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Community dependency and perceptions of a protected area in a threatened ecoregion of Myanmar

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Local communities living adjacent to protected areas (PA) play a vital role in biodiversity conservation. Understanding communities' use and perceptions of a PA will increase its conservation effectiveness through reducing anthropogenic pressures and improving park-people relationship. This study assessed local communities' dependency on the PA and perceptions of benefits and costs accrued from the PA. Using a distance-based stratified random sampling, a total of 230 households from 10 villages around the Indawgyi Wildlife Sanctuary (IWS), in Myanmar, were interviewed. Results showed that 51.3% of local households were dependent on the PA for household income generation and their dependency was determined by the landscape ecology of the residential place. Communities living close to the alluvial area relied the most on the PA due to their lack of permanent agricultural land. Results also showed that although people generated income from the PA, their appreciations of PA's benefits were not significant. However, communities' perceptions of the costs incurred from the PA varied significantly with their resource dependency level, distance from the PA, gender and ethnicity. To promote people's acceptance of the park, this study suggests that future PA management should focus on balancing benefits and costs of the most resource-dependent communities and conservation initiatives should be designed to be supplementary to local economic needs.

Key words: Conservation, Indawgyi, Myanmar, perceptions, protected area, resource dependency.

INTRODUCTION

The unprecedented loss of biodiversity has been a global challenge for conservation, and we are in the era of the sixth mass extinction of biodiversity (Primack, 2006; Symes et al., 2016). The current rate of species extinction is 1,000 times higher than that in historical times, and more than 30,000 known species are threatened with extinction (IUCN, 2020). Protected areas (PA) have therefore been considered as refuges of endangered wildlife species and global conservation initiatives have focused on the increased establishment

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of PAs (Allendorf et al., 2006; West et al., 2006). So far, 14.9% (20 million km^2) of the world's terrestrial landscapes and 7% (6 million km^2) of seascapes have been designated as PAs (UNEP-WCMC et al., 2018).

However, the declining trend of biodiversity is persistent (Leverington et al., 2010). Global climate change, land-use changes, overexploitation of species, invasion of exotic species and spread of diseases are the major threats to biodiversity (Primack, 2006; IPBES, 2019). The impacts of these threats are more serious to the geographically limited species and small populations (Primack, 2006). Many researches have highlighted that the current PA systems are not fully representative or not sufficient to protect areas of threatened taxa (Leverington et al., 2010; Jones et al., 2018; Schulze et al., 2018; UNEP-WCMC et al., 2018). In this regard, effective area-based conservation or ecoregion-based conservation approaches have increasingly been suggested for the conservation of geographically outstanding ecosystems with high concentration vulnerable species (Olson and Dinerstein, 2002; Brooks et al., 2006; Dinerstein et al., 2017; Beyer et al., 2019). WWF defined an ecoregion as a geographically distinct area containing a unique assemblage of species and natural communities that share similar environmental, ecological and biological dynamics (WWF, 2020).

Myanmar is a biodiversity-rich country in Southeast Asia and home to 11,800 plants, 258 mammals, 1,096 birds, 291 reptiles, 119 amphibians, and 1,098 fish species (Forest Department, 2015). It lies within Indo-Burma biodiversity hotspot which overlaps 14 ecoregions (Prescott et al., 2017; Centre for Responsible Business, 2018). At present, 5.85% (39,593 km^2) of the country area has been constituted as 45 PAs (Forest Department, 2015). Almost half of the country's total area is covered by 3 major ecoregions; Irrawaddy moist deciduous forest (20.6%), Northern Indochina subtropical forest (20.5%) and Mizoram-Manipur-Kachin rain forests (10.5%) (IFC, 2017). Among these ecoregions, Mizoram-Manipur-Kachin Rain Forest Ecoregion in northern Myanmar is a globally outstanding ecoregion characterized by the highest diversity of bird species (WWF, 2020). Although almost half of this ecoregion still retains its natural habitats, it is vulnerable due to logging, shifting cultivation and conversion into grazing lands (IFC, 2017; WWF, 2020).

