CHAPTER 7: MAJOR THREATS

Anthropogenic disturbance oriented degradation is irreversible in nature and it may reach the upper limit of the intermediate disturbance hypothesis, where most species may go locally extinct (*Anitha et.al., 2008*). Degradation of forests ecosystems and fragmentation of habitat (at landscape level) are the highest threat all the forest ranges of Mirzapur are facing.

Forest fragmentation occurs when large contiguous forests are perforated by small holes or broken up into edges and smaller patches to form a non-forested matrix of open spaces. Having evolved within the ecosystems of large intact forests, many species are ill-adapted to life outside the forest interior, either in forest edges or in the patches carved from it. Habitat fragmentation is a key conservation concern and is strongly associated with the loss of biodiversity (*Olff and Ritchie, 2002; Fahrig, 2003*).

Habitat fragmentation is usually a time driven process that is innocuously initiated by human habitation or man induced habitat alteration and which eventually accelerates and results in complete isolation of once contiguous habitat. Populations thus isolated face survival pressures through increased competition for food and space and obligated risks in relation to disease outbreaks and episodic calamities such as fire and flood. Over a long interval of time span, species inhabiting isolated habitats also face the risk of extinction through mechanisms such as excessive inbreeding (*Joshi & Singh 2008*; *Weiss 2006, Rathore et.al 2012*). Some of the major threats which are leading to forests and habitat fragmentation are discussed as follows:

7.1 LANDSCAPE CHANGE

Landscape change is mainly induced by land use change driven by human activities. Land-use change is cited as the main driver of habitat loss and fragmentation (*Sala et al. 2000; CBD 2010*), thereby threatening many species (*Barnosky 2008; Ehrlich and Pringle 2008; Vignieri 2014*). Whether by chance or design, small fragments of forest typically persist in the aftermath of deforestation, effectively islands within a sea of agriculture, urbanization, or other modified lands that are unsuitable for most forest species. Many of the species that originally occupied the forest will disappear from these isolated fragments, but this loss occurs over a relaxation period until a new, more depauperate equilibrium community is reached. (*Gibson et.al., 2013*)

While some species can persist in fragmented landscapes, or even benefit from fragmentation, many species become more vulnerable because their populations are smaller (*Cagnolo et al. 2006*), they are more prone to overexploitation (*Michalski and Peres 2005*; *Bennett and Saunders 2010*) and edge effects (*de Casenave et al. 1995*; *Gascon et al. 2000*), and their capacity to adapt to environmental change is lower (*Travis 2003*; *Brook et al. 2008*).

Isolation of forests is one of the major factor of local extinction of sloth bears in other forest areas of India. It was found that 69% of the extirpated areas are highly isolated (>20 km) or moderately (5-20 km) isolated. Isolation results into decline or extirpation of sloth bear population due to several induced impacts such as human caused habitat degradation and killing, and by limiting growth of populations and immigration of Sloth Bears from adjacent areas. (*Yoganand et.al. 2006*)

The main drivers of land use changes in Mirzapur has changed in recent years, where outside drivers are now more invasive than internal drivers. Since last decade this region is undergoing phenomenal change and rapid developmental pressures. There has been considerable land use/land cover change in Mirzapur. Increasing urbanization and agricultural expansion have been the main reasons and have increased pressure on the forests of Mirzapur (*Goparaju & Sinha, 2015*).

The main reasons for landscape change in this forest division is further explained below.

I) URBANIZATION

Urbanization is a serious problem in the forest ranges which are nearer to highways and local tehsil headquarters. The kind of urbanization sprawl which is trending in such areas which are far from the urban areas of the district can be termed as type of exurban development. Exurban development and associated infrastructure can lead to habitat fragmentation, homogenization of animal and plant communities, and increased human-wildlife conflict (*McKinney, 2006*). Habitat fragmentation from dispersed housing development can alter animal movement patterns and behaviour, cause ‘‘pileup’’ or overlap of home ranges, and reduce animal fitness by intensifying inter- and intra-specific interactions (*Riley, 2006*). In addition, exurban development may also disproportionately impact protected lands and could decrease their conservation value (*Knight et al., 1995*; *Leinwand et al., 2010*; *Radeloff et al., 2010*). Exurban development is one of the greatest threat because of the commercial stake involved of the people who often have deep political roots, administrative influence and sometimes linking them with development for national importance. Poor planning, inaccurate demarcation of forest lands, outdated revenue records (which are sometimes manipulated or changed), lack of bureaucratic efforts, poor knowledge of forests & wildlife and influence of regional leaders play a very significant role in failure to control or regulate such activities in the forest areas. The effects of such activities are always irreversible and cause irreparable damage to the landscape leading to local extinction of wild animals.

