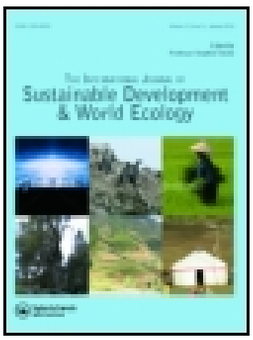

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Community perceptions and responses on bamboo spread in native forests: a case study from Sri Lanka

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ABSTRACT

Bambusa bambos (L.) Voss. expands rapidly in native forests in the dry and intermediate climatic zones in Sri Lanka, raising concerns among environmentalists in recent years. No studies have been undertaken so far to evaluate ecological and socio-economic perceptions of the local communities on this issue. In landsenses ecology, physical senses of the community play a critical role in land-use planning and sustainable management. Thus, a survey was conducted using 78 villagers live in three hamlets bordering native forests where *B. bambos* shown a high prevalence. The study community is a typical rural population with an agriculture-centered existence. Despite low income, their commercial dependence on forest resources was minimal. The villagers are well aware of the bamboo spread and its ecological consequences, though their overall perception on the issue was highly divided. However, their perceptions changed depending on the distance to nearby forests from their abodes. Higher the distance from where they live to bamboo-rich forests, their perception on *B. bambos* become positive and *vice versa*. The heightened fire incidences and increased presence of elephants following the bamboo spread have contributed decisively on their negative perception, suggesting the importance of physical senses in planning land-use interventions. The study concludes that any future management interventions to mitigate some of the ecological and social impacts caused by the *B. Bambos* spread need to consider the community's perceptions and views as well as their active partnership to reap successful outcomes.

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Rural community; perceptions; landsenses ecology; bamboo-rich forests; Sri Lanka

Introduction

Some aggressive native species display traits similar to that of well-known invasive species causing almost comparable ecological and economic consequences. Previously, the term 'invader' is associated with 'non-native', 'exotic' or 'alien' species, with no place for the term 'native' in the definition. This scenario has raised a new set of challenges to policymakers and to the society as a whole. So far, relatively few studies have been carried out to evaluate the social and economic consequences of 'native' invaders in home ranges (van Wilgen et al. 2001; Pimentel et al. 2005; Brunson and Tanaka 2011; Osei et al. 2019). Despite holding a rather negative opinion by the policymakers and scientists, the rural communities at times embrace completely the opposite perception on biological invaders (Shackleton et al. 2007; García-Llorente et al. 2008). The lack of studies on social, economic and cultural perspectives of biological invaders has been highlighted as a serious hindrance in introducing management interventions to mitigate their potential negative impacts (Gobster 2005, 2011; Gozlan et al. 2013; Abrahams et al. 2019). Therefore, the information on social and economic impacts of biological invaders is imperative to introduce effective management strategies to lessen impacts caused by problematic species. The interests and perceptions of the local communities should not be overlooked, when deciding the most appropriate and effective land-use planning. As immediate stakeholders, the communities need to comply with management interventions and participate actively to make management interventions successful. However, the perception of local communities on a particular invader may differ from that of other indirect stakeholders as they rely on them for numerous non-timber uses. Thus, comprehensive studies to evaluate ecological and social perceptions of communities on invaders may assist researchers and policymakers to understand the situation diligently and to introduce effective measures to manage them. Moreover, the humans are considered the key stakeholders shaping and responding to ecological processes, thus is crucial in environmental conservation and management (Bennett et al. 2017; Christie et al. 2017). People's vision and their desires are considered important thus often integrated into land-use planning. Taking a step further, Zhao et al. (2016) proposed

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a novel discipline termed as 'Landsenses Ecology' where social and ecological principles are linked to many other aspects (i.e. natural elements, physical senses, psychological perceptions, socio-economic perspectives, etc.) to provide a sound basis for land use planning, construction, and management towards the sustainable development. Thus, the perspectives of the relevant communities are ignored or else misunderstood, it may jeopardize the success of the intervention (Simberloff 2011; Woodford et al. 2016).

