.g. drought, flood, earthquake, landslides) or man-made disaster (e.g. mass tourism conflict, environmental and industrial accident, impacts of anthropogenic activities). Understanding of the local context of vulnerability and exposure is essential for reducing risk and defining what mitigation practices can be implemented. The involvement of local administrations and communities in the designing and implementation of disaster risk management programmes is well-accepted good practice. There is limited data on localized losses and therefore difficulties connecting local context with national monitoring systems, loss accounting and risk assessments. Adequate resources are not allocated to local administrations for disaster risk management. In some cases, communities undertake their own risk reduction efforts which are either from indigenous knowledge or emerge due to current requirement – also called "autonomous adaptation," with very little guidance or coordination from central bodies.

The convention on biological diversity rightly emphasises the need to recognise traditional knowledge, innovations, sustainable use and conservation practices of indigenous people. Today these practices and knowledge are often condemned as superstitious and unscientific. It is now essential that we recognise their value and encourage them in the modern day perspective by inclusion of such knowledge in policies and plans

Studies, research and consolidated practice confirm that the involvement of communities, and more in general the adoption of a participatory approach to risk management, represent the most cost-effective and sustainable mechanism for reducing risks. There is guidance in some areas including risk assessments with a view to eventually arriving at a common definition of disaster and risk; integration of climate change adaptation and disaster risk management; working at national and local levels; and, vulnerability of communities to the impact of hazards.

Global, regional and national efforts for disaster risk reduction and reinforcing resilience are increasing. International momentum for disaster risk reduction is currently at play whether in discussions and planning around sustainable development, climate change adaptation, the Millennium Development Goals or more broadly public and private investment strategies. The HFA has proved effective in galvanizing and bringing together the many stakeholders in disaster risk reduction including national and local governments, parliamentary forums, inter-government organizations, non-government organizations, community-based organizations and practitioners, the private sector, academic and technical institutions, the media and international organizations.

Many views and several options have been expressed ranging from a more nuanced version of the existing Plans; some overall guiding principles; a set of normative standards; a framework with a target regime; a legally based instrument for disaster risk reduction; or a combination of the above. There is also a case for pursuing greater leverage for disaster risk reduction as a part of development plans, goals.

Myers *et al*., mention in his new analysis of global biodiversity hotspots, recommend areas: where conservation actions should be focused to minimize losses in the imminent extinction crisis. He strongly supports initiatives to produce clear, efficient and practical goals for conservation to guide biodiversity planners and decision-makers in governments, agencies, conventions and non-governmental organizations (NGOs).

However, as things stand there is only limited consensus on global conservation priorities at international level. The time is now right for scientists and practitioners to work together to develop a commonly adopted blueprint for action.

Conclusion:

The creation of the STR has had positive impacts on the protection of biodiversity. The Tiger Reserve is of course good news for the highly endangered tiger. But the impacts on the local communities are predominantly undesirable. They are living in not so good circumstances than before the creation of the protected area, and had little to no influence on the governance processes. But this is not only because of protected area or world heritage site. People from those villages are also developing themselves and competing (rather trying to match) with the people in non-protected area. So they have view that all the amenities and facilities available to other people should be available to them as well. And if we will see this from the point of view of disaster risk reduction it is necessary to provide them with basic infrastructure like all season road, communication facilities, health centre facilities which are necessary to reduce impact of any disaster. If the local communities will receive the full rehabilitation or better employment opportunities, better living conditions and basic infrastructure facilities the local communities will regain the same or even a higher standard of living. And perhaps than, the creation of the protected area could, eventually have a positive impact for both the biodiversity and the local communities.

The current plans and policy have substantively contributed to further disaster risk reduction, but the goals and priorities for action are still far from being achieved. A new policy or framework for disaster risk reduction should be based on the current ground level plans and focus on those elements that are still in need of further action. For example, Inclusive Village Development planning, stronger work on Priority for the Underlying Risk Factors is worth considering. Governance, Local Level Implementation and Multi-Stakeholder Participation could also be a strong focus for new policy and framework. Gender perspectives in disaster risk reduction could also be better addressed.

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Retaining the Outstanding Universal Values of Kaas

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Introduction

Integration of nature-based solutions in to disaster risk reduction planning is called Eco-DRR. Disasters are mainly social constructs, they are largely determined by how society manages its environment, how prepared it is to face adversity, and what resources are available for recovery. By integrating key areas like ecosystem management, livelihoods, vulnerabilities, climate change adaptation, and disaster management we can reduce the disaster risk in a sustainable way. IPCC 2012 report on intergovernmental panel on climate change quoted that "Environmental degradation is leading cause of increased disasters". Disasters cause massive damage to the environment, while degraded environments exacerbate disaster impacts. Responding to disasters often leads to additional environmental impacts, while investments in sound environmental management, especially in disaster prevention and post-disaster recovery stages, can reduce disaster risks and thus contribute to a more resilient and sustainable development.

World Natural Heritage Sites (WHS) are places on Earth that have Outstanding Universal Value. As these sites are considered precious for present and future generations, they deserve collective efforts for conservation and management. WHS are also exposed to Natural and Man-made disasters which threaten their integrity and have negative socio-cultural and economic impacts. The loss or deterioration of these outstanding properties would negatively impact the national and local communities, both for their cultural importance as a source of identity and of information on the past, and for their socio-economic value. Experience, moreover, has demonstrated that the conservation of cultural heritage and the transmission of traditional technology, skills, and local knowledge systems, are not just important, i.e. for their intrinsic historic, artistic or scientific significance, but because they may contribute fundamentally to sustainable development, including the mitigation of disasters. Heritage-sensitive practices, in fact, can assist in significantly reducing the impact of disasters, before, during and after they have taken place.