EXAMPLE 1: DEVELOPMENT OF MARIHAN AS EX-URBAN TOWN OF MIRZAPUR

Image 32 BHU South Campus, Barkachha, Mirzapur (Photo: Anonymous from Internet)

In the year 2005, Prof. Panjab Singh, the then Vice Chancellor of Banaras Hindu University took a stand to develop the University's farm at village Barkachha into Rajiv Gandhi South Campus which is now developed into a 2700 acres of university campus in Mirzapur forest range which used to be 'forests'. This led to rapid acquisition of land near the campus by other real estate developers and businessmen from surrounding districts. Due to availability of large areas of land which were not recognized as forests in revenue records, the purchase of land did not attract much problem for them. Due to hilly terrain and dry climate, the rates of land were also lower than adjoining districts. After the year 2010, there were number of lands being cleared near SH-5, specially near the University Campus. Places like Belahada and Marihan which were once local markets soon started developing and modes of public transportation also improved. As public transportation improved, people started seeing Marihan as next ex-urban destination in Mirzapur due to its locality on SH-5, nearness to Mirzapur city, pre-existing infrastructures like police station, market, hospital, schools, Tehsil office etc coupled with the fact that Marihan is also the administrative headquarter of Marihan sub-district of Mirzapur.

Image 33 Proposed Mulayam Singh Yadav University, Marihan (Photo: Debadityo Sinha)

In 2011, Welspun Energy U.P. (Pvt.) Ltd proposed to establish a 1320 MW coal based thermal power plant in village Dadri Khurd which falls inside Marihan forest range. The EIA documents stated that 875 acres of land is already purchased from farmers and government. The project got Environmental Clearance in the year 2014. In the year 2013-14, few companies proposed townships near the Dadri Khurd Thermal Power Plant in the same range. There are several big townships which have put their signboards with the names- Vindhya Mountain City (Spazio Infracity Pvt. Ltd.), Mountain Heaven Windom Fall (Shine City Infra Project Pvt Ltd) etc. These areas which were once forests in reality and continuous with the Marihan forest range are now transferred for such developmental projects. Due to proposal of such developmental projects in this

area, many more small to medium developmental projects are coming up. The latest example is of Mulayam Singh Yadav University which is also under construction clearing such forests. The stretch of forests adjoining SH-5 from BHU South Campus in Barkachha till Marihan tehsil office (approx. 15 km) is severely affected by development nostalgia and will further limit the wildlife habitat and movement. Unfortunately, the same areas also form source of several rivers, impact on which is bound to affect the entire ecosystem of the forest range, including those areas which are far from these developmental sites. The rapid rate of conversion of forests for such ex-urban developments which happened post 2005 are not only irreversible in nature and caused irreparable damage to the entire landscape and wildlife, but the cumulative impact of all of these projects is bound to multiply the negative impacts beyond the point of our assessments and beyond which we may not be able to get restore the natural wilderness as it existed or remaining present day.

Image 34 Proposed Shine City, Marihan (Photo: Debadityo Sinha)

Image 35 Proposed Spazio Infracity, Marihan (Photo: Debadityo Sinha)

During our survey we got signs of sloth bears inside the project boundary of proposed Dadri Khurd Thermal Power Plant and high presence in areas adjoining the proposed site. Similar signs were also observed in the Patewar forests which is south of SH-5 near Upper Khajuri reservoir which indicate that he animals have been using these forests and grasslands frequently for accessing food and water. Chinkara were found grazing inside the proposed site of thermal power plant as well which shows these areas are favoured much by the wild animals. We were able to spot Blackbucks, Bengal Monitor and Egyptian Vuture in the surrounding areas of the project site. There is no doubt, such haphazard and unplanned development practices will take huge toll on the landscape once these projects start construction and become operational.

There are several religious shrines in this landscape, and in recent years several new ashrams have come up in the forest areas. This has led to frequent movement of people and vehicles inside the forest areas causing disturbances to the wildlife.

