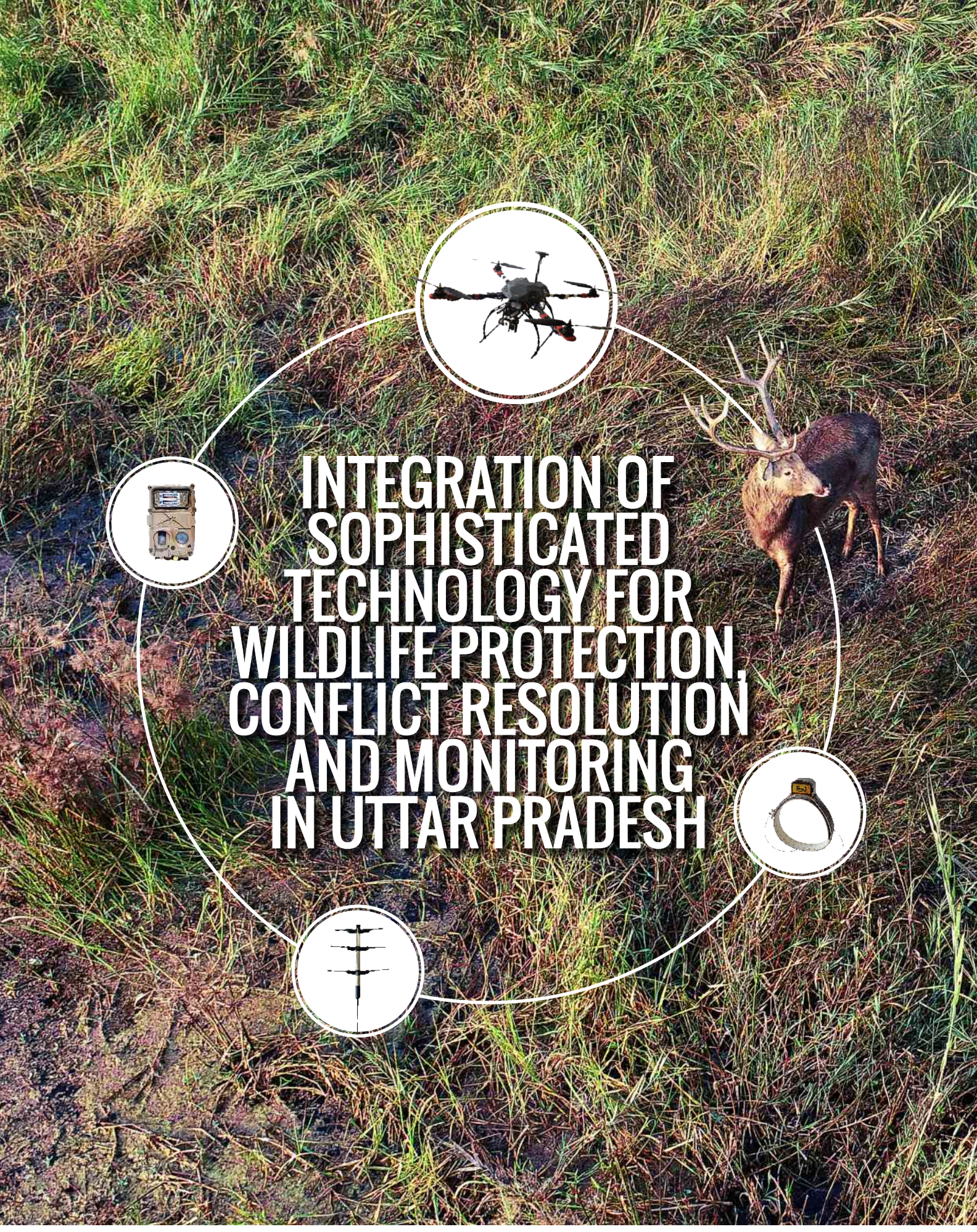


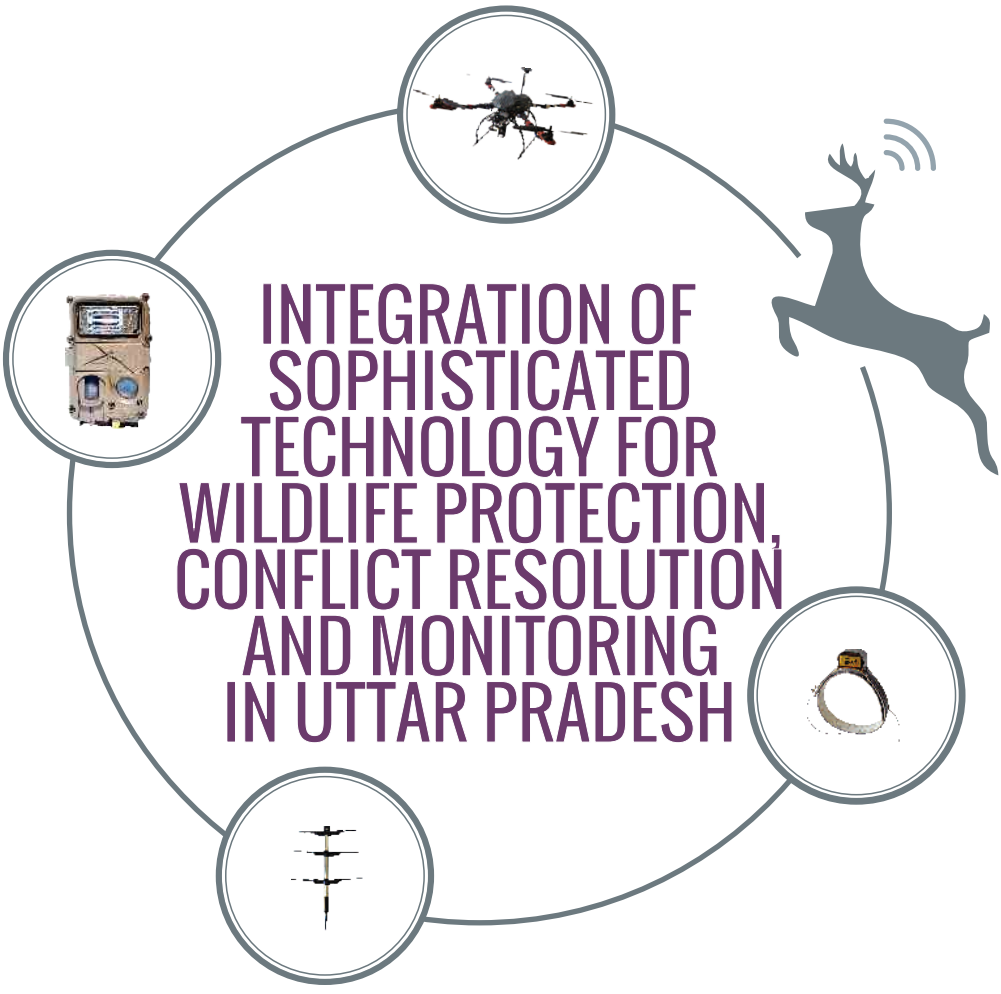
# INTEGRATION OF SOPHISTICATED TECHNOLOGY FOR WILDLIFE PROTECTION, CONFLICT RESOLUTION AND MONITORING IN UTTAR PRADESH

*In collaboration with Wildlife Institute of India*

DETAILED PROJECT REPORT - 5 YEAR PLAN

August 2019

भारतीय वन्यजीव संस्थान
Wildlife Institute of India



# INTEGRATION OF SOPHISTICATED TECHNOLOGY FOR WILDLIFE PROTECTION, CONFLICT RESOLUTION AND MONITORING IN UTTAR PRADESH

TECHNO VISION FOR BIODIVERSITY CONSERVATION
[FIVE YEARS PLAN - 2019/20-2024/25]
UTTAR PRADESH FOREST DEPARTMENT

---

In collaboration with
Wildlife Institute of India
August 2019

भारतीय वन्यजीव संस्थान
Wildlife Institute of India



**Project Team**

Dr. K. Ramesh, Scientist-E

Ms. Susmita Khan, Project Intern

Mr. Balsher Singh, Project Engineer

Mr. Shashank Sawan, Project Engineer

Ms. Tamalai Mondal, Project Biologist

Ms. Ritwika Ghosh, Project Biologist

**Advisor:**

Dr. S.P. Yadav, APCCF & Member Secretary, State Biodiversity Board

**Citation:**

Ramesh K., Khan S., Singh B., Sawan S., Mondal T., Ghosh R., and Yadav S.P., 2019. Integration of Sophisticated Technology for Wildlife Protection, Conflict Resolution and Monitoring in Uttar Pradesh. Detailed Project Report, Wildlife Institute of India, Dehradun and Uttar Pradesh Forest Department, Lucknow.

# FOREWORD

The state of Uttar Pradesh represents the parallel zone between the Himalayas in the north and the Vindhayas in the south. The mighty river Ganga which originates in the Himalayas, flows in the state from northwest to southeast and has facilitated the alluvial-rich flood plain and high agriculture productivity. Some of the last remnants of Terai Forest is now restricted to few pockets in the State and being the habitat specialists, the species such as One-horned Rhino, Swamp Deer, Swamp Francolin and Hispid Hare have special conservation value. Dolphin is the face of our river systems and the mission to clean the Ganga is expected to ensure long-term survival of this species and also the Gharial. Biological diversity of Uttar Pradesh has been the focus of research and management for several decades, with some pioneering conservation programs and innovative experiments. Given that it is one of the largest and most populous state of India, the demand-supply from the natural capital is a significant mismatch and thus, there is constant challenge to manage the unique ecosystems and its biodiversity.

Biodiversity conservation is a noble objective and it is the foundation of quality of life and development. Therefore, it is important to explore and exercise all possible options to advance the conservation objectives, while ensuring that the actions do not impinge on the societal welfare and growth. E-governance, Digital-management and Electronic-surveillance are emerging ideas in the field of conservation, and the State of Uttar Pradesh would strive to position lead role in embracing the modern tools and is determined to upscale to the entire state towards quality of life of biodiversity and people. It is heartening to note that our State Forest Department in collaboration with Wildlife Institute of India has developed a novel concept of 'Techno Vision 2030' for the State of Uttar Pradesh. It is a guiding document and provides specific details for each of the Protected Areas and other Systems that require conservation inputs involving technological options. I am confident that this would develop into a model conservation discourse in the conservation history of Uttar Pradesh and perhaps the whole of India.

I like to place on record the vision and efforts of the team and that this document would change the way we have managed our natural resources, taking us to new era of biodiversity management in the State.

Congratulations and best wishes!

Sd/

(Dr. Pawan Kumar)
PCCF & Head of Forest

# PREFACE

Wildlife conservation continues to remain major challenges from conventional and emerging threats that entails constant and improvised interventions and require enhanced technical capabilities and paradigm shift. The other key issue is, that the work force for managing such a vast and remote area is not only low, but also the quality of management inputs requires significant changeover in order to be efficient and cost-effective. Although the governance mechanism and field applications demand superior level of preparedness, the prevailing condition is enormously deficient to meet the demands. In terms of poaching concerns, the current technological options provide support mostly after the crime has been committed but it would be important to ensure preventive measures. It is always noteworthy to be one-step ahead of criminal elements that poses significant danger to the future scenario of wildlife conservation. The situation is almost similar in the case for human-wildlife conflict patterns, which require intensive efforts not only to prevent loss of life and property, but also to implement short-term and long-term conflict resolution strategies and to integrate community participation for wildlife conservation and management.

The key benefits of adapting to technological solutions include (a) Significant enhancement in the quality of management by bringing in professionals, who are techno-savvy, (b) Offset the lack of or less work force, (c) Enables detection and early warning of crime/conflict occurrence, (d) Supports preventive strategies and help early response actions, (e) Presents additional and effective options for human-wildlife conflict resolution strategies, (f) Facilitates improvement in the intelligence network and communication strategy both within and outside the protected area systems and also trans-boundaries, and (g) Modernization of the department with efficient knowledge management and rapid decision-making process and field functions.

Uttar Pradesh is the largest state of north or north-central India, covering 7.3% of India's land area and is also a rich historical hub, frame of Indian culture and civilization. The state is spread

across in 75 districts with the capital being Lucknow. This state represents 18% of India's higher plants or angiosperm flora. Freshwater ecosystems, especially riverine systems, give rise to unique habitat mosaics, which support unique biodiversity and provide substantial ecosystem services, creating a strong imperative for their protection and restoration. It is also home to large number of endemic flora and there are many invasive alien species also found here. The Ganga is the lifeline to the people of this state and it also harbours a unique assemblage of biodiversity due to its passage through three distinct biogeographic zones and unique habitats. The state is represented by various charismatic species such as Tiger (Panthera tigris), Leopard (Panthera pardus), One-horned rhino (Rhinoceros unicornis), Gangetic river dolphin (Platanista gangetica gangetica), Smooth-coated otter (Lutrogale perspicillata), Gharial (Gavialis gangeticus) and Mugger (Crocodylus palustris). Also, the Ganga river basin is recognized as a Global Turtle Priority Area and a Turtle Biodiversity Hotspot. The state has a total of 121242 wetlands giving home to various obligate species. There are 23 wildlife sanctuaries and one national park and three tiger reserves covering 5712 km² (2.37%) of the state's geographic area.

While there is wealth of biodiversity in the state, immense pressure on forest and wildlife is also prevalent throughout the state. As the state forms the northern boundary of India to Nepal, transboundary management is a major challenge in this state, and the transboundary effects lead to increase in the poaching and illegal trade of wildlife products from this country. Besides, being the most populous state of this country with low economic growth, the substantial biotic pressure including habitat destruction and encroachment of forested area are major conservation challenge here.

This Detailed Project Report (DPR) provides an overview of the biodiversity of the state, the key species represented by each of the geographic units and protected area, management issues and technological options/solutions to address these issues. We expect that the content of this DPR would serve as baseline for technological solution to deal with various management issues. More critically, the DPR provides for Knowledge Management and Decision Support System, which can enhance and integrate field level implementation of these technological solutions, effectiveness, administrative monitoring and policy inputs.

We are very much grateful to the Forest Depart of Uttar Pradesh, especially Dr. Pawan Kuman and Dr. S.P. Yadav for steering the process and providing the enabling environment and resources to undertake the task with limited workforce and timeline. It is them who drove this agenda and ensured that the discussion turns into a road map for implementing the technological solution in the state of Uttar Pradesh. We are also indebted to all the Forest Officials especially Chief Wildlife Ward Mr. Sunil Pandey and senior officers like Shri PK Sharma, PCCF (PI); Shri Sanjay Shrivastava, APCCF (Eco); Shri Ramesh Pandey, Field Director Dudhwa Tiger Reserve; Dr. Rajmohan, Field Director Pilibhit Tiger Reserve; Shri Sunil Chowdhury, CCF Wildlife (West); Shri PP Singh; Shri Sujoy Banerjee for participating in the discussions and providing valuable inputs to improve the DPR. As Institutions, we are thankful to all others in the Uttar Pradesh Forest Department and Wildlife Institute of India for providing support to make this possible.

- The Project Team

# CONTENTS

# INTRODUCTION

## 1.1. PHYSICAL FEATURES OF THE STATE

Set on the banks of the holy river Ganga, Uttar Pradesh (UP) is one of the largest state of the North India covers an area of 243,290 km² which is almost 7.3% of India. It forms the northern border with Nepal and spans between Terai in the north to undulating Bundelkhand region in the Vindhayan hills on the south. Due to its rich historical heritages and impacts on Indian culture and civilization, UP is considered as the cultural frame of India. There is a great mixing of cultures in UP for several decades, which leads to a vibrant cultural background of this state. The primary spoken language in this state is Hindi followed by Urdu, Awadhi, Braj Bhasha, Bundeli, Bagheli, Kannauji, and Bhojpuri. The state is divided into 18 divisions which have 75 districts with the capital being Lucknow. It is also the most populated state in India as well as the most populous country subdivision in the world with a total rural population of 77.72% and urban population of 22.28% with a population density of 828 people/ km2 according to the 2011 census. The Literacy rate of the state according to the 2011 census is 67.7%.

The climatic condition of UP is mostly defined as humid subtropical to semi-arid at parts. Annual rainfall varies from 1000 mm to 1200 mm, and temperature ranges between 45? celsius in summer to 5?celcius in winter. The state experiences mostly three major seasons viz. summer, monsoon, and winter and also experiences cyclic droughts and rains in years. Major rivers flowing through this state is the Ganges and its tributaries, Yamuna, Gomti, Ram Ganga, Ghaghara, Gandak, Ken, Betwa, Chambal and Son. The Gangetic flood plain is the dominant terrain of this landscape. The

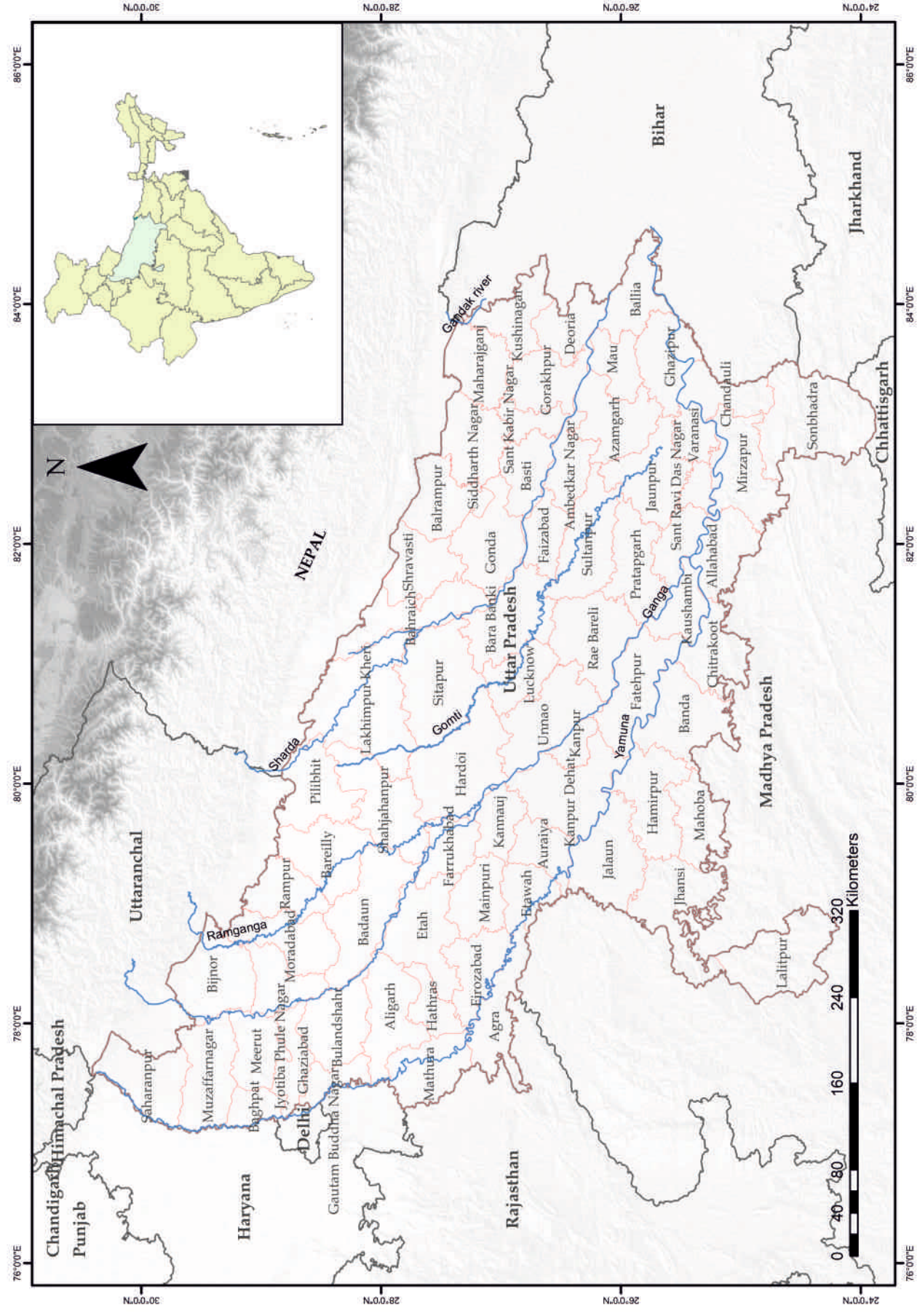
# 1.

southern part of this state comprises of older soil composition. Soil texture varies in different part of the country. Most of the terrain is composed of alluvial soil, loam or sandy loam soil, rocky or stone soil, clay loam with saline and alkaline in nature and rich in calcium. Agriculture is one of the most significant livelihood sources in this state. UP is the largest sugar producing state in India. Other major crops include wheat, rice, maize, and pulses. Apart from this, UP has a vibrant horticultural diversity also. Various varieties of fruits and vegetables are cultivated in this state, which contributes a large amount to the economy of this state as well as the country.

According to the livestock census 2007, UP has 63.96 million livestock, and the cattle population of this state is nearly 19.09 million. Livestock is invaluable because of their enormous contribution to the livelihood and food sources; economy in broad terms in the form of milk, meat, organic manure, bullock power, etc. Major livestock in this state includes cow (three types of breed), buffalo, goat, and sheep.

Land use and land cover pattern in UP is categorized majorly by the Net area shown, which is nearly 68% of the total geographic area of this state. Other categories include Forests (6.86%), Non-available land for cultivation (13.52%), Permanent pastures and other grazing lands (0.27%), Land under misc., tree crops and groves (1.55%), Culturable wasteland (1.82%) and Fallow lands including current fallows (8.06%).

Figure: Map of Uttar Pradesh with Districts and Major Rivers



# 1.2 BIOLOGICAL FEATURES OF THE STATE

Uttar Pradesh has two biogeographic zones, viz., The Gangetic plain (07) and The Deccan Peninsula (06), and three biogeographic provinces, viz. Upper Gangetic plain (07A) and Central Highland (6E) and Chota-Nagpur Plateau (6D), which includes various forest divisions and wetlands (State biodiversity action plan, 2000). The Gangetic Plain biogeographic zone along the Himalayan foothills forms one of the distinct eco-climatic zones in Uttar Pradesh. The landscape is listed among the important eco-regions of the world (Johnsingh et al. 2004). Owing to the relatively recent origin of the transitional conditions, the presence of the Himalaya in the north and the Peninsular plateau in the south, and open connection with the Northeastern range, Uttar Pradesh profoundly influenced by the highly diversified and plastic faunas of the Himalayas, and the northeast, and the relicts and endemics from the south. It is, therefore, rich in unique species and speciation may also appear to be intense in all groups. The state UP is represented by various species of flora and fauna of which many are globally threatened. UP is also home to a large number of endemic flora (almost ten taxa). This state represents India's 18% higher plants or angiosperm flora. Uttar Pradesh is intersected by great rivers that flow through the state and is an abode for freshwater biodiversity of the country. There are many species of aquatic mammals, including the National aquatic animal and critically endangered Platanista gangetica gangetica, critically endangered Gavialis gangeticus, 14 freshwater turtle species, one tortoise species, 115 freshwater fish species. There are over 70 species of avifauna, resident as well as migratory that depends on the river.

## Major forest types and vegetation of the state

The state has 14,679 km² forested area which covers 6.09% of the state's geographical area. It has been observed that there is a net increase of 278 km² of forested area in the state compared to the previous assessment by FSI which can be attributed to plantation and conservation activities (FSI state of forest report, 2017). The forest type of this state typically includes Dry deciduous forest, Mixed forest, Sal forest, Riparian fringe forest, Scrub forest, Grasslands, Swamp vegetation, and Wetlands.

## Threatened and rare species of the state

Due to encroachment, habitat destruction, poaching, and other natural and anthropogenic causes, a large number of species in the landscape is threatened with extinction. That includes large mammals like, Tiger (EN), Asiatic Elephant (EN), One-horned Rhino (VU), Swamp Deer (VU), Sloth Bear (VU), to small mammals like Fishing cat (VU), Indian Pangolin (EN), 6 species of Vultures (CR/EN/NT), a number of migratory ducks, Bengal florican (CR), Ganges river dolphin (EN), Gharial (CR), turtles such as Red-crowned roofed turtle (CR), Three-striped roofed (EN), Indian narrow-headed softshell turtle (EN) and Elongated tortoise (EN) etc.

## Protected Areas

Wildlife protected areas (PAs) are able to provide shelter to the endangered ecosystems and also can boost the growth of these systems. PAs in India have a comparatively long history of forest management and exploitation as a majority of the PAs were initially categorized as reserved forests or other categories of government-owned forests where the focus of management was timber production, to meet the biomass demands of local communities, or soil and water conservation (Rodgers and Sawarkar, 1988). Uttar Pradesh has one national park, 23 wildlife sanctuaries and three tiger reserves covering 5712 km² which constitutes 2.37% of the state's geographic area. The oldest wildlife sanctuary of the country, the Chandraprabha wildlife sanctuary (Area: 78 km²) is located in Uttar Pradesh.

# 1.3 STATE ANIMALS

## State animal

Swamp deer (*Rucervus duvaucelii*) has been declared as the state animal of Uttar Pradesh which is categorized as Vulnerable in the IUCN category. The swamp deer is the largest grassland-dwelling endemic cervid of India and Nepal. With a declining population trend across its range, the northern swamp deer subspecies Rucervus duvaucelii duvaucelii occurs in small wetland patches across the states of Uttarakhand and Uttar Pradesh in India.

## State bird

The sarus crane (*Grus antigone*), a bird species of wetlands, is categorized as vulnerable on the IUCN Red List. In India, it is the tallest flying bird which occurs mostly outside protected areas and uses these human-dominated areas near water body for feeding and breeding. They are therefore threatened by poaching and the destruction of their eggs and juveniles. Uttar Pradesh has the largest population of Sarus crane in the country.

## State aquatic animal

Gangetic river dolphin (*Platanista gangetica gangetica*), also the national aquatic animal of India is listed as Endangered in IUCN red list and included in the schedule I in Wildlife (Protection) Act, 1972. This mammal is a species of the freshwater river system and therefore also the indicator of the water quality of the river. Because of its very particular and pure habitat demand this species is very much threatened throughout its entire habitat due to pollution, siltation and rising deforestation.

## State fish

Chital/Mohi (*Chitala chitala*) Commonly known as Feather back, it bears spots or chitti on its body. It is found in Gomti, Gerua, Ken, Betwa, and Yamuna river basins. The adults and sub adults carry a series of 15 transverse gold or silver bars on dorsum.

# FLAGSHIP SPECIES OF THE STATE 1.4.

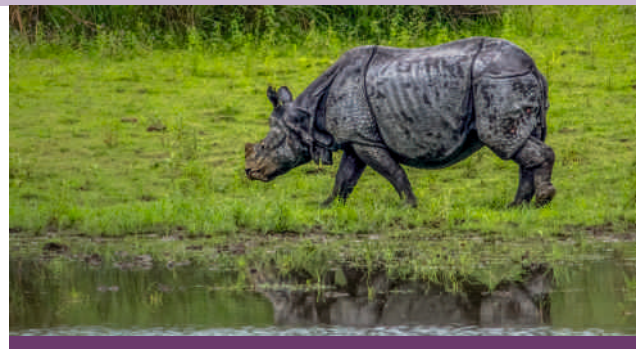
**The forests of this state are dwelt by many elusive and charismatic animals and flagship species of major ecological importance. These species also provide a major role in maintaining the forest health and ecological balance of the system. Apart from their ecological significance, many of these animals are sought after in illegal trade market because of their high-priced body parts, hence also very much threatened. Some flagship species found in this state are;**

### Tiger

*Panthera tigris,*
the national animal of India is the largest species among Felidae and an apex predator. This animal is mostly territorial and solitary in nature, and it is currently categorized as 'Endangered' in IUCN red list. In UP, this animal is distributed mainly in three tiger reserves, viz. Dudhwa TR, Pilibhit TR, and Amangarh TR and in few wildlife sanctuaries.