The State of Maharashtra is known for its unique biodiversity & hill ranges such as Western Ghats. One such unique biodiverse ecosystem in Maharashtra is 'Kaas Plateau'. Kaas plateau is wonderful, eye-catching creation of nature nestled in Sahyadri Hill range of Western Ghats. It has significant ecological as well as tourism value. In the month of August and September, the whole plateau looks like a carpet of flowers colored with various shades of green, yellow, pink, purple etc. Due to this it attracts lakhs of tourists, scientists and nature lovers. The value of Kaas is noticed not only at state level but also globally. Kaas got the tag of World Natural Heritage Site in June 2012 by the United Nations Educational Scientific and Cultural Organization (UNESCO) & this brought Kaas plateau in limelight.

Kaas Plateau is among some of the important sadas of Sahyadri Sub-cluster which are characterized by herbaceous ephemeral vegetation. More than 850 species of flowering plants occur here. Of these, 39 species find mention in the Red Data Book as endangered, forming approximately 6% of the total Red Data species. The herbaceous flora of the plateau includes more than 300 species of grasses, besides many Impatiens, Utricularia, Eriocaulon, ground orchids, Smithia, Dipcadies, Senecio, Rotala, Disophylla and Strobilanthes species. The ephemerals, herbs, bulbous plants, tuberous plants and orchids present a panorama of colors during the monsoon months on Kaas Plateau. Kaas plateau appears to change in color every 10-20 days as the monsoon progresses, with the yellows of Senecio and Smithia species, blues of Utricularia species, rosy pinks of Impatiens species, whites of Eriocaulon and Habaneria species and the purple colours of Strobilanthes species.

The panorama of colours by wild flowers makes it a ‘plateau of flowers’ between August and September. Many rare endemic and endangered plants such as Ceropegia, Seshagiria, Arisaema, Decaschistia, Trithuria and Dipcadi species also grow here. Cyanobacterial crust, lichens, desiccation-tolerant ferns and varied mosses also occur abundantly on the rocky outcrops. Thus, more than 400 species endemic to the Western Ghats occur in the region. Some monotypic genera endemic to the Western Ghats such as Erinocarpus nimmonii, Seshagiria sahyadrica, Frerea indica, Carvia callosa and Pinda concanensis are found in the region. The genus Ceropegia is represented in the region by about 24 species, of which about 10 are endemic to the sanctuaries. This apart, Vigna khandalensis, Atylosia lineata, A. scarabraeoides, Cucumis setosus and a number of other such wild relatives of cultivated plants are endemic to the protected area.

Literature review

As part of the literature we came across many locally and internationally published papers and the reports submitted by the government and non-government institutions. Many authors follow the same path and some are quite opposite each other. Here are the important concepts came across the literature review.

Sustainable Practices

Natural heritage systems planning is about maintaining, restoring and enhancing ecologically sustainable and resilient landscapes. It is a strategic approach to addressing biodiversity loss, land use change and the uncertainties of climate change so that we always have clean air, clean water and a rich diversity of plant and animal life to sustain present and future generations. Natural heritage systems planning seeks to engage communities and educate citizens about the many benefits that nature provides and about nature's fundamental place in supporting social and economic health. In a country like India where more than half of the population lives in the rural areas and practicing agriculture as the primary occupation we have to consider their interests in developing the sustainable methods. Fencing the flowering area is one of the major issue here but some scholars believe that fencing the only option we got but the counterpart suggest that natural fences like growing trees as barricade is a sustainable solution. Here in the case of Kaas plateau one more problem is human animal conflict is high in the agriculture lands. so here the first priority went with agriculture crop protection in sustainable manner is the primary aspect but controlling animals without causing damage is very complex issue. We have to develop alternative food options for wild animals and later we have to work on the farming areas.

Eco-Tourism

The World Conservation Union (IUCN) defines ecotourism as "responsible travel and visitation to relatively undisturbed natural areas, in order to appreciate nature (any accompanying cultural features – both past and present) that promotes conservation, has low negative impact; and provides for beneficially active socio-economic involvement of local population". The various aspects which need attention at operational level for sustainable management of ecotourism are assessment of carrying capacities, better transportation managements, conservation and adaptations, design and control of developments, marketing effects in tune with the sustainability concept, local community involvement while planning eco tourist destinations. Here in the case of Kaas maximum number of visitors allowed is 2000 per day but so far in the span of 25 days 53000 people visited Kaas. This is far away from the carrying capacity of the Kaas Plateau. But many scholars argue what is base in deciding the carrying capacity. Some people argue that there is never a concept of carrying capacity for flowers. Here in the case of Kaas all the basic principles of echo tourism are satisfying but this is not helping its slowly becoming a bane for the diversity of flowers.

Disaster Risk Reduction

Disaster Risk Reduction (DRR): The concept and practice of reducing disaster risks through systematic efforts to analyze and manage the causal factors of disasters, including through reduced exposure to hazards, lessened vulnerability of people and property, wise management of land and the environment, and improved preparedness for adverse events. Here its little bit complex because the element at risk is the diversity of flowers which is a unique feature of this Kaas plateau. It's different from "creating plan for not human habitant. Here every factors changes the list of vulnerabilities, hazards and capacities.