II) AGRICULTURAL EXPANSION

Agricultural expansion is one of the serious problem the forested areas of Mirzapur, particularly in the forests of lower elevation (<200 m) and forests near rivers and reservoirs. Because of hilly terrain and low-nutrients soil, there is limitation of land where prime cultivation can be done. Cultivation of crops is further constrained by availability of water. As most of the forests in Mirzapur are catchment of many rivers and numerous streams originate from these forests, people and government started construction of check dams and barriers on such streams and rivers to facilitate irrigation. As these forest are quite pristine in nature, the soil quality is found to be quite favorable compared to other old fallow lands where nutrients are exhausted. This attracts the local villagers to clear the forests and start cultivation of crops nearer to these dams. These activities had a great cascading effect on forests, as these agricultural farms soon turned into settlements with infrastructures similar to a village. All of these villages also have access to those areas of forests which were earlier untouched and disturbance occurs in the form of fuelwood collection, grazing, logging etc. Due to dry deciduous climate, the agricultural activity is also restricted to only wet season and until November-December, when the reservoirs have water to sustain crops. Therefore, people living away from such water sources started rearing livestock, which appeared to be very much favorable because of freely available forest land for grazing and dams for water requirements. Cattle camps can be easily observed inside these forests where people from nearby villages go to forests for few months and make a temporary hut where they keep their cattle and maintain them. These camps often have 2-3 number of dogs accompanying them, which further aggravates the disturbance to free ranging wild animals. These led to a very huge cumulative impact on the forests and great level of disturbances to wildlife.

The impact of agricultural expansion is 4 fold- first it comes after clearing forests thus encroaching wildlife habitats, second the cumulative impact on surrounding forests and wildlife for the reasons as mentioned in previous para; third impact is loss of soil quality and alteration to hydrology; and fourth obstruction of the movement of wild animals to water sources.

Cultivation causes an increase in bulk density as compared to soil found in forest ecosystems which means higher runoff, lower water infiltration and the soil becoming unfit for natural regeneration of forests. *Tripathi & Singh (2013)* found that cultivation caused significant decrease in WHC, sand and clay content of the soil and severe reduction in the organic C, total N and P content of the soil. Cultivation also caused significant decline in mean annual nitrification and N-mineralization and decline of microbial C & N by up to 50%.

Agricultural expansion within forest areas (especially where water availability is dependent on rainfall) has been observed only for few number of years until the site has ecological conditions enough to support cultivation. After the farm owner realizes that the site is not suitable for agriculture, he abandons the site which turns fallow land or he sells it to real estate developers. In our survey, we found that abandonment of farmland does not always necessarily mean that the site has lost its good soil quality or water is scarce. We found that most of the cultivators within Marihan and Sukrit range refrains from cultivation because of the increasing raids of crops by wild animals especially wild boars, nilgai and other deer species. As most of the farmers are quite poor, they show their inability to permanently fence their farms. However, we also observed few farms which are fenced by wires. We also found few ashrams which do cultivation within bricked walls.

In those abandoned farmlands which has rich soil condition, over the years, natural regeneration occurs and the site soon turns into grasslands or shrublands (often mistakenly recorded as wasteland) and in some cases mimic natural forests found in this region as well. Often these secondary forests have been seen to act as highly suitable feeding grounds for animals as the grasses and Zizyphus seeds quickly grow on such lands.

III) MINING

Mining not only create permanent scar on land by removing vegetation and topsoil from a site. The sound pollution from open-cast mining activities has a significant impact on the biophonical soundscape of a neighbouring forest.

Image 36 A stone quarry near SH-5A in Sukrit Range (Photo: Debadityo Sinha)

Open-cast mining is known to produce high sound pressure levels through exploratory and production drilling, blasting, cutting, handling of materials, ventilation, crushing, conveying, ore processing and transportation (*Donoghue, 2004*). Many species exhibit behavioural changes including avoiding noisy areas during foraging (*Miksis-Olds et al., 2007*; *Schaub et al., 2008*) and other daily activities (*Sousa-Lima and Clark, 2009*; *Duarte et al., 2011*). Area avoidance and acoustic compensatory mechanisms to reduce or offset the effects of noise may alter the acoustic complexity of a community in a given location, resulting in a decrease in species' abundance (*Bayne et al., 2008*) and/or diversity (*Proppe et al., 2013*) at noise-polluted sites.