Bamboos represent a unique group of plants with an intense rhizomatous activity leading to rapid asexual reproduction and exceptionally lengthy intervals of flowering events (Janzen 1976; Isagi et al., 1997; Li et al. 1998). Despite its origin in the Southeast Asia, it is widely distributed in the tropical and sub-tropical regions, and accounted approximately 0.8% of the world's total forest cover (FAO 2010). Both native and exotic species of bamboo show rapid expansion of populations possibly driven by natural and anthropogenic factors. Studies to evaluate their ecological and social impacts are relatively low perhaps due to their overriding economic uses. Bamboo has been an important source of income for many rural communities in the tropics (FAO 2014), and according to statistics, over a billion of people in the world are depend on bamboos for numerous economic uses such as food, fuel and as a raw material in housing and agriculture (Mera, 2014). In addition to commercial values, bamboos also considered as a good soil conservator and a pioneer species in forest succession (Basumatary et al. 2015). Bamboos provide environmental security to communities through the protection of catchments, regulation of water flow, recharge of water flow (Lalhruaitluanga and Prasad 2009) and mitigate causes of climate change through sequestration of carbon (Yipling et al., 2010; Song et al. 2011). Bamboos demonstrate a close link with culture and tradition of many nations including China, Japan, South and South East Asian, South America, etc.

In Sri Lanka, both native as well as exotic bamboo species thrive in all climatic zones. Bamboo culms are used as a raw material for construction and agricultural activities in the island. Moreover, the rural communities use bamboo culms to make household items such as baskets, winnowing fans, mats, utensils, etc. (Rao, 1999). In Sri Lanka, only four native species including *Bambusa bambos* support the cottage industry as a raw material while seven exotic species provide a wide range of uses thus in great demand (De Soyza and Vivekanandan 1991). Despite its spiny nature, *B. bambos* is categorized as a multipurpose plant that supplies a range of goods and services to the people in the region (Banik 2016), though its utilization is somewhat limited in Sri Lanka. Some native bamboo species including *B. bambos* are known to expand their populations similar to exotic invasive species causing serious threats to their resident habitats and raising concerns among local communities (Yang et al. 2015). Due to their renowned economic benefits (Shackleton et al. 2007), few comprehensive studies have been undertaken so far to evaluate the impacts of bamboo on local communities (Lots, 2013). According to some reports, *B. bambos* has been introduced to forest reserves in the Dry Zone of the island few decades ago as a source of fibre material for paper manufacturing though it has been never utilized (Wijenayake 2016). Since then, it is spreading fast in some areas even replacing the native forests. Though, *B. bambos* is not identified as an invasive species in Sri Lanka, its rapid spread in native forests in the Dry and Intermediate zones has raised concerns among the scientists and environmentalists of their potential harmful impacts. In contrary to other bamboo species in Sri Lanka, *B. bambos* has not shown any significant economic promises among the local communities. This survey was carried out in order to explore the perceptions of the local people on *B. bambos* and its patchy spread by selecting three villages located close to *B. bambos*-rich native forests in the Intermediate Zone of the island.

Materials and methods

Study area

The study was conducted in three small villages in the Central Province of Sri Lanka *viz*., Galboda (GAL), Moragolla (MOR) and Maragomuwa (MAR), bordering native forests (Tropical Moist Evergreen forests) where *Bambusa bambos* (L.) Voss. prevails. The three villages are located approximately 2–6 km apart from each other. *B. bambos* is showing a patchy distribution in fire-prone forests in the dry and intermediate zones of the island. Except few private lands belonged to the local people, the forested area is managed by the Forest Department of Sri Lanka. In recent times, this area has been subjected to significant land-use changes due to the construction of a mega hydropower project under which two large reservoirs, townships and other infrastructure facilities were constructed. Large extent of forests in the area has been lost due to the inundation following the construction of the reservoirs. The people in the area are largely depending on subsistence farming.

There are many reports of human-elephant conflicts (HEC) in the area causing both human and elephant casualties in recent years.

Data collection

A survey was conducted using 78 households in the three villages (22, 32 and 24 households in GAL, MOR, and MAR, respectively). As they are small hamlets, almost all households in respective villages were used in the survey. Informal interviews were carried out using a semi-structured questionnaire consisted of 33 questions categorized under three main themes *viz*., demographic characteristics of the population, perceptions, and responses on ecological and socio-economic impacts of *B. bambos*. Section A was composed of 11 questions, while sections B and C contained 7 and 15 questions, respectively. The semi-structured questionnaire was initially developed in English and was later translated into the local language, *Sinhala*. From each household, the bread winner of the family was selected for the interview. However, sometimes it differed depending on the availability at the time of the researchers visited the household to conduct the interview. The interviews were held at their respective homes or in the immediate surroundings using their native language. The responses were noted down accordingly.