Community Based Disaster Risk Management

The process in which at risk communities are actively engaged in the identification, analysis, treatment, monitoring and evaluation of the disaster risks in order to reduce their vulnerabilities and enhance their capacities. The key aspect of community involvement is the sustainability of community level initiatives for disaster reduction. External agencies, like government, non-government organizations may initiate and implement community level programs before and after disasters. Main gaps in this community based are they can't be ready for new hazards, especially like fire accidents and sometimes communities won't be having technical knowledge about some issues at the same time it should be done under experts at times results can be biased.

Study Objectives

The main objective of the study is to prepare a disaster risk reduction plan for retaining the Universal values of the Kaas Plateau, which is world heritage site.

First we have to know about the different hazards and frequency that are going to impact the Kaas plateau threatening to its universal value.

We have to find vulnerable areas and categorize them.

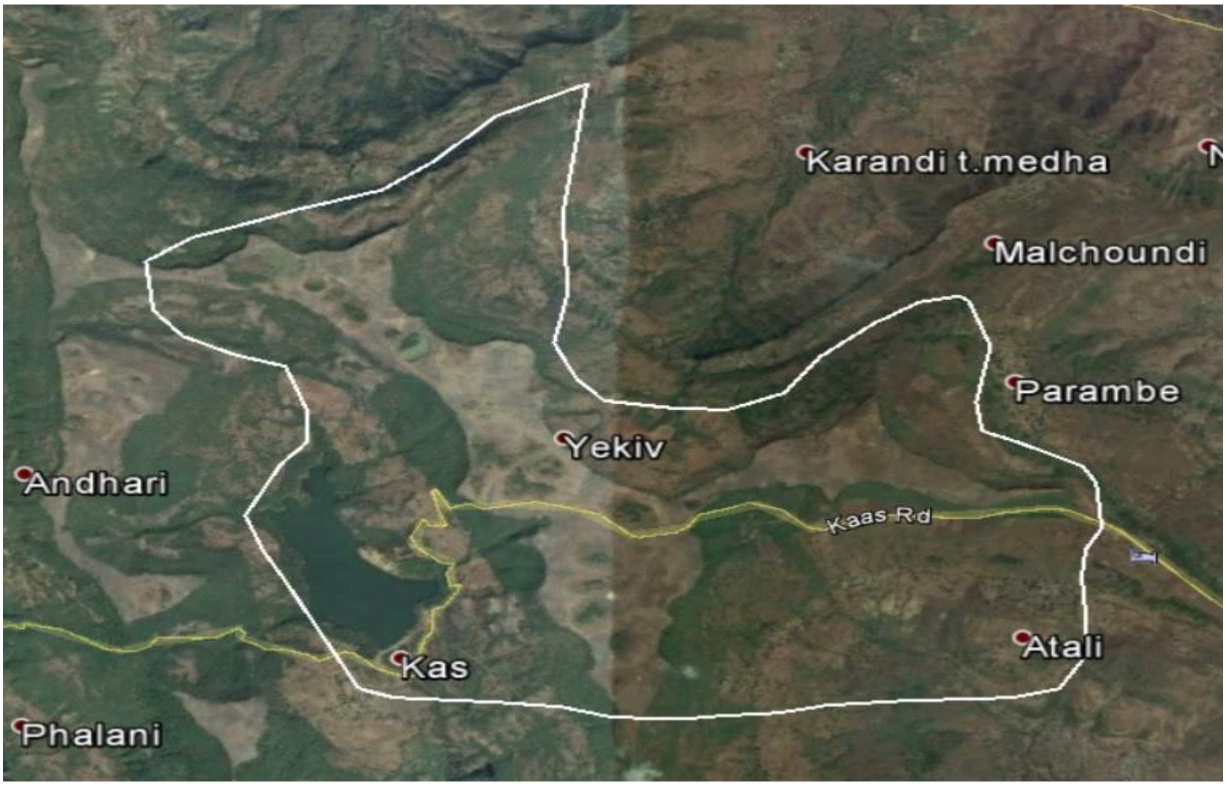
We have to calculate the risk and suggest the capacities.

We have to give sustainable eco-tourism plan for sustainable development.

Create a 1 KM radius buffer zone around the plateau.

Study Area

Kaas plateau is a plateau located near Satara. It is situated high hill plateaus and grasslands turns into a 'valley of flowers' during monsoon season, particularly from August to early October. Kaas Plateau has more than 150 or more types of flowers, shrubs and grasses. The orchids bloom here for a period of 3–4 weeks during this season. Kaas plateau is a World Natural Heritage site. To control possible damage by tourists, the number of visitors to the plateau has been restricted to 3,000 per day. Along with Kaas adjacent 6 villages are taken for preparing the buffer zone. The 6 villages are Kaas, Yekiv, Kasani, Pateghar, Atali, Kusumbimuran.



Methodology

This is a mixed method we need the qualitative and quantitative data for this study. Here I collected the data from all the six villages about their socio-economic condition and the past history of the hazards and frequency in each village. Secondary data is collected from the Department of Environment and Forests, Satara, District Disaster Management Authority, and the data.gov.in website. The questionnaire made is a closed ended questions. One more questionnaire is given to tourists for studying the trends in tourism on Kaas Plateau. This help in the making of sustainable tourism plan.

