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Status of *Mikania micrantha* Invasion in the Rhino Habitat of Chitwan National Park, Nepal

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Abstract

Mikania micrantha (Mikania) is one of the world's 100 worst weeds and the primary invasive species in Chitwan National Park (CNP), Nepal. Following a Mikania survey in 2008, an additional survey was carried out in 2011 as part of greater one-horned rhinoceros (rhino) censuses to measure the extent of change of Mikania invasion in major rhino habitats in CNP. 2008 survey protocols were adopted: a plot including a half-circle of 50 m radius in front of a researcher was surveyed from elephant back for the ocular estimation of Mikania cover. Mikania coverage was quantified in the scales of 0, 1 and 2 where 0 - Mikania absent, 1 - Mikania present but less than 50 % coverage and 2 - Mikania covering more than 50% of the plot area. Mikania was found present (1 and 2 combined) in 43.3% (n=3073) of the plots in 2011 and this was approximately the same as of 2008. In 2011, as in 2008, the preferred rhino habitats - wetland, tall grassland, riverine forest - were found to have higher level of Mikania invasion than other habitats. In between the three years of the assessment percentage of the plots in category 2 (more than half of plots covered by Mikania) has increased by 3.45% from 14.50 % in 2008 to 17.95 % in 2011. Overall, Mikania has not spread out in new areas but intensified where it was already present. Thus there is still the threat of Mikania high infestation on the area where it is present.

Keywords: *Mikania micrantha*, extent of invasion, rhino habitat, Chitwan National Park.

Introduction

Naturally occurring usually in low abundance in its native range i.e. tropical and subtropical Central and South America, *Mikania micarantha* (hereafter 'Mikania') is a notorious weed in most of the South and South-East Asia (Murphy *et al.*, 2013; Barreto and Evans, 1995). It is one of the 100 worst invasive plants, also commonly known as mile-a-minute weed because of exceptionally faster growth rate (Holm *et al.*, 1977). It poses high risk of smothering and sometimes killing the native flora and affects both natural ecosystem as well as agricultural areas. Mikania is the most problematic invasive plants in tropical Nepal which already have spread in twenty Terai and Siwalik districts (Rai, 2013; Siwakoti, 2007) in the south of the country. It was first reported in Nepal from the eastern district of Ilam in 1963 (Tiwari *et al.*, 2005) and appears to be spreading aggressively westwards up to Dang along the terai (grassland–forest) habitats of Southern Nepal (Murphy *et al.*, 2013). Three protected areas i.e. Koshi Tappu Wildlife Reserve, Parsa Wildlife Reserve and Chitwan National Park (CNP) have been already affected by Mikania invasion (Murphy *et al.*, 2013).

Mikania is the primary invasive plant of CNP. It is believed that Mikania reached CNP in early 1990s as nature guides reported this weed in low densities from the Rapti floodplain of Bhimle-Tiger tops area of Chitwan. The plant was identified positively as Mikania in 1997 (Murphy *et al.*, 2013). Many local people believe the Mikania is distributed throughout the park after a large flood in 1994; it did become widespread and abundant after another large flood in 2003, although no scientific explanation could be found (NTNC, 2009). Mikania is now abundant especially on the floodplains of the three major river systems i.e. Rapti, Reu and Narayani along with their tributaries.

The Mikania is one of the major concerns as it has been invading the prime one-horned rhinoceros

(rhino) habitats i.e. the alluvial floodplain grasslands, wetlands and riverine forests. A recent study in Chitwan by Subedi (2013) has shown the significant reduction on biomass production of rhino food plants in Mikania invaded areas. The home range of the rhino has also increased significantly which indicates the deteriorating habitat quality due to Mikania and other factors such as drying of water holes. It has the potential to destroy prime habitats of threatened and important species in CNP, a UNESCO World Heritage Site. Although it was a concern for park managers, researchers and other stakeholders, no systematic assessment of Mikania was carried out till 2008. Along with a rhino census, an assessment in 2008 measured the actual extent of the invasion in all rhino habitats of CNP which showed 44% of the rhino habitat is already being invaded by Mikania (Murphy, 2013; DNPWC, 2009). This study is based on the other replication of such assessment which was conducted in 2011 in conjunction with another rhino census. Thus, the primary objective of the study was to measure the extent of Mikania, invasion in CNP and to assess how the extent of Mikania invasion has changed in three years from the previous 2008 survey. But the opportunity was also taken to measure the extent of two other important invasive plants in CNP: *Chromolaena odorata* (= Chromolaena) and *Lantana camara* (=Lantana).