### Asian Elephant

*Elephus maximus*
is the only living species of Elephus genus, and also it is the largest land-dwelling animal in Asia. It is distributed across Indian-subcontinent and South-East Asia and mostly threatened by forest fragmentation, habitat loss and pooching. Globally it is categorized as 'End angered' by IUCN. In UP this elusive animal is found throughout the forests of Terai belt.



### Indian One-Horned Rhino

*Rhinoceros unicornis*
is native to Indian-subcontinent and listed as 'vulnerable' on IUCN list due to its fragmented and less population. This animal is very much habitat sensitive and can only survive in alluvial grassland and riverine forests. Once it was distributed throughout theGangetic flood plain but now they are only distributed in small patches due to habitat loss and human encroachment. Poaching of rhino for its horn is also a major threat to the survival of the animal. In UP this animal was reintroduced in Dudhwa in 1984.

## Swamp Deer

*Rucervus duvaucelii*
is categorized as Vulnerable in the IUCN category. It is the largest grassland-dwelling endemic cervid of India and Nepal. With a declining population trend across its range, the northern swamp deer subspecies Rucervus duvaucelii duvaucelii occurs in small wetland patches across the states of Uttarakhand and Uttar Pradesh in India.

## Leopard

*Panthera pardus*
is well distributed throughout Indian-subcontinent, and this big cat is listed as vulnerable in IUCN red list due to the threats faced by habitat loss, forest fragmentation poaching for the illegal trade of its body parts. This is one of the major species involved in man-animal conflict throughout the distribution range. In UP this animal is found in all the tiger reserves and few wildlife sanctuaries like Kaimur, Chandraprabha, Sohelwa, etc.

## Indian Pangolin

*Manis crassicaudata*
or scaly anteater is found throughout the Indian sub-continent. It is a solitary nocturnal animal and mainly insectivorous. This species is common in various forest patches of this state and mostly threatened by poaching for meat. Currently, it is categorized as threatened in the IUCN red list category.

## Sarus Crane

*Grus antigone*
is a bird species of wetlands. It has been categorized as vulnerable on the IUCN Red List. In India, it is the tallest flying bird which occurs mostly outside protected areas and uses these human-dominated areas near water body for feeding and breeding. They are therefore threatened by poaching and the destruction of their eggs and juveniles. Uttar Pradesh has the largest population of Sarus crane in the country.

## Bengal Florican

*Houbaropsis bengalensis*

is a critically endangered species found in the Grasslands of Gangetic floodplain. There are approx. One thousand individuals left in the wild but no recent total population estimates are known from India. A very rapid decline in the global population of this species is estimated to have occurred over the last three generations.

## Gangetic river dolphin

*Platanista gangetica gangetica*

I is an aquatic mammal species of the freshwater river system and found in Ganges and Brahmaputra river system. It is listed as 'Endangered' in IUCN red list and included in the schedule I in Wildlife (Protection) Act, 1972. Because of its very particular and pure habitat need this species is very much threatened throughout its entire habitat due to pollution, siltation and rising deforestation.

## Gharial

*Gavialis gangeticus*

is one of the three crocodilian species found in India. It derived its name from the bulbous growth or "Ghara" on the tip of the snout of the male.The gharial is listed as Critically Endangered in IUCN red list and is in the Schedule I of Wildlife (Protection) Act, 1972. The species found majorly in the Ganga and tributaries. The major diet of the species is fish. Uttar Pradesh has a good population of gharials left.

# KEY ECOSYSTEMS OF THE STATE 1.4

## Shivalik's

The Shivalik Hills or the outer Himalayan deposits are a mountain range of the Himalayas that stretches from the Indus river to near Brahmaputra river for almost about 2,400 km (1,500 mi). This state Uttar Pradesh has a small part of Shivalik hills in its geological component near Uttarakhand border. Part of Dudhwa National Park, Hastinapur Wildlife Sanctuary and Suhelwa Wildlife Sanctuary fall in the foothills of Shivalik and it is called Churia hills in Nepal. This area is mostly hilly, and rocky terrain and the forest types are mostly misc. Dry deciduous Sal forest and are home to various wild species.

## Terai

The Terai Arc Landscape or TAL is a trans-border protected ecosystem of the Terai or foothills of Himalayas. This landscape stretches across 12.3 million acres and home to many endangered and endemic species of higher conservation importance. In Uttar Pradesh, the total Indo-Nepal border and the protected areas of that region comes under this landscape. Various species found in TAL include Tiger, Leopard, Elephants, Gaur, Rhinoceros, Hispid hare, Sambar, Swamp deer, Sarus crane, Bengal florican, Black stork, Swamp francolin, Ganges river dolphin, etc. The rivers and wetlands of the TAL are also very much rich in species diversity and forms diverse ecosystems and specific niches for many endemic species of birds, mammals, a varied range of fish, amphibians, and fresh water turtles and tortoises. Although fragmented, Terai arc landscape has clusters of areas which harbors several species like swamp deer, sloth bear, hispid hare, honey badger, elephant, and barking deer which are strong indicator species of the Dudhwa national park. Chital and hog deer act as indicator species for KWLS. Indicator species of the managed forest areas include cattle, Indian hare, and wild boar. Nilgai also has high indicator values in managed forests.

## Gangetic Flood Plains

The Gangetic flood plain is considered as the worlds larges fresh water flood plain system and distributed throughout five states of India. The plain is destined on the north by the Himalayas, and The southern edge of the plain is marked by the Chota-Nagpur Plateau. The major part of this flood plain falls on the geographic boundary of the state UP. Freshwater ecosystems, particularly the riverine systems, give rise to unique habitat mosaics, which support unique biodiversity and deliver substantial ecosystem services, creating a strong imperative for their protection and restoration. The Ganga is the lifeline to more than 500 million people as it flows through five riparian states and it also harbors a unique assemblage of biodiversity due to its passage through three distinct biogeographic zones and unique habitats. Apart from nurturing umbrella species like the Gangetic river dolphin, Otters, Gharial and Mugger, the Ganga River basin is also known as a Global Turtle Priority Area and a Turtle Biodiversity Hotspot (Buhlmann et al. 2010, Mittermeier et al. 2015). Other obligate aquatic species like water birds and island nesting birds are also vital components of this riverscape. The Ganga is also known to support more than 143 species of fish belonging to 11 orders, 72 genera and 32 families (Sarkar et al. 2012), which accounts for 20% of the total freshwater fishes reported in India. The Ganges River is known as home for up to 13 species of freshwater turtles, classified into nine genera. Of these, nine species are under threatened categories such as.Turtles and tortoises are very much sensitive to particular habitat as are good indicator species forthe river system.  Some species found here are Red-crowned roofed turtle Batagur kachuga (CR), Three-striped roofed turtle Batagur dhongoka (EN), Indian narrow-headed softshell turtle Chitra indica (EN), Gangetic softshell turtle Nilssonia gangetica (VU), and Elongated tortoise

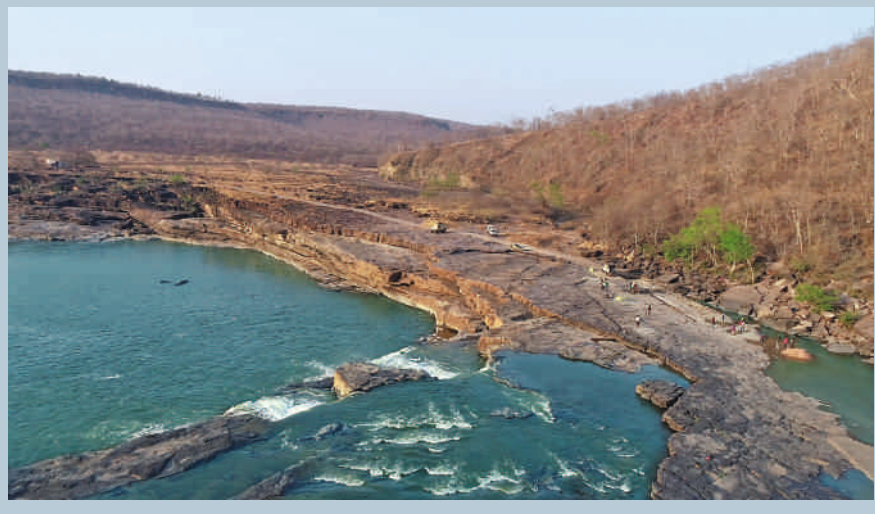
Indian narrow-headed
shoftshell turtle (*Chitra indica*)

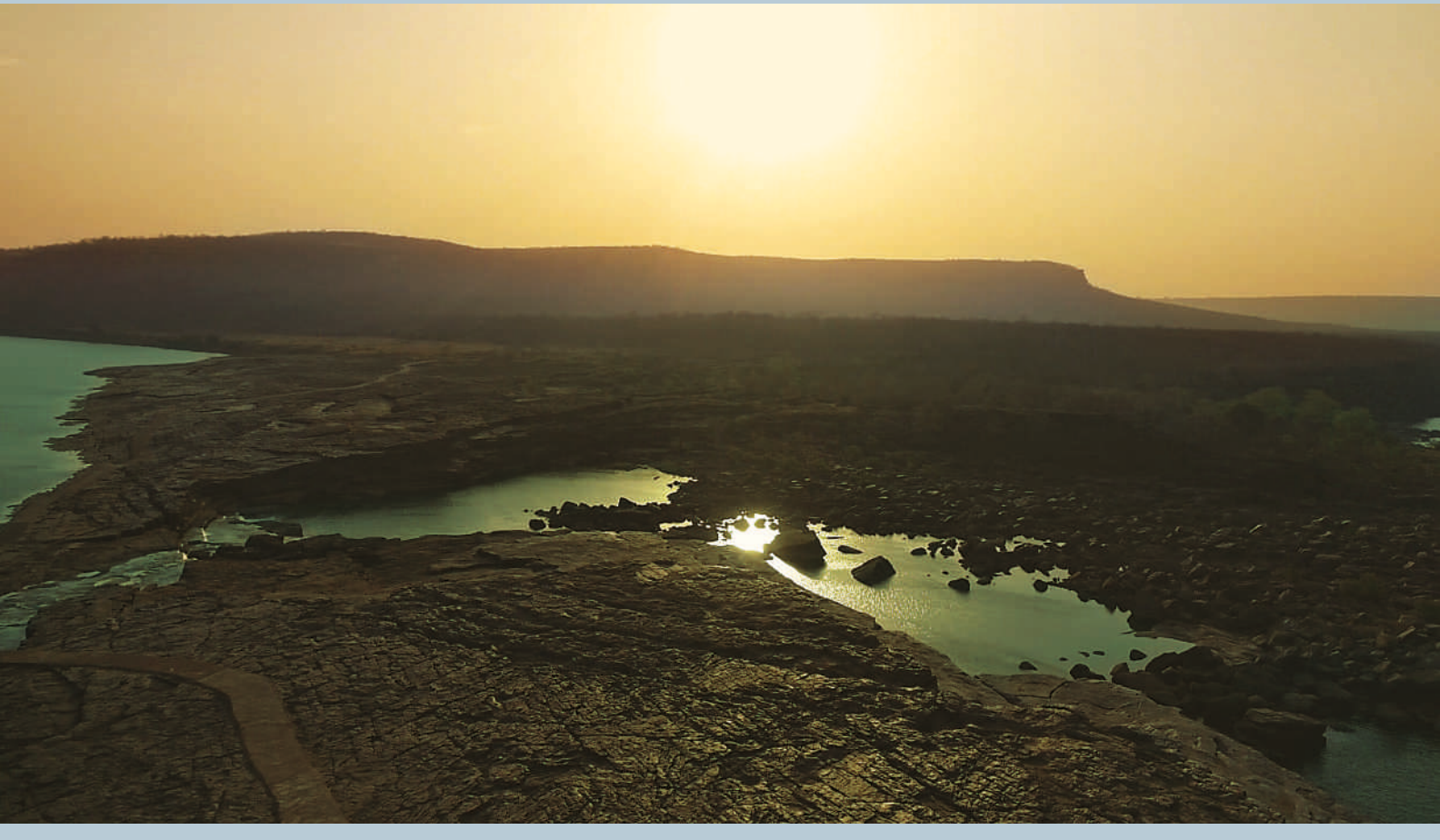
Black pond turtle
*Geoclemys hamiltonii*

Crowned river turtle
*Hardella thurjii*

## Vindhayas

The Vindhayan-Aravalli basin is the part of Vidhyas and Aravalli hill system of central India. The region is made of very old Precambrian basement rocks and divided into four subgroups. Because of its very early origin, this area supports many endemic species and are very much significant from evolutionary prospective. The southern border of the state with Madya Pradesh comes in Vindhayan basin, and the National Chambal Sanctuary is also part of this system.

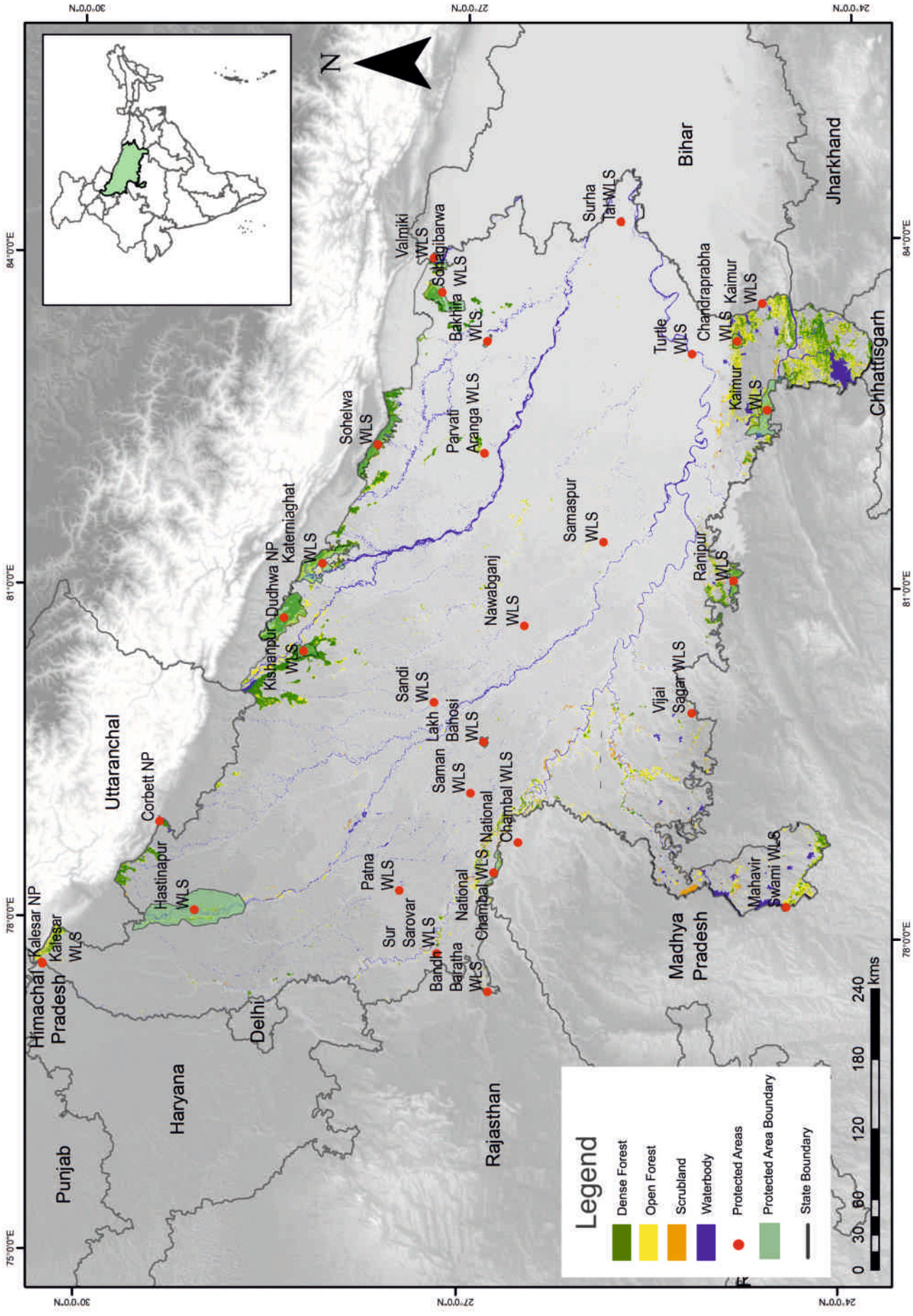




## Wetlands

The Indo- Gangetic flood plain is considered as the largest freshwater wetland system in India. These wetlands provide certain exclusive niches for the species which are unique to these ecosystems. As per the 2009 RSAC records, UP has an area of 1145178 ha identified as Wetland, which is almost 4.8% of its geographical area. All the various kinds include lakes/ponds, oxbow lake/ cut off meanders, riverine wetlands, waterlogged, river stream, reservoirs/barrages, and tanks/ponds, a total of 121242 wetlands (NWIA:UP, 2010). All these wetlands harbor a large number of aquatic flora and fauna including some rare and endangered species. The upper Ganga river stretch, almost 266 $km^2$ area from Brijghat to Narora has also been designated as the Ramsar Site. Wetland is kidneys of the ecosystem, and are prone to minimal disturbances. Wetland health is generally indicated by different types of flora and fauna that thrives in it. Different types of migratory birds, Cranes, storks, herons are major indicator species of wetlands.

Figure: Protected areas of Uttar Pradesh



# PROBLEM STATEMENT AND CONCERNS

## Forest fragmentation and habitat loss

The state is enriched with fertile land for crop cultivation. Thus, the expansion of agricultural land was bound to happen, and the highest economy comes from it to the people of this region. Apart from cultivation commercial farms, industrialization, and urbanization also took place by clearing natural resources. These actions leave the natural habitat in fragmented and degraded conditions, which causes local extinction of several species (Chitale and Behera, 2014).

## Poaching

Most of the forest of this state is rich in elusive and charismatic species like, tiger, elephant, rhino, pangolin, various bird species, turtles, etc., which also have high demand in the illegal trade market for its body parts and meat. This causes poaching incidents very often in this state. Also being situated in the international border, this illegal hunting of animal is very difficult to handle for the forest officials without any smart technological supervision.

## Human-wildlife conflict

UP is the most populated state of this country, which parallelly causes high degradation of forest patches and encroachment of forest lands to support the high demand for agricultural and household land for people.

Forest degradation ultimately leads to the habitat loss of wild animals, which forces them to come in contact with the human community to meet the need for food and survival. On the other hand, forest encroachment by local people also causes direct contact of people with wild animals many times. These situations ultimately increase human-wildlife conflict issues in this state gradually.

## Limited workforce

Understaff is a vexing problem and this generally affects overall management of the natural areas. This also leads to ineffective outcomes except in places where central

2.

support is also available. Invasive alien species like Lantana camara, Parthenium hysterophorus, Ageratum conyzoides are spreading within the protected areas rapidly. Manual removal is not enough to cope up with this problem, and it needs immediate actions to protect the natural and endemic flora of the state. Few protected areas like Chandraprabha wildlife sanctuary are affected by Naxalite activities causing casualties among the forest officials during patrolling. There is also insufficient knowledge base as well as lack of training for field staff which needs to be addressed.

## Anthropogenic pressure

Anthropogenic activities like encroachment, firewood collection, grazing, and livestock issues are quite prevalent in several protected areas of the state.

## Trans boundary management challenge and illegal trade

The state lies within the northern border of India with Nepal, and that requires potential force to deal with problems like poaching and illegal trading of the animal part.

## Road and railway kill

Road kills are another major threat to the wild fauna of this state. Most of the places of this state are well connected with road and railway networks. This also leads to the section of many forested areas by roads and railway lines that ultimately causes forest patch fragmentation. Most of the times while crossing those roads and railway lines lead to accidental deaths of many wild animals of this state. Also, speed limit breaking and rush driving increase the number of death incidents day by day.

## Wetland management issues

Wetlands are the landmarks of the state and also a target with conservation issues and management. The state holds a Ramsar site also. Thus, it makes it is very crucial to look after the conservation and management challenges of wetlands. Destruction of wetlands can lead to an existential crisis of various species as wetlands form very particular and endangered niches. Also, improper management and degradation of large wetlands can lead to flooding due to loss of natural drainage.

## Insufficient funding

Funding deficiency and inadequate equipment are two important issues in a few protected areas. Delaying in declaring the status of selected protected areas like Sohelwa wildlife sanctuary and Sur Sarovar wildlife sanctuary is to be noted. The declaration of Eco-sensitive zone notification is still pending in these Pas.

# TECHNOLOGICAL OPTIONS

## 3.1. WIRELESS COMMUNICATION SYSTEM

**The field of wildlife research and management greatly benefits from technological innovations, not only to overcome the many challenges to understand and monitor wild, free-ranging species and their habitats but also to upscale the conservation, protection, and research. Some of the technologies for general conservation and protection in terms of technology and their application are provided below.**

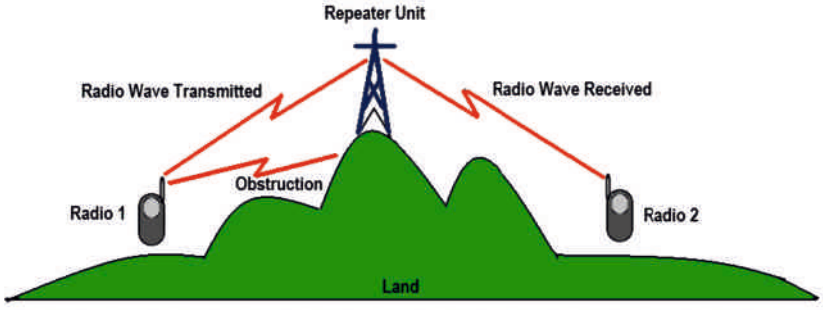
A two-way radio is a device which can both transmit and receive a signal (a transceiver), unlike a broadcast receiver that only able to receive content. It is an audio (sound) transceiver designed mainly for bidirectional voice communication with other users who are using similar radio frequency (channel). These type of bidirectional radios are available in mobile, stationary base and hand-held portable formations. Walkie-talkies, handy-talkies or hand-helds are types of this two-way radio communication system.

The most used two-way radio systems operate in the VHF and UHF parts of the radio spectrum as this part of the spectrum is profoundly used for broadcasting, and multiple contending uses. Spectrum management has become a crucial activity of governments to regulate radio users in the interests of both efficient and non-interfering use of radio.

3.

| Unit | UHF - Ultra high frequency frequency | VHF - Very high frequency |
|---|---|---|
| Use | Ideal for use indoors reinforced concrete structures, or high-rise in a city landscape. Due to high obstruction, the higher frequencies are desirable. Emergency services like fire department. paramedics and police also use these to avoid the transmission bottlenecks. | Handy for general residential area. rural terrain or or for groups trying to keep in touch while hiking, road-trips, camping or similar outdoor operations. |
| Range | 2-12 miles (mobile to portable) 0.5 to 6 miles (portable to portable) | 2-10 miles (mobile to portable) 0.25-5 miles (portable to portable) |
| | 25+ miles (with repeater) | 20+ miles (repeater) |

UHF has a shorter wavelength that makes the availability of signal easier to find its way through narrow openings inside of a building. The longer the wavelength of VHF causes it to transmit further under normal conditions. On the other hand concern with higher frequencies (UHF) is that smaller sized objects can absorb or reflect the energy more which results in range loss and multipath reflections weaken the signal by causing an "Out of Time/Out of Phase" signal to reach the antenna of the receiver.




VHF radio can be the best choice if it is mostly required to work outside, particularly if a base station radio is used indoor and an external antenna is added. The transmitting and receiver quality and distance of the radio depends on how high the antenna is placed. If the radios are used inside buildings, then UHF can be the best option as its shorter wavelength can travel through minor openings in the building well. There are also repeaters that can be installed to relay any signal frequency (VHF or UHF) to increase the range of communication.

## 3.2. EARLY WARNING SYSTEM

**An Early Warning System (EWS) is technology and associated policies and procedures designed to predict and mitigate the harm of natural and human-initiated disasters and other undesirable events. It can be applied as a chain of information communication systems and comprises of sensors, event detection, and decision subsystems. They work together to forecast and signal disturbances, which adversely affect the stability of the physical world, and provide time to the response system to prepare for the adverse situation and to minimize its impact.**

### Application

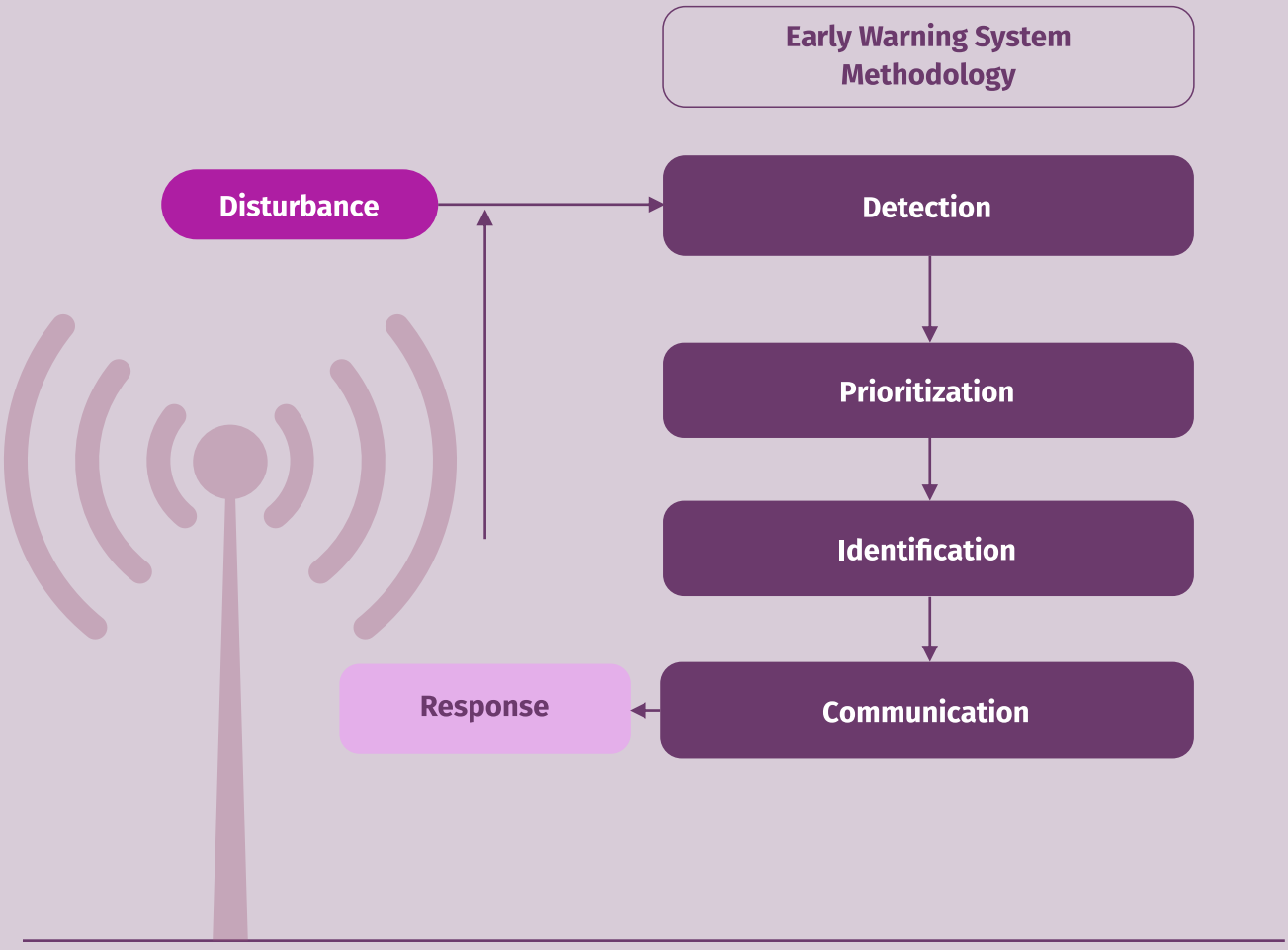
i. Risk analysis involves thoroughly collection of data and undertaking risk assessments of predefined hazards and vulnerabilities.