Results

Demographic characteristics of the study population

The average age of the study population was 52.4 years. The male to female ratio was approximately 1:1.7. Of the total population, 22 (28.2%) and 46 (58.9%) were completed their primary (Grade 1–5) and secondary level (Grade 6–11) education, respectively. The majority (73.1%) of the respondents were farmers and the rest were employees of the government or private sectors, small-scale businessmen, foreign-or self-employed. About 68% of the respondents did not receive a stable monthly income. Approximately28% of the respondents had a monthly income of LKR 30,000.00 (Sri Lankan rupees, LKR; 1 LKR = 178 US$), with none exceeding LKR 50,000.00. According to the survey, none of the villagers were depended on non-timber forest products (NTFPs) to generate an income (Table 1). Overall, the majority of respondents (74.4%) owned land not more than 2 acres, with a slight disparity between the three villages (55%, 97%, and 63% in GAL, MOR and MAR, respectively).

Awareness among villagers

All respondents were aware of the *B. bambos* spread in the area, while 96% of them believed that the origin, existence and the spread are influenced by natural factors. The majority of the respondents (≈ 69%) were in agreement that the rocky slopes are the most preferred habitat for the spread of *B. bambos*. Also, 32% of respondents were noticed a sudden expansion of bamboo population during the past few decades, while 17 respondents (21.8%) observed a decline or a shifting of bamboo patches.

Ecological impacts of B. bambos

The respondents were identified several bamboo-influenced impacts on native forests. A clear majority of respondents (92%) felt that the population expansion of *B. bambos* has increased the frequency of fire incidences in the area. The reduction of useful lands and damages to the forest cover were also identified as the negative consequences of the spread of bamboo (Figure 1).

Uses of B. bambos

Approximately 92% of the villagers were stated that they utilize bamboo culms for various day to day activities, but not as a commercial commodity. According to them, the bamboo culm has been identified as the most usable part of the plant, despite its thorny nature. The villagers use bamboo culms as a building material (75.6%), for agricultural activities, fencing material, raw material for household tool making, fuel wood etc. (Table 2). However, none of the respondents mentioned any edible uses of *B. Bambos* except few indicating a distant memory of consuming bamboo seeds. Only 11 respondents (14.1%) indicated that the spread of *B. bambos* enhances the aesthetic beauty of the area while 3.8% stated that the bamboo spread has prevented elephants wandering into their villages. The villagers claimed that *B. bambos* cannot be considered as a culturally important plant despite a clear majority (≈ 85%) stated that they use bamboo culms as a raw material for decorations in religious and cultural events (Table 2).

Negative impacts of B. bambos

Despite many uses, a clear majority of respondents (71/78) was in agreement that there are many negative impacts due to the prevalence *B. Bambos* in forests bordering their villages. Of them, the difficulty of gaining access to forests (due to its thorny nature) has identified as the most noted negative impact of bamboos (≈ 85%). Furthermore, approximately 59% of

villagers observed an increased presence of elephants near bamboo groves, disturbing their day to day activities. About 44% of the villagers also noted that the expansion of *B. bambos* populations damages the natural habitats surrounding their villages, while a clear majority (≈ 89%) was in agreement of known incidences of human and livestock injuries due to the thorny nature of *B. bambos*, thus identifying bamboo groves as high-risk areas (Table 3).

Physical senses versus overall perception of villagers

Approximately 47% of respondents showed a positive perception on the spread of *B. bambos* in native forests bordering their villages, while others indicated either a negative (≈ 17%) or a neutral perception (≈ 36%). The majority of those who have shown a negative perception on the bamboo spread were farmers (92.3%). Interestingly, the distance to where the villagers live from nearby bamboo-rich forests has influenced their perception on bamboos. The results noted a gradual decrease in the number of respondents having neutral perception on *B. bambos* with the increasing distance from bamboo-rich forests to their dwellings (Figure 2(a)). Correspondingly, an increase in the number of respondents with positive perceptions was recorded with the increasing distance from non-bamboo forests to their respective abodes (Figure 2(b)). Furthermore, a majority of respondents (73%) who noted that *B. bambos* has increased the aesthetic beauty in the area has indicated a positive perception on the bamboo spread, further suggesting the impact of physical senses (sight) on community's perception. In contrast, frequent fires, difficulty in accessing bamboo-rich forests and injuries to humans and

Table 1. Demographic characteristics of the study population in the three villages, Galboda (GAL), Moragolla (MOR) and Maragamuwa (MAR).