Study Area

Chitwan National Park (27°16.56' - 27°42.14'N and 83°50.23' - 84°46.25'E), a World Heritage Site and the first National Park (1973 AD) of Nepal, is home for second largest population of greater one-horned rhinoceros (hereafter rhino) (CNP, 2012). Covering an area of 932 km² in core and 750 km² in buffer zone, the park is situated in south central lowlands of inner Terai (Figure 1). The majority of the park is dominated by forest (sal, riverine and mixed hardwood) 80 %, grassland 12%, exposed surface 5% and water bodies (3%)

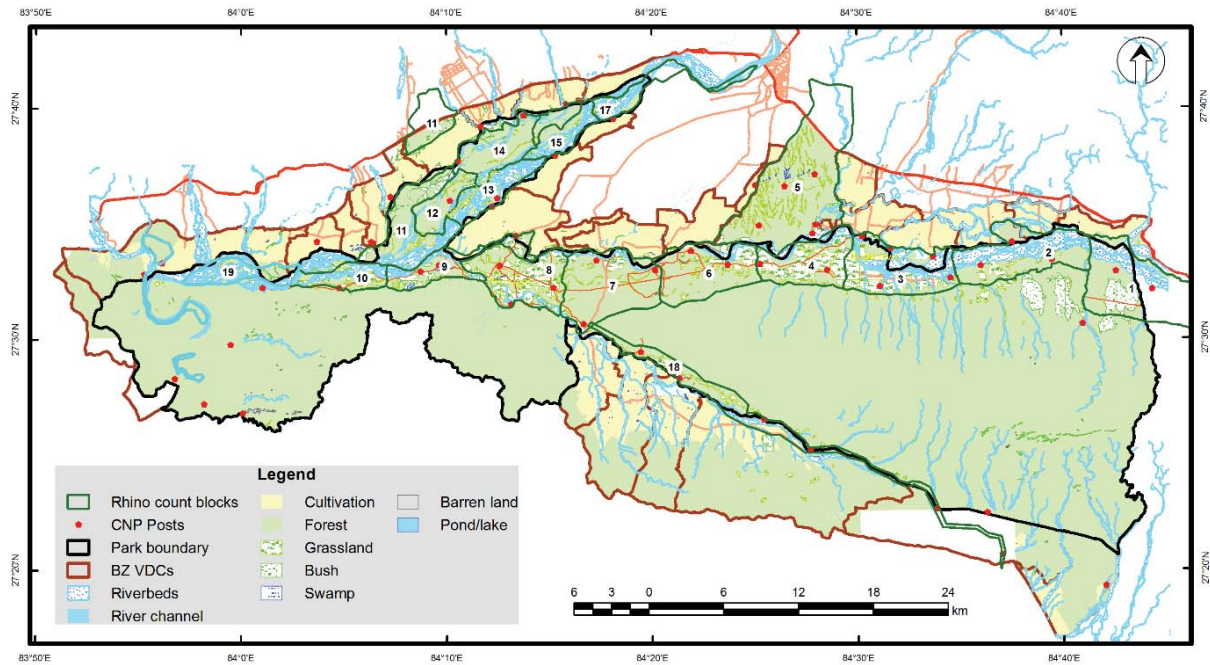


Figure 1. Map of CNP, Buffer zone and rhino count blocks (2011)

(Thapa, 2011) and is drained by three major river systems i.e. Narayani, Rapti and Reu. The Narayani River marks the western boundary, the Rapti River marks the northern boundary, the Parsa Wildlife Reserve is contiguous at the eastern boundary and the Reu River and the international border with India along the Valmiki Tiger Reserve marks the southern boundary of CNP. The park has monsoon dominated sub-tropical climate with average monthly maximum temperature 24 - 38 °C, monthly minimum temperature 11 - 26 °C, average rainfall 2,437 mm/year (2004-2007) and relative humidity 89-98% (Thapa, 2011). About 70 mammal species, over 600 bird species, 49 species of reptiles and amphibians, 156 species of butterfly, 120 species of fish have been reported from the park (CNP, 2012).