Deforestation, agricultural expansion, and poaching have been the most common threats to Myanmar's PA and its biodiversity (Rao et al., 2002; Tordoff et al., 2005). These threats are mainly due to the subsistence needs of local communities, rather than large scale incompatibilities. "Biological resource use" is the most common threat both inside and outside of all PAs. In this category, the extraction of non-timber forest products is ranked the highest and is found in 85% of all PAs. Other threats including fuelwood collection, hunting, grazing and human settlements are observed in more than 50% of them (Rao et al., 2002). Such kinds of threats are unlikely to be reduced in the absence of local community support because 70% of the country's population who lives in rural areas is heavily dependent on natural resources for livelihoods (Forest Department, 2015).

Furthermore, traditional PA management strategies using "fences and fines principle" without considering the needs and aspirations of the local community has demonstrated very limited success (Lele et al., 2010). Especially in a developing country like Myanmar with high natural resource dependency and limited financial capacity, a stewardship approach is not a viable solution. The strong dependence on natural resources, combined with inadequate PA law enforcement, have intensified illegal resource exploitation and leading to the degradation of PAs (Rao et al., 2002). Chances of conservation success will be enhanced when local communities' expectations are integrated into PA management (Andrade and Rhodes, 2012). In this regards, PA management strategies should be designed to balance the trade-offs between conservation objectives and socio-economic needs of local community living in its proximity (Oldekop et al., 2016).

For this reason, Myanmar National Sustainable Development Plan highlights the interlinkage between people's wellbeing and healthy ecosystems and set ambitious intersectoral goals (Ministry of Planning and Finance, 2018). Specific to the conservation, National Biodiversity Strategy and Action Plan has been implemented in support of sustainable utilization of biological resources to ensure the long-term survival of PAs and their biodiversity (Forest Department, 2015). Not only that, but the role of the local community in the management of PA is also increasingly recognized and "Community Protected Area" is added as a category of PA in the newly stipulated Biodiversity and Conservation of Protected Areas Law in 2018 (Forest Department, 2018a).

However, these enabling conditions lack scientific research that could suggest how to facilitate and integrate local community in the conservation projects. Empirical studies on community dependency on the PA are of fundamental importance not only to reduce the threats to the PA and but also to provide appropriate livelihood strategies. Similar importance is to identify PA-induced costs and benefits among the local community to understand their appreciation of the PA. Many researches have shown that the extent of benefits and costs vary with people's dependency on the PA and their socio-economic status (Marshall et al., 2010; Karanth and Nepal 2012; Lamsal et al., 2015; Kyando et al., 2019). Poor households are usually high in resource dependency and more vulnerable to the costs of restriction from the PA (Rahman et al., 2017). Attitudinal studies additionally reported that communities will not be motivated enough to support conservation unless the benefits from the PA offset their costs (Coad et al., 2008; Nepal and Spiteri,

2011; Paudyal et al., 2018). A good example is the Koshi Tappu Wetland in Nepal, where the incentive program to harvest grass and thatch as livelihood support could not successfully integrate local communities because its benefits were too little when compared with the economic loss of resource restriction (Shrestha and Alavalapati, 2006). A better knowledge of the distribution of benefits and costs concerning communities' dependency is critical in designing efficient and effective conservation strategy.

Although there are studies conducted on resource dependency in Myanmar, most focus has been on economic valuation of forest resources (Khaine et al., 2014; Aung et al., 2015; Htun et al., 2017; Aye et al., 2019). Significant knowledge gap remains in understanding the relationship between such dependency and community perceptions of the PA. Remarkably, the spatial and socio-economical distribution of park-driven benefits and costs remain uncovered for most of the parks. Our study aims to contribute to closing this gap by investigating:

(1) To what extent local communities depend on PA resources?
(2) What benefits and costs local communities experienced from the PA?
(3) How these benefits and costs vary with the spatial and socio-economic attributes?