Forests of Mirzapur is badly hit by numerous mines due to presence of highly valuable Kaimur sandstone beneath. Wyndham fall and Chunar range is the worst affected forest range, where control of such sporadic small scale mining activities has been a tough challenge for the authorities. During our survey, we found innumerable small scale mining areas in Chunar & Sukrit range. The Forest Ranger of Chunar range showed his inability to control the mining activities because of lack of administrative support from other departments and also because of the immense political influence which are often linked to Ministers. He is aware of the fact that due to mining activities, the big mammals have disappeared from the forests. In Marihan range, there are few mining sites near SH-5, however we could not find any mining activity deep inside the forest.

Large continuous tract of mining inside forest areas are observed in Sukrit (near SH-5A) and Dramadganj range (near Banjari Kala village). Few abandoned mining sites were also observed in Dramadganj forest range (Babura beat). Most of the mining activities in Dramadganj were found to be on hill top. In all the forest range, the department staff were very much aware of mining and the ill-effects they have on their forests, but they all showed their incapability to completely stop it until there is strong administrative support and political will.

Map 21 Google Earth Imagery showing the continuous patch of stone quarries within Sukrit forest range

7.2 DEFORESTATION/LOSS OF FORESTS

Rapid deforestation poses a major threat to tropical forests (*Gibson et.al., 2013*). Apart from opening up forests to many abiotic and biotic influences, fragmentation can affect species dispersal and migration through its effects on forest connectivity. Having evolved within the ecosystems of large intact forests, many species are ill-adapted to life outside the forest interior, either in forest edges or in the patches carved from it (*Tole, 2006*). One of the main reason for deforestation in Mirzapur is because of over-dependence on forests for livelihood. In a survey done in sub-district Marihan in Mirzapur, it was reported that 92.86% of households are dependent on fuelwood for cooking purposes with average requirement of fuelwood per family is 6.87 Kg per day *(Sinha, 2011)*. Owing to the fact that Mirzapur- Sonbhadra region has the largest area of land under forests and has very poor monitoring, it is undoubtedly has become a centre for fuelwood export and commercial wood for neighbouring districts. We also observed old trees being cut from stem in some of the forest areas. In Dramadganj range, during our survey the forest staff caught local villagers red-handedly with two bi-cycles with at least 400 kg of wood each and confiscated the same. Similar aggressive counter-action was also observed in Marihan forest range. However, in both of the cases, no formal complaints were reported on humanitarian grounds and they were left after being strictly warned and noting their name and address. During our survey, we have also observed deforestation carrying out openly, in some cases in presence of forest department staff as well (in Sukrit & Chunar range).

Goparaju & Sinha, 2015 reported that in Mirzapur, very dense forests (>70% canopy) present in the year 2010 has disappeared in the year 2013. However, the dense forests (>40% canopy), scrubland, grassland and agricultural lands have increased in 2013.

EXAMPLE 2: DEFORESTATION OF WYNDHAMFALL RANGE AND BARKACHHA FORESTS

During our survey, we interacted with few local tea stall owners who have been running their shops since past many years in Belahada Mode (1 km from BHU South Campus, Barkachha). We were surprised to know that Sloth Bears, Sambhars and Leopards were used to found even upto Barkachha forests until 6-7 years ago, but after establishment of BHU South Campus and subsequent development of the area the forests became very much disturbed and they have hardly spotted any Sloth Bear or Sambhar in the area. The forest department staff told us that Sambhar deer were used to be spotted easily in Marihan forests until last 3-4 years, but now they are hard to spot. We were informed by a known local resident of Barkachha that a Leopard was killed 3-4 months ago (in year-end of 2015) and villagers buried the animal and according to him that incident was never reported to Forest Department. He added similar incidents has occurred in the past as well. We were also informed by the students of BHU South Campus that few months ago a full grown Bengal Monitor was killed by Hostel attendants of Vindhyachal Hostel in the campus. We were further informed that Kraits and Cobras whenever spotted inside the campus

are killed by the attendants and guards. Though Barkachha has denuded hills with very less forest cover, but the fact Lower Khajuri Reservoir is situated in Barkacchaa which is adjoining Wyndhamfall range where large tracts of severely degraded and denuded hills are found, during dry seasons animals often cross through the Wyndhamfall range to the water reservoir to access water.

