Conservation Science
Translating Knowledge into Actions

Assessing the Temporal Variation in the Perceived Effects of Invasive Plant Species on Rural Livelihoods: A Case of *Mikania micrantha* Invasion in Nepal

Rajesh Kumar Rai*, Roshani Rai

Summary

Aim This study aims to assess effects of invasion of Mikania micrantha on the livelihoods of rural communities and evaluates how perceived effects vary with the presence duration of invasive plants in a particular landscape.

Location The study was conducted in the buffer zone communities of two protected areas in Nepal—Koshi Tappu Wildlife Reserve and Chitwan National Park.

Materials and Methods Questionnaire interviews were performed among a total of 473 households from the target communities. The questionnaire mainly focused on a five-year gap evaluation of the current situation. The households were stratified into three strata based on their proximity to the forest and a systematic random sampling was used to select the households. Household heads of either gender were interviewed based on their availability during the visit.

Key findings The results show that time decay effects exist in the interface between invasive plants and rural livelihoods, as people gradually start to consider that these plants have self-grown in their landscape. However, the number of affected households increases with duration of the stay of invasive plants in the landscape.

Conservation implications The study shows that the perceived effects of invasive plants on rural households vary over time, and hence the response of rural households to the invasion. On the contrary, the perceived ecological effects of invasive plants remain the same. The results indicate the complication in managing the invaded area particularly in rural areas, which has forced the local people to use invasive plants such as Mikania in their daily lives in the absence of any strategy to control its spread. However, it can be concluded that Mikania cannot win the support of local communities in the invaded areas.

Keywords buffer zone, Invasive plants, *Mikania micrantha*, rural livelihoods, temporal effects

Short Communication

Article History:
Received 6 February 2013
Accepted 14 June 2013
Published Online 20 July 2013

Edited by - Uttam Babu Shrestha

*Corresponding author
Rajesh Kumar Rai
rjerung@gmail.com

Green Governance Nepal
PO Box 11759, Babarmahal,
Kathmandu, Nepal
Phone +977-1-4250827

Citation: Rai RK, Rai R (2013) Assessing the temporal variation in the perceived effects of invasive plant species on rural livelihoods: A case of *Mikania micrantha* invasion in Nepal. Conservation Science 1, 13–18

Funding: Not available

Introduction

Invasive plants are exotic species that threaten native species, and ecosystems, and cause economic damage (Olson 2006). The introduction of exotic plants however does not assure that they become invasive in new habitats. The exotic species has to go through different phases of invasion processes— introduction, colonization and naturalization— to invade the host ecosystem (Mack et al. 2000). There are three possible outcomes after arrival of new species in a novel environment (Crowl et al. 2008); they may either perish or persist but fail to spread, or begin to reproduce and naturalize.

A long stay of invasive plants in landscape means local people have a history of interacting with those plants (Rai et al. 2012b). Two distinct types of interfaces between invasive plants and rural livelihoods are observed—either rural household adapt to the particular species or they transform the plants into a valuable resource through appropriate technology (Kannan et al. 2008, Hall 2009). Adaptation is usually motivated by maximum opportunity cost of not using the invasive plant (Shackleton et al. 2007). As there are temporal and spatial variations on invasion patterns across landscapes, the effects of particular species may vary (Strayer et al. 2006). The understanding of livelihood effects of invasive plants in different stages of invasion would be helpful to prepare rural communities to combat with potential risks of invasion particularly in the newly invaded area and potential geographic areas at risk for invasion. This study investigates the temporal variations in the effects of *Mikania micrantha* on the livelihoods of buffer zone households in two protected areas in Nepal.

A case of Mikania micrantha invasion in Nepal

Mikania micrantha (hereafter, Mikania) — a neo-tropical climbing perennial weed— is one of the most important invasive plant species in many tropical and sub-tropical Asian countries including Nepal (Zhang et al. 2004, Willis et al. 2008). In Nepal, Mikania was first reported in 1963 from the eastern region and has continuously been spreading westwards (Tiwari et al. 2005). **Figure 1** shows the distribution of Mikania in Nepal (Rai et al. 2012a). This is one of the most problematic terrestrial invasive species in tropical parts of Nepal (Poudel et al. 2005). It has demonstrated its hostility by displacing native species particularly young plants (Sapkota 2007). Three protected areas—Koshi Tappu Wildlife Reserve (KTWLR), Chitwan National Park (CNP), and Parsa Wildlife Reserve (PWLR)— are affected by the colonization of Mikania. The first one is located in the eastern part and latter two are in the central part of Nepal with shared border.