We hypothesized that communities living closer to the PA will be more dependent on the PA's resources. The influence of socio-economic factors on resource dependency was also expected. Therefore, another hypothesis was tested that communities who are more dependent on the PA resources will be more affected by the costs of resource restrictions.

MATERIALS AND METHODS

Study area

This study was conducted in Indawgyi Wildlife Sanctuary (IWS) located within Mohnyin Township of Kachin State in Northern Myanmar, with geographic coordinates between 24° 56' N - 25° 24' N and 96° E - 96° 39' E (Isituto Oikos and BANCA, 2011). It covers 815 km², consisting of three ecosystems, the lake in the centre surrounded by the wetland, which is encircled by forested mountain ranges up to 1,180 m above sea level (Forest Department, 2018b). Indawgyi Lake is the largest inland freshwater lake in Myanmar and is fed by eight streams draining from the hills around the sanctuary. The Indaw Stream that flows to the north of the sanctuary is the only outflow and eventually drains into the Ayeyarwaddy River. The area has a subtropical monsoon climate with an average annual rainfall of 2,196 mm and an average temperature of 24.1°C (Forest Department, 2018b).

The IWS lies in Mizoram-Manipur-Kachin Rain Forest Ecoregion dominated by mixed evergreen and deciduous forests consisting of Dipterocarp species and teak (*Tectona grandis*) as the characteristic species. The sanctuary was established in 2004 to preserve 38 mammals, 448 birds, 41 reptiles, 34 amphibians, 80 fish, 50 butterflies, 165 trees and medicinal plants (Isituto Oikos and BANCA, 2011). Key biodiversity species are Hoolock gibbon (*Hoolock leuconedys*), Hog deer (*Axis porcinus*), water birds and endemic fishes. The IWS is also an important stopover point of the East-Asian-Australian Flyway and supports a large number of migratory birds. Therefore, it was designated as an Association of Southeast Asian Nations (ASEAN) Heritage Park in 2013, an Important Bird Area in 2014, a Ramsar site in 2016, and a UNESCO Man and Biosphere Reserve in 2017 (Forest Department, 2018b).

There are 36 villages near the sanctuary with a population of 50,357 people in 8,806 households (Forest Department, 2018b). Farming is the primary livelihood of the communities, while other livelihoods include fishing, hunting, shifting cultivation, logging and gold mining (Than, 2011). The development of ecotourism is in its infancy. Local communities are ethnically heterogeneous, mainly consisting of Shan and Bamar and other small ethnic minorities like Kachin, each having their own culture and traditions that shape their dependency on the PA in different ways. A zoning system characterizes the resource utilization in the IWS. In the buffer zone of the PA, local communities can have access to forest resources for non-commercial purposes and to lake resources to some extent for economic uses. However, resource exploitation in the core zone and during fish spawning season is not officially allowed (Forest Department, 2018b).

Survey design and sampling

The sampling framework was based on stratified random sampling. Ten villages were randomly selected from four strata divided by their relative distances to the PA boundary, which were on the fringe (less than 1 km), near (1 to 2 km), intermediate (2 to 3 km), and far (more than 5 km), respectively. The sample villages included four villages each in the first two strata and one village in each of the last two strata (Figure 1).

Within each sample village, 23 households were randomly selected for interview survey. As only one respondent was interviewed from each of the selected households, a total of 230 participants were included in the study. The determination of the sample size was based on the common criteria of behavioural science, which indicated the need to represent a minimum of 10% of the total population (Sophat et al., 2019). Interviews with 230 households from 10 villages consisting of 2,357 households were in agreement with this criterion. The logistics and accessibility to the study villages during the monsoon season, were also taken into consideration in the selection of sample villages.

Data collection

Face to face interviews were conducted with 230 respondents using questionnaires which were structured into three sections as (1) socio-demographic information, (2) resource dependency on the PA, (3) the perception of benefits and costs from the PA (provided as supplementary material). Questions about resource utilization were collected at the household level, whereas those concerning perceptions were recorded at the individual level. All the questions were closed-ended. For ethical reasons, the respondents were informed that their identity would be anonymous. Additionally, they were assured that their answers would be used only for research purposes. All the questionnaires were pre-tested with a few villagers near the IWS (not part of the villages in the selected sample) to ensure the clarity and data quality. Data were collected from June to August 2019.