After getting the data HRVA analysis and hazard prioritization will be done by using following procedure of making Risk Matrix.

Impact	**Severity**	**Mishap results criteria**
severe	1	Death Permanent disability irreversible significant environmental impact
significant	2	Permanent partial disability injuries or occupational illness reversible environmental impact
Moderate	3	Injury or occupational illness one or more lost work days or reversible moderate environmental impact
Minor	4	Injury or occupational illness not resulting in a lost work day environmental impact
Minimal	5	Very little impact

Impact						
	Severe	15	19	22	24	25
	Significant	10	14	18	21	23
	Moderate	6	9	13	17	20
	Minor	3	5	8	12	16
	Minimal	1	2	4	7	11
		Almost Never	**Possible but Unlikely**	**Possible**	**Highly Probable**	**Frequent**

Likelihood

Probability Levels

Description	level	Specific individual Item	Fleet of Inventory
Frequent	A	Likely to occur in the life of an item	Continuously experienced
Probable	B	Will occur several times	Occur frequently
Possible	C	Likely to occur	Will occur several times
Possible unlikely	D	Unlikely but possible to occur	Reasonably expected
Almost never	E	Unlikely it can be assumed occurrence May not be experienced	Unlikely to occur but possible

Results and discussion

From the ground Data available hazards are prioritized as followed

Trampling of Flowers

Trampling of the flowers is the most common phenomenon found in the Kaas Plateau according to the guide lines of the UNESCO World Heritage site 2000 visitors should be allowed into Kaas and they should be monitored but because of lack of facilities and man power and proper paths and over enthusiasm of the tourist's flowers are getting destroyed by trampling. Official Records says from Aug 25 to sept 27 Kaas was visited by 53000 people of different age groups. As the frequency is high and impact is high its given the highest score of risk.

Air pollution

Official records say that 13000 vehicles visited Kaas in the span of 30 Days i.e. almost 400 vehicles per day. As it is a high altitude and rough terrain they consume more fuel and release more carbon gases into atmosphere and causes damage to this sensitive eco-system. Unplanned Parking which is on the west side where most of the vehicles come from the East side, Vehicles has to pass through the park in order to reach Parking area and Parking Area is 1300 mts from gate so tourists illegally park their vehicles on the road side creating damage to echo-system.

Noise pollution

UNESCO guide lines say that world heritages sites should be no-honking zones but vehicles to parking has to pass through the park and no signs of boards no honking and the traffic leads to medium to high level honking. Due to which the birds and insects which are key pollinators in the park gets disturbed and making them confined for certain areas. This became a big trouble for the diversity of the park.

Land slide and Lightning

Here both of different origin and showing only indirect effects on the Kaas Plateau so they are given fourth priority. Lightning mostly killing the cattle that graze on the plateau these cattle are natural fertilizer provider on the plateau already because of fencing they are avoiding the cattle on Plateau. Land slide is the most common in the rain season even though it’s not affecting main plateau its affecting valley of plateau disturbing the adjacent eco-system. It may lead to cascading effects.

Earth quake

Partial part of the park comes under the zone IV and III where there is probability earth quakes up to magnitude of 6 which could cause less damage but will cause trigger many Landslides in this in and around Kaas Plateau.

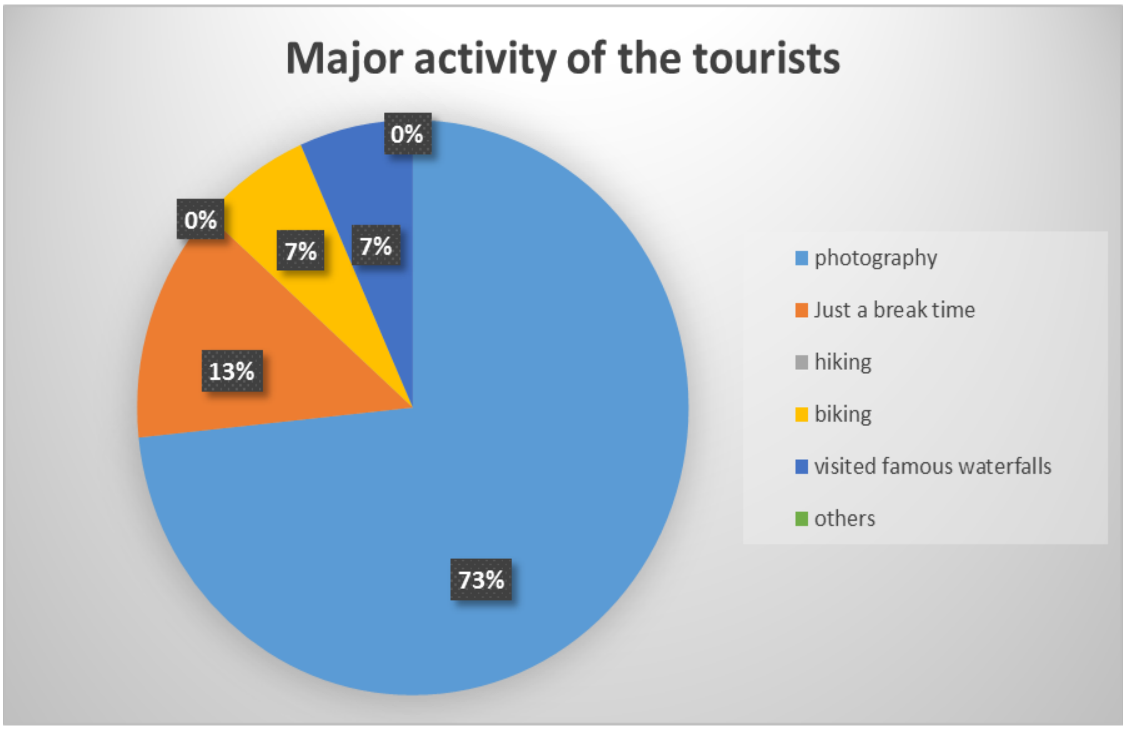
Impact	**Severe**	15	19	22	24	25 Trampling of flowers