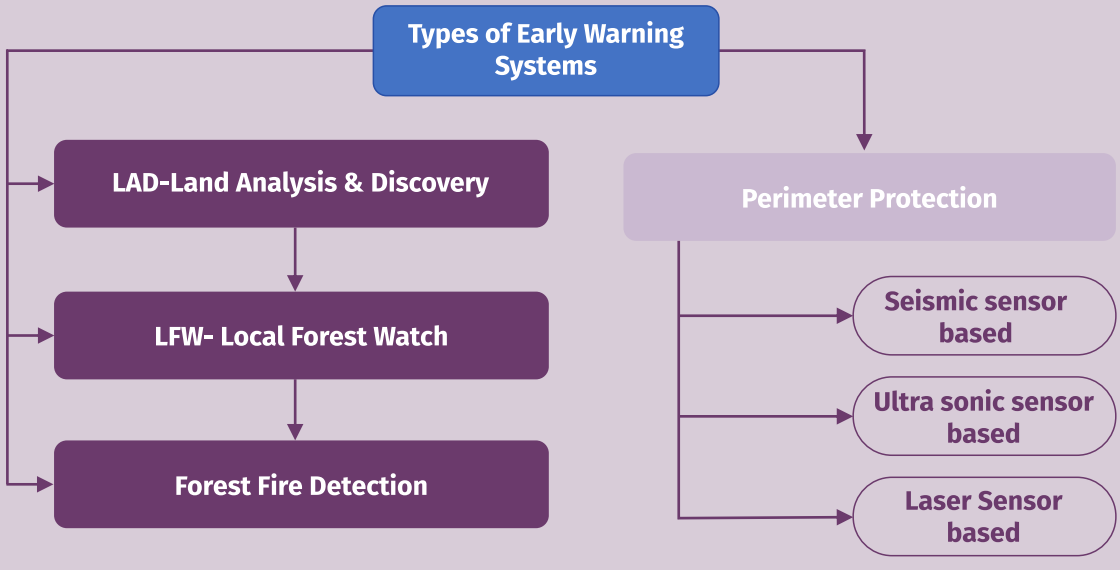
ii. Monitoring and warning involve a study of the factors that indicate a disaster or disturbance is forthcoming, as well as the methods used to detect these factors.

iii. Dissemination and communication concerns are the communication of risk information and warnings to reach those in danger in a way that is strong and clear.

iv. Adequate response ability needs the construction of national and community response plan, testing it, and the promotion of readiness to confirm that people are aware of responding to warnings.

v. An early warning system is mainly a warning system, which simply can generate an alert, and activates an adequate, timely response.

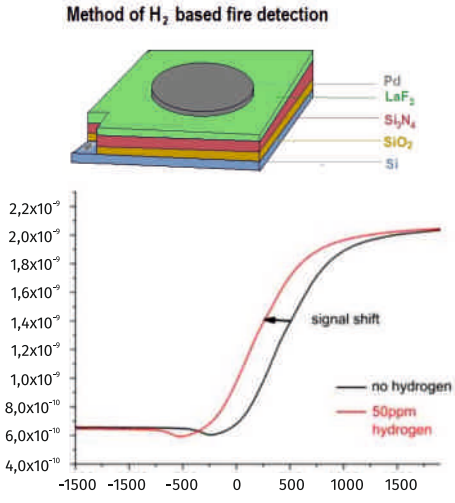

Early Warning System Methodology
Disturbance
Detection
Prioritization
Identification
Communication
Response


Types of Early Warning Systems
LAD-Land Analysis & Discovery
LFW- Local Forest Watch
Forest Fire Detection
Perimeter Protection
Seismic sensor based
Ultra sonic sensor based
Laser Sensor based

# TYPES OF EARLY WARNING SYSTEMS FOR FOREST PROTECTION

## a. Forest Fire Detection

This system detects the presence of either smoke particle, heat signature, or chemical ion from the forest fire to actuate an alarm signal. The gas sensors that are emission based can detect the pyrolysis (Thermal Transformation) of organic materials which releases Hydrogen (H2), which in turn causes a change in capacitance leading to an alarm signal peak.



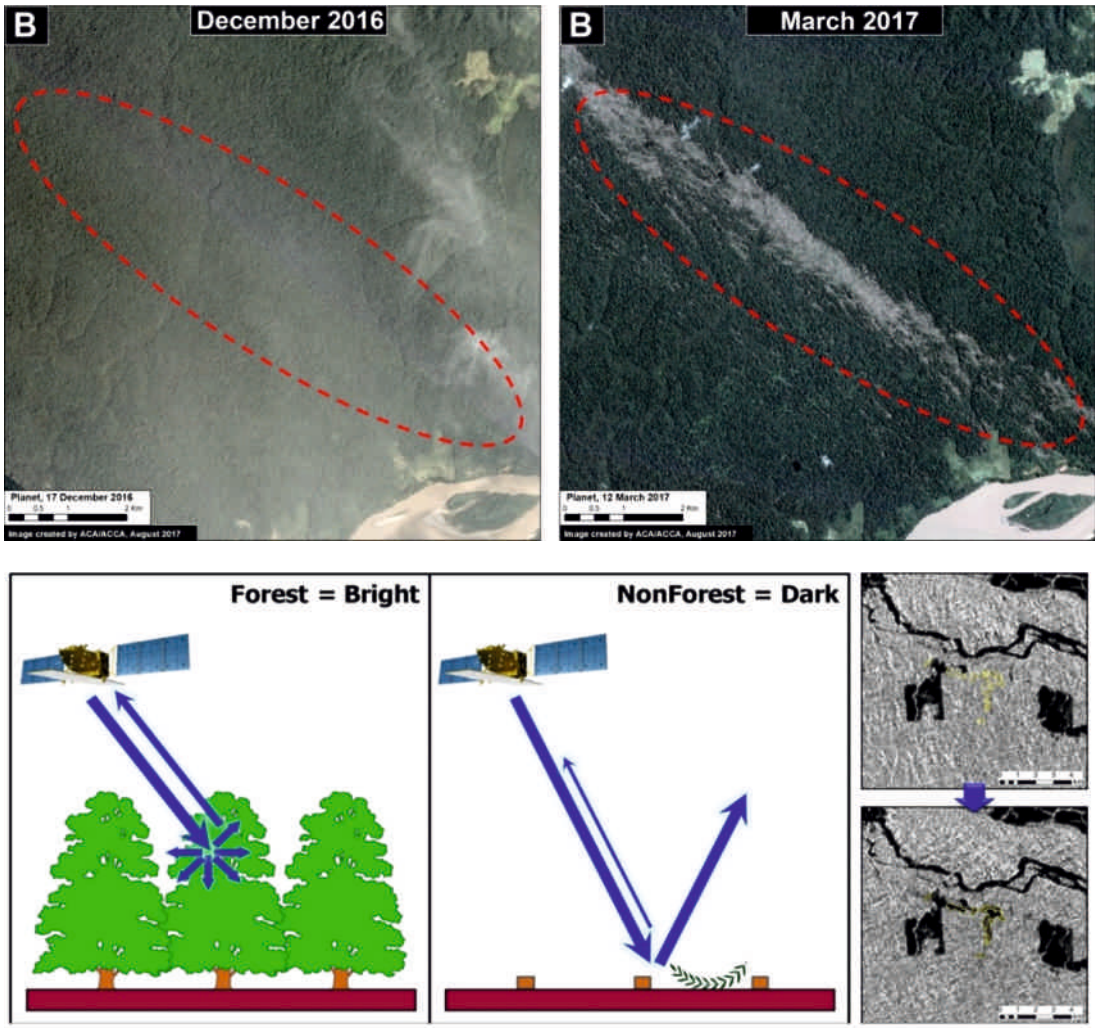

## b. Local Forest Watch (LFW)

This method uses the tools from GIS to monitor the forest area monthly or quarterly for any significant changes.

### Application

I. A weekly or periodic forest cover can be analyzed using GIS tools, and the data may be compared with the previously downloaded imagery, and any alteration in the imagery can be analyzed, and area calculated simultaneously generating an alert.

ii. The generated alert may actuate the ground-based team for the deployment of either a foot patrol or a drone to the specified location.




## c. Perimeter Intrusion and Detection System (PIDS)

Perimeter Intrusion Detection Systems (PIDS) are used in the external environment to detect the presence of an intruder endeavoring to breach a perimeter. These are divided into two types;

### I. Barrier-Mounted Fence Intrusion Detection System

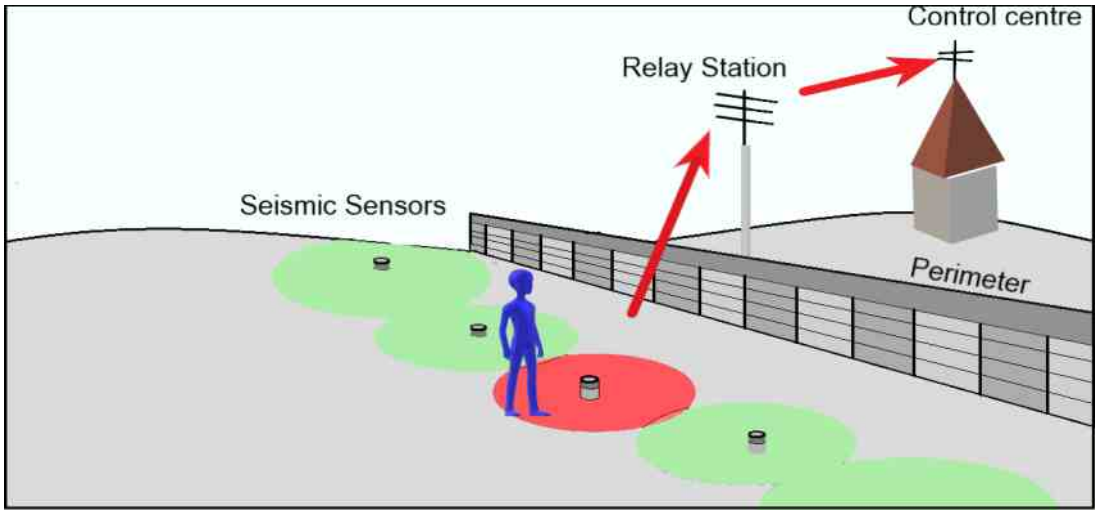
PIDS deployed on or in combination with a fence or other physical barrier (e.g., DAS cable or other motion sensors mounted on a fence).

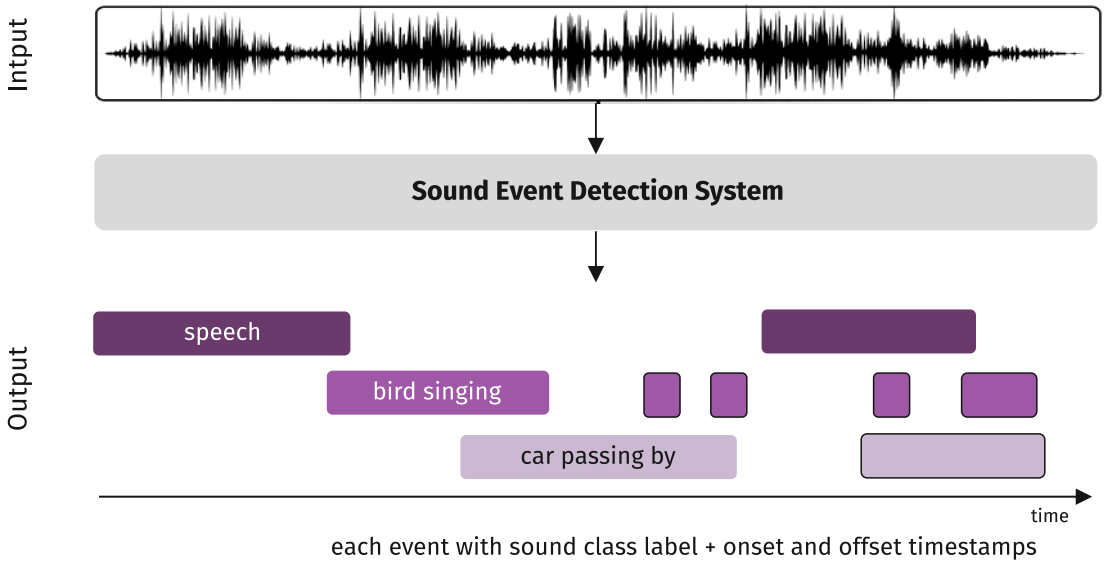
### ii. Ground-based or Below-ground

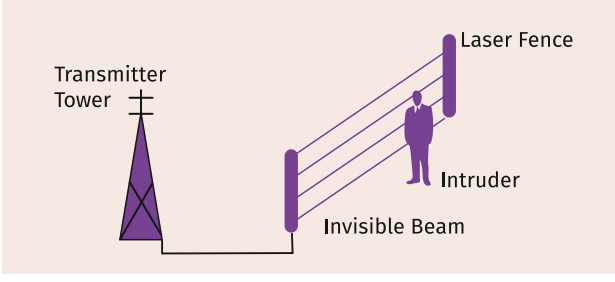
PIDS deployed below ground (again a DAS cable can be used or pressure sensitive cable or electromagnetic field). These do not require a physical barrier.

## d. Seismic Sensor Perimeter Protection system

Seismic sensor detects foot-borne intruders or vehicles based on the seismic signature they produce. An array of sensors placed in strategic locations detects and scan for vibrations continuously with time. These vibrations produced may be analyzed and filtered to cut-off the extra noise and to generate an effective pulse. The signal pulse generated is communicated to the control center for adequate action.



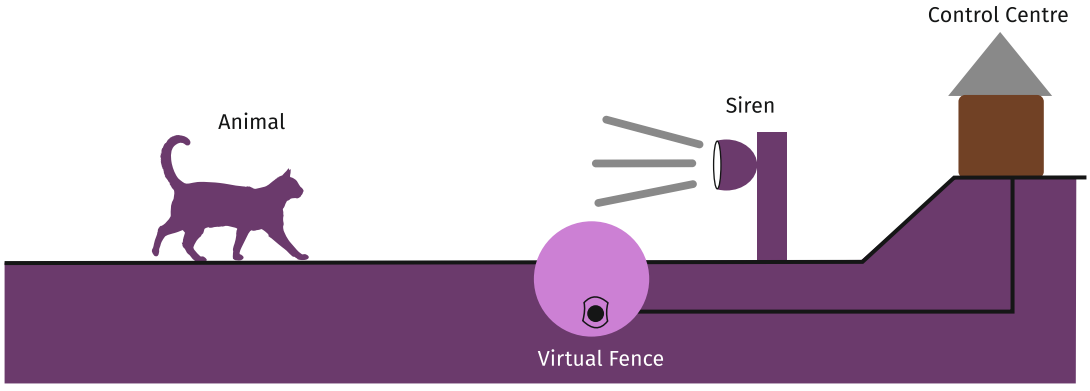

## e. Laser Sensor Perimeter Protection system

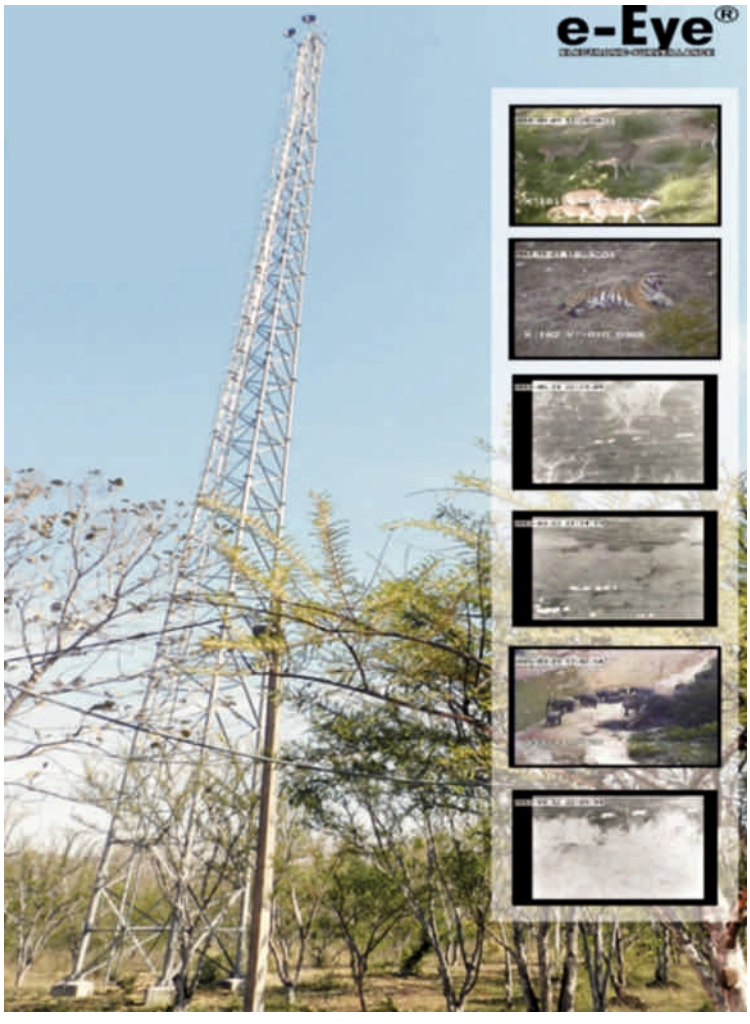
LASER refers to Light Amplification by Stimulated Emission of Radiation, where a beam of light is projected on a light-sensitive photo-voltaic sensor placed on another side of cross-sectional coverage area creating a virtual fence or barrier. When the flow of light has obstructed a signal hence generated actuates an alarm which can alert the department.

These type of virtual fence may use the IR based laser beams which are invisible by nature and can be used in the forest for intrusion as well as extrusion detection.

### f. Ultra-sonic sensor
### Perimeter Protection system

This type of technology uses the ultra-sonic sensors, which creates an ultra-sonic virtual field of vibrations ahead of the area to be protected. Any excursion or intrusion that obstructs the vibration beam which in turn actuates the alarm can be accordingly used either as a signal or an animal deterrent alarm that play the sound to stop the animal from crossing the desired path.




## 3.3. ELECTRONIC SURVEILLANCE SYSTEM

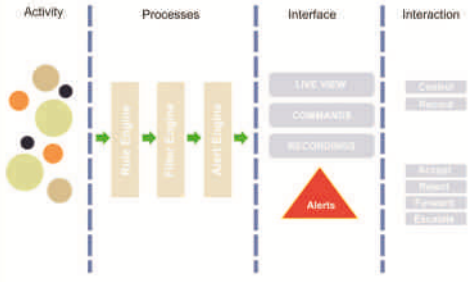
Electronic surveillance or e-Eye technology involves the deployment of thermal cameras on specially built high towers overlooking forest canopy and open habitats. The camera is a 24 7 monitoring tool capturing images/videos of all wildlife and human activities. The information is carried by live transmission to the base station and is available through the internet for the managers at state headquarters.

The e-Eye technology helps in rapid response to deal with any illegal activity and also helps in discouraging the occurrence of such activities. Additionally, it also helps in monitoring animal movement and population estimation in open habitat

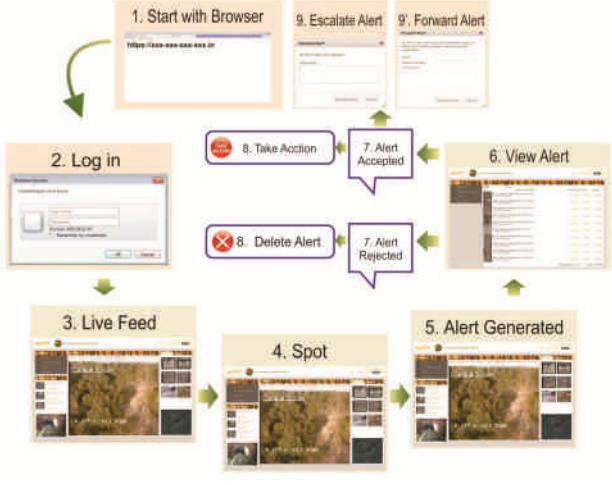
## e-Eye®- Recording Flow


## e-Eye®- Alert Action Cycle


## e-Eye®-Flow Diagram

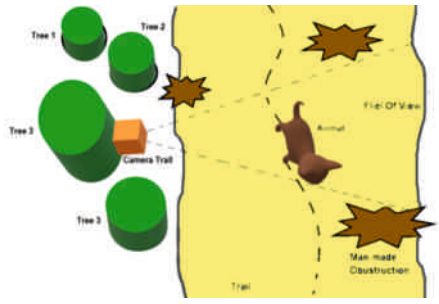



## e-Eye®- Alert Cycle



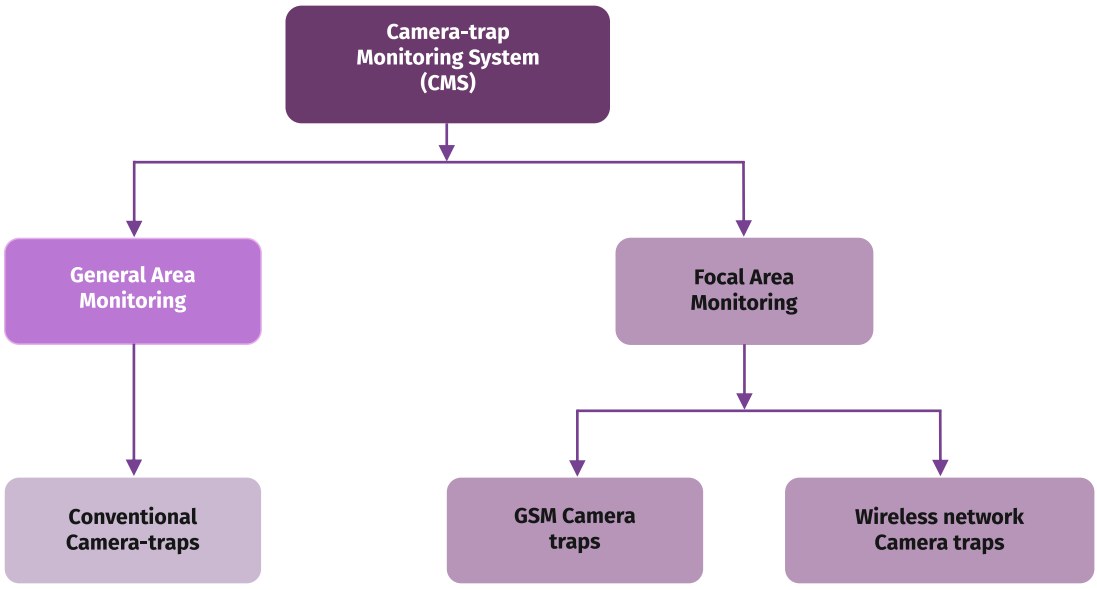
# 3.4. CAMERA TRAP MONITORING SYSTEM

**A camera trap is a remotely activated camera which is used as a trap to capture animal images. It is equipped with a motion sensor or an infrared sensor or uses a light beam as a trigger. Camera trapping is a method for capturing wild animals on film when researchers are not present. This technology has been used in ecological research for decades. In addition to applications in hunting and wildlife viewing, research applications include studies of nest ecology, detection of rare species, estimation of population size and species richness, as well as research on habitat use and occupation of human-built structures.**




**Types of camera Traps:**

| Type | Feature | Flash Type |
|---|---|---|
| Cuddyback X Change | 20 MP, 100 Feet, ¼ sec | Colour Night Images |
| Cuddyback Blackflash | 20 MP, 50 Feet, ¼ sec | IR based, Invisible light |
| Cuddyback DualFlash | 20 MP, 50-100 Feet, ¼ sec | Low glow & No Glow IR |
| Cuddyback Professional Color | 20 MP, 100 Feet, ¼ sec | Colour Night Images |
| Cuddylink Dual Flash G-5055 | 20 MP, 50-100 Feet, ¼ sec, wireless but non-cellular | No Glow IR and Low Glow |
| Cuddylink Double Barrel G 5086 | 20 MP, 100 Feet, ¼ sec, wireless but non-cellular | Double Barrel Flash Strobe, Colour Night Images |
| Cuddylink Power House IR G-5062 | 20 MP, ¼ sec, 100 Feet, Wireless but non-cellular | Low Glow IR |
| Reconyx HP2X Hyperfire | 3 MP standard aspect ratio, 150 feet, 0.2 sec | IR No-Glow |
| Reconyx XR6 Ultrafire | 3.5, 5 to 8 MP, 80 Feet, 1-sec Trigger | No Glow High Output Covert Infrared |
| Reconyx XP9 Ultrafire | 3.4, 5 and 8 MP, 80 Feet, 1sec Trigger | GEN2 Covert Infrared |
| Reconyx WP9 Ultrafire | 3.4, 5 and 8 MP, 60 Feet, 1sec | White Flash Colour LED Illumination |
| Reconyx PC900C Hyperfire Cellular | 3.1 MP, 60 Feet, 1/5th sec, wireless connectivity and cellular alerts, Deft Deterrence Passcode protection | No-Glow High Output Covert IR |




## a. General Area Monitoring

In this type of monitoring the camera traps are usually deployed over the regular patrolling area where suspected animal movement is maximum; it generally captures diurnal as well as nocturnal activities using white and black flash (IR based) cameras. The data hence is continuously stored is solid drive, which can be accessed weekly or monthly manually by the researchers or forest guards. The data is not immediate for extraction, hence, its utilization is limited to post-processing only.

## b. Focal Area Monitoring

This is a specialized monitoring method in which GSM or Wireless network-based camera traps are used and where the requirement of data is immediate in nature. The data captured by the camera is immediately transmitted to the near-by control center using Global System for Mobile (GSM) network or wireless radio frequency depending upon the landscape as well as the availability of network signals.

Conventional WhiteFlash camera trap

Wireless Black Flash (IR) Flash camera trap

# 3.5. TELEMETRY TRACKING SYSTEM

**Telemetry is the process of transmitting instrument data through the atmosphere. The arrangement consists of a radio collar and radio receiver antenna (tracker). Wildlife radio-telemetry tracking involves monitoring the signals from the radio collar, which is attached to the animal, to monitor its movement and activities. This technology is relatively old, but it is being used in India since the 1980s.**

**Figure:** Animal Collar with Transmitting device and Signal Receiver

## a. VHF tracking telemetry

This is the conventional telemetry method which typically requires a user to track the signals from the collar using an Antenna Tracker which is a Hand-held Radio device with a speaker to indicate the proximity of the animal.

To identify the location of the collared animal, the triangulation technique is used, which involves taking a compass reading from two different locations to determine the third target triangle point.