Statistical analyses

As most of the variables were categorical and not normally

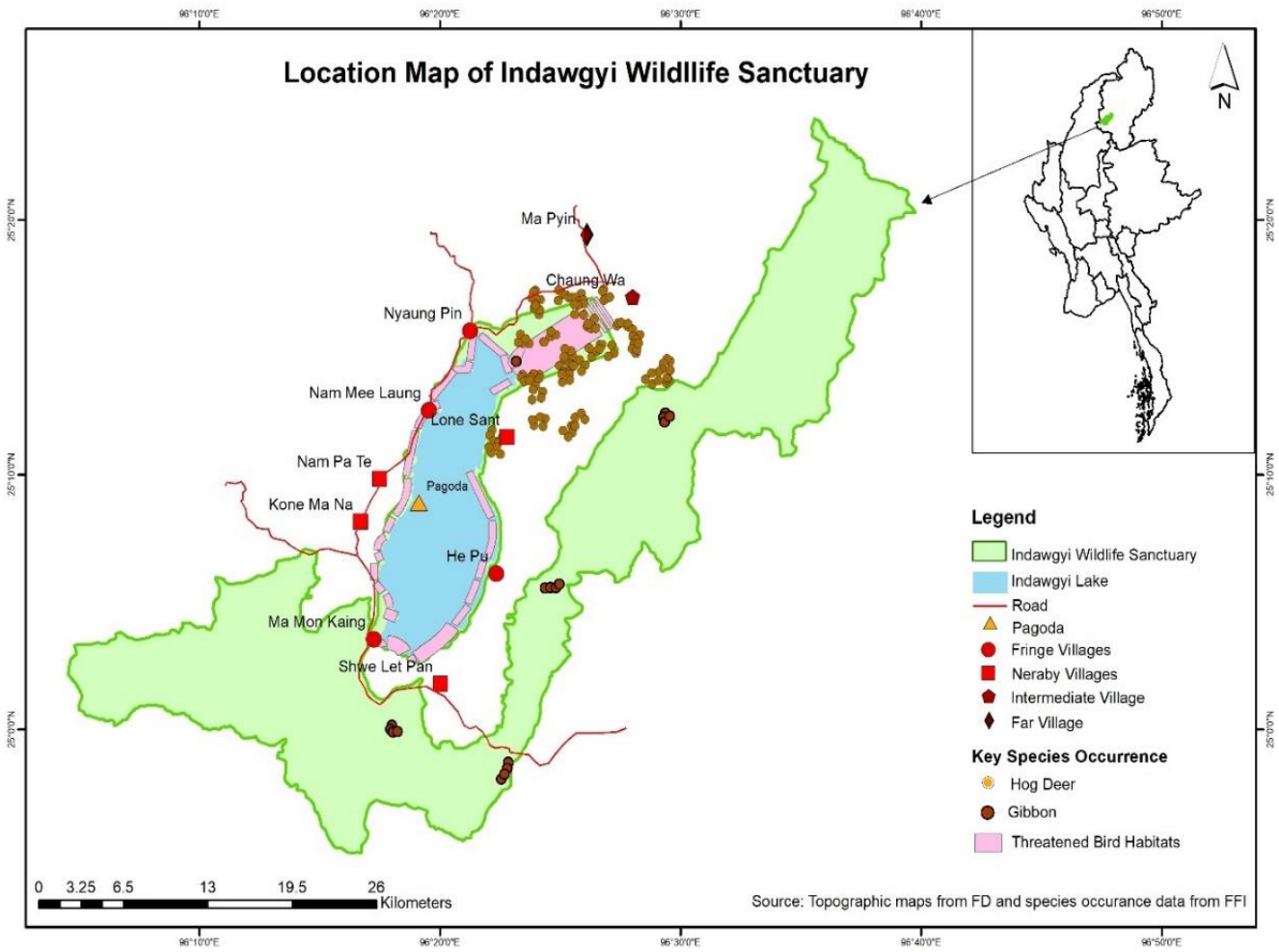

Figure 1. Map of the study area with key species occurrences (hog deer, gibbon and threatened birds) and the distribution of sampled villages. Inset at the right corner is the map of Myanmar with the location of Indawgyi Wildlife Sanctuary.