Significant	10	14	18	21 Air Pollution	23
Moderate	6	9	13 Noise Pollution	17	20
Minor	3	5 Land slide & Lightning	8	12	16
Minimal	1 Earth quake	2	4	7	11
	Almost Never	**Possible but Unlikely**	**Possible**	**Highly Probable**	**Frequent**

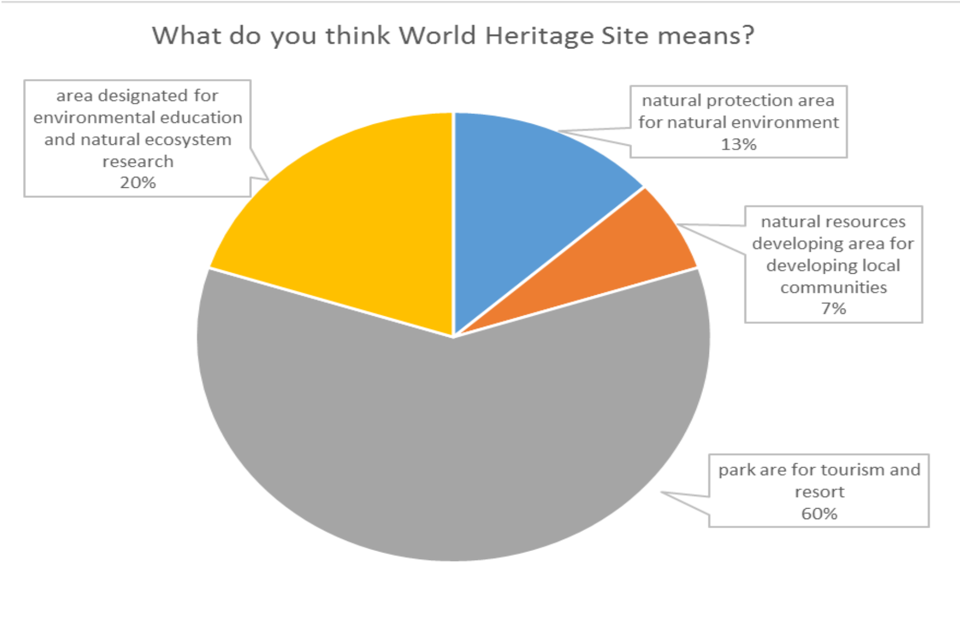
Likelihood

Eco Tourism Plan

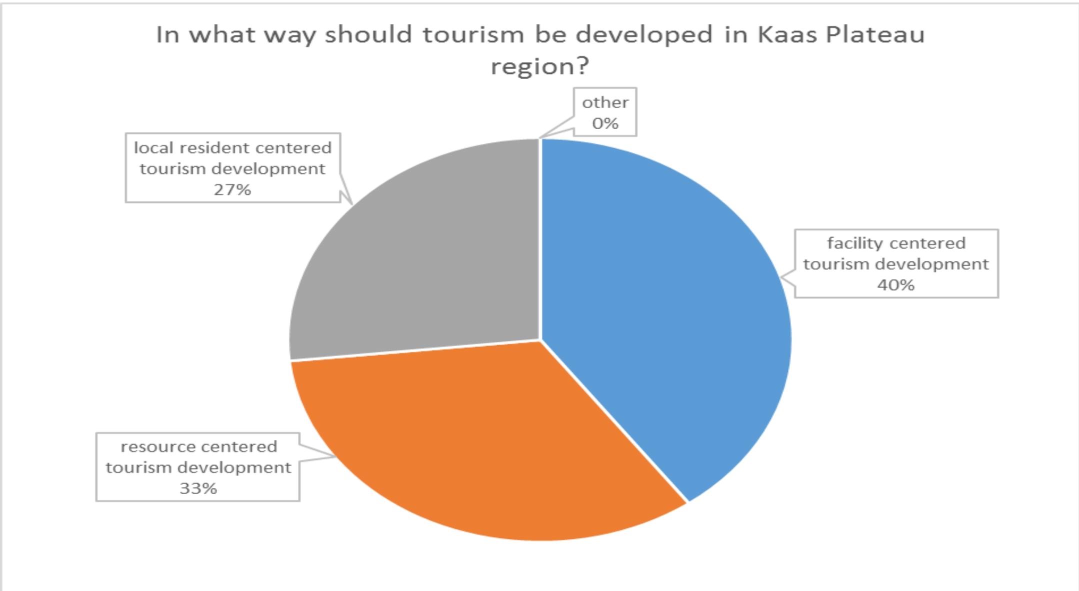
Firstly, let's see some of the trends in the tourists visiting Kaas.