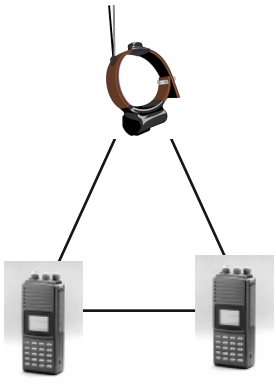


**Figure:** Triangulation Method

**Figure:** Tracking Antenna and Radio Receiver

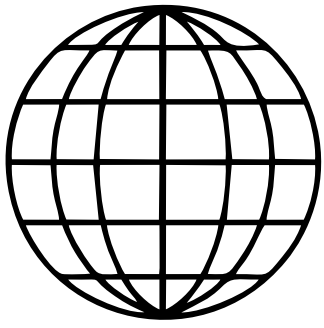
## b. GPS tracking telemetry

GPS tracking telemetry typically involves attaching a collar with a GPS device in it, to an animal to track the animal's location. GPS technology involves a GPS receiver that accepts signals from several GPS satellites that orbit the earth. The GPS collar/receiver stores the time and location data on the device which can be retrieved by:

i. Accessing the collar to retrieve GPS data by recapturing the animal,

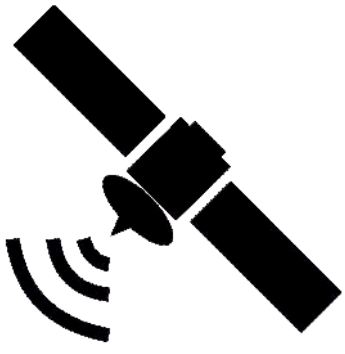
ii. Downloading GPS data from the collar to a wireless receiver device,

iii. Relaying the GPS data to the Satellite system.



## c. Satellite (UHF) tracking telemetry

Satellite telemetry is used extensively for tracking animals. This technology provides the ease of data access through portals that retrieve data from satellites. The data stored on the collar is transmitted to the satellite and stored in the database, this data is relayed to the user who can log in and downloads the GPS data and tracks the animal's movement over time. Due to its range and accessibility, this telemetry technology is best used only for far-ranging species.



## d. PTT Transmitter

Satellite tracking allows animal movement to be tracked around the globe. Platform terminal transmitters (PTT) allows tracking for large to the very small bodied animal. The transmitter sends electromagnetic signals to the Argos equipment on satellites. The Argos receivers estimate the distance to the transmitter to decide its location by Argos data collection relay system. Some PTT transmitters may require larger batteries, causing This data is received to be heavier than VHF transmitters. Satellite tracking is more accurate at locating animals that are more exposed to the sky, such as birds, local or migratory, or animals living in grasslands, open deserts, or savannas.

## e. Global System for Mobile Communications (GSM)

GPS location of tagged animal data can be transmitted via the GSM mobile/cell phone network, using SMS messages or internet protocols over a GPRS session.

## f. Radio-frequency identification (RFID)

RFID tags are one of the oldest uses tagging techniques for animals. It was originally meant for large ranches and rough terrain. An implantable RFID tag or transponder are also used for animal identification. The transponders are nowadays widely known as PIT (Passive Integrated Transponder) tags, passive RFID, or "chips" on animals. Presently, CCIA tags are used in Wisconsin and by United States farmers voluntarily. The USDA is currently developing its own system.

## g. Implants

Even though most VHF telemetry involves transmitters attached to animals externally via collars, harnesses, or other means; implantable transmitters are a preferred choice in some applications. Few species, such as otters, do not wear collars well and harnessing techniques are also ineffectual or harmful, so implants are used. Snakes, lizards, and fish are also commonly tagged using implants. Implants can also be used to measure body temperature, heart rate, or other physiological parameters.

# UN-MANNED AERIAL SYSTEM

3.6.

**Un-manned Vehicles are used for surveillance and monitoring purposes in defense and security sectors and are proving their use in forest and wildlife sectors as well. These machines are designed to carry out tasks which involve working on the land, water, and air.**

## a. Aerial Systems

Un-manned Aerial Systems has three components: UAV (Un-manned Aerial Vehicle) or commonly known as Drones; Radio (Remote) Control and Ground Control Station (GCS). Drones are flying vehicles which carry a payload in the form of a camera or a combination of multiple cameras and sensors. These are generally maneuvered by the remote control. However, completely autonomous systems are in use now in which the flight computer controls the whole mission from take-off to landing. These drones have been subdivided into categories that follow:

### i. Rotary-wing System

A rotary wing UAV is an aircraft which has rotary wings or rotor blades which rotate about a shaft or mast. These rotor blades rotate at high rpm to generate lift. Depending on the applications, these aircraft may have multiple rotors. Most common rotary-wing aircraft is the Quad-copter (shown in illustration). It is considered to be the most cost-effective drone system.

### ii. Fixed-wing System

A fixed-wing UAV is an aircraft which can fly using lift generated by the vehicle's forward motion and the airfoil shape of the wings. These aircraft has propellers to generate thrust force.

### iii. Hybrid System

Both the Fixed-wing system and Rotary-wing System have certain limitations, to build upon those limitations, Hybrid systems were developed, they are termed as VTOL system (Vertical Take-Off and Landing). VTOL drones have the capability to take-off and land like a Quad-copter and can scale large areas in one go just like a fixed-wing airplane. This platform boasts the stability of copters and endurance of planes.

## Applications of Drones


These UAVs have been successful in aiding us in numerous ways, in sectors like defense, emergency response, and disaster management, urban planning, healthcare, agriculture, and conservation practices. Considering the field of environment conservation, drones provide the ability to carry out surveillance and monitoring of protected areas and endangered animals. Advanced sensors and object tracking technologies help to tackle tough conditions like night flying, rough weather, following moving vehicles, etc.

| Description | Purpose | Cost |
|---|---|---|
| Fixed-wing UAV | 1. Surveillance,<br>2. monitoring and<br>3. mapping of large areas | 2.5-60 lakhs |
| Rotary-wing UAV | 1. Surveillance,<br>2. Monitoring,<br>3. Mapping of small areas and<br>4. Rapid Response for emergencies | 1.5-25 lakhs |
| Hybrid VTOL UAV | 1. Combines the possibilities of both Fixed-wing and Rotary-wing UAV.<br>2. Can provide long range and endurance without the need for open areas to launch. | 10-50 lakhs |
| Under-water ROV | 1. Collecting water samples, underwater surveys using cameras, lights, and sonars. | 10-40 lakhs |

# KNOWLEDGE MANAGEMENT SYSTEM

3.7.

**Knowledge management is key aspect of effective support system and feedback loops. Such unit is very critical for decision support and policy formulation, in addition to being guiding force on regular management. The knowledge management system requires the following hardware and software set up:**

### a. Geographical Information System

Geographic Information System (GIS) is a framework for gathering, managing, and analyzing a spatial database. GIS tools allow us to prepare accurate maps of any location and another spatial database that can be used multiple times. A specialized GIS station is mandatory in every range of the reserve for effective management.

### b. Ground Station

A ground station dedicated to the GIS work is essential in the tiger reserve. Accurately prepared maps with hard copy can be made available here for the forest guards. Any changes in the area or new addition of tracks can be added to the maps without outside help.

### c. Database

Maintaining the database properly is a crucial task. All data should be saved according to Division/Range/Beat and into compartment level. Co-ordinated files can be located easily without any difficulty. Regular track records of the forest guards can be transported to the system and can be monitored weekly.

### d. High-resolution Vegetation Mapping

Vegetation mapping is a priority when managing natural resources in protected areas. Very high-resolution satellite remote sensing data can be fundamental in providing accurate vegetation cartography at the species level. A detailed vegetation map can provide various information related to the status of the reserve and issues. Updated vegetation map is necessary to have in the forest offices.

### e. Change Detection

Change detection for GIS is a process that is used to measure how the attributes of a particular area have changed between two or more time frames. Change detection often involves comparing satellite imagery of the area taken at different times. This method has been widely used to assess shifting cultivation, deforestation, urban growth, the impact of natural calamities like tsunamis, earthquakes, and use/land cover changes, etc. In every five-year gap, a land use/cover map of the reserve need to be prepared for the knowledge of the changes during the time.

### f. Data Collection and Monitoring

Data collection using GPS and maintaining the data log is important for long term monitoring. This data can be imported in the spatial reference for analysis and digital visualization.

### g. Spatial Decision Support System

A Spatial Decision Support System (SDSS) is a communicating, computer-based system that can assist in decision making while solving a semi-structured spatial problem (Sprague and Carlson 1982). It is designed for assisting the spatial planner with guidance in making land use decisions. An SDSS is sometimes referred to as a policy support system and comprises a decision support system (DSS) and a geographic information system (GIS). This system also entails the use of a Database Management System (DBMS), which stores and handles the geographical data; a library of potential models that are useful to forecast the possible outcomes of decisions; and an interface to aid the user's interaction with the computer system to assist in the analysis of outcomes. To

maintain an SDSS system with good resolution spatial maps of the protected area is the first basic step. Once the database is implemented, the survey along with areas of high poaching/ conflict zone map can be developed and analyzed through the SDSS system. These maps can be used by the forest department at the time of decision making or preparing for management issues.

## h. Visualization Theatre System (VTS)

This is a significant part of the Knowledge Management and Science-Policy Interface activities. This is essentially a state-of-art technology facility which is increasingly being used for engaging stakeholders, people and policymakers wherein the hard science is translated in visual forms and spatially explicit, so that the current and future trend of the on-going and proposed development projects or conflict situation can be visualized and appropriate planning could be devised to integrate Science-Policy Interface. 2D/3D Visualization Theatre can be planned for sitting of 50 to 75 people and can include Video Walls and Video Conference facilities and other require support such as CCTV and Fire Alarm Systems. The facility can also be used to conduct regular meetings of senior-level officials and can be used to serve Science-Policy Reporting on a regular basis and need basis.

## i. Science policy interface

Science- policy interface is defined as social processes which encompass relations between scientists and other actors in the policy process, and which allow for exchanges, co-evolution, and joint construction of knowledge to enrich decision-making. Unless major steps are implemented in the field in the stipulated time, there will be no change to prevent poaching/conflict or other management problems. That is only possible if the decision makers and the stakeholders come along with the scientific results obtained by regular monitoring and non-biased data analysis.

## j. State Forest and Wildlife Report

A report in every two years of the interval is desirable to record the population estimation of the present species in reserve. Information's about flora and fauna with the mortal rate should be mentioned in the report. This will help the managers to keep a track on the gain and loss of the reserve.

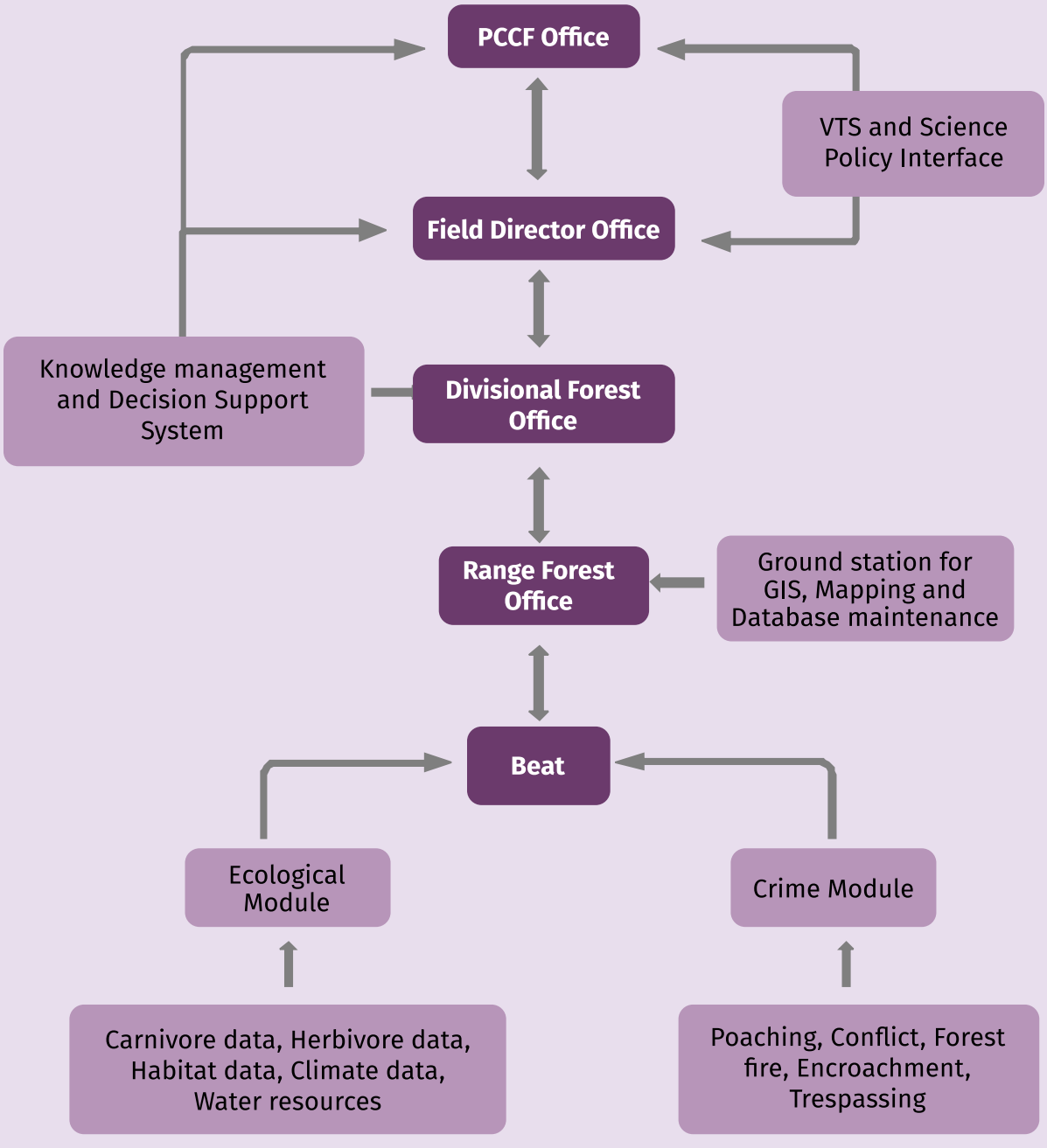
## k. Technology and Knowledge Management Cell

Major role of the Technology and Knowledge Management Cell (TKMC) would be integrating and institutionalization effective use of sophisticated technologies for research and management applications, and establishment of inter-operable database and decision support system including 2D/3D visualization tools towards regular management inputs and science-policy interface activities. The facility being visualized would be able to integrate all the on-going activities that involve technology and create a centralized database towards mainstreaming of technology support for all the management activities. While TKMC would procure hardware and software, and provide technical inputs in all the activities, the following would be major outputs of the TKMC:

i. Integrate and institutionalize all the technologies such as camera trapping and wireless communications, including telemetry and sensor technologies.

ii. Knowledge management of all the information generated by various research and monitoring activities and create a Decision Support System for the conservation of state's wildlife species and their habitats.

iii. Produce State of Wildlife Report every two years and State Wildlife Action Plan every five years or ten years depending on the requirement and resource allocation processes at the state level (or central level if resources are sourced from central allocations).


PCCF Office
VTS and Science Policy Interface
Field Director Office
Knowledge management and Decision Support System
Divisional Forest Office
Range Forest Office
Ground station for GIS, Mapping and Database maintenance
Beat
Ecological Module
Crime Module
Carnivore data, Herbivore data, Habitat data, Climate data, Water resources
Poaching, Conflict, Forest fire, Encroachment, Trespassing

# OPERATIONAL STRATEGIES

## 4.1. THEMATIC AREAS/ THEME PLANS

**Over the nations, the administration issues are unpredictable and require context based arrangements keeping in view the dynamics engaged in space and time. With many options available, deployment of technology considered under the following functional areas to make a ready connection and effective implementation.**

### a. Governance

In forest management, great parts of the exercises are field based and require solid correspondence systems. At present, such prerequisites are being satisfied by the remote correspondence sets (walkie-talkie); however; it is a traditional arrangement and does not give prompt reaction time. There would be a need to establish a strong network of information to keep activities in an around the protected area in control.

i. Wireless Communication Devices with patrolling teams both hand-held and mounted on Dash-board of patrolling vehicles.

ii. Camera Trap Monitoring on a regular basis will reveal the activities both in day time and night. Regular checking of images can prevent any unwanted changes to occur.

iii. Introduce technology for better governance in terms of establishing a strong spatial database and Decision Support System (DSS), which typically form the Knowledge Management Unit. This would involve the creation of RS&GIS based information at multiple scales so that the field information can be understood clearly, and management inputs can be provided accordingly. This also requires the

4.

establishment of a strong intelligence and communication network for the exchange of information both within and outside the protected area network.

## b. Control of Poaching

Poaching is a significant menace across the tiger range countries and in other parts of the world. Much of the current option helps only after the crime has taken place, and thus, there is an important requirement to prevent the crime much before it reaches the field. From a technology perspective, this requires:

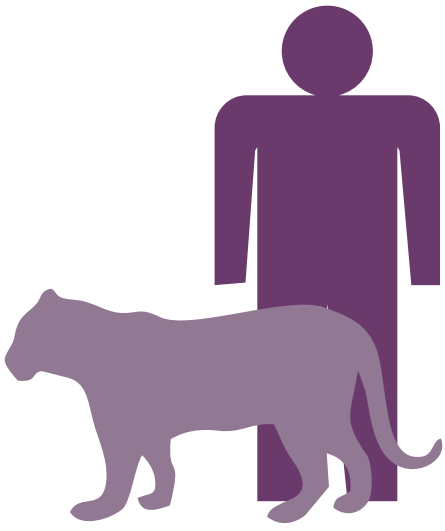
i. A strong intelligence network with proper communication devices and if need be, local area network may also have to be established with the help of available cellular networks providers, and

ii. Virtual Fencing around the sensitive areas. There are wireless sensors and communication networks that can detect human intrusion and communicate the information within seconds, thus enabling the field team to undertake quick response strategy. In order to be effective with this technology, a dedicated a workforce tuned to such technology should be created, and their capacity development should take place. Sensor networks can form the virtual fence, and these can provide an early warning even in animal crossing the roads.

iii. Focal Area Camera Trap Monitoring brings those areas into account which require 24x7 surveillance and monitoring, these camera traps are capable of transmitting images just after they are captured, images are mailed to the user, and necessary action can be taken without any delay.

iv. UAV technology clubbed with all these technologies form a robust system to keep an eye on every suspicious activity from the air. Including these in regular patrolling of target areas will prevent poaching activities.

v. Survey work at the beat level in every forest using a questionnaire with information of the levels of poaching in each beat could be helpful as it would be easier to identify and give emphasis to the target areas for heavy monitoring and surveillance with UAVs.



## c. Human-Wildlife Conflict mitigation

It is arguably the most dreaded threat to wildlife conservation across south Asia, and it is also the one that presents the danger of alleviating people from conservation support. It is stated that human-wildlife conflict will bring down the wildlife population than any other threats.  Similar to control of poaching;

I. The virtual fence could also be used to inform local people when wild animals cross the sensitive areas towards human habitations. In addition, some of the UAVs can be designed for monitoring and preventing the wild animals causing damage to habitation and crops. This should also be supported by a strong local communication network so that people receive the information in time for taking preventive actions.

ii. There are acoustic choices that can make discouragement for specific creatures; for instance, elephants are wary of bees and tiger calls. Records of such sounds, played through UAV close to elephant herd may elicit expected response. The conflict-prone areas in a forest can be identified at beat level with the help of a survey that will collect data from beat guards stating the level of human-wildlife conflict in all the beats. This would make it easier for the team to identify the conflict-prone areas and deploy UAVs accordingly for preventive actions.

iii. Shock collars can be used to deter problem animals, and it has been proven that these collars have the capacity to keep target animals away from designated areas. Harmless yet effective techniques are needed to ensure conflict resolution.

## d. Habitat Protection and Population Estimation

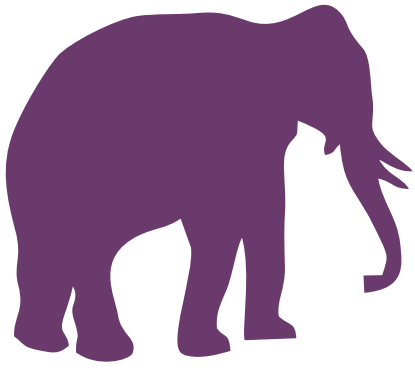
Habitat is fundamental to wildlife population management. While there has been enhanced focus on population estimation and monitoring, habitat conservation has not received due focus. Much of the areas in South Asia is under conversion for commercial activities and encroachments are being experienced. Because, forest areas are vast and rugged, and there is less manpower to the area being management, illegal activities are taking place. In developed countries, aerial surveillance using small planes, helicopters, and high-resolution satellite images are being used, but these are expensive for developing nations. Alternatively,

i. Use of Unmanned Aerial System or Drone can provide a better option and is cost effective. BioCarbon Engineering, a start - up based in the UK, has developed a technology to potentially plant trees with the help of drones. Initially, a Drone examines the landscape and builds up a 3-D guide of the territory. At that point, utilizing the information from this "brilliant guide," the group builds up a calculation for extraordinary planting design.

ii. A "firing drone" utilizes the calculation to complete the planting system. The drone flies around six feet over the ground, terminating developed seed units at a speed that will get them under the soil.

iii. GIS tools provide the capability to access and analyze any changes that undergo from time to time in the target areas to preserve and protect the habitat.

Aerial surveys are possible with mapping cameras and can be a cost-effective solution for wildlife population estimation and monitoring. Aerial missions carried out at periodic intervals, can be a very useful source of information for long-term monitoring, including dealing with climate change effects and fire management.



## e. Engagement of Local Communities

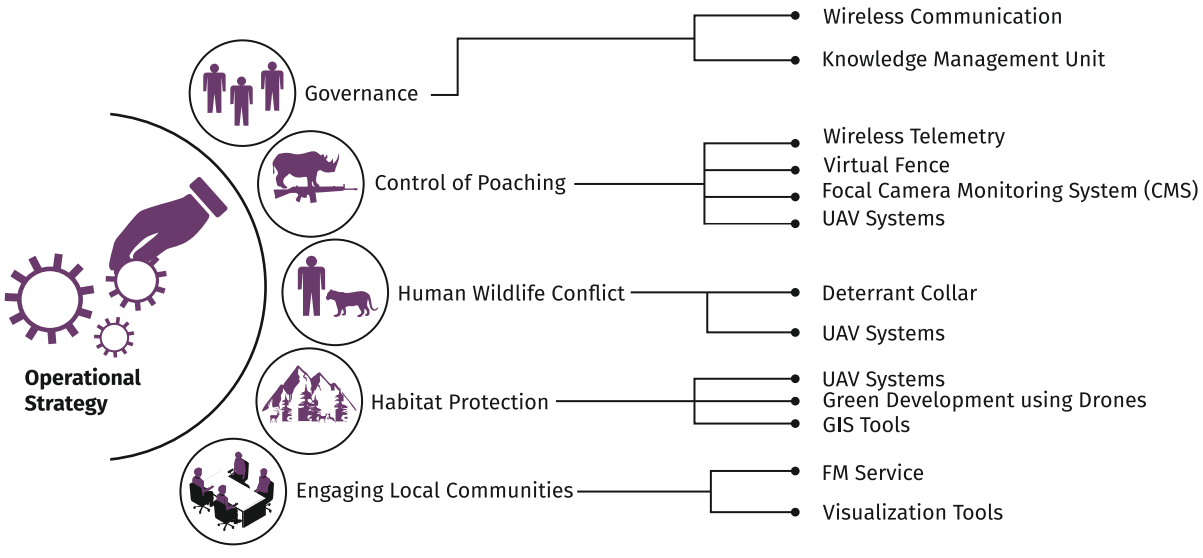
Although local communities are a critical part of wildlife conservation, their involvement is sporadic and is often project-based when funding is made available by the external agencies and central governments.

i. It is important to establish a communication network with the people and engage them through visual media or visualization tools so that conservation message can be taken to them effectively.

ii. FM service is an effective way of reaching the masses and spreading awareness.

iii. There is mobile visualization technology that is effective to take the information at the village level.

iv. In turn, one can expect greater involvement of the local people. It is also important to establish an informant network with proper communication strategy so that any new person in the vicinity of the protected areas may be brought to the knowledge of forest and wildlife administration. Awareness is an important feature that will connect people with park management. One can consider developing specialized Software Applications that may be taken to local communities for updated information sharing and engaging throughout the period.



## 4.2. RESEARCH AND DEVELOPMENT

### a. Shock Collars

These devices are special collars integrated a circuit that delivers electrical shocks to the animal and can be controlled with a hand-held radio device. Initially developed to train hunting dogs, these are now being used for wild animals like coyotes. With GPS technology, collars with GPS chips provide the capability to create a virtual fence or perimeter and prevents the animal from crossing the barrier.

Advanced shock collars have features like:

i. Vibration or tone alerts
ii. Geo-fencing options
iii Customizable for different animals
iv. Enhanced battery life up to 40 hours
v. Emergency Alert feature
vi. Radio range up to 15 km.

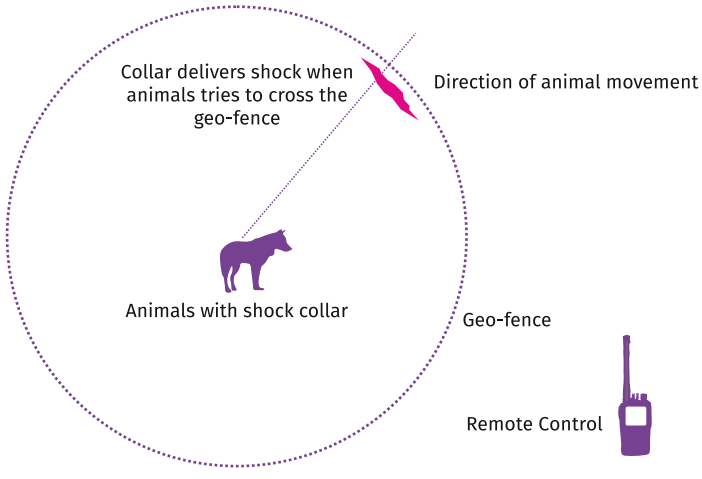



Figure: Graphical representation of shock collar technology

Some of the most reliable shock collar models and manufacturers are:

Garmin Pro 550 Plus

Garmin Alpha 100

Garmin Astro 430

### b. Darting Drone

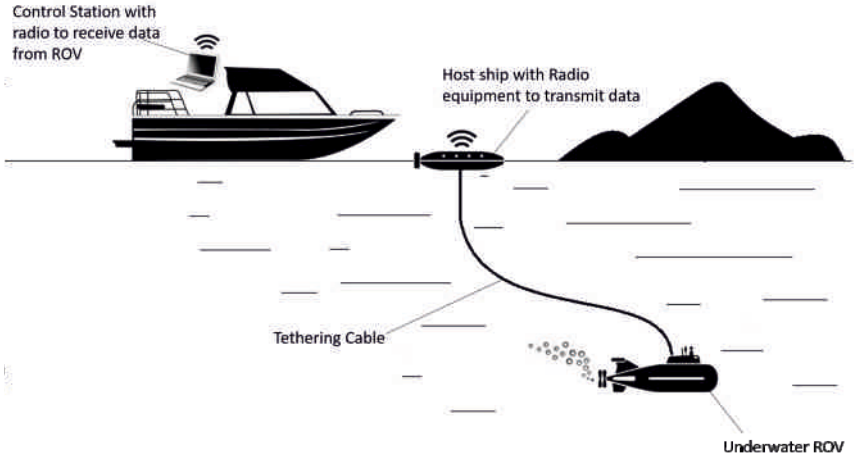
This is the advance drone mounted with a dart gun used for tranquilizing the animal remotely. This technology enables the crew to operate a UAV fitted with a dart gun together to tranquilize from a safe distance and the air overlooking the canopy cover.