7.3 EXCESSIVE GRAZING

Excessive grazing in a forests may reduce structural complexity and species richness resulting in deleterious changes (*Milner et al., 2002*; *Mysterud and Østbye, 2004*; *Pollock et al., 2005*). The development of tree seedlings to maturity or attaining canopy status is prevented by grazing (*Hester et al., 2000*), adversely affecting the continuity of entire forest ecosystems (*Pulido et al., 2001*; *Mountford and Peterken, 2003*; *Plieninger et al., 2004*; *Dufour-Dror, 2007*). According to *Pulido and Díaz (2005)*, the main direct damage seems to occur at the 'seedling emergence and establishment stage' when livestock graze, browse or trample the seedlings. This prevents recruitment of juveniles (*Hester et al., 2000*). When the regeneration process is continuously hampered, it may then lead to progressive decay of the forest cover (*Leiva and Fernandez-Ales, 2003*; *Quézel and Médail, 2003*; *Plieninger et al., 2004*; *Dufour-Dror, 2007*). Unlike seedlings, juveniles may not be killed straightway when browsed, however, their development can be severely hampered as the maximum efficiency of photosynthesis is reduced by having insufficient leaf area of photosynthetic tissue (*Putman, 1996*). According to *Belsky and Blumenthal, 1997* the effects of livestock grazing and trampling on vegetative cover vary with rainfall, slope, soil stability and vegetation type, as well as with animal density, season of use, duration of use and animal distribution.

Chaturvedi et.al., 2012 carried out a study on effect of grazing and harvesting on forests in this landscape and found that number of newly damaged juveniles was greatest in June and lowest in September. They reported that in the TDF found in this region, grazing/browsing by livestock and harvesting by humans are the major causes of damage to juvenile trees, in addition to the long drought periods within the annual cycle. The site which had the greatest level of disturbance in terms of damaged juveniles, also contained the lowest number of species and juvenile stems.

Grazing also leads to higher soil compaction and erosion of topsoil further deteriorating the soil conditions which won't support natural regeneration of forests.

The conversion of forest to pasture causes changes in topsoil morphology, increased water erosion, mass movements, soil compaction by trampling and alteration of the hydrologic cycle, among others (*Oram, 1990*). Trampling causes changes in physical soil properties. Infiltration is reduced, while runoff, erosion and bulk density increase (*Rouzi and Hanson, 1966*; *Blackburn et al., 1982*; *Van Haveren, 1983*; *McCalla et al., 1984*; Reátegui et al., 1990). The subsurface layer (usually at 5–10/15 cm depth) can be also affected by compaction, as reported for grazed pastures in tropical conditions (*Chauvel et al., 1999*).

As per *19th National Livestock Census (2012)* the total number of livestock in district Mirzapur is reported to be 956259 which was reported in *18th National Livestock census (2007)* as 898232. This means every year 11,605 livestock are added. With increasing number livestock population and reduction in forest quality and quantity, it is imperative that the remaining forests are highly susceptible to impacts from excessive grazing.

Image 37 Grazing by domestic goat, sheep and cow were found to be common in the forest areas. (Photo: Debadityo Sinha)

7.4 ROADS, RAIL & CANALS

Roads are a large threat to some wildlife populations. Most studies of the effects of roads on wildlife focus upon animal-vehicle collisions (*Forman et al. 2003*). However, it has also been suggested that roads act as complete or partial barriers to movement for some species (e.g. *Oxley et al. 1974*; *Mader 1984*; *Swihart&Slade 1984*; *Brody &Pelton 1989*; *Burnett 1992*; *Rondinini & Doncaster 2002*; *Shine et al. 2004*; *Whittington et al. 2004*). Such a barrier effect could fragment habitat and reduce population persistence by reducing recolonization of empty habitats and/or limiting immigration. (*McGregor et.al., 2008*) *Jaeger et al. (2005)* discussed three types of possible road avoidance and argued that the type of avoidance largely determines the mechanism and strength of road effects on a population. The three types of avoidance behaviour are: (i) animals may avoid the road itself as it is a hostile environment onto which they will not venture (called 'road surface avoidance'); (ii) animals may avoid emissions from traffic such as fumes or noise, keeping them some distance away from the road ('general traffic avoidance' or 'noise avoidance'); or (iii) animals may avoid individual vehicles, waiting for a break in traffic before attempting to cross the road ('car avoidance').