Two protected areas, KTWLR in the eastern development region and CNP in the mid development region, were selected for this study concluding that Mikania infested the KTWLR earlier than the CNP. Households residing in the buffer zone of these protected areas were selected for the questionnaire survey. The buffer zone is the peripheral area of the protected areas including villages, settlements or hamlets declared by the Government (Government of Nepal 1996). It was established to minimize conflicts between local people and protected areas facilitating harmonious relationships (Stræde and Treue 2006). People manage forest patches in their vicinity as buffer zone community forest.

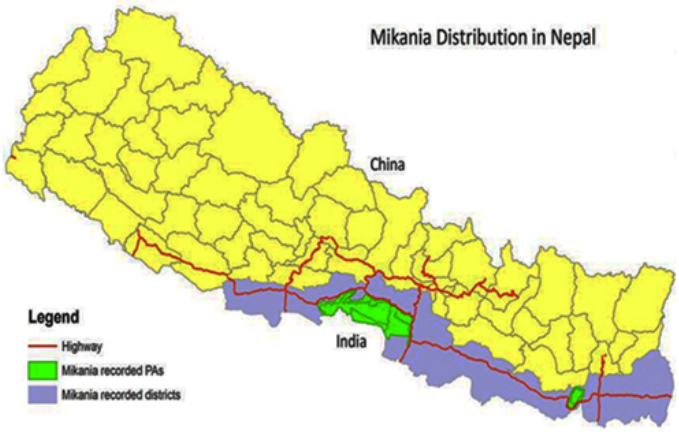

Figure 1: *Mikania micrantha* invasion in Nepal

Materials and Methods

A questionnaire interview was carried out in both buffer zones. 148 households in KTWLR and 325 households in CNP were interviewed. The questionnaire mainly focused on the evaluation of the current situation compared to that five years ago. The households were stratified into three strata based on their proximity to the forest— less than 1 km, 1-2 km and more than 2 km— considering the relationships between households' dependency on forest products and distance to the forest (Sapkota and Oden 2008). A systematic random sampling was used to select the households i.e. the first household was selected randomly and then every next tenth household, considering their locations on both sides of the street, was interviewed along with scattered houses as well. Household heads of any gender were interviewed based on their availability during the visit.

Table 1 shows the socioeconomic characteristics of sample households in the study areas. Agriculture is the dominant household livelihood option in both areas. Buffer zone households are diversifying their livelihood strategies as off-farm opportunities are increasing due to tourism and education. This indicates the importance of forest resources in their daily livelihoods. Respondents of both areas have almost similar education level and average landholdings.

Shackleton et al. (2007) proposed a conceptual framework to interpret the livelihood effects of invasive species. The framework illustrates how the effects of invasive species vary over time. According to the framework, invasive species like Mikania with high competitiveness and low use value have the most severe effects in the later phases of invasion. The study assumed that the livelihood effects of Mikania are relatively higher in KTWLR than in CNP.

Table 1: Socio -economic characteristics of sample households

	KTWLR	CNP	Description
Male	128 (86.5%)	183 (56%)	Number of male respondents
Female	20 (13.5%)	142 (44%)	Number of female respondents
Age	41.14 (9.81)	46.42(12.83)	Average age of respondents in years
Education	4.89 (3.16)	4.59(4.52)	Average education of respondents in year
Landholdings	12.68 (21.43)	11.16(7.15)	Average landholding size in kattha*
Family	8.08 (3.60)	6.26 (2.7)	Average family size
Income (Agr)	63 (43%)	214 (66%)	Number of households having agriculture as the source of family income
Income (both)	70 (47%)	10 (3%)	Number of households having both agriculture and off -farm activities as source of family income
Income (Off -farm)	15 (1%)	101 (31%)	Number of households having off farm activities as the source of family income

Note: Standard deviation in parentheses not followed by %.
*1 Kattha : is a unit of area which is equivalent to 338.57 square metres .