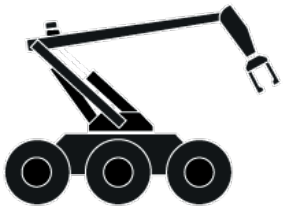
Attaching a lightweight air gun to the Super Drone makes this machine remarkably nimble yet a fast flying performer. It can reach a top airspeed of 67km/h, and the pilot can follow the target during flight using his special live-view goggles. With the use of clean LiPo battery-driven motors, the Dart Gun provides silent yet long-endurance flying times of up to 20 minutes per operation.

Unique laser-guided vision aligned with a built-in laser beam, allows the pilot to view the target through the on-board HD camera during flight. Pointing the laser beam on the target, the dart will find the exact spot indicated by the laser beam. The pilot's goggles are linked to the movement of the Dart Gun. When the pilot moves his head up and down, the gimbal-mounted Dart Gun will follow suit and aim the gun accordingly.

## c. Underwater Systems

Underwater vehicle system consists of a submersible drone, a tethering cable, and a host ship or floating platform. Remotely Operated Underwater Vehicles are called ROVs, they are equipped with water samplers, cameras, and flashlights, sonars, instruments to measure water temperature, water density and turbidity, etc.



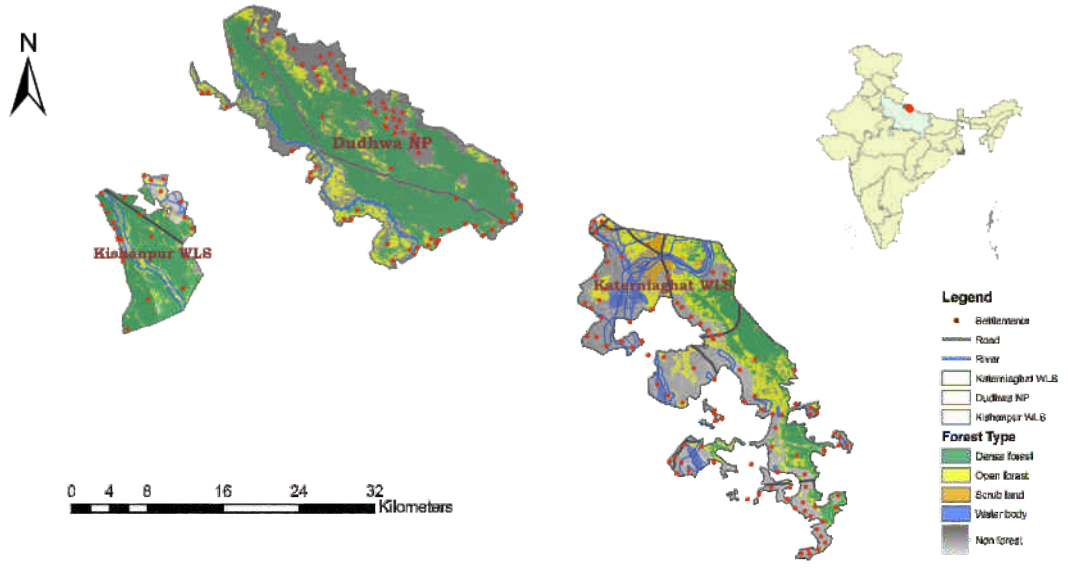



## d. Land-rover systems

Similar to drones, these Unmanned Ground Vehicles are robots that are mounted with cameras and sensors to monitor areas of interest on the ground. They are custom made devices that are built to transmit data from the camera to the Remote-Control Station, where it can be analyzed in real-time to decide the further course of action.

# A. DUDHWA TIGER RESERVE

**Dudhwa Tiger Reserve comprises the Dudhwa National Park, Kishanpur Wildlife Sanctuary and Katerniaghat WLS, covers an area of 1284.3 km². It is situated in Lakhimpur-Kheri and Behraich district (28°31?N 80°41?E) and was declared as Tiger Reserve in 1987, although the Dudhwa NP was established in 1977. This TR has a rich faunal diversity. Various elusive animals found in this area include Tiger, Leopard, Elephant, One Horned Rhino, etc. The NP and Kishanpur WLS have also been declared as third most important grassland in India because of the conservation priority of various endangered and threatened species like One-horned rhinoceros, Swamp deer, Hispid hare, Bengal florican, Swamp francolin, etc. This park and reserve area play a major role in maintaining the climatic scenario and water level in this region and also provide a vital role in agricultural and other livelihood practices.**




### Management Challenges:

Although there are not many human settlements inside this area, the peripheral villages have a major influence on the reserve. The villagers are very much dependent on the forest resources for their daily livelihood. Major conservation challenges include,

- Biotic pressure for resource (fuelwood, fodder, thatching grass) utilization.
- Livestock pressure leads to forest and soil degradation.
- Poaching and man-animal conflict.
- Illegal wildlife product trade and transboundary management issues.
- Fragmented corridor within adjacent PAs and encroachment.

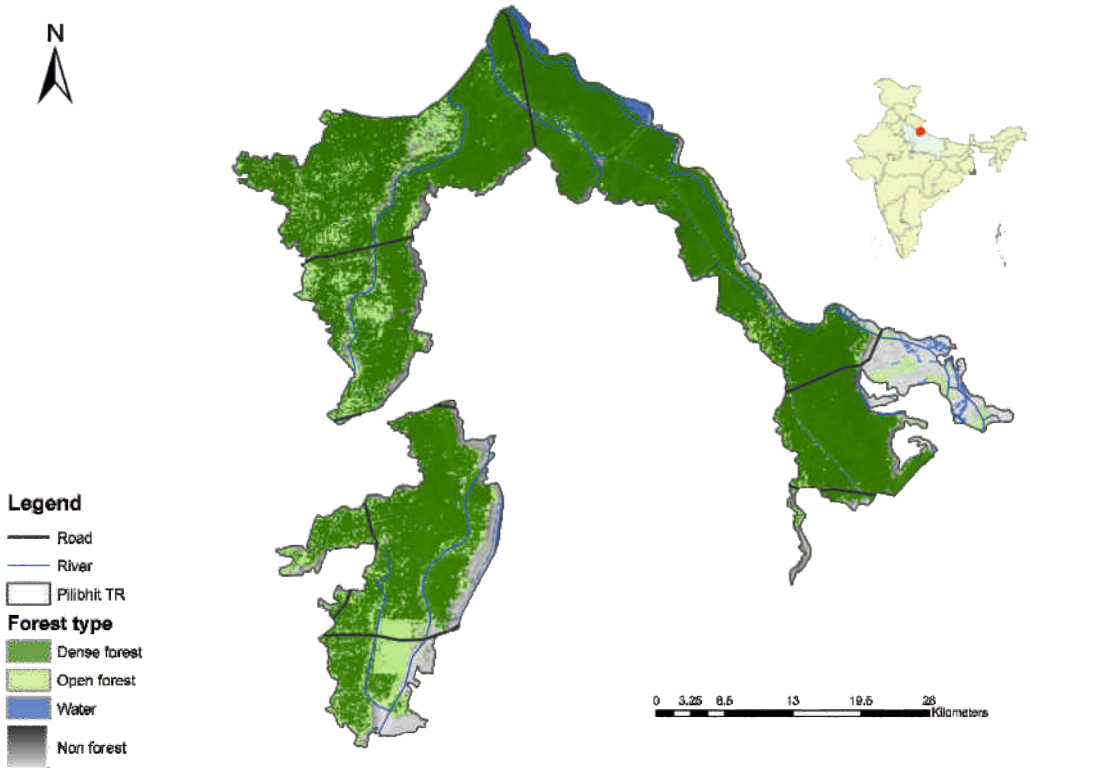
### Technological Solutions:

To mitigate the challenges in conservation practices following technologies can be implemented,

- Camera Trap technology for monitoring movement of animals and villagers
- UAVs to counter poaching and transboundary management issues
- Electronic Surveillance Towers

# B. PILIBHIT TIGER RESERVE

**Pilibhit Tiger Reserve is situated in Pilibhit and Lakhimpur Kheri district covering an area of 730.20 km². This area was declared as Tiger Reserve in 2008. The reserve is highly diversified with various flora and fauna and also an important and productive Terai-Duar Savanna and grasslands. Various animals that found in this reserve include Tiger, leopard, Elephant, Swamp deer, Hispid hare, Bengal florican, etc.**




## Management Challenges:

Being one of the highly productive zones in this region, this reserve faces many biotic pressures from surrounding villages. People use forest resources for their livelihood. And also, being situated in Indo-Nepal border, transboundary conservation challenge is a major issue here. Various conservation issues include,

- Illegal wildlife product trade and transboundary management issues.
- Biotic pressure for resource (fuelwood, fodder, thatching grass) utilization.
- Livestock pressure
- Poaching

## Technological Solutions:

To mitigate the challenges in conservation practices following technologies can be implemented,

- UAV application for monitoring and anti-poaching
- PIDS (Perimeter Intrusion Detection System) for illegal movements.

# C. AMANGARH TIGER RESERVE

**This Tiger Reserve is situated in Bijnor district of Uttar Pradesh and was declared as Tiger Reserve in 2012. This reserve is comparatively small with an area of 80 km². The major fauna found here include Tiger, Leopard, Elephant, various small mammals, and birds.**

### Management Challenges:

Major management issues here include,

- Livestock grazing
- Encroachment and forest land destruction by surrounding villagers
- Man-animal conflict

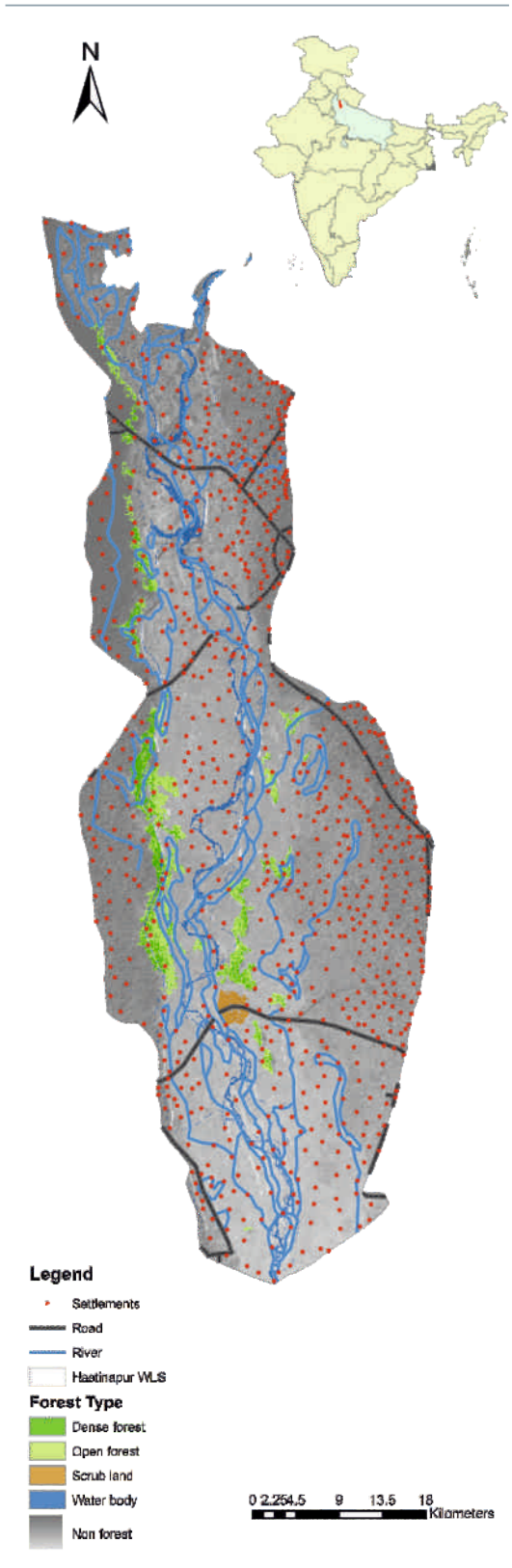
### Technological Solutions:

To mitigate the challenges in conservation practices following technologies can be implemented,

- PIDS (Perimeter Intrusion Detection System) for illegal movements.
- Camera Trap

# A. HASTINAPUR WLS

**Hastinapur WLS is situated in Gangetic plains of Uttar Pradesh across Muzzafar Nagar, Meerut, Ghaziabad, Bijnor and JP Nagar districts covering an area of 2073 km². It was established in 1986. This area is situated on the western Bank of the Ganga river and forms one of the most important Swamps and Marshland in Terai-arc landscape. This area comprises various small wetlands which support many unique birds and other wetland species. Major fauna species found in this sanctuary include Swamp deer, Smooth-coated otter, Gangetic river dolphin, Gharial, etc.**




## Management Challenges:

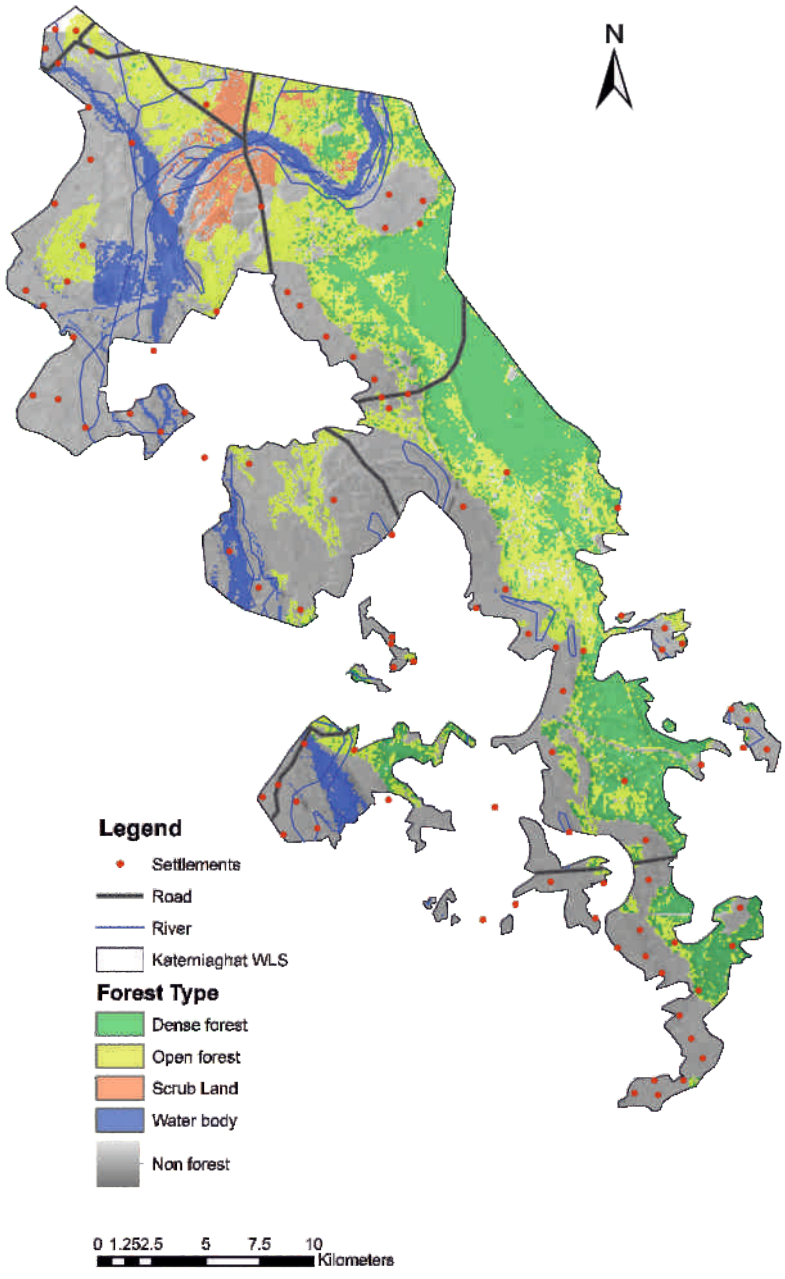
Being highly productive and high-water availability of this region, this sanctuary suffers various biotic pressure from local people and interaction with wild animals also increases man-animal conflicts. Major challenges faced by this sanctuary include,

- Ncroachment of local villagers
- No proper monitoring of wetland health
- Lack of training within staffs
- Man-animal conflict
- Electrocution of wild animals by live electric wire around the croplands.

## Technological Solutions:

PIDS (Perimeter Intrusion Detection System) for illegal movements.

# B. KATERNIAGHAT WLS




**The Katerniaghat WLS, located on the Indo-Nepal border of Terai-arc region, covers an area of 400.09 km² and was designated as Wildlife Sanctuary back in 1976. This sanctuary supports a highly diversified mixed vegetation type such as Sal, miscellaneous forests and grasslands and an immense diversity of floral species. This sanctuary houses species like Tiger, Rhino, various species of deer, blackbuck, Nilgai, Gharial, Gangetic river dolphin, Hispid hare, birds like; Bengal florican, White-backed and Long-billed vultures, etc.**

## Management Challenges:

This sanctuary is very much affected by the encroachment of local people. There are nearly 100 villages who are dependent on the forest resources and mostly fuelwood and grazing. Major management challenges include,

- Grassland management.
- Fragmented corridor connection.
- Vehicular pressure and disturbances.
- Management of forest fire.
- Poaching, mostly towards Nepal side.
- High biotic pressure.
- Road and railway line within the park

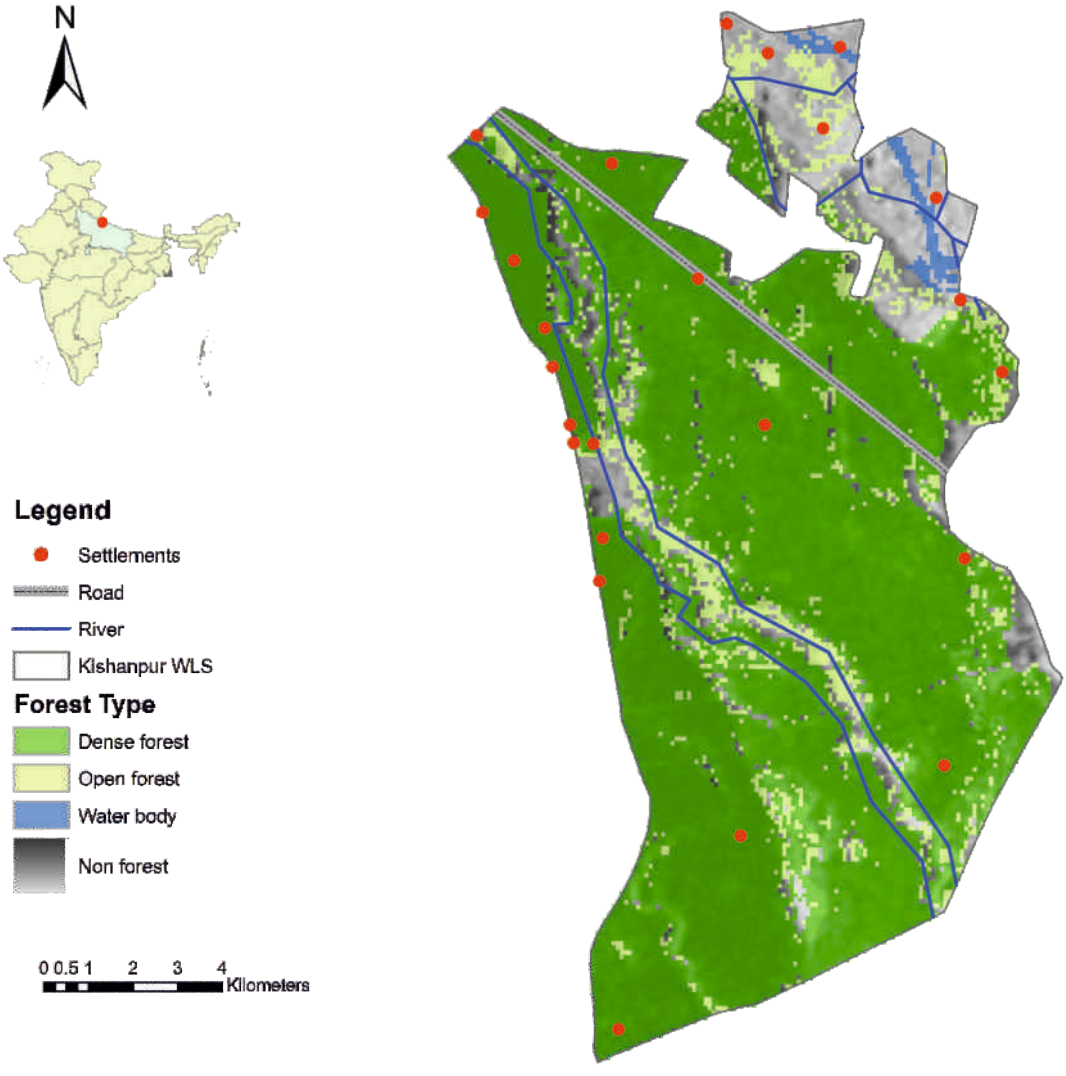
## Technological Solutions:

To mitigate the challenges in conservation practices following technologies can be implemented,

- UAV application for monitoring and anti-poaching
- PIDS (Perimeter Intrusion Detection System) for illegal movements.

# C. KISHANPUR WLS

**Kishanpur WLS is a part of Dudhwa Tiger Reserve located in Lakhimpur-Kheri, Shahjahanpur districts of Uttar Pradesh over 227 km² area. It was established in 1972 and is home to various animals like Tiger, leopard, Swamp deer, Bengal florican, lesser florican, White-rumped vulture, etc. Apart from fauna, floral diversity is also high in this region with a diverse species range.**




## Management Challenges:

Major management challenges faced by this sanctuary include,

- Fragmented corridor connectivity.
- Poaching
- High biotic pressure
- Road and railway line within the park

## Technological Solutions:

- UAV Application
- Camera Trap

# D. PATNA WLS (BIRD SANCTUARY)


**With an area of 1.09 km², Patna WLS (Bird sanctuary) is located in Etah district of eastern Uttar Pradesh. This area is mainly a rainfed lake, but also receives some waters from surrounding nallahs and drains. This sanctuary is a water refuge for various wetland bird species and waterfowls. Major bird species found include Grey francolin, Rain quail, Oriental white-backed vulture, Greater spotted eagle, Lesser flamingo, Oriental white ibis, Black-bellied tern, etc. The submerged vegetation of this lake comprises species like Hydrilla sp., Vallisneria sp., Potamogeton sp., etc. This jheel also supports a large number of migratory birds.**

## Management Challenges:

Management challenges faced by this area include,

- Wrong management practices lead to reduce of several species.
- Lack of regulation of tourist activity.
- Total ban on grazing leads to thick ground vegetation.
- Spreading of Ipomea sp. causes choke of water body making area unfavorable for diving ducks.

## Technological Solutions:

- Use of GIS and knowledge management tools and techniques for proper management of the park

# E. SUR SAROVAR WLS

**This wetland was declared as a bird sanctuary in 1991. The sanctuary covers a total area of 4.03 km² and is located in Agra district of UP. The lake is originally owned by Irrigation department mainly to meet the need of irrigation water of local farmers. Along with various resident and migratory bird species, this sanctuary supports a large number of mammals, such as Hyena, Spotted deer, Porcupine, Indian pangolin, Jackal, Purple heron, Indian shag, etc.**


## Management Challenges:

Major management Challenges include,

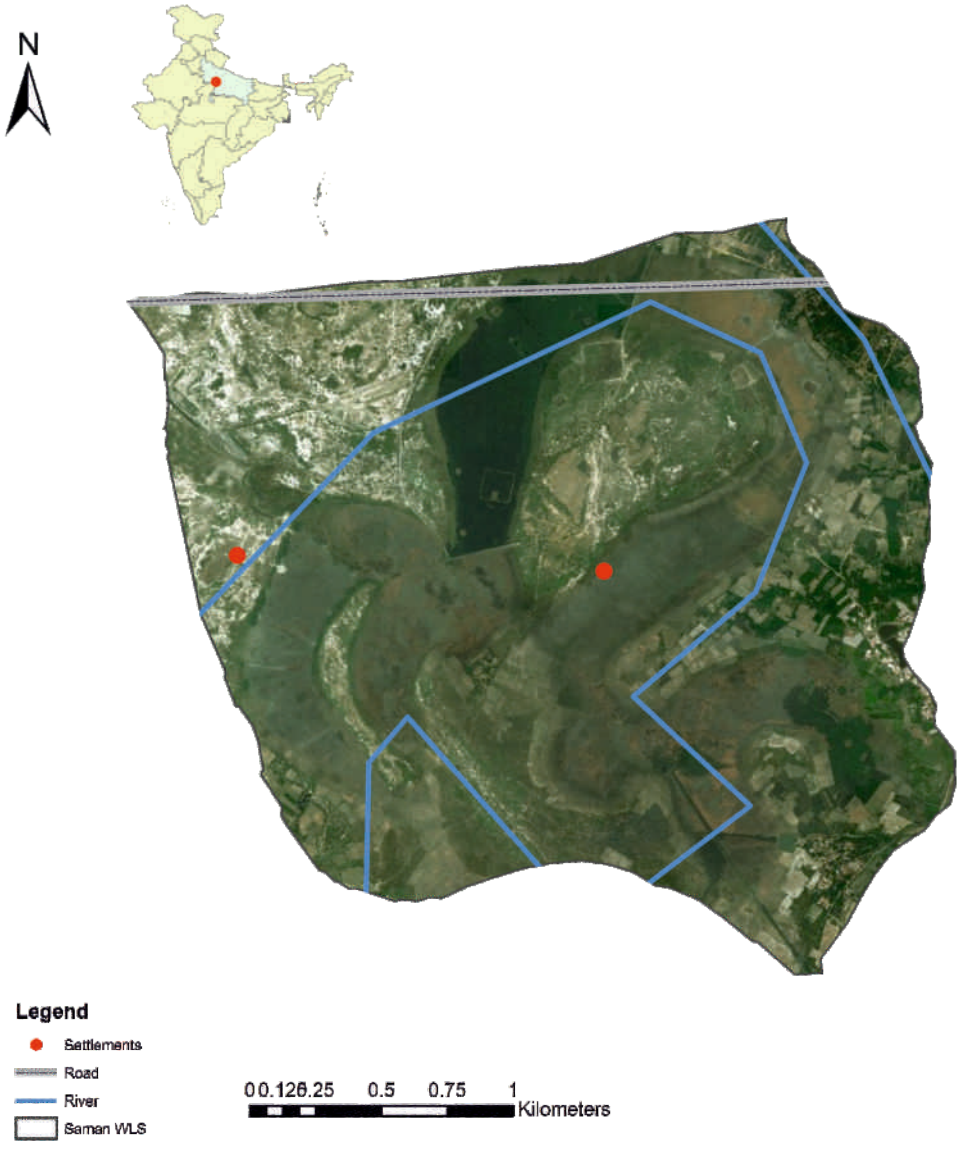
- Grazing pressure
- Siltation of lake.
- Infestation of water hyacinth.

## Technological Solutions:

- PIDS (Perimeter Intrusion Detection System) for illegal movements.