Methods

The assessment of the Mikania in the rhino habitats of CNP was carried out along with the rhino censuses in 2011 and followed the methods in Murphy *et al.* (2013) and DNPWC, 2009. The rhino censuses were carried out by a direct head

count method sweeping all the potential rhino habitat but not including the dry and hilly area of the park. The survey area was divided into 19 blocks (11–75 km²) respectively in 2011. Within each block 30–40 parallel strip transects were surveyed simultaneously from elephants. The distance between two transects was maintained at c. 100–200 m in open grasslands and 50 m in dense forests, to ensure areas were thoroughly covered. On each transect, an observer sits on the elephant back and looks for rhinos within his range.

The assessment of the Mikania infestation level was carried out through estimation of Mikania cover by each observer within an approximately semi-circular plot of 50 m in front, left and right of the elephant. The level of infestation was measured using a simple ranking of cover within the area through ocular estimation as: 0 - absence; 1 - Mikania present but coverage < 50%; 2 - High Mikania infestation covering > 50%. All the technicians and observers were trained on this measurement system to reduce the observer's biases. Assessments were made every c. 30 minutes during the census and thus sampling was approximately proportional

to the area covered by each habitat. In 2011, an assessment was also carried out for the other major invasive plants, *Chromolaena* and *Lantana* using the same scale of 0, 1 and 2 in each of the plots (DNPWC, 2011).

The survey block, type of habitat and GPS position of each plot were recorded as covariates along with the level of *Mikania* infestation. The major rhino habitats that the rhino uses in Chitwan were divided into six types: riverine forests, subtropical mixed hardwood forests, Sal forest, tall grassland, short grassland, and wetland (Murphy *et al.*, 2013; DNPWC, 2009). The information on the recorded sheets was checked and entered into a spreadsheet at the end of each survey day. The level of invasion of *Mikania* was summarized as frequencies of plots invaded in each habitat. Rhino count data was similarly summarized in relation to habitats assessed. The *Mikania* data was mapped using ArcGIS v. 10.0 (ESRI, Redlands, USA).

Rhino density based on sighting records was calculated in ArcGIS Kernel density estimation method (output grid size - 1 ha, buffer 2 km). This rhino density value was assigned to each *Mikania* assessment plots using 'Extract values to point' tool in ArcGIS. Average rhino density for the three categories of *Mikania* coverage was calculated. Comparative analysis of the overall and habitat wise *Mikania* coverage between the assessments of 2008

(Murphy *et al.*, 2013; DNPWC, 2009) and 2011 was done in MS-Excel 2007.

Results

1. Assessment of Mikania, Chromolaena and Lantana distribution and incidence

In the 2011 study, a total of 3073 locations were assessed to measure the distribution and level of invasion by *Mikania*, *Chromolaena* and *Lantana*. The area surveyed was 504 km² and took 3,194 elephant hours to complete. As the assessments were taken uniformly across the habitats, the total number of assessed plots in each habitat provides a relative measure of the geographical size of the habitats.

Overall, 43.29 % of plots contained *Mikania*. Of these, 17.95 % of plots had severe *Mikania* invasion (>50% coverage (Table 1). Wetlands were the most invaded habitats by *Mikania* with its presence on total 76 of the plots including 40 % of the plots highly invaded (covered < 50%). Habitat types in descending order of invasion level were wetland, riverine forest, tall grassland, sub-tropical mixed forest, short grassland and Sal forest (Table 1). The distribution of levels of invasion of *Mikania* across CNP is shown in Figure 2.