Results

Perceptions on Mickania carriers

All respondents were aware about the infestation of Mikania, as they recognized the vine by sight. **Figure 2** reports the causes of the transportation of Mikania in study sites as per the knowledge of the respondents. In KTWLR, respondents have three different views on the means of the transportation of Mikania. Of total 48% respondents believed that floods in Koshi River brought the species, 23% answered birds and wild-animals as the main carriers, while rest 18 % thought it was germinated naturally. In CNP, 76% of total respondents answered that they noticed Mikania after flood in the river occurred in 2002, while 15% believed that other natural agents such as air, birds and animals brought the species.

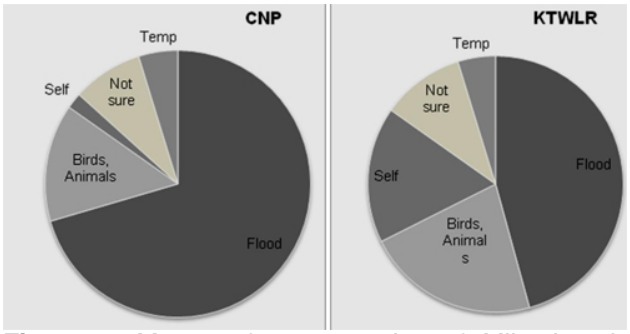

Figure 2: Means of transportation of *Mikania micrantha* (respondents' view)

Ecological aspects of Mickania

Table 2 depicts the evaluation of the ecological effects of Mikania in terms of spreading Mikania and the condition of community forest. In KTWLR, of respondents observed that the spread of Mikania has increased only 9% and 11% substantial portion of respondents considered that the spread has either decreased or no-change over the last five years respectively. In CNP, there was almost total consensus among respondents that the abundance of Mikania has increased over the last five years. Regarding the effects of Mikania on forest condition, it is almost similar in both sites.

Table 2: Evaluation of the invasion compared to five years ago (number of respondents in %)

Spread of Mikania	KTWLR	CNP	Forest Condition	KTWLR	CNP
Increased	78	99	Improved	-	-
No -change	11	-	No -change	25	25
Decreased	9	1	Degraded	70	73
Can't assess	2	-	Can't assess	5	2

Effects of Mikania on rural livelihoods

Table 3 reports the evaluation of livelihood effects of Mikania in terms of availability of basic forest products—fuelwood and fodder. The results showed that none of the respondents from CNP saw any positive effects in their livelihoods; while a small portion (6%) of respondents in KTWLR see positive effects of the invasion. Respondents were using Mikania as fodder in both sites. Mikania users constitute 37% and 7% of

total respondents in KTWLR and CNP respectively. However, comparatively higher number of respondents have downsized livestock herd in KTWLR.

Table 3: Livelihood effects of the invasion compared to five years ago (number of respondents in %)

	KTWLR			CNP		
	Effects of Mikania	Forest products availability	Livestock herd size	Effects of Mikania	Forest products availability	Livestock herd size
Positive	6	6	16	-	-	17
No-change	15	-	6	2	16	18
Negative	79	9	78	98	54	65
Can't assess	-	85	-	-	30	-

Despite the fact that community forest is contributing towards the provisioning of locally important ecosystem services and enriching biodiversity (Shrestha et al. 2010, Pandit and Bevilacqua 2011), there is a substantial reduction in the availability of forest products in these two buffer zones after the invasion of Mikania. In KWTLR, previously all respondents used to rely on community forest for fuelwood and now only 16% are doing so. Likewise, reliance of household in community forest to collect fodder decreased from 97% to 26%. In CNP, 63% respondents have decreased their frequency of visiting community forest, while 36% respondents didn't mention any changes. Similarly, 61% respondents evaluated that availability of fodder has decreased, while 34% self-assessed that there is no change and 5% considered it has increased. Likewise, 52% experienced a decrease in fuelwood, while 37% experienced no-change and 11% experienced it has increased.

Discussion

The analyses show a variation in interaction between rural community and invasive plants between two study sites. In general, population growth of invasive plants follows the logistic growth curve (Hobbs and Humphries 1995). This might be the reason why there is almost a consensus in CNP that the spread of Mikania is increasing. As the invasive plants become abundant over time but in decreasing rate in the latter phases, a substantial portion of the population in KTWLR does not see that it is increasing. Despite the fact that there is a variation in the evaluation of the pace of spread of Mikania, respondents of both study sites have similar experience about the effects of Mikania in their community forests. In general, the negative ecological effects of the invasion of Mikania are unequivocal (Sapkota 2007, Willis et al. 2008, Zhang et al. 2004).