# F. SAMAN WLS (BIRD SANCTUARY)

**Saman bird sanctuary is situated in Minapuri district of Uttar Pradesh covering an area of 5.26 km² and was declared as a bird sanctuary in 1990. It is a natural rainfed lake that usually dries up in summer. Major bird species found in this sanctuary are Black partridge, Rain quail, Bar-headed goose, Pintail, Eurasian wigeon, etc.**




## Management Challenges:

This area faces management challenges due to biotic pressure from surrounding villages. Major challenges include,

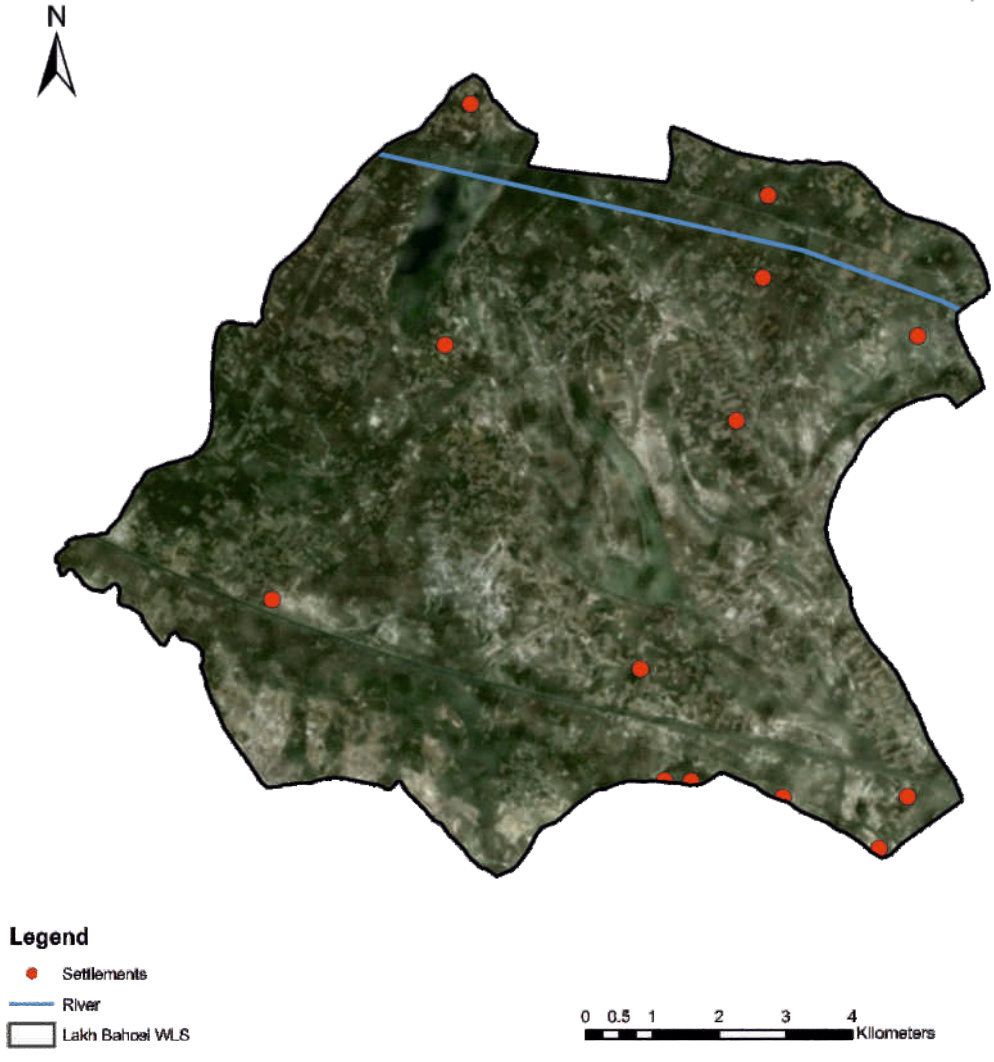
- Encroachment of forest land and livestock grazing.
- Illegal hunting and bird trapping.
- Weed infestation.

## Technological Solutions:

- UAV Application for surveillance and anti-poaching activity
- PIDS System such as Electric wires for preventing illegal intrusion
- GIS forest Watch

# G. LAKH BAHOSI WLS

**Lakh Bahosi WLS is situated in Kannauj district of UP over an area of 80.24 km². This area has been designated as Important Bird Area (IBA) due to the presence of IUCN red-listed species such as Sarus crane; Greater spotted eagle. Other species include Storks, Herons, Pochards, Egrets, Cormorants, etc.**




## Management Challenges:

As this area is situated in the vicinity to villages and croplands, great biotic pressure is faced by this sanctuary like,

- Encroachment of forest land.
- Illegal hunting and bird trapping.
- Weed infestation.

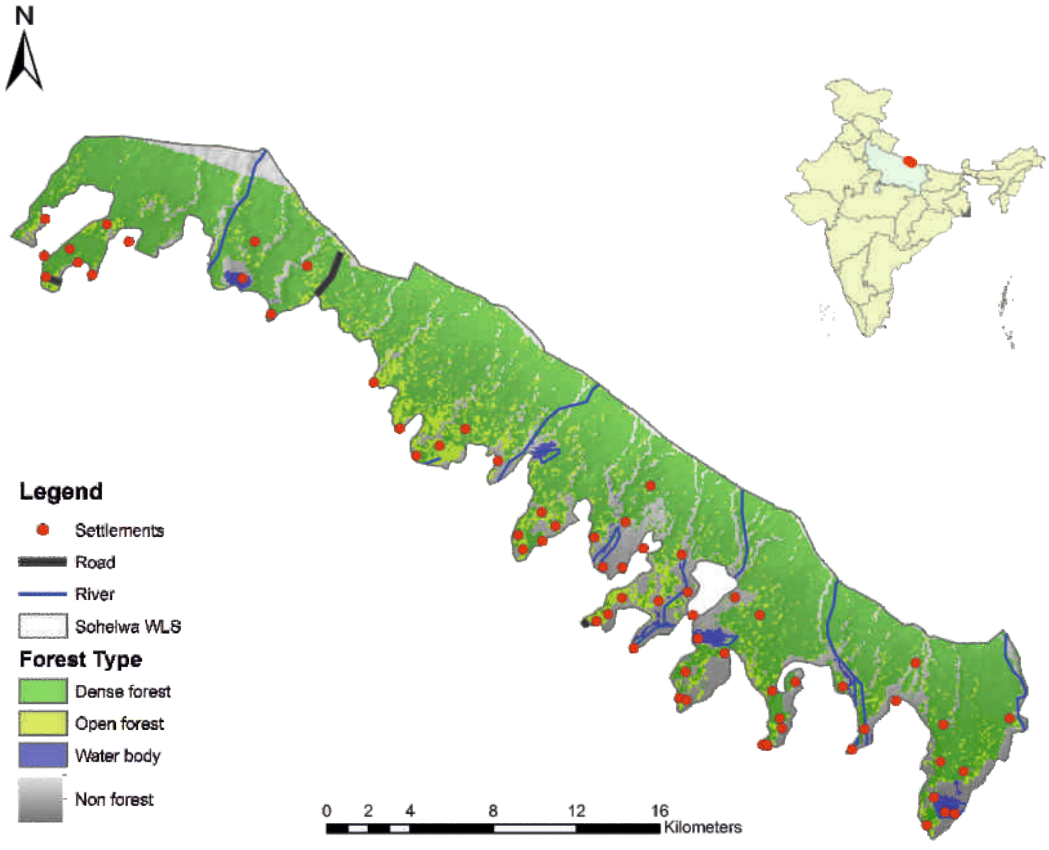
## Technological Solutions

To mitigated the conservation challenges following technologies can be implemented,

- UAV Application for monitoring and surveillance.
- PID System such as electric wires
- GIS Forest watch

# H. SOHELWA WLS

**Sohelwa wildlife sanctuary is located in Shravasti and Balrampur district on the Indo-Nepal border forming a parallel strip-like structure with Nepal. The total area of this sanctuary is 452.4 km² and was established in 1988. It is situated in the Bhabar region of Nepal Himalayas and is dominated by very good Sal forest. It houses various mega fauna species such as Tiger, Leopard, One-horned rhino, Hyena, Jackal, Fox, Wolf, Bear, Deer, Sambar, Chital, Hog deer, Swamp deer, Hispid hare, Bengal florican, Swamp francolin, Finn's baya, etc.**




## Management Challenges:

As located in Indo-Nepal border, this sanctuary faces many conservation and management challenges. Various problems include,

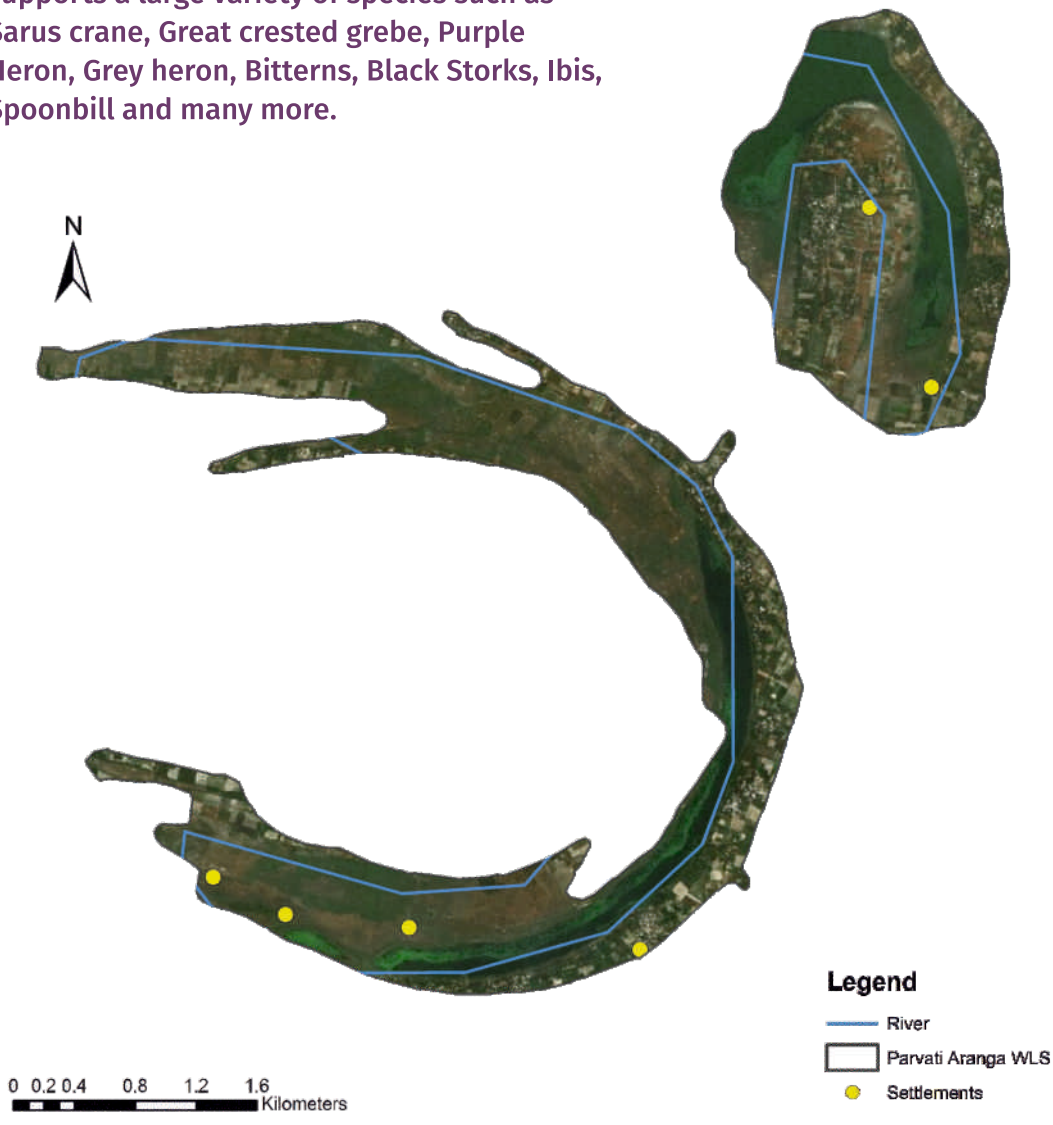
- Poaching
- Illegal trade of wildlife products and transboundary management issue.
- Biotic pressure.
- Tourism management and boosting.

## Technological Solutions:

- To mitigated the conservation challenges following technologies can be implemented,
- UAV Application for surveillance and antipoaching.
- Camera Traps

# I. PARVATI ARANGA WLS

**This sanctuary is formed by two connected water bodies Parvati and Aranga comprising an area of 10.84 km² is located in Gonda district of UP and was created in 1990. It is situated in the Gangetic flood plain and supports a large variety of species such as Sarus crane, Great crested grebe, Purple Heron, Grey heron, Bitterns, Black Storks, Ibis, Spoonbill and many more.**




## Management Challenges:

Major management challenges faced by this sanctuary are,

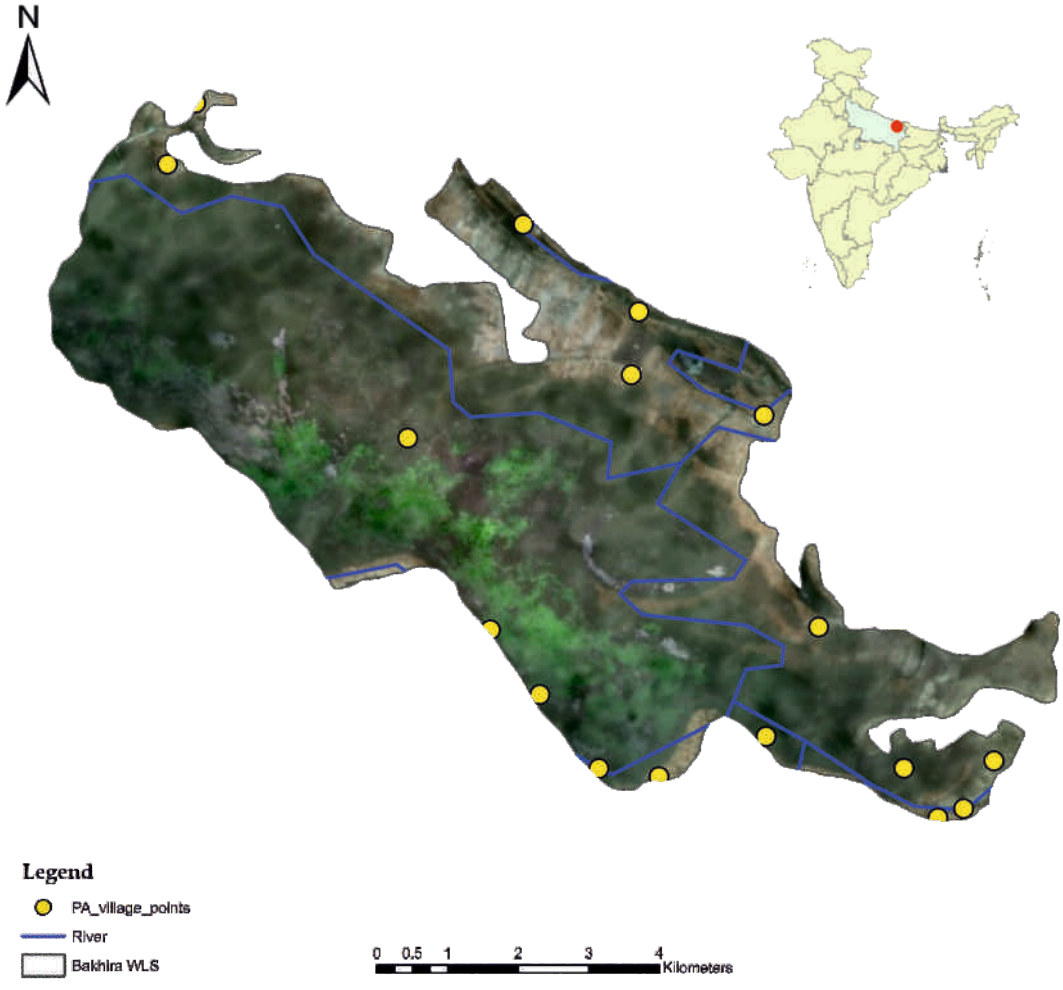
- Agricultural fields are on vicinity result in high biotic pressure.
- Illegal fishing and bird hunting.

## Technological Solutions:

- Technological solutions to mitigate the management challenges are,
- UAV surveillance of water bodies.
- E-eye Towers for day/night monitoring.

# J. BAKHIRA WLS

**Bakhira WLS is a mainly a bird sanctuary, established in 1980 in Sant Kabir Nagar district of Uttar Pradesh covering an area of 29km². The core area is mainly stretch of the water body. This sanctuary provides wintering ground to many migratory birds traveling from Siberia, Europe, Tibet, China. The major bird species found here are Great crested grebe, Purple heron, Grey heron, Bitterns, Storks, Ibis, Waterfowls, etc.**




## Management Challenges:

Major management challenges faced by this sanctuary are,

- Encroachment and grazing pressure.
- Illegal fishing and bird hunting.
- Use of lake water by villagers.

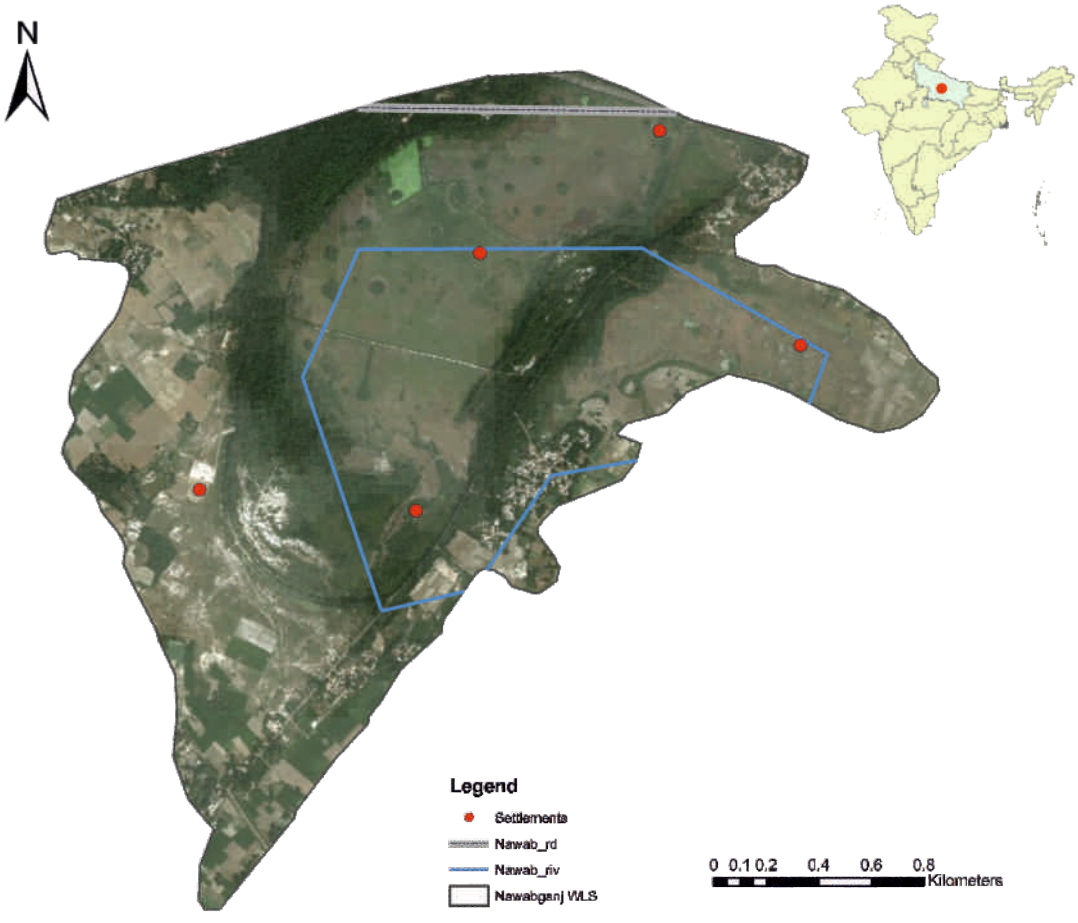
## Technological Solutions:

Technological solutions that can be implemented to mitigate the management challenges are,

- PIDS (Perimeter Intrusion Detection System) for illegal movements.
- UAV application for monitoring.

# K. NAWABGANJ WLS

**Nawabganj WLS is located in Unnao district of Uttar Pradesh over a stretch of 2.25 km². This sanctuary is situated on Gangetic plain biogeographic zone and comprises a permanent shallow freshwater lake with marches surrounded by a riparian forest. It was created in 1984. This lake supports various species of aquatic flora and fauna and also a very important habitat for resident and migratory bird species. Major species of birds include Greylag goose, Pintail, Cotton teal, Red-crested pochard, Gadwall, Shoveller, Coot, Sarus crane, Painted stork, Peafowl, Purple moorhen, Vulture, etc. This area has also been listed as an IBA.**




## Management Challenges:

Major conservation and management issues here include,

- Illegal trade of birds and turtles.
- Over exploitation of aquatic plant and livestock grazing.
- Weed infestation of the lake
- Polluted runoffs often reach the lake from surrounding industries and areas.

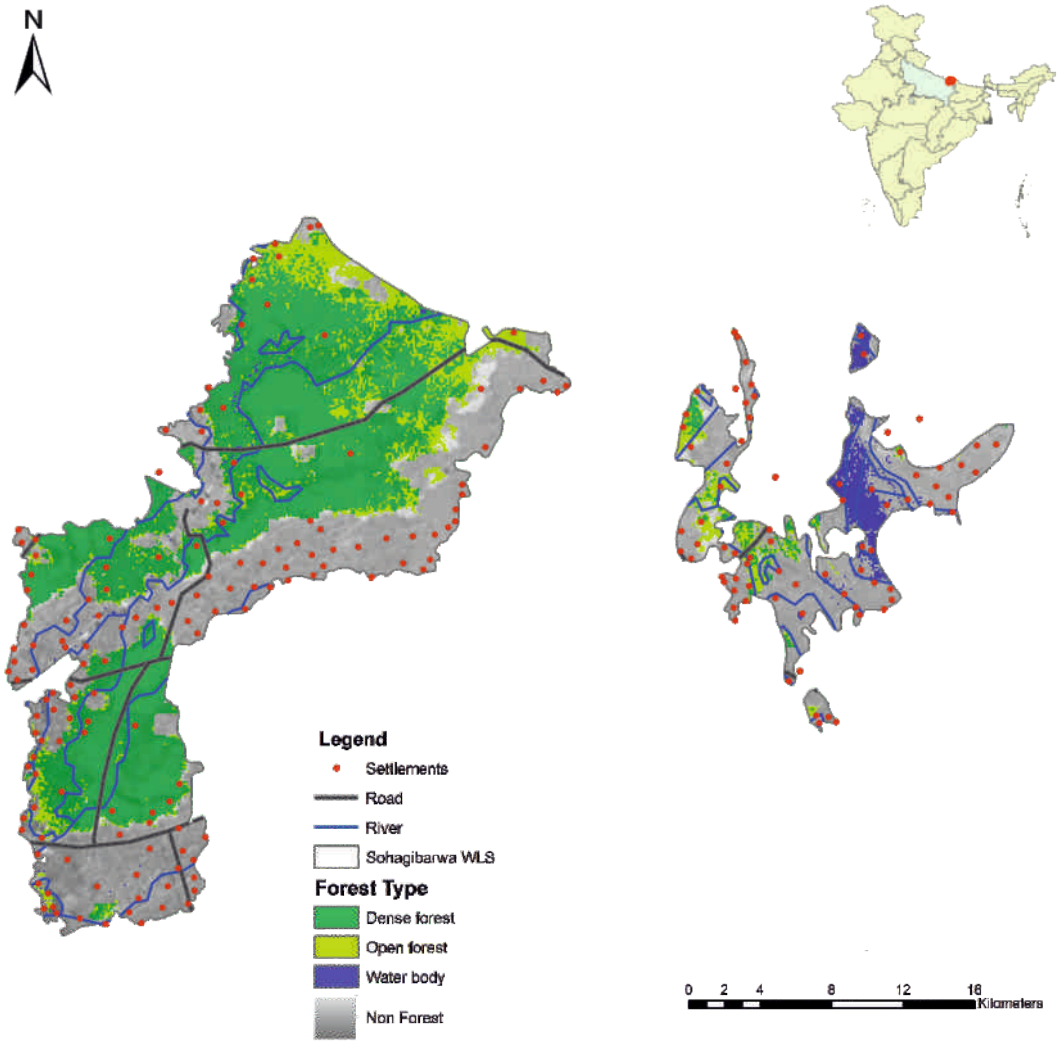
## Technological Solutions:

Technological solutions that can be implemented to mitigate the management challenges are,

- UAV application along with the water bodies.
- Camera trap technology to keep a watch on key areas.

# L. SOHAGIBARWA WLS

**Sohagibarwa WLS is located in Maharajganj district of UP covering an of 428.2 km² and was established in 1984. This area has been listed as priority three grassland due to conservation need for various grassland species like Rhinoceros, Swamp deer, Hispid hare, Bengal florican, Swamp francolin, Finn's Baya, etc. Other major animals include Tiger, Leopard, Wild cat, Civet cat, Fox, Fishing cat, Indian porcupine, Turtles and bird species such as Sarus crane, Grey heron, migratory species of birds such as Red crested pochard, Storks, Herons.**




## Management Challenges:

The major issues for management in this WLS are the monitoring of Tigers and rhinoceros. Other problems include,

- Shortage of ground level staff
- Man-animal conflict.
- Habitat degradation and management.

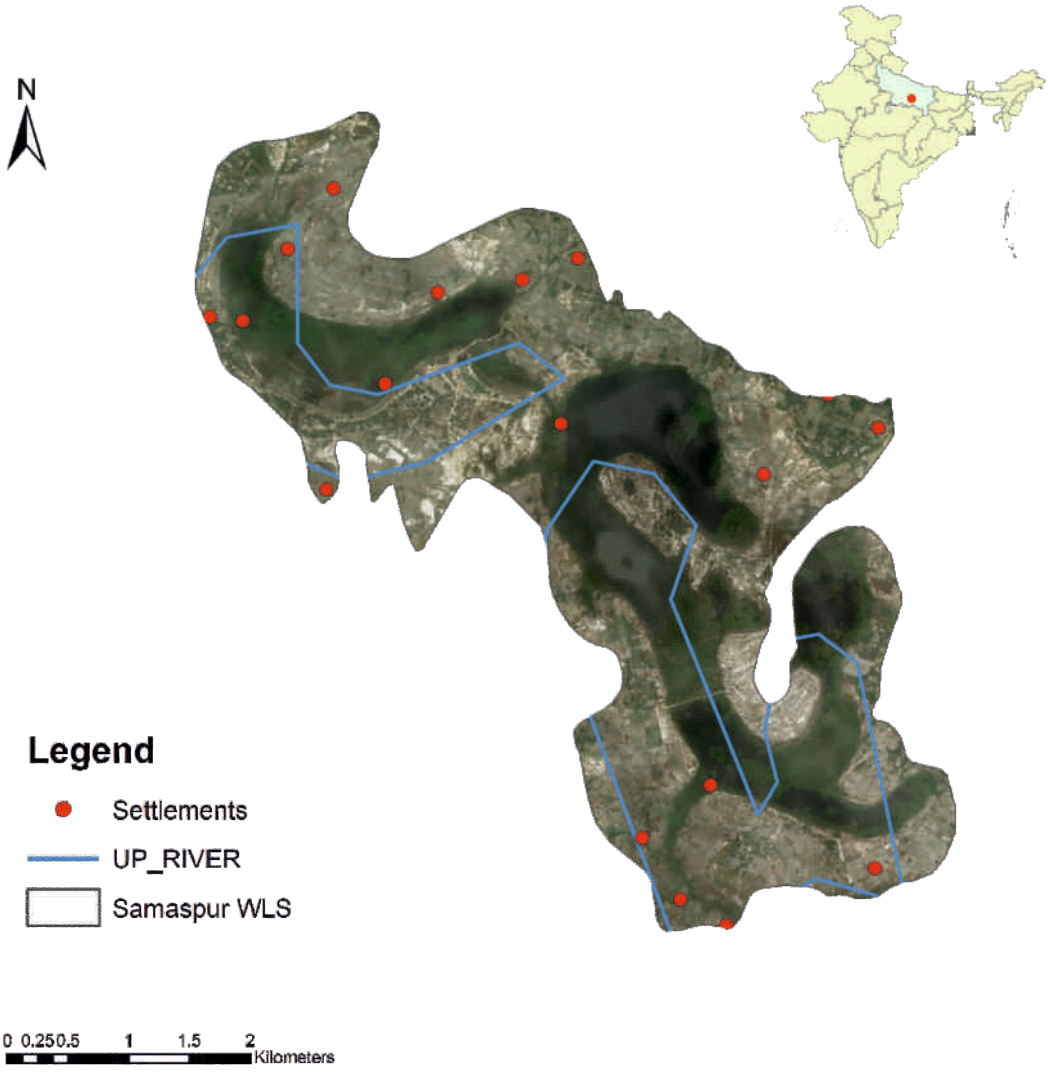
## Technological Solutions:

Technological solutions to mitigate the management challenges are,

- UAV application for monitoring man-animal conflict.
- GIS Forest Watch for habitat monitoring.