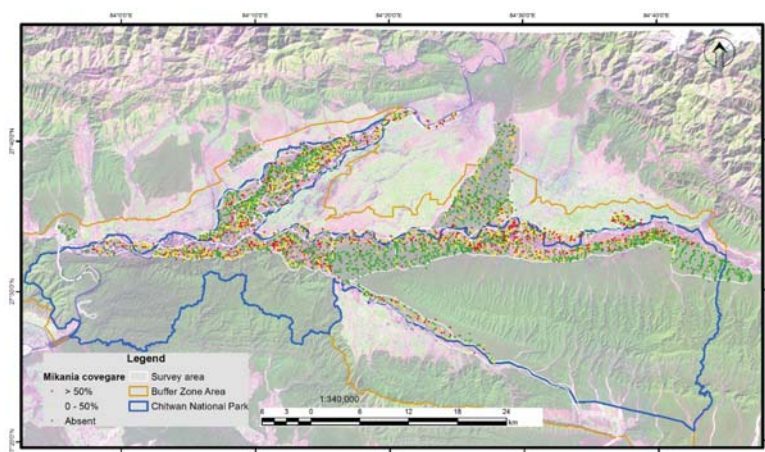


Figure 2. Distribution and level of *Mikania* invasion in CNP, Nepal (2011)

Table 1. Level of Mikania, Chromolaena and Lantana invasion in CNP, Nepal (2011).

Vegetation type	No of plots	Mikania			Chromolaena			Lantana		
		0	1	2	0	1	2	0	1	2
Riverine Forest	949	39.99	32.98	27.03	65.12	24.39	10.48	83.03	10.91	6.06
Sal Forest	602	85.88	9.88	4.24	73.42	19.77	6.81	97.51	1.74	0.75
Tall Grassland	828	49.64	30.19	20.17	79.47	14.61	5.92	92.51	4.35	3.14
Sub-tropical mixed forest	235	58.85	26.44	14.71	75.48	19.83	4.69	88.49	8.32	3.20
Short Grassland	251	61.75	25.9	12.35	70.12	22.31	7.57	91.63	8.37	0.00
Wetland	80	23.75	36.25	40.00	26.25	38.75	35.00	78.75	11.25	10.00
Not Specified	68	91.18	5.88	2.94	89.71	7.35	2.94	98.53	1.47	0.00
Other	60	65.00	23.33	11.67	68.33	28.33	3.33	86.67	11.67	1.67
Total	3073	56.71	25.34	17.95	70.63	21.08	8.3	89.4	7.02	3.58

Similarly, Chromolaena and Lantana were present in 29.37 and 10.6 % of the plots and a high level of invasion was observed from only 8.30 and 3.58 % of the plots respectively. Wetland was the most invaded habitat by Chromolaena and Lantana too. The descending order of Chromolaena invasion

on different habitat types were wetland, riverine forest, short grassland, sal forest, sub-tropical mixed forest and tall grassland. Likewise, Lantana invasion in different habitats in decreasing order were wetland, riverine forest, sub-tropical mixed forest, short grassland, tall grassland and sal forest.