The increasing abundance of Mikania in community forest implies that there is a lower availability of native species. As Mikania is considered as suitable species for the production of locally important forest products (Rai et al. 2012b, Siwakoti 2007), a decrease in the availability of forest products in the Mikania invaded forest is likely. The respondents practiced different strategies to respond the invasion of Mikania as fodder. These strategies include reducing reliance on community forest for forest resources, downsizing the household livestock herd and using Mikania. But the proportion of respondents reducing livestock size and not relying on community forest for forest resources is higher in KTWLR compared to CNP. This finding corroborates Shackelton et al. (2007) that livelihood vulnerability usually increases with the abundance of invasive plants.

In addition, the abundance of invasive plants favors their use because of the opportunity cost of not using (Shackleton et al. 2007). As they become more abundant with time it is not uncommon that more respondents use Mikania in KTWLR. In addition, a longer stay in the KTWLR means respondents have history of interacting with Mikania and households are likely to adapt to the invaded environment compared to the households in the recently invaded area (Rai et al. 2012b). The results also show that as invasive plants stay longer in the landscape respondents do not use Mikania forcibly; they start to receive benefits from it. In

KTWLR a small portion (6%) of households see benefits of Mikania but this is not true in CNP. We see that there is a huge reduction in demand for forest products as most of the households are not relying community forest in CNP. For households who are visiting community forest, a reduction in demand may become an opportunity to collect more forest products.

The perception of farmers on invasive plants usually changes over time (Kannan et al. 2008, Rai et al. 2012b). Initially unwanted species may become valuable resources over time and vice-versa. In the CNP, majority of respondents said that forest products availability has decreased after the invasion. While, in KTWLR, the situation is different as a large portion of respondents were unable to assess whether there is a change in forest products availability within the last five years and some of them believe that it has been increasing.

The results of this study signal that time decay effects exist in the interface between invasive species and rural livelihoods. For instance; in KTWLR, a large portion of respondents (18%) considered that Mikania germinated naturally, while in the buffer zone of CNP only a small portion (2%) believes they are not introduced. In addition, there is almost consensus among the respondents in CNP about the carrier of Mikania, while in KTWLR there is not such clear picture; however, 48% think it as one of the flood debris from a local river.

Conclusions and Conservation Implications

The study shows that the perceived effects of invasive plants on rural households vary over time, so as the response of rural households to the invasion. As people usually evaluate the species based on how their economic activities are influenced by the particular species this variation is unavoidable. This is because livelihood strategy is one of the major determinants of households' perception of invasive plants and it is always heterogeneous in rural communities (Mwangi and Swallow 2008). However, the perceived ecological effects of invasive plants remain the same. The results indicate the complication in managing the invaded area particularly in rural areas. Indeed, people are forced to use the invasive plants as there is no strategy to control spreading of Mikania. Hence, decision-makers should not be confused with the variation in peoples' attitude towards invasive plants. In conclusion, the invasion of exotic species which have rapid growth rate and are not suitable to produce locally important forest products— usually undermine the farm based livelihoods. Despite the use of Mikania for different livelihood activities, rural people evaluate them as ecological bad. Rural perspective indicates that Mikania cannot win the support of local communities in the invaded habitat. Negative ecological effects of Mikania cannot be compensated by their limited uses.

References

Cousens R, Mortimer M (1995) Dynamics of weed populations. Cambridge Unviersity press, Cambridge

Crowl TA, Crist TO, Parmenter RR, Belovsky G, Lugo AE (2008) The spread of invasive species and infectious disease as drivers of ecosystem change. Frontiers in Ecology and the Environment 6, 238-246

Government of Nepal (1996) Buffer Zone Management Regulation 2052. Government of Nepal, Kathmandu

Hall S (2009) Cultural Disturbances and Local Ecological Knowledge Mediate Cattail (Typha domingensis) Invasion in Lake Pátzcuaro, México. Human Ecology 37, 241—249