Image 38 SH-5 cutting through the Marihan forest range (Photo: Debadityo Sinha)

SH-5 (Mirzapur-Roberstganj) and Chunar-Rajgarh road has severely impaired the landscape connectivity of the continuous forests of Marihan range. The under construction Bansagar canal on northern and eastern side of the range will further restrict the range's free connectivity with other landscape. Though various rivers are found in the entire forest range, but these rivers do not hinder wildlife movement as the water flow in such rivers are limited only to wet season and during dry season, they allow free movement of animals. This is not in the case of artificial water canals which flows year round with significant depth restricting animals from crossing it. The 20 km railway corridor proposed by Welspun Energy U.P. (Pvt.) Ltd from Sarsogram to Dadri Khurd will further fragment the entire forest range in two halves which will severely affect the wildlife habitat and movement in this range.

Similar bifurcation of forest is seen in Sukrit range and Dramadganj range where SH-5A and NH-7 respectively cuts through the forests making it difficult for wild animals to cross the road due to movement of traffic day and night. This has greatly hampered the free movement of wild animals from neighbouring wildlife areas.

In all cases, we have observed significant land use change in areas around the roads. For eg. There are sandstone mines which came up recently in Sukrit range adjoining SH-5A and numerous illegal mines also opened up in surrounding areas. The forest areas around

roads are cleared for development of residential colonies, shops and petrol pumps which cumulatively add up to the forest-gap creating great hindrances to not only movement of animals but also increasing the habitat fragmentation. This phenomenon is becoming a reason of local extinction of animals as the ecological niche of the animals are greatly reduced due to constriction of home range, restriction of migration and increasing inter-specific as well as intra-specific competition.

7.5 FOREST FIRES

Forest fires are common in the forests of Mirzapur. The forest fires occur mostly in dry seasons. Local villagers believe that plantation of bamboo is the main reason that fire ignites easily in the forest ranges. Forest department staff had mixed explanation of such fires, and they claimed that in few incidents in past they have got evidences of human induced fires like presence of burnt bidi or match sticks from the fire affected areas. In Patehara forest range, a forest guard informed that forest fires are also used as a tool to clear and encroach forests for agricultural uses.

Human induced forest fires is common in most tropical dry forests. Many scientists agree that almost all of them are caused by humans (*Brandis 1897*; *Pyne 1994*; *Bahuguna and Upadhyay 2002*; *Semwal et al. 2003*), some unintentionally, but the majority are assumed intentional. 95% of forest fires are caused either by negligence or unknowingly by the human being (*Satendra & Kaushik, 2014*).

One of the dominant motivations to ignite fire in Indian TDFs is to increase the availability and quality of grasses for pasture use. Possibly of equal importance on a global level is the utilization of fire to facilitate hunting. Hunters use fire in two ways: (i) to drive prey to where it can be easily killed (*Lewis 1989*) and (ii) to prepare hunting grounds by attracting prey to the fresh flush of grasses (*Laris 2002*; *Mistry et al. 2005*). Moreover, burned sites make hunting easier because the animals are easier to see. Fire was used by early inhabitants of India for hunting (*Goldammer 1993*; *Satyendra & Kaushik, 2014*).

The most famous and often-cited example is the use of *Diospyros melanoxylon* tree leaves (tendu leaves) that function as cigarette paper for the small Indian cigarettes called ‘‘beedis’’ (*Saigal 1990*; *Goldammer 1993*). Fire is applied to the forest in the dry season (mainly April–May) so that the trees produce new leaves which can be harvested once they are fully green (*Hunter 1981*).

A product that does not depend mainly on the modification of vegetation is the ash production by the burning of (mainly) forest land adjacent to agricultural areas which can serve to fertilize the agricultural areas when the ash gets transported by water—especially on slopes—or by wind (e.g., *Vayda 1996*; *Shaffer 2010*). *Pyne (1994)* states that this was a common practice prior to the British period and *Roveta (2008)* found evidence for such fire application among the Soliga tribe in the Biligirirangan Hills, Karnataka. However, for India this relation hardly appears in the available literature and is not known what proportion of this application holds among other reasons for forest fires.

There is abundant evidence that high fire frequency hinders woody plants from establishing in savannah and TDF ecosystems (e.g., *Hopkins 1992*; *Setterfield 2002*; *Favier et al. 2004*; *Sankaran et al. 2008*; *Ratnam et al. 2011*) while the season in which fire occurs influences the density and composition of the regenerating species (e.g., *Bond and van Wilgen 1996*).