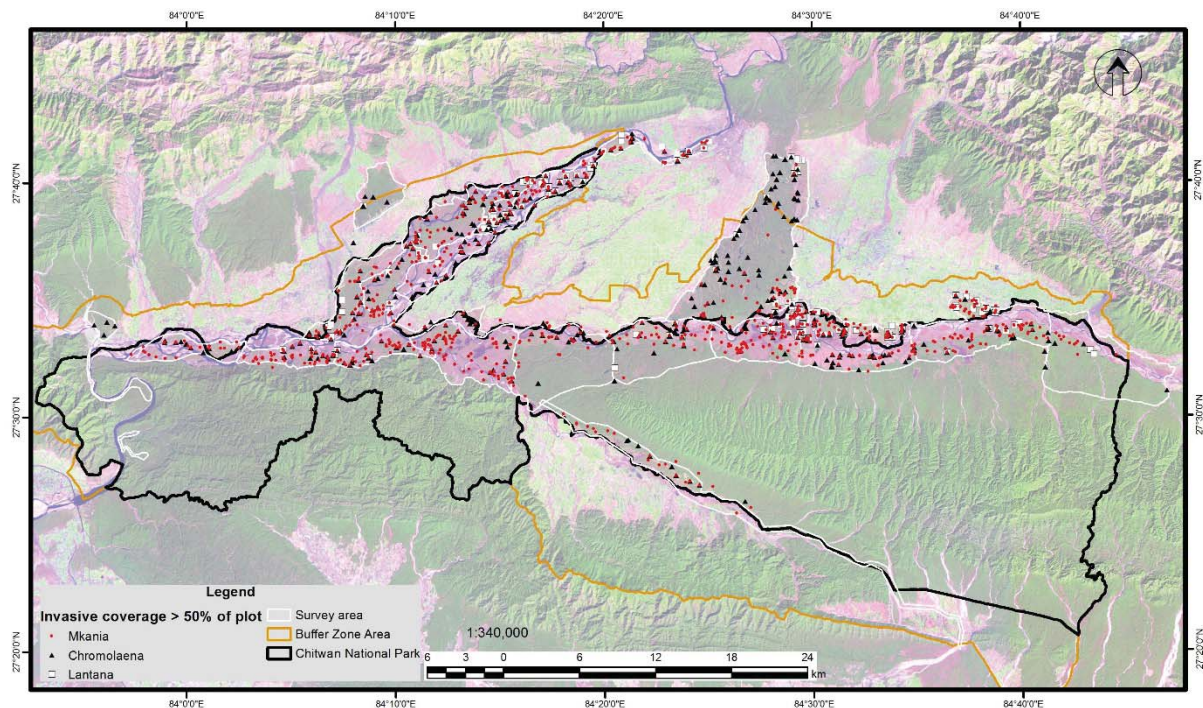


Figure 3. Distribution of high invasion of Mikania, Chromolaena and Lantana in CNP, Nepal (2011).

Table 2. Mikania and other invasives in CNP (2011)

		Mikania			Total
		0	1	2	
Chromolaena	0	45.94	15.21	9.47	70.63
	1	8.15	7.99	4.94	21.08
	2	2.61	2.14	3.54	8.30
Lantana	0	54.30	21.28	13.81	89.40
	1	1.83	2.94	2.24	7.02
	2	0.58	1.11	1.89	3.58
Total		56.71	25.34	17.95	100.00

The combined analysis of Mikania and Chromolaena showed that 55.06 % of the surveyed habitat have been invaded by either Mikania or Chromolaena or both (Table 2). A small portion of overlap is observed between Mikania and Chromolaena invasion (category 1 - 7.99% and category 2 - 3.54). Nearly a quarter (24.68%) of the total plots having Mikania were found free from Chromolaena 10.67% plots with Chromolaena were free from Mikania.

This further explains the ecology of these two species whose favorable habitat is different, Mikania is found more in moist areas whereas Chromolaena is found in drier areas. But interestingly Chromolaena has been recorded from many wetland areas (73.75% of total 80 plots) which is not usual. This could be due to oxbow lakes in

the river floodplains which acts as primary wetland sites in Chitwan. As these sites have high chance of getting flood which brings the Chromolaena seeds/ plant from the upstream and when flood dries up, these seed/plant finds a way to colonize.

2. Mikania and rhino

Mikania was distributed widely in all potential rhino habitat across CNP. The highest rhino density was recorded from tall grassland followed by wetland, short grassland, riverine forest, sub-tropical mixed forest and sal forest (Table 3). The average rhino density for all plots was found to be 1.18 rhinos/ km². Although there is no significant difference ($F_{df(3)}=0.28, p=0.83$) of the rhino density between the different Mikania invasion levels, the average rhino density on the plots with Mikania invasion was found to be higher.

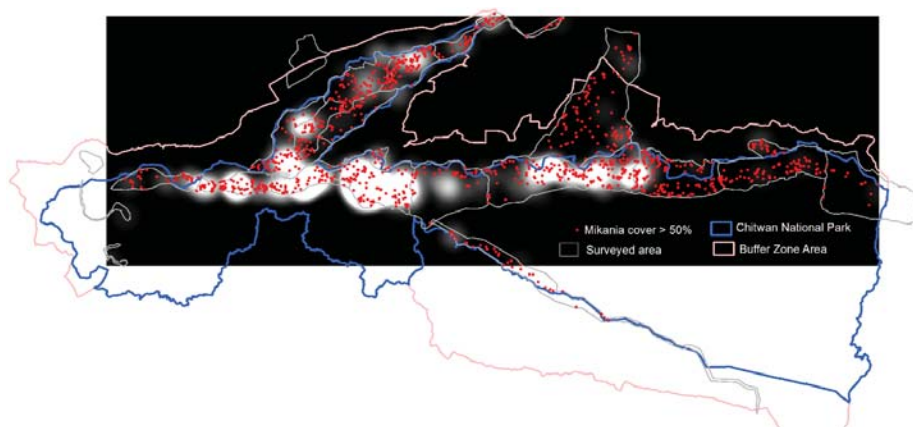


Figure 4. Mikania Invasion and rhino density in CNP (Increasing brightness shows the higher rhino density)