Hobbs RJ, Humphries SE (1995) An Integrated Approach to the Ecology and Management of Plant Invasions Conservation Biology 9, 761—770

Holm LG, Plucknett DL, Pancho JV, Herberger JP (1977) The world's worst weeds; distribution and biology. Univ. Press of Hawaii, Honolulu

Kannan R, Joseph G, Uma Shaanker R (2008) Lantana Furniture: Value added Lantana products to conserve Bamboo and Rattan. in A. Arunachalam, K. Arunachalam editors. Biodiversity Utilization and Conservation. Aaviskar Publishers, Jaipur

Mack RN, Simberloff D, Mark LW, Evans H, Clout M, Bazzaz FA (2000) Biotic Invasions: Causes, Epidemiology, Global consequences and control. Ecological Applications 10, 689—710

Mwangi E, Swallow B (2008) Prosopis juliflora Invasion and Rural Livelihoods in the Lake Baringo Area of Kenya. Conservation and Society 6, 130—140

Olson LJ (2006) The economics of terrestrial invasive species: a review of the literature. Agricultural and Resource Economics Review 35, 178-194.

Pandit R, Bevilacqua E (2011) Forest users and environmental impacts of community forestry in the hills of Nepal. Forest Policy and Economics 13, 345—352

Poudel A, Baral HS, Ellison C, Subedi K, Thomas S, Murphy S (2005) Mikania micrantha weed invasion in Nepal: A summary report. The first national workshop for stakeholders. Himalayan Nature, IUCN-Nepal and CAB International, Kathmandu.

Rai RK, Sandilya M, Subedi R (2012a) Controlling Mikania micrantha HBK: How effective manual cutting is? Journal of Ecology and Field Biology 35, 235—242

Rai RK, Scarborough H, Subedi N, Lamichhane B (2012b) Invasive plants – Do they devastate or diversify rural livelihoods? Rural farmers' perception of three invasive plants in Nepal. Journal for Nature Conservation 20, 170—176

Sapkota I, Oden PC (2008) Household characteristics and dependency on community forests in Terai of Nepal. International Journal of Social Forestry 52, 253—282

Sapkota L (2007) Ecology and management issues of Mikania micrantha in Chitwan national park, Nepal. Banko Janakari 17, 27—39

Shackleton CM, McGarry D, Fourie S, Gambiza J, Shackleton SE, Fabricius C (2007) Assessing the Effects of Invasive Alien Species on Rural Livelihoods: Case Examples and a Framework from South Africa. Human Ecology 35, 113—127

Siwakoti M (2007) Mikania weed: a challenge for conservationists. Our Nature 5, 70-74.

Shrestha UB, Shrestha BB,Shrestha S (2010) Biodiversity conservation in community forests of Nepal: Rhetoric and reality. International Journal of Biodiversity and Conservation 2, 98—104

Stræde S, Treue T (2006) Beyond buffer zone protection: A comparative study of park and buffer zone products' importance to villagers living inside Royal Chitwan National Park and to villagers living in its buffer zone. Journal of Environmental Management 78, 251—267

Strayer DL, Eviner VT, Jeschke JK, Pace ML (2006) Understanding the long-term effects of species invasions. Trends in Ecology & Evolution 21, 645—651

Swamy PS, Ramakrishnan PS (1987) Weed potential of Mikania micrantha H.B.K., and its control in fallows after shifting agriculture (Jhum) in North-East India. Agriculture, Ecosystems & Environment 18, 195—204

Tiwari S, Adhikari B, Siwakoti M, Subedi K (2005) An inventory and assessment of invasive alien plant species in Nepal. IUCN The World Conservation Union, Kathmandu

Willis M, Zerbe S, Kuo YL (2008) Distribution and Ecological Range of the Alien Plant Species Mikania micrantha Kunth (Asteraceae) in Taiwan. Journal of Ecology and Field Biology 31, 277—290

Zhang LY, Ye WH, Cao HL, Feng HL (2004) Mikania micrantha H. B. K. in China – an overview. Weed Research 44, 42—49

Biography

Rajesh Kumar Rai is an environmental economist. His main research interest is in non-market valuation, ecosystem services, invasive plant species and sustainable forest management.

Roshani Rai is a forester working on invasive plants, climate change adaptations and payment for ecosystem services.