	GAL (n = 22)		MOR (n = 32)		MAR (n = 24)		Total (n = 78)	
Variable	Frequency	(%)	Frequency	(%)	Frequency	(%)	Frequency	(%)
Age (years)								
<20	0	0	1	3.1	0	0	1	1.3
21 – 30	0	0	1	3.1	3	12.5	4	5.1
31 – 40	2	9.1	7	21.9	2	8.3	11	14.1
41 – 50	3	13.6	12	37.5	4	16.7	19	24.4
51 – 60	4	18.2	6	18.8	7	29.2	17	21.8
61 – 70	10	45.5	3	9.4	5	20.8	18	23.1
>70	3	13.6	2	6.3	3	12.5	8	10.3
Gender								
Male	20	9.1	17	46.9	12	50.0	49	62.8
Female	2	90.9	15	53.1	12	50.0	29	37.2
Occupation*								
Farmer	22	100.0	22	68.8	14	58.3	58	74.4
Government employer	1	4.5	0	0.0	3	12.5	4	5.1
Private sector employer	0	0	4	12.5	0	0	4	5.1
Self-Employed	0	0	4	12.5	2	8.3	6	7.7
Businessman	0	0	2	6.3	1	4.2	3	3.8
Un employed	0	0	2	6.3	2	8.3	4	5.1
Foreign employer	0	0	2	6.3	2	8.3	4	5.1
Retired	0	0	0	0	4	16.7	4	5.1
Monthly Income								
<10,000	3	13.6	3	9.4	1	4.2	7	9.0
10,000-20,000	1	4.5	3	9.4	3	12.5	7	9.0
20,000-30,000	1	4.5	3	9.4	4	16.7	8	10.3
30,000-40,000	0	0	0	0	1	4.2	1	1.3
40,000-50,000	0	0	0	0	2	8.3	2	2.6
>50,000	0	0	0	0	0	0	0	0
No stable income	17	77.3	23	71.9	13	54.2	53	67.9
Level of education#								
Primary Level	9	40.9	8	25.0	6	25.0	23	29.5
Secondary Level	11	50.0	22	68.8	13	54.2	46	59.0
Tertiary Level	1	4.5	2	6.3	5	20.8	8	10.3
Technical education	0	0.0	0	0	0	0	0	0
No education	1	4.5	0	0	0	0	1	1.3
Land ownership (in acres)								
<1	7	31.8	19	59.4	7	29.2	33	42.3
1 – 2	5	22.7	12	37.5	8	33.3	25	32.1
2 – 3	2	9.1	1	3.1	4	16.7	7	9.0
3 – 4	1	4.5	0	0	1	4.2	2	2.6
4 – 5	2	9.1	0	0	0	0	2	2.6
>5	5	22.7	0	0	4	16.7	9	11.5

*Some respondents had more than one occupation.
#Primary Level (Grade 1–5); Secondary Level (Grade 6–11) and Tertiary Level (Advanced Level and above).