Table 3. Rhino density and Mikania invasion

Habitat type	Number (& %) of rhinos recorded	Average rhino density on different Mikania invasion level			Total
		0	1	2	
Tall Grassland	199 (39.56)	2.57	2.04	2.09	2.32
Wetland	32 (6.36)	1.28	1.45	1.80	1.55
Short Grassland	25 (4.97)	1.26	1.53	1.72	1.39
Riverine Forest	160 (31.81)	1.05	1.16	1.12	1.11
Mixed Tropical	4(0.80)				
Hardwood		0.91	1.08	1.51	1.05
Sal Forest	22(4.37)	0.44	0.56	0.79	0.47
Other	7 (1.39)	0.41	1.5	0.43	0.69
Not specified	54 (10.74)	0.62	0.56	0.00	0.60
Grand Total	503	1.06	1.31	1.36	1.18

Table 4. Mikania infestation change over time (2008–2011).

Mikania infestation on assessment plots	% of assessed plots		Change (%)
	2008	2011	
0 - (No Mikania)	55.90	56.71	0.81
1 - Mikania < 50%	29.50	25.34	-4.16
2 - Mikania > 50%	14.50	17.95	3.45

3. Change on Mikania invasion in three years (2008 - 2011)

A total of 1,506 plots were assessed in 2008 using the same protocols of data collection and Mikania was found in 44.0 % of the plots (see Murphy et al., 2013) whereas in 2011 Mikania was found in 43.29% of the assessed plots (n=3,073). The plots with high Mikania infestation (> 50%) has increased by 3.45 % from 14.5% in 2008. This suggests, the rate of Mikania range expansion has stabilized in these three years but Mikania is intensifying on the areas where it is already present (Table 4).

If such intensification continues it may cover more than 40 % of the prime rhino habitats which could adversely affect on carrying capacity of the rhinos and other herbivores. Thus, Mikania poses an increasing threat in Chitwan.

In three years (2008–2011) Mikania infestation has increased in all the habitat types except subtropical mixed forest (Table 5). The maximum increase (intensification) was observed in wetland habitats (30.38%) which can be linked with the ecology of Mikania.

Table 5. Habitat wise Mikania infestation change from 2008 to 2011

Vegetation type	% of the plots having high <i>Mikania</i> infestation (> 50%)		% Increase from 2008 to 2011
	2008	2011	
Riverine Forest	26.02	27.03	1.01
Sal Forest	2.23	4.24	2.01
Short Grassland	1.02	12.35	11.33
Tall Grassland	19.86	20.17	0.31
Subtropical mixed Forest	51.33	14.71	-36.62
Wetland	9.62	40	30.38
Other	14.89	11.67	-3.23
Not specified	N/A	2.94	2.94
Grand Total	15.12	17.95	2.83

Discussion

CNP is one of the high priority national parks with high diversity. Spread of Mikania, Chromolaena, Lantana and other invasive plants pose a high threat to the park. Earlier studies have already proved that abundance and cover of the native food plants of herbivores decreases significantly in the Mikania invaded areas (Subedi, 2013; Sapkota, 2007). Mikania invasion was found to be higher in the more preferred rhino habitats such as tall grassland (39.56% rhino sightings), riverine forests (31.81 %) and wetland (6.36%) which is very consistent with the previous observations in 2008 (Murphy et al. 2013). The higher average rhino density on the plots with high Mikania invasion also indicates the strong incidence of Mikania in the rhino preferred habitats.