# M. SAMASPUR WLS

**This sanctuary is located in Raebareily district of UP across an area of 8 km². It was earlier named as Salin wetland and declared as a wildlife sanctuary in 1987. It comprises six connected lakes and all the lakes are perennial rain fed lakes. The waterbody supports nearly 200 species of birds, so the area is listed as an Important Bird Area. Apart from birds, many species of small mammals also can be found in this area. Priority species of this sanctuary include Purple heron, Little bittern black Francolin, Fishing cat, Jungle cat, Fox, etc.**




## Management Challenges:

Major management issues include,

- Illegal fishing and bird trapping.
- Weed infestation.

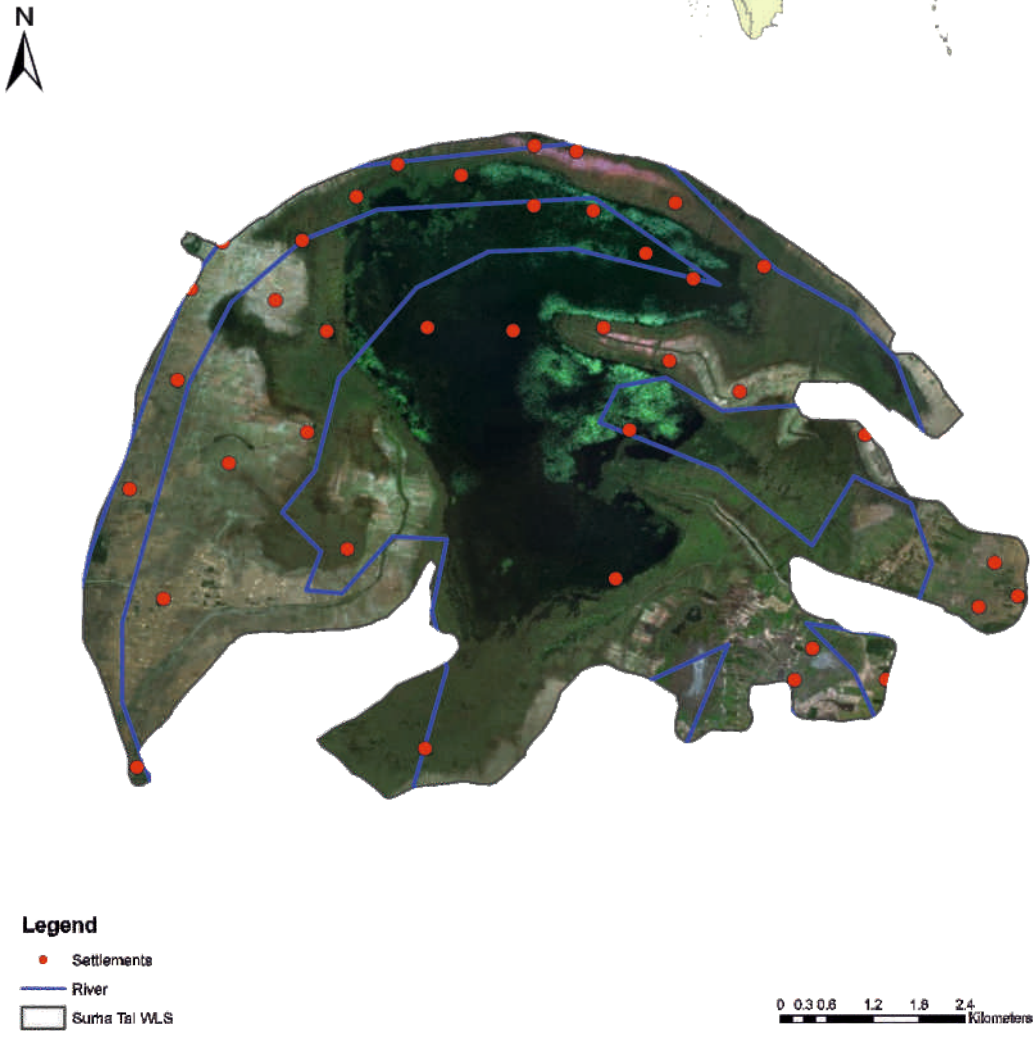
## Technological Solutions:

Technological solutions to mitigate the management challenges are,

- UAV surveillance of water bodies.
- E-eye Towers for day/night monitoring.

# N. SURHATAL WLS

**Surha Tal is a natural rainfed lake. It is located in Ballia district over an area of 34.32 km². This water body houses to several residents and migratory bird species and also other wetland species such as Herons and Jacanas, Cormorants, Migratory ducks, etc.**




## Management Challenges:

Major management issues include,

- Illegal fishing and use of water vegetation by local people.
- Weed infestation.
- Drainage of lake water for irrigation.

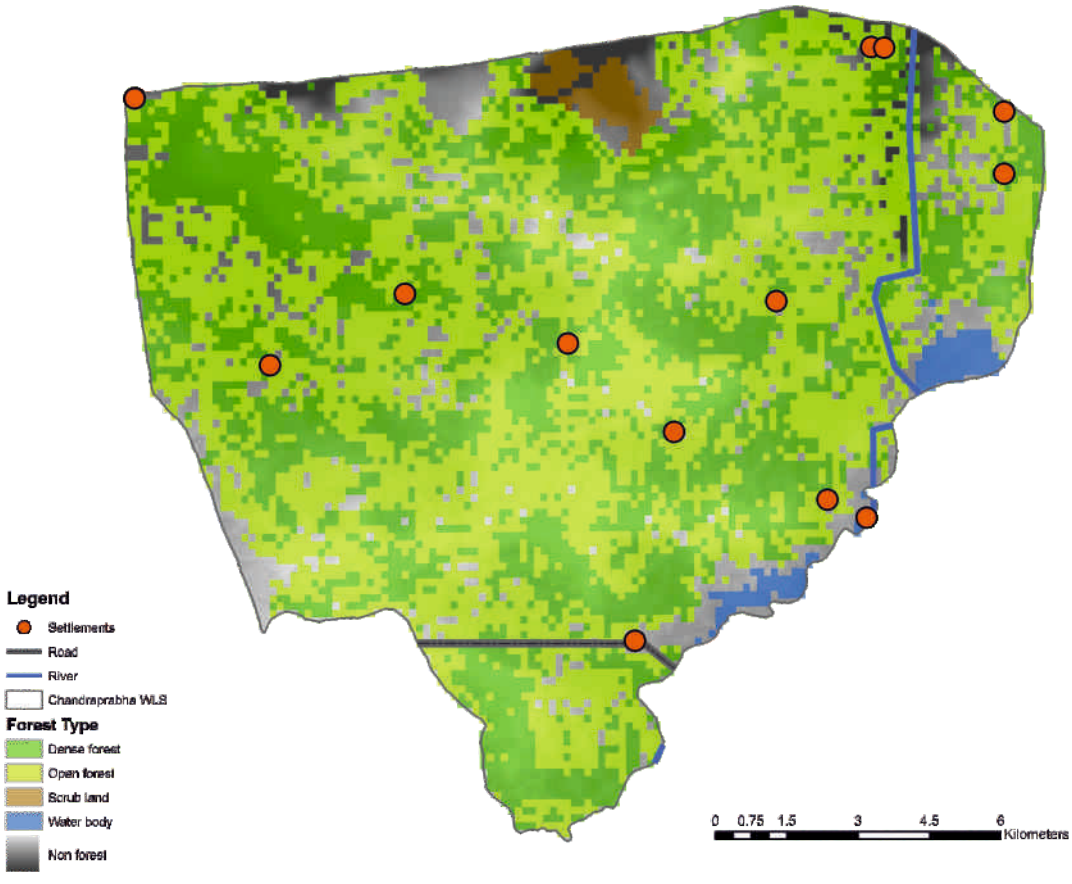
## Technological Solutions:

Technological solutions which can be used include,

- Camera traps around water bodies for checking illegal activities.

# O. CHANDRAPRABHA WLS

**This sanctuary is the oldest WLS of UP and was established in 1957. It is located in Chandauli district if Uttar Pradesh, covering an area of 78 km². This area has mainly mix dry deciduous forest and also small patches of moist Sal forest and riparian fringing forest. Major wild animals found in the sanctuary includes are Gharial, Sloth bear, Chinkara, Nilgai, Sambar, etc.**




## Management Challenges:

There are few significant management challenges present in the sanctuary, which are,

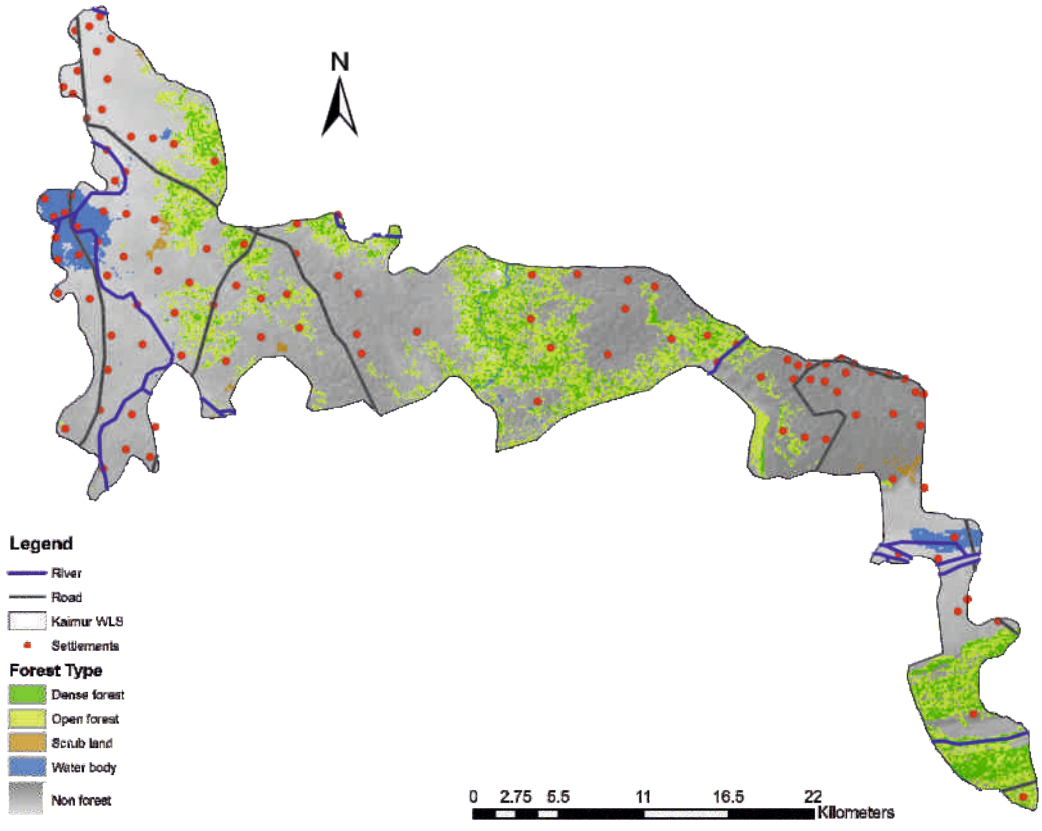
- Biotic pressure from surrounding villages.
- Low prey density leads to attack on cattle and human causing man-animal conflict.
- No proper management training within staffs.

## Technological Solutions:

- UAV Application for monitoring and surveillance.
- PID System such as electric wires
- Camera trap monitoring

# P. KAIMUR WLS

**This sanctuary is in Mirzapur and Sonbhadra district and is a part of the central highland province of Deccan peninsula. It was declared as a WLS in 1982, and the total area is 500.73 km². The forest type is majorly mixed tropical dry deciduous, and there are few patches of savanna and scrub forest, the animals found in the sanctuary are Tiger, leopard, Sloth bear, Wolf, Jungle cat, Fishing cat, Blackbuck, Sambar, different types of birds of prey and vultures.**




## Management Challenges:

Major management issues associated with this WLS are,

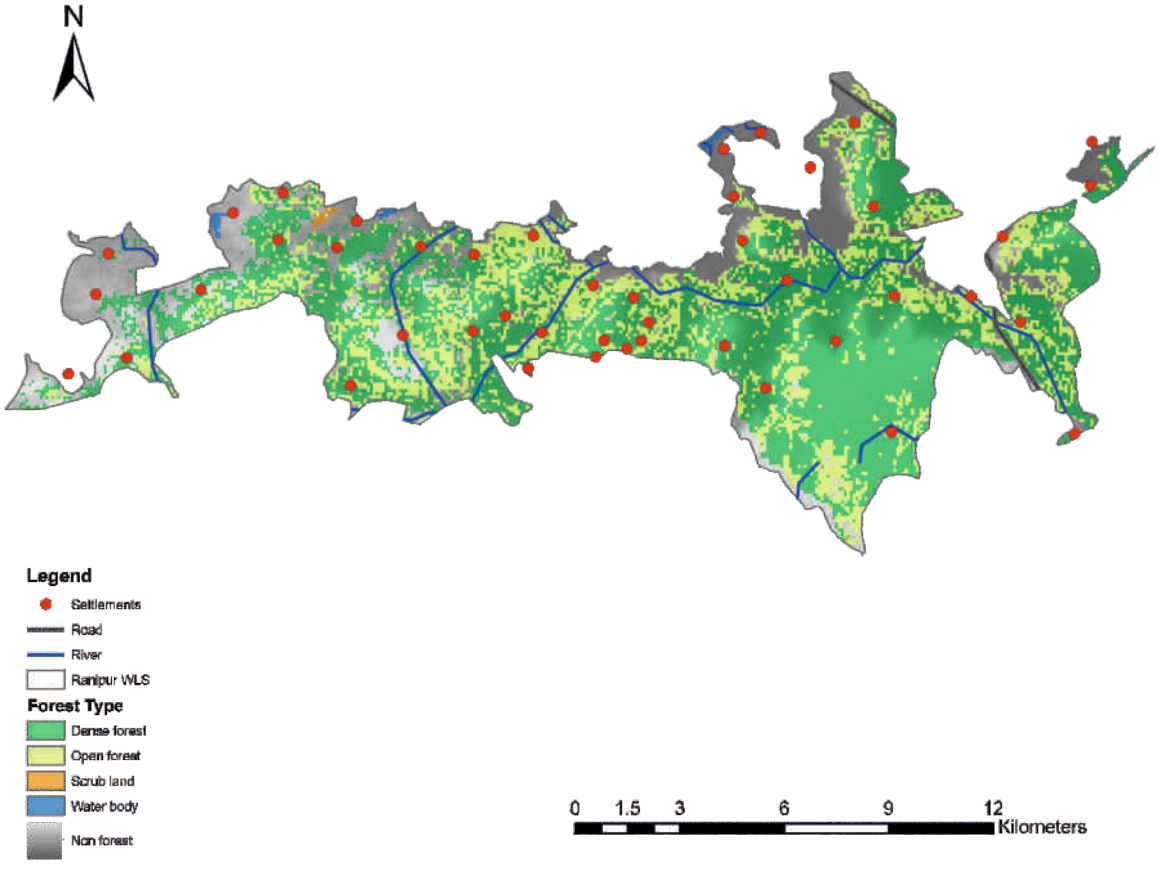
- Poaching of the wild animal
- Livestock grazing and fuelwood collection.
- Weed proliferation such as Lantana camara, Cassia tora.

## Technological Solutions:

- UAV application for monitoring and antipoaching activities.
- GIS monitoring and mapping for identifying affected areas.

# Q. RANIPUR WLS

**This sanctuary is located in Banda and Chitrakoot district. It was declared as a WLS in 1977, and the total area is 230.31 km². The major vegetation type of this area consists of Northern Tropical dry deciduous forest. The animals found in the sanctuary are Tiger, Leopard, Sloth bear, Black buck, Indian fox, Hyena, Porcupine, Sambar. It was given a very high priority PA status by BCPP in 2001.**




## Management Challenges:

Major management issues attributed to this WLS are,

- Cattle grazing.
- Forest exploitation.
- Poaching.
- NWFPs collection such as Mahua, Tendu, Amla, Bahra, and setting of forest fire for NWFP collection.

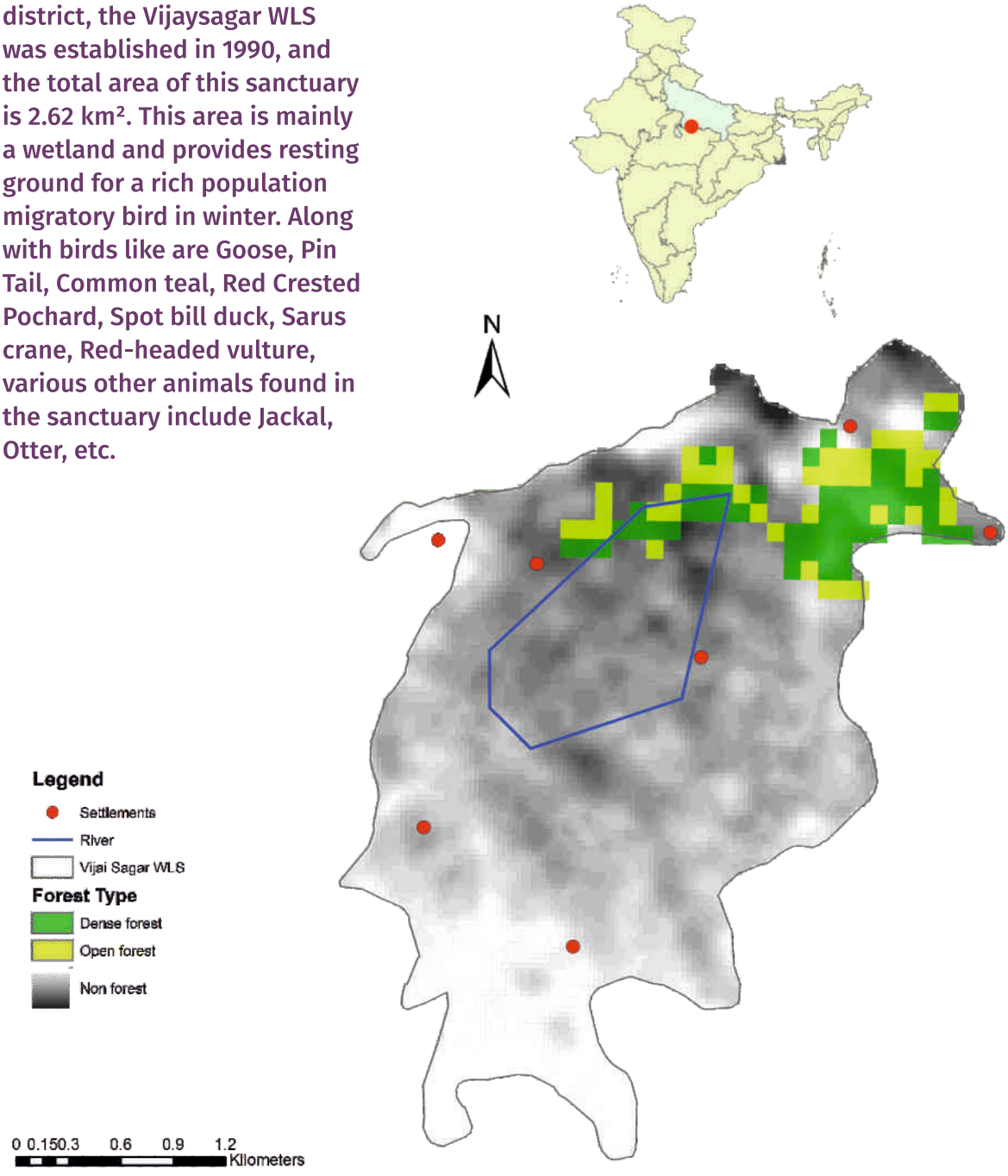
## Technological Solutions:

Suitable technical solutions to mitigate the issues include,

- UAV application for countering poaching, and also monitoring the fire.
- Early warning systems and Fire detection sensors.
- GIS system for checking forest exploitation.

# R. VIJAYSAGAR WLS

**Situated in the Mahoba district, the Vijaysagar WLS was established in 1990, and the total area of this sanctuary is 2.62 km². This area is mainly a wetland and provides resting ground for a rich population migratory bird in winter. Along with birds like are Goose, Pin Tail, Common teal, Red Crested Pochard, Spot bill duck, Sarus crane, Red-headed vulture, various other animals found in the sanctuary include Jackal, Otter, etc.**




## Management Challenges:

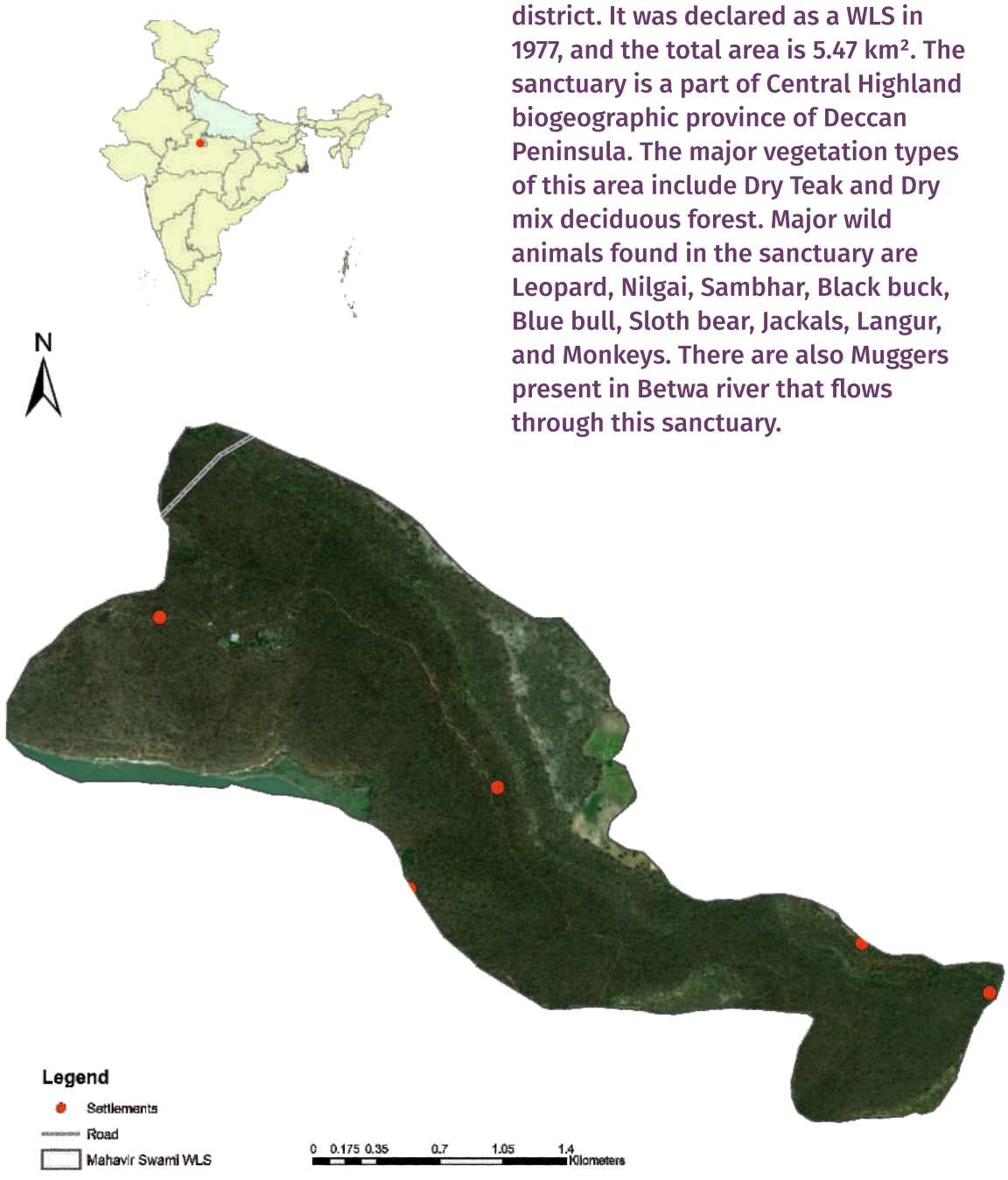
Major management issues attributed to this WLS are,

- Poaching and hunting.
- Fishing and collection of lotus pods create pressure within the sanctuary.

## Technological Solutions:

- UAV application for monitoring and countering poaching

# S. MAHAVIR SWAMI WLS




**This sanctuary is located in Lalitpur district. It was declared as a WLS in 1977, and the total area is 5.47 km². The sanctuary is a part of Central Highland biogeographic province of Deccan Peninsula. The major vegetation types of this area include Dry Teak and Dry mix deciduous forest. Major wild animals found in the sanctuary are Leopard, Nilgai, Sambhar, Black buck, Blue bull, Sloth bear, Jackals, Langur, and Monkeys. There are also Muggers present in Betwa river that flows through this sanctuary.**

## Management Challenges:

Major management issues attributed to this WLS are,

- Illegal sand mining, tree cutting.
- Biotic pressure.
- Forest fire due to NTFP cultivation.

## Technological Solutions:

- UAV application for checking on illegal mining from above, changes in land after mining.
- Early warning systems and Fire Detection sensors for forest fires.

# T. SANDI WLS

This sanctuary is located in Hardoi district. It was declared as a WLS in 1990, and the total area is 3.09 km². The sanctuary is mainly a rainfed wetland and also listed as Important Bird Area (IBA). The animals found in the sanctuary are Fox, Jungle cat, Fishing cat, Major avifauna present in the sanctuary are, Purple heron, Black ibis, Little bittern, etc.


## Management Challenges:

Major management issues attributed to this WLS are,

- Ill Extensive water usage from
- Jheel for agricultural purposes.
- Illegal hunting.
- Livestock grazing.