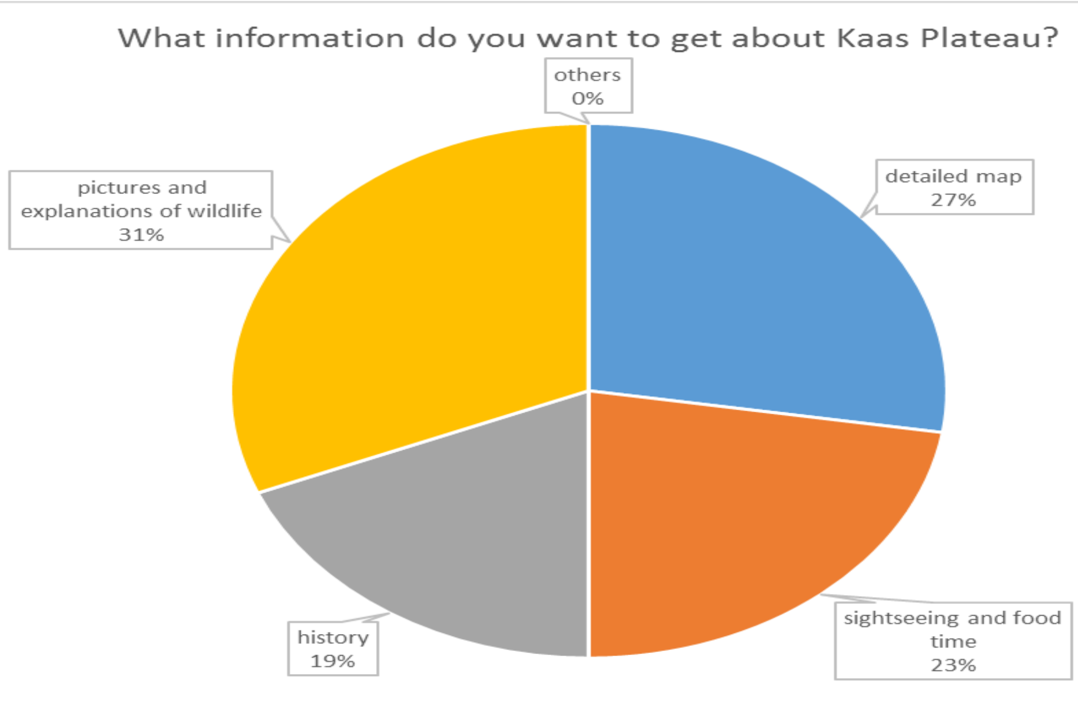
This is collected from the tourist data collected from the sample of 30 tourists randomly in different days. This clearly shows that that tourist are more interested in capturing the scenic beauties of the Kaas Plateau.so we have to spot and develop some scenic spots and make arrangements for tourists taking photos without disturbing echo system.



This graph interprets that they are not aware of the importance of the Kaas plateau so we have to create awareness in the visitors so that they themselves take part in protecting the eco system.

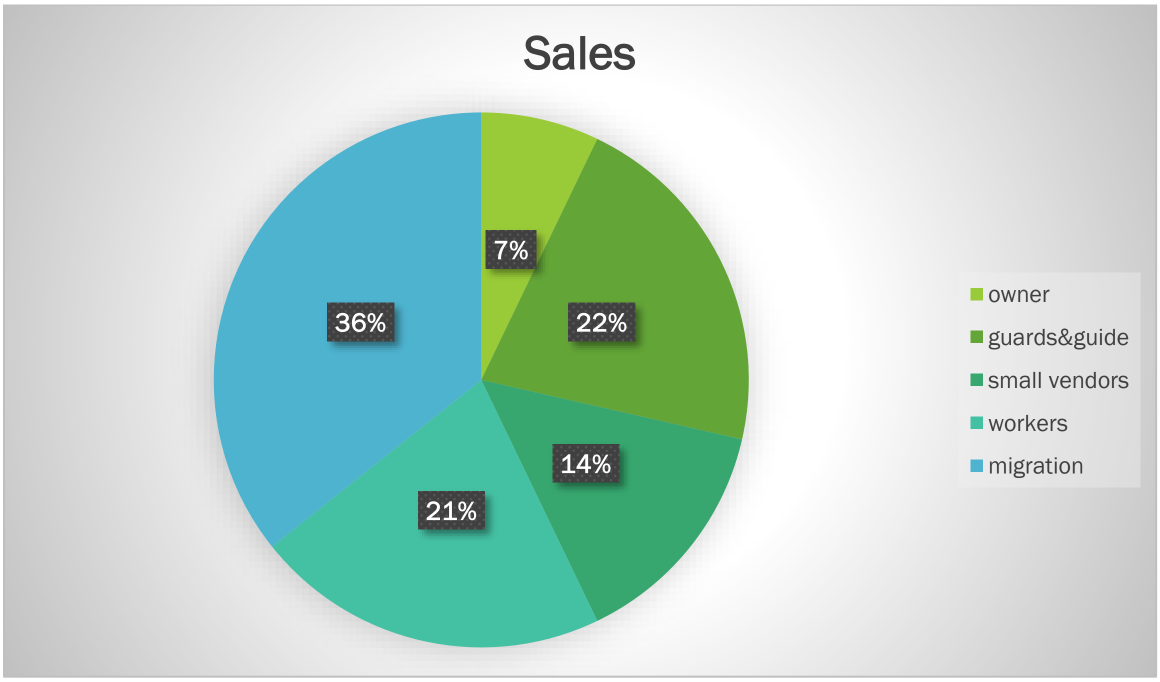


Mostly tourists are towards the facility centered development as there are no wash rooms says how bad the facilities are developed.