The 2011 assessment of the other two invasive plants i.e. Chromolaena and Lantana was also carried out in addition to the Mikania. These are also a threat to CNP. Chromolaena was found fairly widespread although higher level of invasion was occurred in pockets especially in drier sal forest and subtropical mixed forest habitats which is unsuitable for Mikania. Lantana was found only from few

pockets, thus still at the manageable level. Sporadic observation of the *Parthenium hysterophorus*, another notorious weed, is also recorded from CNP although actual extent and level of invasion is unknown.

From the comparative analysis of 2008 and 2011 data, the rate of Mikania expansion in new areas was found to have stabilized. This finding indicates that Mikania is widespread in the Park but there are ecological limitations to further spread. All of CNP cannot be suitable for the Mikania, thus it is now intensifying on the optimum habitats where it is already present. The overall impact of invasion has increased as Mikania has been colonizing in the areas where it is already present. A recent study of Subedi (2013), shows Mikania have devastating effects on rhinos when it covers more than 40% of the habitats. Rhinos during their foraging avoid the areas with such high invasion areas. Low to medium level invasion (<20%) is not a problem for rhinos (Subedi, 2013). The number of the plots with high Mikania invasion has increased by over three percent from 2008 to 2011. This three percent of the area which is converted from low mikania invasion to high is less suitable for rhinos.

References

- Barreto, R. W. and Evans, H. C. (1995), The Mycobiota of the Weed *Mikania micrantha* in Southern Brazil with Particular Reference to Fungal Pathogens for Biological Control, *Mycological Research*, 99(3), pp. 343–352.
- CNP (Chitwan National Park). (2012), *Management plan (2012-16) Chitwan National Park and Buffer Zone*, Department of National Parks and Wildlife Conservation, Kathmandu.
- DNPWC (Department of National Parks and Wildlife Conservation) (2009), *The Status and Distribution of the Greater One-horned Rhinoceros in Nepal*, DNPWC, Ministry of Forests and Soil Conservation, Government of Nepal, Kathmandu, Nepal.
- DNPWC (Department of National Parks and Wildlife Conservation) (2011), *Rhino Count 2011 Final Report*. Unpublished report. DNPWC, Ministry of Forests and Soil Conservation, Government of Nepal, Kathmandu, Nepal.
- Holm, L. G., Plucknett, D. L., Pancho, J. V. and Herberger, J. P. (1977), *The World's Worst Weeds—Distribution and Biology*, University Press of Hawaii, Honolulu, USA.
- Murphy, S. T., Subedi, N., Jnawali, S. R., Lamichhane, B. R., Upadhyay, G. P., Cock, R. and Amin, R. (2013), Invasive *Mikania* in Chitwan National Park, Nepal: the Threat to the Indian rhinoceros and factors driving the invasion, *Oryx*, 47(3): pp. 361–368.
- NTNC (National Trust for Nature Conservation) (2009), *Community Survey on Human-mediated Factors Driving the Spread of Invasive Alien Plant Species in Chitwan National Park*. Unpublished Report. NTNC, Kathmandu, Nepal.
- Rai, R. (2013), *Estimating the Benefits of Managing Invasive Plants in Subsistence Communities*. Ph.D. thesis. Deakin University, Australia.
- Sapkota, L. (2007), Ecology and Management Issues of *Mikania micrantha* Chitwan National Park, Nepal. *Banko Janakari*, 17: pp. 27–39.
- Siwakoti, M. (2007), *Mikania Weed: a Challenge for Conservationists*, *Our Nature*, 5: pp. 70–74.
- Subedi, N. (2013), *Effect of Mikania micrantha on the Demography, Habitat Use and Nutrition of Greater One Horned Rhinoceros in Chitwan National Park, Nepal*. Ph.D. thesis. Forest Research Institute University, Dehradun.
- Thapa, T. B. (2011), *Habitat Suitability Evaluation for Leopard (Panthera pardus) Using Remote Sensing and GIS in and around Chitwan National Park, Nepal*. Ph.D. thesis. Wildlife Institute of India, Dehradun.
- Tiwari, S., Adhikari, B., Siwakoti, M. and Subedi, K. (2005), *An Inventory and Assessment of Invasive Alien Plant Species of Nepal*, IUCN, Kathmandu, Nepal.