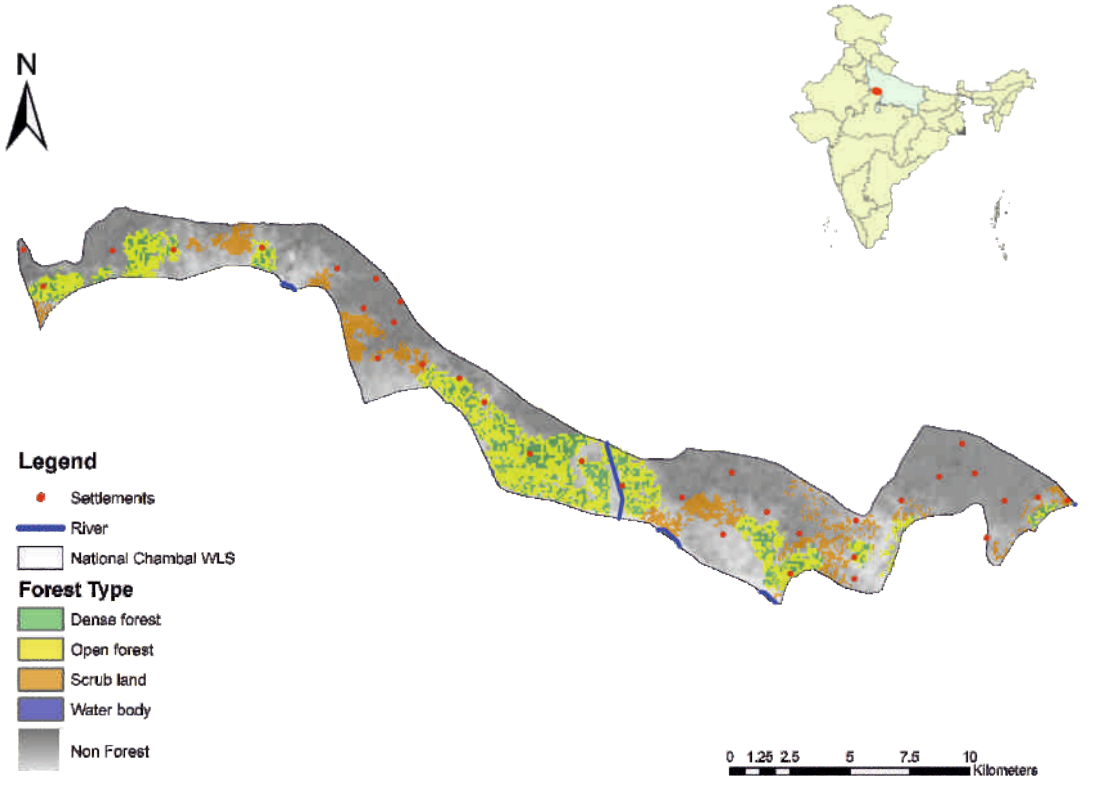
## Technological Solutions:

- UAV application for monitoring from above, and also checking on illegal hunting activities.

# U. NATIONAL CHAMBAL WLS

**This tri-state sanctuary spans across Rajasthan, Madhya Pradesh, and Uttar Pradesh. In Uttar Pradesh, this sanctuary falls within Agra and Etawah district and has an area of 635 km². It was designated as a wildlife sanctuary in 1979. The river Chambal flows through this sanctuary creates a variety of land features providing a diverse habitat type. Major species of this sanctuary include Gharial, Mugger, Otter, Gangetic river dolphin, and multiple species of freshwater turtles.**

**The area has also been listed as high priority wetland and Important Bird Area (IBA). Major avifauna present in the sanctuary includes Dalmatian pelican, Greater spotted eagle, Sarus crane, Indian skimmer.**




## Management Challenges:

Major management issues attributed to this WLS are,

- Illegal hunting and sand mining.

## Technological Solutions:

- UAV application for checking on illegal mining from above, changes in the land after mining.

## V. OKHLA BIRD WLS

**This sanctuary is located in Gautam Budh Nagar district of Uttar Pradesh. It was declared as a WLS in 1990, with the total area is four km². The bird sanctuary has been recognized as IBA, majorly for Bristled grassbird, Greater spotted eagle and Indian skimmer. Other important avifauna present in the sanctuary is, Oriental darter, Painted stork, Black-headed ibis, Ferruginous duck, etc.**

### Management Challenges:

Major management issues attributed to this WLS are,

- Illegal fishing and poaching of birds.
- Grass and lotus buds and pods cutting.
- Grazing of livestock.

### Technological Solutions:

- UAV application for monitoring and countering poaching

## W. BHIMRAO AMBEDKAR PAKSHI VIHAR

**This sanctuary is located in Pratapgarh district. It was declared as a WLS in 2003, and the total area is 4.27 km². The animals found in the sanctuary are Jungle cats, Mongoose, Wolves. Major avian species are Sarus crane, Open -billed stork, Painted stork, White naked stork, Black naked stork, Darter, Little cormorant, etc.**

### Management Challenges:

Major management issues attributed to this WLS are,

- Fishing and bird trapping
- Tourist pressure

### Technological Solutions:

- UAV application for monitoring from above, and also checking on illegal hunting activities.

Key species and management issues of each PA in Uttar Pradesh and the possible technological solutions

| Name of PA (National Park/ Tiger Reserve) | District | Year of Notification | Total Area ($km^2$) | Key Species | Management Challenges | Technological Solutions |
|---|---|---|---|---|---|---|
| Dudhwa NP & TR | Lakhimpur-Kheri, Bahraich | 1977 & 1987 | 1284. | Tiger, Leopards, Elephant, One-horned Rhinoceros, Swamp deer, Hispid hare, Bengal florican, Swamp francolin, Saurus crane, White-rumped vulture | • Biotic pressure for resource (fuel wood, fodder, thatching grass) utilization.<br>• Livestock pressure leads to forest and soil degradation.<br>• Poaching and man-animal conflict.<br>• Illegal wildlife product trade and transboundary management issues. | • Camera Trap technology for monitoring movement of animals and villagers<br>• UAVs to counter poaching and transboundary management issues, also<br>• Electronic Surveillance Towers |
| Pilibhit TR | Pilibhit, Lakhimpur, Bahraich | 2008 | 730.2 | Tiger, leopard, Elephant, Swamp deer, Hispid hare, Bengal florican | • Fragmented corridor within adjacent PAs and encroachment.<br>• Illegal wildlife product trade and transboundary management issues.<br>• Biotic pressure for resource (fuel wood, fodder, thatching grass) utilization.<br>• Livestock pressure<br>• Poaching | • UAV application for monitoring and anti-poaching<br>• PIDS (Perimeter Intrusion Detection System) for illegal movements. |
| Amangarh TR | Bijnor | 2012 | 80 | Tiger, Leopard, Elephant | • Livestock grazing<br>• Encroachment and forest land destruction<br>• Man-animal conflict | • PIDS (Perimeter Intrusion Detection System) for illegal movements<br>• Camera trap monitoring |

| Name of PA (WLS) | District | Year of Notification | Total Area ($km^2$) | Key Species | Management Challenges | Technological Solutions |
|---|---|---|---|---|---|---|
| Hastinapur WLS | Muzzafar Nagar, Meerut, Ghaziabad Bijnor & JP Nagar | 1986 | 2073 | Swamp deer, Smooth coated otter, Gangetic river dolphin, Ghaial | • Encroachment of local villagers<br>• No proper monitoring of wetland health<br>• Lack of training within staffs<br>• Man-animal conflict<br>• Electrocution of wild<br>• animals by live electric wire around the croplands. | • PIDS (Perimeter Intrusion Detection System) for illegal movements. |
| Katerniaghat WLS | Behraich | 1976 | 400.0 | Tiger, Rhino, Gharial, Gangetic river dolphin, Swamp deer, Hispid hare, Bengal florican, White backed and Long-billed vultures | • Grassland management.<br>• Fragmented corridor connection.<br>• Vehicular pressure and disturbances.<br>• Management of forest fire.<br>• Poaching, mostly towards Nepal side.<br>• High biotic pressure.<br>• Road and railway line within the park | • UAV application for monitoring and anti-poaching<br>• PIDS (Perimeter Intrusion Detection System) for illegal movements. |
| Kishanpur WLS | Lakhimpur-Kheri, Shahjahanpur | 1972 | 227 | Tiger, leopard, swamp deer, Bengal florican, lesser florican, White-rumped vulture | • Fragmented corridor connection.<br>• Poaching<br>• High biotic pressure<br>• Road and railway line within the park | • UAV Application<br>• Camera Trap |

| Name of PA (WLS) | District | Year of Notification | Total Area ($km^2$) | Key Species | Management Challenges | Technological Solutions |
|---|---|---|---|---|---|---|
| Patna WLS (Bird Sanctuary) | Etah | 1990 | 1.09 | Grey francolin, Rain quail, Oriental white-backed vulture, Greater spotted eagle, Lesser flamingo, Oriental white ibis, Black bellied tern | • Wrong management practices lead to reduce in a number of various species.<br>• Lack of regulation of tourist activity.<br>• Total ban on grazing leads to thick ground vegetation.<br>• Spreading of Ipomea causes choke of water body making area unfavorable for diving ducks. | • Use of GIS and knowledge management tools and techniques for proper management of the park |
| Sur Sarovar WLS | Agra | 1991 | 4.03 | Hyena, Spotted deer, Porcupine, Indian pangolin, Jackal, Purple heron, Indian shag, Darter, etc. | • Grazing pressure<br>• Siltation of lake.<br>• Infestation of water hyacinth. | • PIDS (Perimeter Intrusion Detection System) for illegal movements. |
| Saman WLS | Mainpuri | 1990 | 5.26 | Black partridge, Rain quail, Bar-headed goose, Pintail, Eurasian wigeon | • Encroachment of forest land and livestock grazing.<br>• Illegal hunting and bird trapping.<br>• Weed infestation. | • UAV Application for surveillance and antipoaching activity<br>• PIDS System such as Electric wires for preventing illegal intrusion |
| Lakh Bahosi WLS | Kannauj | 1988 | 80.24 | Storks, Herons, Pochards, Egrets, Cormorants, etc | • Encroachment of forest land.<br>• Illegal hunting and bird trapping.<br>• Weed infestation. | • GIS forest Watch<br>• UAV Application for monitoring and surveillance.<br>• PID System such as electric wires<br>• GIS (Geographic Information System) Forest watch |

| Name of PA (WLS) | District | Year of Notification | Total Area ($km^2$) | Key Species | Management Challenges | Technological Solutions |
|---|---|---|---|---|---|---|
| Sohelwa WLS | Shravasti, Balrampur | 1988 | 452.4 | Tiger, Leopard, One Horned Rhino, Hyena, Jackal, Fox, Wolf, Bear, Deer, Sambar, Chital, Hog deer, Swamp deer, Hispid hare, Bengal florican, Swamp francolin, Finn's baya, etc. | • Poaching.<br>• Illegal trade of wildlife products and transboundary management issue.<br>• Biotic pressure.<br>• Tourism management and boosting.<br>• Management and eradication of Lantana. | • UAV Application for surveillance and antipoaching.<br>• Camera Traps |
| Parvati Aranga WLS | Gonda | 1990 | 10.84 | Sarus Crane, Great Crested Grebe, Purple Heron, Grey heron, Bitterns, Black storks, Ibis, Spoonbill | • Agricultural fields are on vicinity result in high biotic pressure.<br>• Illegal fishing and bird hunting. | • UAV surveillance of water bodies.<br>• E-eye Towers for day/night monitoring. |
| Bakhira WLS | Sant Kabir Nagar | 1980 | 29 | Great crested grebe, Purple heron, Grey heron, Bitterns, storks, Ibis, Waterfowls | • Encroachment and grazing pressure.<br>• Illegal fishing and bird hunting.<br>• Use of lake water by villagers. | • PIDS (Perimeter Intrusion Detection System) for illegal movements.<br>• UAV application for monitoring. |
| Nawabganj WLS | Unnao | 1984 | 2.25 | Greylag goose, Pintail, Cotton teal, Red-crested pochard, Gadwall, Shoveller, Coot, Sarus crane, Painted stork, Peafowl, Purple moorhen, Vulture | • Illegal trade of birds and turtles.<br>• Over exploitation of aquatic plant and livestock grazing.<br>• Weed infestation of the lake<br>• Polluted runoffs often reach the lake from surrounding industries and areas. | • UAV application along with water bodies.<br>• Camera trap technology to keep a watch on key areas |

| Name of PA (WLS) | District | Year of Notification | Total Area ($km^2$) | Key Species | Management Challenges | Technological Solutions |
|---|---|---|---|---|---|---|
| Sohagibarwa WLS | Maharajganj | 1984 | 428.2 | Tiger, Leopard, Wild cat, Civet cat, Fox, Fishing cat, Indian porcupine, Turtles and bird species such as Sarus crane, Grey heron, migratory species of birds such as Red crested pochard, Storks, Herons | • Shortage of ground level staff<br>• Man-animal conflict.<br>• Habitat degradation and management. | • UAV application for monitoring man-animal conflict.<br>• GIS Forest Watch for habitat monitoring. |
| Samaspur WLS | Raebareily | 1987 | 7.99 | Purple heron, Little bittern black Francolin, Fishing cat, Jungle cat, Fox | • Illegal fishing and bird trapping.<br>• Weed infestation. | • UAV surveillance of water bodies.<br>• E-eye Towers for day/night monitoring. |
| Surhatal WLS | Ballia | 1991 | 34.32 | Herons and Jacanas, Cormorants, Migratory ducks | • Illegal fishing and use of water vegetation by local people.<br>• Weed infestation.<br>• Drainage of lake water for irrigation. | • Camera traps around water bodies for checking illegal activities. |
| Chandraprabha WLS | Chandauli | 1957 | 78 | Gharial, Sloth bear, Medicinal plants | • Biotic pressure from surrounding villages.<br>• Low prey density leads to attack on cattle and human causing man-animal conflict.<br>• No proper management training within staffs. | • UAV Application for monitoring and surveillance.<br>• PID System such as electric wires<br>• Camera trap monitoring |

| Name of PA (WLS) | District | Year of Notification | Total Area ($km^2$) | Key Species | Management Challenges | Technological Solutions |
|---|---|---|---|---|---|---|
| Kaimur WLS | Mirzapur, Sonbhadra | 1982 | 500.7 | Tiger, leopard, Sloth bear, Wolf, Jungle cat, Fishing cat, Blackbuck, Sambar, different types of birds of prey and Vultures. | • Poaching.<br>• Livestock grazing and fuelwood collection.<br>• Weed proliferation such as Lantana, Cassia tora. | • UAV application for monitoring and antipoaching activities.<br>• GIS monitoring and mapping for identifying affected areas. |
| Ranipur WLS | Banda, Chitrakoot | 1977 | 230.3 | Leopard, Sloth bear, Black buck, Indian fox | • Cattle grazing.<br>• Forest exploitation.<br>• Poaching.<br>• NWFPs collection and setting of forest fire for NWFP collection. | • UAV application for countering poaching, and also monitoring fire.<br>• Early warning systems and Fire detection sensors.<br>• GIS system for checking forest exploitation. |
| Vijaysagar WLS | Mahoba | 1990 | 2.62 | Goose, Pin tail, Common teal, Red crested pochard, Spot bill, Sarus crane, Red headed vulture, Jackal, Otter | • Poaching and hunting.<br>• Fishing and collection of lotus pods create pressure within the sanctuary. | • UAV application for monitoring and countering poaching. |
| Mahavir swami WLS | Lalitpur | 1977 | 5.41 | Leopard, Nilgai, Sambhar, Black buck, Blue bull, Bear, Jackals, Langur, and Monkeys | • Illegal sand mining, tree cutting.<br>• Biotic pressure.<br>• Forest fire due to NTFP cultivation. | • UAV application for checking on illegal mining from above, changes in the land after mining.<br>• Early warning systems and Fire Detection sensors for forest fires. |
| Sandi WLS | Hardoi | 1990 | 3.09 | Fox, Jungle cat, Fishing cat, Purple heron, Black ibis, Little bittern | • Extensive water usage from<br>• Jheel for agricultural purposes.<br>• Illegal hunting.<br>• Livestock grazing. | • UAV application for monitoring from above, and also checking on illegal hunting activities. |

| Name of PA (WLS) | District | Year of Notification | Total Area ($km^2$) | Key Species | Management Challenges | Technological Solutions |
|---|---|---|---|---|---|---|
| National Chambal WLS | Agra, Etawah | 1979 | 635 | Gharial, Mugger, Otter, Gangetic river dolphin, various freshwater Turtles | • Illegal hunting and sand mining. | • UAV application for checking on illegal mining from above, changes in the land after mining |
| Okhla Bird WLS Designated as IBA | Gautam Budh Nagar | 1990 | 4 | Oriental darter, Painted stork, Black-headed ibis, Ferruginous duck, etc | • Illegal fishing and poaching of birds.<br>• Grass and lotus buds and pods cutting.<br>• Grazing of livestock. | • UAV application for monitoring and countering poaching |
| Bhimrao Ambedkar Pakshi Vihar | Pratapgarh | 2003 | 4.27 | Jungle Cats, Mongoose, Wolves, Sarus crane, Open billed stork, Painted stork, White naked stork, Black naked stork, Darter, Little cormorant | • Fishing and bird trapping<br>• Tourist pressure | • UAV application for monitoring and countering poaching |

# BUDGET

5.

Budget Requirement (for the five-year plan)

| Sl. No. | Details | Unit Cost (lakhs) | Number | Total Cost (lakhs) |
|---|---|---|---|---|
| 1. | Early Warning System | 300 | 02 | 600 |
| 2. | 24x7 E-Surveillance | 300 | 04 | 1200 |
| 3. | Virtual Fence (Perimeter Intrusion and Detection System) | 200 | 02 | 400 |
| 4. | Continuous Camera Trap Monitoring System | 200 | 03 | 600 |
| 5. | Radio and Satellite Telemetry | 120 | 03 | 460 |
| 6. | Drone/UAV Surveillance and Monitoring | 30 | 10 | 300 |
| 7. | Knowledge Management and Decision Support System | 300 | 02 | 600 |
| 8. | Professional Inputs and Capacity Building including R&D | 200 | 05 | 1000 |
| | **Total Cost** | | **51.60 crores** | |

* NOTE: The deployment of these units would be done based on field requirement and prioritization.

# KEY REFERENCE


Buhlmann, K.A., Akre, T.S., Iverson, J.B., Karapatakis, D., Mittermeier, R.A., Georges, A., Rhodin, A.G., Van Dijk, P.P. and Gibbons, J.W., 2009. A global analysis of tortoise and freshwater turtle distributions with identification of priority conservation areas. *Chelonian Conservation and Biology,* 8(2), pp.116-149.

Chitale, V.S., Behera, M.D. and Roy, P.S., 2014. Future of endemic flora of biodiversity hotspots in India. *PloS one*, 9(12), p.e115264.

FSI, 2017. *State forest report*. Forest Survey of India. Dehradun, India.

Johnsingh, A.J.T., Ramesh, K., Qureshi, Q., David, A., Goyal, S.P., Rawat, G.S., Rajapandian, K. and Prasad, S., 2004. *Conservation status of tiger and associated species in the Terai Arc Landscape, India* (pp. viii+-110). Dehradun: Wildlife Institute of India.

Mani, M.S. ed., 2012. *Ecology and biogeography in India* (Vol. 23). Springer Science & Business Media.

Marvin, D.C., Koh, L.P., Lynam, A.J., Wich, S., Davies, A.B., Krishnamurthy, R., Stokes, E., Starkey, R. and Asner, G.P., 2016. Integrating technologies for scalable ecology and conservation. *Global Ecology and Conservation*, 7, pp.262-275.

Mittermeier, R.A., van Dijk, P.P., Rhodin, A.G. and Nash, S.D., 2015. Turtle hotspots: an analysis of the occurrence of tortoises and freshwater turtles in biodiversity hotspots, high-biodiversity wilderness areas, and turtle priority areas. *Chelonian Conservation and Biology*, 14(1), pp.2-10.

National Wetland Atlas: Uttar Pradesh, SAC/RESA/AFEG/NWIA/ATLAS/12/2010, Space Applications Centre, ISRO, Ahmedabad, India, pp.372.

Rodgers, W.A. and Sawarkar, V.B., 1988. Vegetation management in wildlife protected areas in India. *Aspects of applied biology.*

Sarkar, U.K., Pathak, A.K., Sinha, R.K., Sivakumar, K., Pandian, A.K., Pandey, A., Dubey, V.K. and Lakra, W.S., 2012. Freshwater fish biodiversity in the River Ganga (India): changing pattern, threats and conservation perspectives. *Reviews in Fish Biology and Fisheries*, 22(1), pp.251-272.

Sprague Jr, R.H. and Carlson, E.D., 1982. *Building effective decision support systems*. Prentice Hall Professional Technical Reference.

TERI, 2000. Strategies and action plan foe biodiversity conservation in Uttar Pradesh. Position paper. Report n. 1999SF61. Vol. 1.

# APPENDIX I: DETAILS OF UAVs

## 1.1. Models and manufacturers details of UAV

Both these categories include models from different manufacturers from India as well as the world. For some of the currently available solutions, we have the following units:

| UAV | Range (km) | Flight Time (mins) | Cost (lakhs) |
|---|---|---|---|
| Dji Phantom Pro | 4-5 | 25 | 2.5 |
| Hexcopter | 5-6 | 30 | 5 |
| Dji Mattrice 200 | 5-7 | 30-35 | 15 |
| Dji Inspire | 5-7 | 25-30 | 9 |
| Dji Mavic pro thermal | 5 | 31 | 4 |
| Custom Drone | 7-10 | 30-45 | 5 |
| Ideaforge Netra V2 | 5 | 40-50 | 25 |

Various Fixed-wing UAVs provide an upper hand when it comes to monitoring larger areas in small time; they can fly at very high horizontal velocity and also produce less noise compared to other drones. Most efficient fixed-wing models are listed below:

| UAV | Range | Flight Time | Cost (lakhs) |
|---|---|---|---|
| TBS Caiprinha | 10 km | 30-40 mins | 2 |
| TBS Vanguard | Upto 40 km | 40-60 mins | 5 |
| FPV Ranger | 10 km | 40-45 mins | 4.5 |
| Ebee Sensefly | 15 km | 45-50 mins | 13 |

## 1.2. Models and manufacturers details of Drones

This document contains list of selected UAV suppliers in India, thermal camera drone details and darting drone information.

- RCobserver, New Delhi. URL: www.rcobserver.com
- Garuda Aerospace Pvt. Ltd. Chennai URL: www.garudaaerospace.com
- Icarus Propulsion Research Pvt. Ltd., Greater Noida, Ecotech-II, Udyog Vihar, Malakpur,
- Uttar Pradesh 201306 Ph: 099999 03818
- Aerialair , 203 Bhanu Villa, Ghatkopar West, Mumbai 400086 URL: http://aerialair.in
- Technosys Embedded Systems URL: www.technosysind.com
- Some Popular online stores that deliver drone-related components:
- Robu.in
- Robokits.in
- Rcbazaar.com
- Buysnip.com
- Rchyderabad.com

**Darting drone: HAVEIC Drone**

URL: http://www.haevic.co.za/

- Speed -67 kmph Approx. Payload-10kgapprox
- Endurance-20-30 mins
- Gun-It's apparently accurate from up to 98 ft (30 m) away when using the recommended air pressure in the gun, which can be fiddled with to adjust the speed and distance the dart will travel.
- Price - Around USD 14500 with full kit.

**Thermal Camera Drone:**

DJI Drones with Thermal Camera- Matrice series drones with FLIR sensors.

1.DJI M100- Range: 5 km, Flight time: 23 minutes, IP 43, ZenmuseXT Thermal camera. Price: USD 12000*

2.DJI M200- Range: 7 km, Flight time: 35 minutes, IP 43, ZenmuseXT Thermal camera

**Thermal Camera Specs (ZenmuseXT)**

?FPA/Digital Video Display Formats

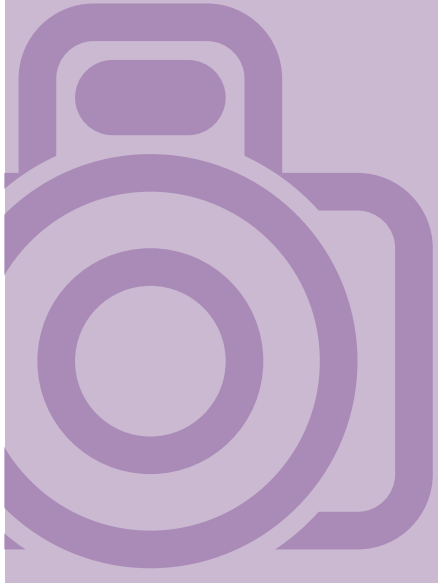
# APPENDIX II: GUIDELINES BY THE DGCA FOR OPERATION IN CIVILIAN AIRSPACE

Drones today are as common for civilian purposes ranging from aerial photography and mapping to delivery of products. This proliferation of use raises a number of regulatory issues including safety - both in the air and on the ground - privacy, and security. So, in order to control this, DGCA issued primary drafts and standard operation procedures in order to regulate it, such that the regulation does not stifle the innovation as well as it does not get un-controlled in its usage.

- The Directorate General of Civil Aviation (hereinafter referred to as the 'DGCA') on November 1, 2017, released a draft regulation stipulating the requirements for Operation of Civil Remotely Pilot Aircraft System.
- On 2014 a public notice banning the use of UAS in the country was released. The notice for the first time recognized the menace of drones and acknowledged the underling safety and privacy issues in it. It concluded by stating that, till the time new regulations are issued, no non-governmental agency, organization, or any individual will launch a UAS in Indian Civil Airspace for any purpose whatsoever.
- The circular for first drafted document became available for comments in April 2016, where advance technological inputs were given for safe UAV flying.
- The Directorate General of Civil Aviation (the "DGCA") released the much awaited National Drone Policy, 2018 version 1 or drone policy 1.0 on 27th August, 2018. The subject matter of the regulation was 'Requirements for Operation of Civil Remotely Piloted Aircraft System (RPAS)'. The policy came to effect from 1st December 2018. This regulation succeeded two other daft regulations that were issued by the DGCA in April 2016 and November 2017. Both the drafts went open to stakeholders, also a task force called the drone task force was set up that was to provide further recommendations when needed and may even modify the current regulation or create the new ones.
- The Minister of Civil Aviation, again released the final draft Drone Policy 2.0 on 15th January, 2019. This was also a recommendation and the policy got finalized by a task force led by the Civil Aviation Secretary and the Director General of Civil Aviation. Under Drone Policy 1.0, the potential to exploit drones for commercial purposes was limited, for instance, through Visual Line of Sight (VLOS) requirements. Hence the drafted Drone Policy 2.0 recommended expanding operations to beyond VLOS and beyond the current limit of 400 feet. This policy became an essential

tool for forest operation as well, because the fixed wing aircrafts operated by E-Bird team performed Beyond Visual Line of Sight (BVLOS) and also under automated tasked missions.

- Finally in order to regulate and maintain the implementation of format flying a Proposed development of Infrastructure (Drone corridors, Droneports and UAS Traffic Management (UTM)) was structured.- The drafted Drone Policy 2.0 conceives of drone corridors (a segregated airspace demarcated by appropriate authorities) to keep commercial UAS operations out of non-segregated airspace in which manned aircraft operate. It is also proposed that UTM should be established which would be responsible for managing UAS induced traffic especially in drone corridors. Further, there should be designated areas known as 'droneports' to facilitate the landing and take-off of drones.
- With the structuring of Drone policy 2.0 and after the planning of Un-manned Traffic Management system, the E-Bird also proposed a segregated airspace and allocation of various drone ports over protected forest area which would require continuous monitoring and surveillance.



A.G. Ansari
Arnab Chattopadhyay
Balsher Singh
Debanjan Sarkar
Dhritiman Mukherjee
Dnyanesh Rathod
Moumita Chakraborty
Shashank Sawan
Sourav Mondal
Susmita Khan
Suyash Katdare
Swaroop Singha Roy
Tamali Mondal
Upamanyu Chakraborty
Open source

Uttar Pradesh Forest Department
Office of Chief Wildlife Warden
17 Rana Pratap Marg, Lucknow- 226001
Ph. No. - 0522 02006584

भारतीय वन्यजीव संस्थान
Wildlife Institute of India
Post Box #18, Chandrabani
Dehradun - 248001
Uttarakhand, India
t.: +91 135 2640114 - 15, 2646100
f.: +91 135 2640117

XPRESSIONS: 9219552563 | Doc. No. XPS280619029