This clearly says that they want to know about the pictorial information for better understanding helps them and later detailed maps showing where to and where not to movie on the Kaas Plateau.

Sustainable Plan



This graph is taken from the employment status of the villagers most of them are migration workers in large cities like Mumbai and Pune. They are leaving this place because of lack of opportunities. If we could develop the opportunities in tourism they can remain here and that reduces burden of migration on large cities.

All the 6 villages got separate routes from the their own to Kaas Plateau instead of developing big resorts that feed pockets of outsiders if we could develop the home stays and allow them to go to Kaas through these paths this also shares the burden of traffic and tourist's through main entrance. And if we can change the parking to the east side. The problems of pollution and sound pollution will be minimized. Strict count of visitors should be maintained with a proper center that provides all the info about the plateau should be established.

Conclusion

By monitoring the HRVA of the Kaas plateau and implementation of the echo-tourism together help us in eco-Disaster Risk Reduction which help us in Retaining the Universal values of the Kaas. Strict framing and execution can only help in achieving the goal of retaining the importance of Kaas.

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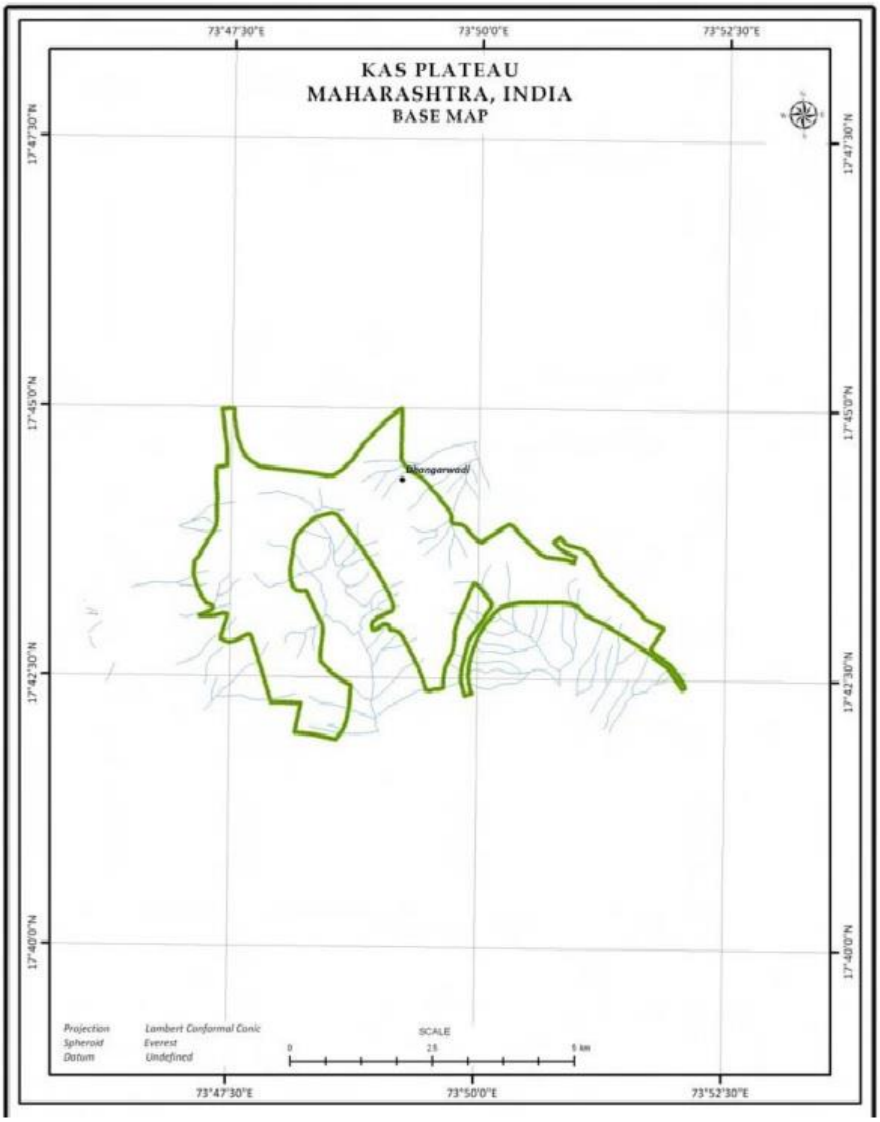
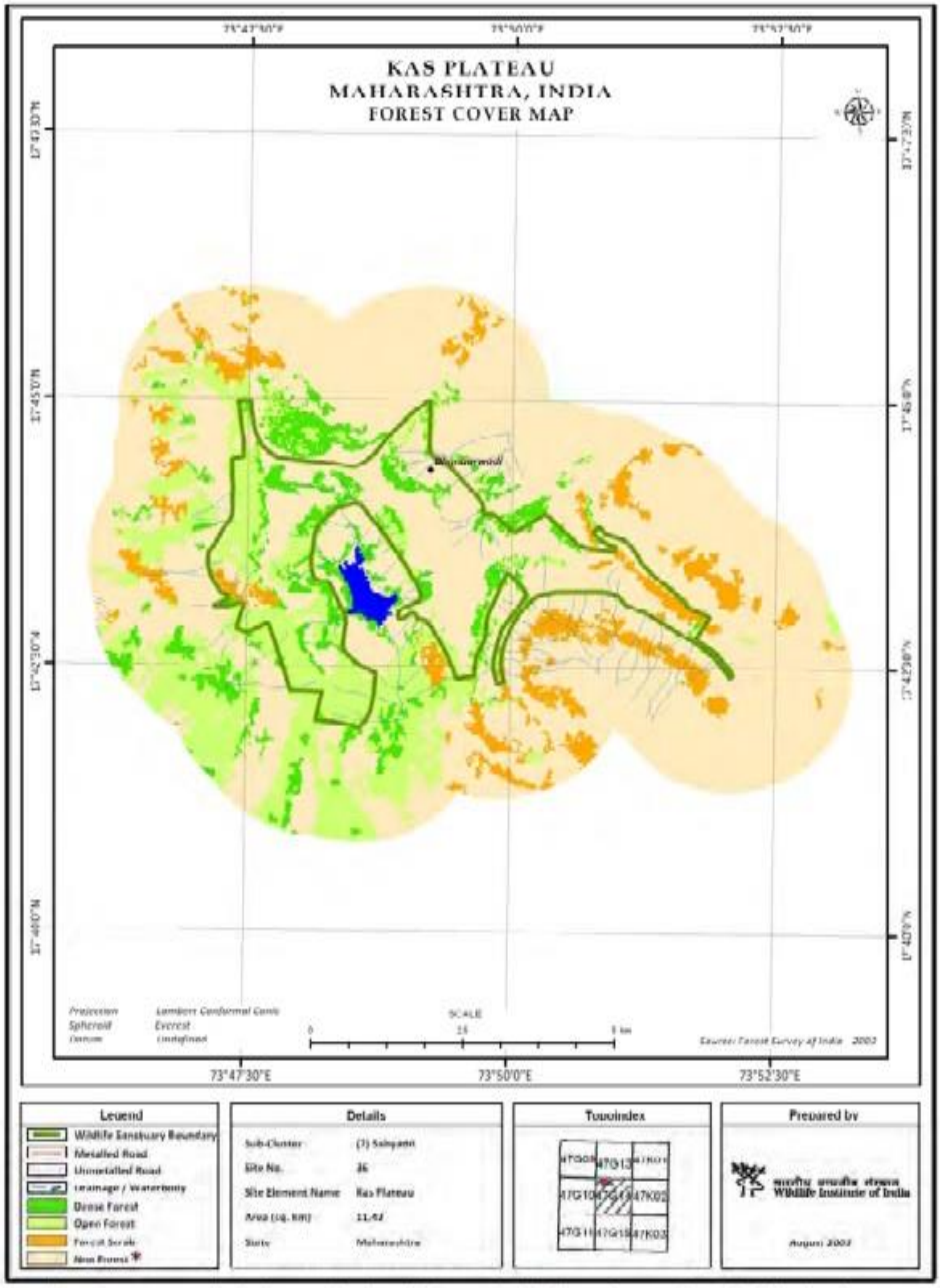
ANNEXURE-1