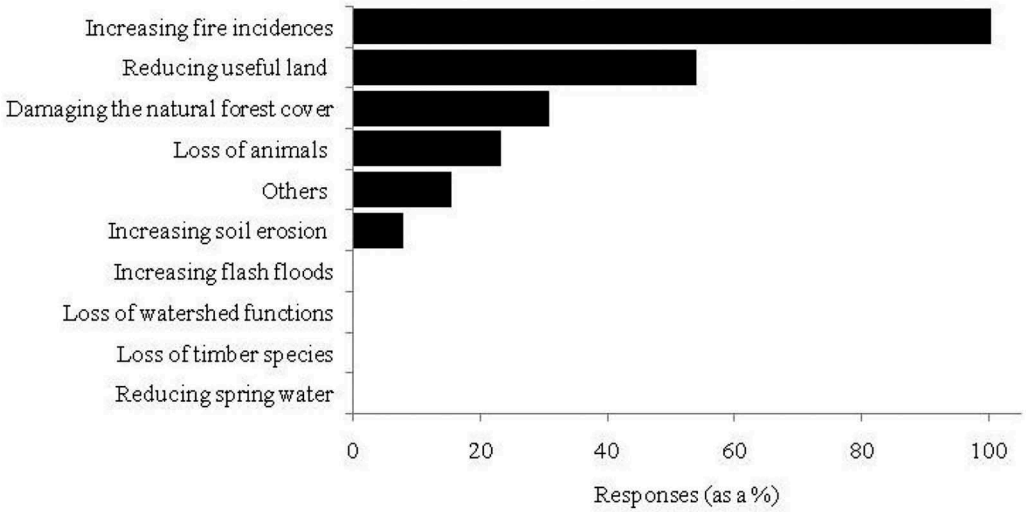

Figure 1. The cumulative responses (as a percentage from the total study population) of the villagers from three study hamlets on the ecological impacts of *B. bambos* spread on nearby forests.

livestock have influenced villagers' negative perceptions on *B. bambos* (100%, 92.3%, and 100%, respectively).

Irrespective of their perception (negative, positive or neutral) on the spread of *B. bambos*, a clear majority of respondents (62%, 68%, and 92%, respectively) were noted a gradual increase in the bamboo spread during the past few decades. Also, a majority of respondents (85 – 97%) emphasized many uses of *B. bambos* for their day to day activities, irrespective of their perceptions. According to the survey, approximately 51 – 69% of villagers extract various non-timber forest products (NTFPs) from forests bordering their villages. However, a majority of the respondents (61 – 87%) did not agree that the availability of these NTFPs are adversely affected by the bamboo spread (Figure 3).

Despite different perceptions on the spread of *B. bambos*, approximately 57% of the interviewees have tried one or more measures *viz*., cutting, digging out and burning, to remove *B. bambos*. Approximately half of the respondents have admitted that cutting and burning as the most effective method in removing bamboo bushes. In contrast, 36% of the respondents suggested that the use of machinery would be more effective than the physical measures such as cutting, digging and burning.

Discussion

The demographic analysis indicated that the study population is mainly an agriculture-based rural community. Based on the country statistics, the study community can be categorized as a 'low income' community with an average level education (Department of Census and Statistics of Sri Lanka 2016). Approximately 59% of the study population has completed either the lower (Grade 6 – Grade 8) or the upper secondary (Grade 9 – Grade 11) level education, and it was in par with the national percentage (58.4%). However, the monthly household income was relatively lower than the national level statistics for a rural community in Sri Lanka (LKR 58,137.00 as in 2016) as none of the households in the study population exceeded the monthly household income of LKR 50,000. Despite slight disparities between the three hamlets, 74.4% of the respondents were farmers, indicating their agriculture-centered life styles. Regardless of insignificant variations of demographic characteristics, the social and economic statuses are more or less comparable between the three communities selected for the study.

Interestingly, the results suggested that the perceptions of the study community on the spread of *B. bambos* are rather divided with almost half of the respondents (47%) showing a positive perception, while the remaining either neutral (36%) or negative (17%). The results also demonstrated that the perception (negative, positive or neutral) of the communities on the bamboo spread varies depending on the distance from the bamboo/non-bamboo forests to their dwellings. The changing perceptions with the distance to their respective dwellings indicated that the attitudes of the community may change based on where they live in relative to these native forests. The results identified the distance as a major physical sense influencing the perception of the communities on the spread of bamboo, highlighting the importance of the concept of landsenses ecology in managing similar issues related to ecology and conservation (Dong et al. 2016). Sundriyal and Sundriyal (2004) too observed that the community attitude towards forest resources may vary depending on the distance to the forest in addition their access status.

The extraction of NTFPs is the most significant source of livelihood among the rural communities in the tropics, and considered as one of the most

Table 2. Past and present uses of *Bambusa bambos* by the villagers of the three hamlets (Galboda, Moragolla, and Maragomuwa) in the Central Province of Sri Lanka.