Frequent fires seem to maintain a soil seed bank of short term plant species (Graminoids) over life forms with a longer-term life cycles like broadleaved herbs and woody plants (*Gashaw et al. 2002*). Fire also promotes fire-tolerant species (*Furley et al. 2008*). This selective attribute of fire also reduces tree seedling species diversity as *Saha and Howe (2003)* found in a TDF in central India and *Verma and Jayakumar (2015)* as well as *Kodandapani et al. (2009)* report form TDF of the Western Ghats.

An increase in fire intensity and frequency leads to the transformation of forests to savannah or grasslands. An area locally affected by wildfires may substantially loose short-term water retention if heavy rainfall occurs after the dry period.

Fire also affects the biodiversity and therefore the functions of ecosystems, especially those depending on species interaction like pollination and dispersal.

7.6 HUNTING

In almost all forest ranges where wildlife is present we found that hunting is openly practiced. Mirzapur has been a traditional hunting ground during British government and there was a time when the district had abundance of Cheetahs, tigers, leopards, sloth bears, caracals and several species of antelopes which diminished slowly mainly due to hunting and habitat loss. We were shocked to realize that hunting activities are going unabated in these forest range till now. Wild boar and deer species are mostly hunted by people. We also got information from the villagers that people from nearby cities come in vehicles during night, often accompanied by trained dogs to hunt herbivores.

There is no reason to disbelieve the same because we also got to know from forest department that the forest guards generally avoid going in forests after sunset due to fear of Naxalites and that may have resulted into unchecked entry of the hunters into the forests of Mirzapur. There are also occasions where villagers kill wild animals like leopard, hyena, fox and sloth bears in an unexpected confrontation. A large number of such incidences go unreported.

We were informed by some local people that a sloth bear was killed in a village in Marihan range around January-February, 2016 by a food item packed with explosive which is usually used to kill wild boar. A forest guard informed that a person was arrested in Chunar 2-3 years ago, who was selling a sloth bear cub he poached from Marihan forest range. A local shopkeeper of Barkachha informed that a leopard was killed by villagers in Barkachha (approx. 10 km from Marihan) around December, 2015 and was buried. A tea stall owner at Marihan informed that a person was killed in March, 2015 by an electric wire which was laid to kill wild animals. Very recently, a hyena was killed by villagers due

to the fear that it will lift their livestock and children. The forest staff of Dramadganj range informed that 2 sloth bears were shot dead few years ago which was believed to be due to unexpected confrontation by people who went for hunting herbivores. There was common unanimity among all people we interacted about hunting of animals in forests, especially of wild boars. We are also sceptical of these reserve forests serving the illegal market dealing with trade of sloth bear parts.

7.7 EXOTIC SPECIES

Invasion of species may lead to local declines (*Islam, 2001*) and even extinction of native

Image 39 A Hyena which was killed by villagers on 27th March, 2016 near village Bhadauli, Mirzapur (Photo: local journalist)

species (*Pimm, 1986*) thus altering species richness in the forest fragment (*Carey et al., 1996*). Invasive species can alter ecosystem function by changing disturbance frequency or intensity (*D'Antonio and Vitousek, 1992*; *Fensham et al., 1994*; *Smith, 1994*; *Mullett and Simmons, 1995*), altering trophic structure (*Cross, 1982*; *Hobbs and Mooney, 1986*; Braithwaite et al., 1989) and changing resource availability (*Vivrette and Muller, 1977*; *Vitousek and Walker, 1989*; *Boswell and Espie, 1998*). Among these factors, disturbance may favour invasions by disrupting strong competitive-species interactions (*Fox and Fox, 1986*; *Crawley, 1987*) and locally increasing different limiting resources (*Hobbs, 1989*).

A. LANTANA CAMARA

Lantana (*Lantana camara L.*) has spread in almost all the fragmented areas in the Vindhyan dry deciduous forest, and has been ranked as the highest impacting invasive

species (*Batianoff and Butler, 2003*), because it possesses great potential to escape cultivation and have deleterious effect on species richness (*Islam, 2001*). In India it was introduced in early nineteenth century as an ornamental plant (*Sharma, 1988*), but now it is growing densely throughout India (*Sharma et al., 2005 a, b*).

Light availability on the forest floor has been recognized as a key factor that influences intrinsic traits of inhabiting species (*Jones et al., 1994*; *Walters and Reich, 1996*). The dense cover created by vertical stratification of lantana may reduce the intensity or duration of light under its canopy and thus decrease the herbaceous cover. *Sharma and Raghubanshi (2011)* reported that Lantana is not found in forests where the canopy cover was at least 63%.