SOURCE: World Heritage Site Nomination Dossier by WII

ANNEXURE- 1.36a
Base Map of Site element: 036-Kas Plateau of Sahyadri Sub-cluster





*Non-Forest areas include grasslands, which are vital habitats for a variety of wild animals

ANNEXURE-II

QUESTIONNAIRE

Questionnaire for villagers

1.Name

2.Age

Below 14 years 14-35 years 35-55 years above 55 years

Gender?

3.Village

4.Profession

Agriculture. Restaurant. Tourism. House wife business (outside Kaas) Others.

5.Job role

Owner Employer

6.Annual income

Below 2 lakhs 2-4 lakhs 4-6lakhs above 6 lakhs

7. If tourism is Profession

Home stay owner employer in resort Guide on Kaas Restaurant Owner

JFMC member other

8. Reasons for migration?

No Job opportunities Higher Earning chances

9. Nearest Primary Health Centre?

10. Medical practitioners in the village?

11. School?

Element secondary PUC UG PG

12. Fire Station

Questions for Home Stay Owner?

14.Since how many years he is running that?

Below 5years 5 years above 5 years

15.cost per day per person?

500 500-800 800-1200 1200 - 1500

16.How they are disposing the solid Waste generated?

Disposing out village panchayat compost Burning it

17.How they are providing the drinking Water for tourists?

Packaged Drinking Water Self Treated Nontreated Water

18.Has any infrastructure been developed after introduction of tourism in this village?

Yes

No

19.Material used for construction of accommodation?

Concrete Timber Asbestos sheets

20. Permissions obtained for establishing it?

Revenue Tourist Police Forest Department

Questions for Employer in resort

21. Job role

Manager Helper Cook others

22. Salary

5-10k 10-15k 15-20k 20-25k above 25k

23. Working since

24. Previous job

25. Any skill development programs by government or NGO?

Yes No

26.What are they?

Guides on Plateau

27.Salary

28.What they will be doing in the off season

Agriculture Business Migrating to another place Stay unemployed Others

29.Training by Forest Department?

30.Professional problems they face in day to day life? Climate

Long working hours

Transport issues

31. Role of JFMC

Alternative livelihood arrangements in off season?

Involvement in the decision making

Hazard	Past Occurrence	Frequency	Damage	causality
Earth Quake				
Flood				
Land slide				
Fire Accidents				

Road Accidents				
Health Hazards				