Purpose	Uses	Present	Past
Construction	Wall frames in constructing mud houses	√	√
	Frame for thatched roofing	√	√
	Tree huts	√	√
	Scaffolding	√	√
Agricultural	Fencing material	√	√
	Gantry	√	√
Household utensils	Winnovers	-	√
	Steamers(for preparation of traditional foods)	√	√
	Handles in coconut shell spoons	-	√
	Ladders and supportive poles for tree climbing	√	√
	Plucking sticks	√	√
	Rat traps		√
Toys	Kid's play houses	√	√
	Toy guns	√	√
Cultural	Traditional lanterns for Buddhist festivals	√	√
	Dais of Buddhist chantings	-	√
	Pandols	-	√
	Funeral decorations	-	√
Medicinal	Traditional medicine (flush)	-	√
Other	Handicrafts	-	√
	Incense sticks	-	√

Table 3. Percentage responses (of the total population) of negative impacts due to the spread of *Bambusa bambos* in native forests, Sri Lanka.

Negative Impact	Frequency	Percentage (%)
Reduces crop yields	4	5.1
Reduces grazing land	1	1.3
Damages infrastructure	0	0.0
Competes with non-timber forest products (NTFPs)	2	2.6
Increases pest attacks (Peacocks, wild boar etc.)	2	2.6
Increases the presence of wild elephants	46	59.0
Affects hunting	0	0.0
Difficulty in accessing forests	66	84.6
Reduces aesthetic view	1	1.3
Rapid spread damages the natural habitat	34	43.6
Other negative impacts	5	6.4

effective means of managing forests in a sustainable manner (Peters et al. 1989; Barbier et al. 1994; Wollenberg and Ingles 1999; Larsen et al. 2000; Wollenberg 2000; Ros-Tonen 2000; Sundriyal and Sundriyal 2004; Saha and Sundriyal 2012). However, the results of the present study indicated that the contribution of NTFPs to the household income of the rural communities was negligible. The respondents confirmed that they extract NTFPs from nearby forests (including bee honey, medicinal plants, wild fruits, leafy vegetables and cycad seeds) for their day to day consumption but not for trade. According to the survey, almost all villagers (92%) use bamboo culms for various day to day activities, thus their positive perception on the bamboo spread may be largely driven by its many uses that override its undesirable effects.

The villagers of the three hamlets pointed out that they use culms of *B. bambos* for construction, agriculture, house hold activities, confirming findings of the previous studies (Jamatia 2012; Atanda 2015). Due to the strength, flexibility, and versatility, bamboo culms are considered as a cheaper and a viable alternative for housing and other construction purposes for centuries (Akoto et al. 2017). In countries like Ghana, the government has introduced incentives and technical support to encourage people to use bamboo as a raw material in housing construction (Akoto et al. 2017). An island wide survey carried out by the Forest Department of Sri Lanka showed that rural communities harvest bamboo from state forests and use them as a raw material to manufacture tools of household importance such as baskets, winnowing fans, spoons, etc. (Forest Department 1991). Except *Ochlandra stridula* (a spiny bamboo species endemic to the island), other native bamboo species showed somewhat limited utility value in Sri Lanka, while the exotic species demonstrate many applications thus in great demand. Even though the seeds of *B. bambos* are known to be edible elsewhere in the tropics (Janzen 1976), the current