It is likely that herbs are influenced by the amount of light that reaches the forest floor, and this may be probably one of the mechanisms responsible for the decline of herbaceous vegetation. *Sharma and Raghubanshi, 2006 & 2007* advocated that the growth architecture pattern of lantana is such that it prevents the light penetration to the forest floor, leading to the decline of tree seedlings and possibly the herb flora.

Lantana also possesses the capability to trap wind-blown litter. This trapping of litter is also dependent on lantana cover, as denser the lantana cover, greater the trapping potential. So, more organic matter accumulates/builds up with increasing lantana cover.

Image 40 Invasion of Lantana in Sukrit Forest Range (Photo: Debadityo Sinha)

Accumulation of litter beneath the lantana canopies builds up soil organic matter. Accumulation of soil N closely follows that of soil organic matter because, on average 99% of the N in terrestrial ecosystem is organically bound (*Rosswall, 1976*). *Raghubanshi (1992)* reported strong positive relation between total N content and organic C content

of soil in the dry deciduous forest ecosystem. This self-perpetuating changed microhabitat could probably provide lantana with increased resource leading to its successful proliferation. Therefore, the presence of *L. camara* in the dry deciduous forest alters the spatial pattern of herbaceous layer vegetation and also changes the microhabitat conditions which could probably help towards its successful proliferation.

B. HYPTIS SUAVEOLENS

Image 41 Hyptis invasion as appears in dry season, Marihan (Photo: Debadityo Sinha)

Image 42 Hyptis invasion as appears after monsoon, Marihan (Photo: Debadityo Sinha)

Hyptis suaveolens or Bushmint may be considered as one of the most serious invaders in the Vindhyan dry deciduous forest of India after *Lantana camara* (*Sharma et al. 2008*). Locally known as *Bantulsi,* it is an erect annual woody herb, commonly 1 m in height (maximum height = 1.5 m), and reproduces by seed (*Willis, 1973*). It is one among the world's most noxious weeds, which are invading natural ecosystems across tropical and sub-tropical regions of the world (*Afolayan, 1993*; *Sarmiento, 1984*; *Wulff and Medina, 1971*). It is a native of tropical America. Because of its widespread occurrence in the tropics, it is now regarded as a pan-tropical weed. In India. Bushmint occurrence is reported from North-East India, Vindhyas, Deccan Peninsula, and Andaman and Nicobar Islands (*Wealth of India, 1959*; *Yoganarasimhan, 2000*).

Hyptis suaveolens is a prolific seed producer and dense infestations can yield up to ~3000 seeds m^{-2}, forming persistent propagule banks within a short period. The seeds are slightly notched and they are protected by spined burrs that help in the seeds' dispersal through animal fur (*Stone 1970*; *Parsons & Cuthbertson 2000*). It is found on a variety of habitats, like railway tracks, roadsides, foothills of open forests, and forest clearings, and

can heavily invade wastelands, particularly on arid and rocky substrates (*Verma & Mishra 1992*; *Mudgal et al. 1997*).

Raizada (2006) suggested that species loss in the area occupied by *H. suaveolens* was related to its unpalatability to livestock and, thus, selective avoidance, resulting in other species being heavily used as fodder by livestock. (*Sharma et.al., 2009*)

In its native range, the local dominance of bushmint in savannahs was associated with the anthropogenic disturbances viz., removal of vegetation, fire, over-grazing, and tillage (*Holmes 1969*; *Wulff 1987*). It was widely present in the areas where mechanized agriculture and intensive cattle raising were practiced (*Holmes 1969*). In the invaded range, it is commonly found alongside roads and water courses, open forests, and the over-grazed pastures. Bushmint forms large thickets and is believed to produce allelochemicals, which impede seed germination of native species. The traits which make bushmint a potent invader are: prolific seed production (*Raizada 2006*), high dispersal ability (*Parsons and Cuthburtson 2000*), phenotypic plasticity to a variety of habitats (*Sharma and Raghubanshi 2009*), proliferation from perennial rootstocks (*Raizada 2006*), unpalatability to livestock (*Holmes 1969*), and probable allelopathy effects on native species (*Raizada 2006*).

We found *Hyptis* invasion very prevalent in Marihan range and Patehara range as compared to other forest ranges. In both cases, they were more dominant in periphery areas and where large openings were present.