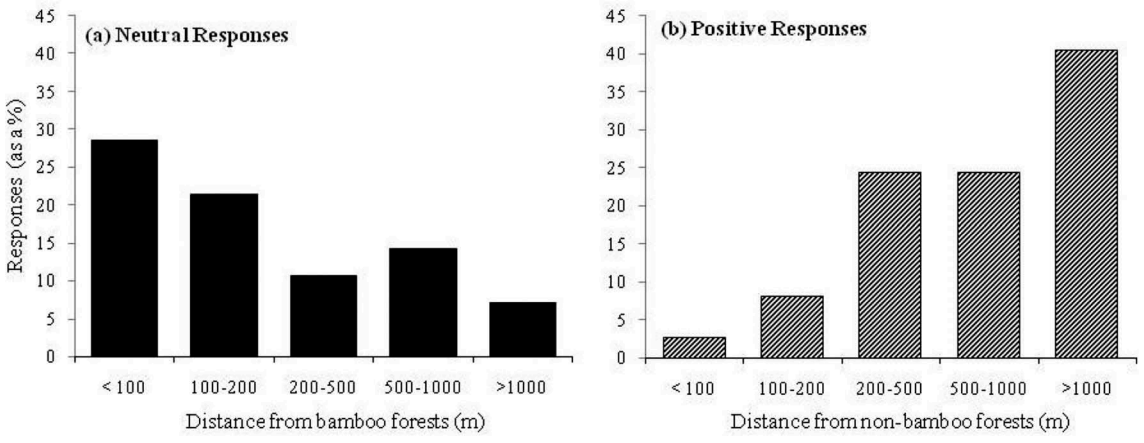

Figure 2. The relationship between the respondents of (a) neutral and (b) positive perceptions on the *B. bambos* spread with distance ranges (m) where they reside away from bamboo and non-bamboo forests.

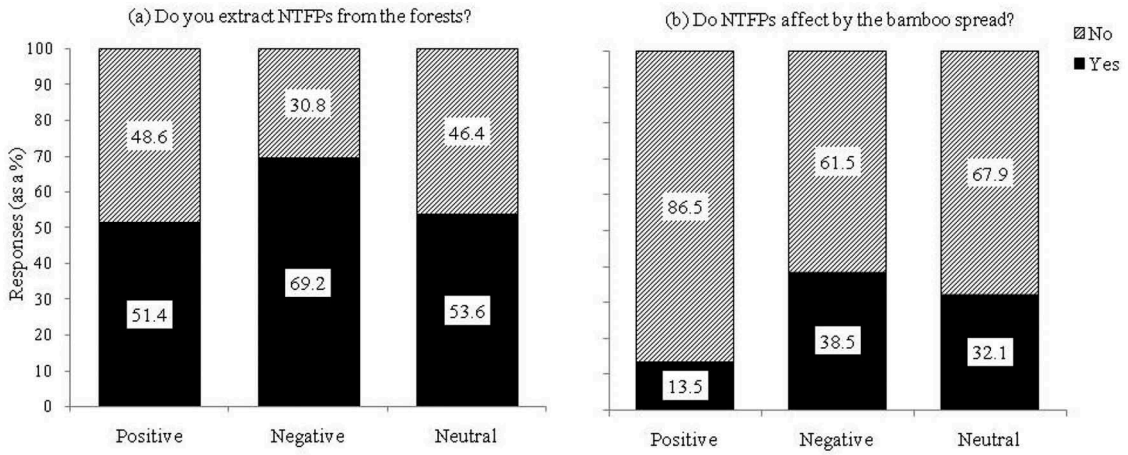

Figure 3. Responses (as a percentage) of the villagers of (a) the use of NTFPs from nearby forests and (**b)** any negative effects on NTFPs due to the bamboo spread.

study confirmed no dietary value of *B. bambos*. According to Mertens et al. (2008), the young shoots of about 200 bamboo species are a popular food source among communities in many Asian countries, though it is not the case with *B. bambos*. In spite of many benefits, the use of bamboo has been gradually declined over time in Sri Lanka mainly due to legal prohibitions in extracting bamboo since the declaration of forests as forest reserves and also due to changing life styles of the local communities.

In addition to other uses, bamboos play a significant role in cultural and religious events in Asian countries including China, Thailand, Malaysia, the Philippines (Yuming et al. 2004; FAO 2005). In the present study, the respondents were also highlighted some religious/cultural uses of *B. bambos*, though much of these practices are non-existing at present. According to the villagers, they use bamboo culms to make lanterns for religious events, erecting pandols for auspicious occasions like weddings, and decorating funeral processions, etc. However, a clear majority of the respondents considered *B. bambos* as a culturally insignificant plant, possibly due to the change of lifestyle of rural communities over time. However, other countries in the region still use bamboo for clothing, food, shelter, and travel (Xiang 2010; Hogarth and Belcher 2013), while others propose its potential uses in meeting energy needs of the rural communities thus alleviating pressure on natural forests (Osei et al. 2019). However, the present study population did not indicate any use of *B. bambos* to fulfill their needs for firewood, probably due to difficulty in handling them owing to its thorny nature.

Due to the presence of thorns and spines in *Bambusa* species, harvesting them has been culturally prohibited for children and women in some countries in the tropics (Ogunjinmi et al. 2009). The respondents of the current study too highlighted the difficulty of accessing forests due to the thorny nature of *B. bambos*. The study also revealed that *B. bambos* has caused injuries to humans and livestock thus considering these bamboo-rich forests as high-risk areas. The people living in these border villages are experiencing many difficulties in their day to day activities due to heightened human-elephant conflicts (HEC), even causing casualties in both parties. Nearly half of the villagers felt that the bamboo spread has increased the presence of elephants in these bordering forests, as elephants are relish feeding on young bamboo shoots. Young bamboo shoots and leaves are known to be a food source with high nutritive value (Halvorson et al. 2010; Satya et al. 2012; Nongdam and Tikendra 2014), thus considered as an excellent herbage for elephants. The researchers of the current study observed that some bamboo stands have been severely damaged by elephants due to their intense feeding on them. Previous studies too confirmed that elephants are one of the subsidiary feeders of bamboo in the south-east Asian region (Yeasmin et al. 2015). Some respondents even felt that the bamboo spread has extended the duration of visits by the elephants in these native forests, hence making the HEC even a more complex issue. Some speculated that the thorns and the dense nature of *B. bambos* stands seem to restrict the movement of elephants (Wijenayake 2016), though the present study has indicated otherwise.

A majority of the villagers were aware that the *B. bambos* has expanded its populations in recent years, either through aggressive rhizomatous growth or wind-dispersed seeds following a mass flowering event that took place few decades back. In favour of the latter scenario, the emergence of new bamboo thickets were observed away from the existing bamboo stands rather than expanding the existing

populations. Though the present findings cannot precisely determine the mode of expansion of *B. bambos* populations in the area, the patchy distribution of *B. bambos* favours the latter mode of expansion, which is by wind-dispersed seeds. It is a well-known fact that the flowering intervals of bamboos can vary between 7 and 100 years, with *B. bambos* showing an average of 32-year intervals (Veller et al. 2015). According to the responses given by the villagers of the three hamlets, the last mass flowering event has been taken place about 20 to 30 years back, indicating another mass flowering event in the near future.

The majority of the respondents claimed that the most preferred habitat for the bamboo spread in the area is rocky slopes. The researchers too observed that bamboo clumps were more conspicuous on rocky slopes and forest margins in the area. The steep slopes and well-drained soils are ideal conditions for the growth and expansion of *B. bambos* (Boa and Rahman 1984). The villagers also recognized that the bamboo spread has intensified the frequency of forest fires in the area during the dry season, thus identifying it as the most critical ecological impact of the bamboo spread. Human-induced forest fires are common in native forests in the area, and the accumulation of bamboo leaf litter and dead culms on the forest floor act as a fuel during fire incidences in prolonged dry seasons. High accumulation of lignin-rich leaf litter in bamboo-rich forests has been observed by other workers too (Liu et al. 2000; Zhou et al. 2005). According to the fire hypothesis, frequent fires are critical in maintaining bamboos in forests (Keeley and Bond 1999; Smith and Nelson 2010). However, the heightened fire events following the bamboo spread may adversely affect composition, diversity and structure of native forest vegetation as well as the soil chemistry (Cochrane and Laurance 2002; Knicker 2007; Laurance et al. 2012; Jua´rez-Orozco et al., 2017). The villagers also identified the bamboo spread as a major cause for the decline of the forest cover in the area. A previous study carried out in the same area revealed higher tree mortality incidences in bamboo-rich forests in comparison to non-bamboo forests, though underlying causes are not understood yet (Wijewickrama et al. 2018). Therefore, higher tree mortality together with fire-induced impacts may eventually diminish the quality of these native forests markedly.

The study concludes that the communities in the study area are least depend on forest products for income generation, indicating no direct impact of the bamboo spread on their economic status. The results further confirmed that forest resources in the area are not under any threats due to over-exploitation. As a result of the thorny nature of *B. bambos*, changing lifestyles and strict regulations introduced by the authorities, the community's dependence on bamboo for cultural and religious purposes seems to have diminished over the years. Despite negative influences on day to day activities of the communities, they showed highly divided perception on the bamboo spread. The study also confirmed the significant role of physical senses (such as sight and touch) on communities' perception on the bamboo spread. The outcome of the study reiterate the importance of the concept of 'landsenses ecology' when introducing land-use planning to mitigate issues related to the bamboo spread in the region.

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