distributed, non-parametric tests were applied for the analysis. Data were analysed in three steps. First, descriptive statistics were used to determine the frequencies of different variables. Second, Chi-square tests were used to identify the relationships between resource dependency, perceptions of the benefits and costs from the PA and socio-demographic characteristics. Then, a generalized linear mixed model (GLMM) was fitted to seek the strongest predictors for each dependent variable. The GLMM aimed to detect random variation due to stratification, that is, the effect of the unequal number of respondents in each stratum (Lee et al., 2009). Therefore, the village was set as a random factor in the model in clarifying the effects of predictors on the resource dependency, perceived benefits and costs from the PA. Collinearity among the potential predictors was satisfied before running the model as only the variables with Spearman's rho, $\rho < 0.5$ were retained. All GLMMs fitted for one categorical dependent variable with a binomial distribution and the logit link function. Model selection was not included in the analysis, as the study was only interested in the contribution of predictors (that is, significant variables in Chi-square analysis) on the response variables (Sodhi et al., 2010). Both the overall model and the coefficient estimates of significant predictors were reported. All the statistical tests were performed using IBM SPSS Version 25, and the significance level was set at $p \leq 0.05$.

RESULTS

Characteristics of respondents

Among 230 respondents, 58.3% were male participants. The dominant ethnic community was Shan (77%) and 82.6% of the people interviewed were native inhabitants. One-third of the respondents were at the age of 50 years or above (36.1%), while the remaining were at the age groups of 18-29 years (16.1%), 30-39 years (20%) and 40-49 years (27.8%). Almost half of the respondents (48.7%) had primary education and main economic activities were farming (70%) and fishing (20%) (Table 1).

Approximately, 75% of the households had more than 5 family members. About 60.4% of these households were landowners and mainly grew rice (60%). Approximately 90% of the households possessed at least one kind of livestock; cattle, pigs, chickens and elephants. Although the cattle were grazed inside or near the PA, pigs and chickens were raised domestically. While 52.6% of the

Table 1. Descriptive summary of characteristics of respondents.

Variable (N = 230)	Respondents (%)
Individual level	
Distance from PA	
Fringe	40.0
Near	40.0
Intermediate	10.0
Far	10.0
Gender	
Male	58.3
Female	41.7
Age (years)	
18-29	16.1
30-39	20.0
40-49	27.8
50 +	36.1
Ethnicity	
Shan	77.0
Bamar	23.0
Religion	
Buddist	98.7
Christian	1.3
Education	
Illiterate	4.0
Primary	48.7
Secondary	32.2
Higher	15.1
Occupation	
Farmer	70.0
Fisherman	20.0
Other[1]	10.0
Residency Status	
Native	82.6
Migrant	17.4
Household level	
Family Size	
Small (2-4 members)	24.8
Medium (5-7 members)	39.1
Large (> 7 members)	36.1
Daily Household Income (Good season)	
0-10$	47.4
> 10$	52.6
Daily Household Income (Bad season)	
0-10$	81.3
> 10$	18.7

Table 1. Contd

Land Ownership	
Land Owner	60.4
Landless	39.6
Land Size (Acre)	
0	39.6
1-9	34.8
10+	25.6
Crop	
Rice	60.0
Peanuts	12.2
Other	27.8
Livestock Ownership	
Yes	90.0
No	10.0
Types of livestock owned[2]	
Cattle[3]	45.7
Pigs	57.8
Chicken	76.1
Elephant[3]	<1

(1) Other occupation included mining, casual labourers and own businesses. (2) Ownership of different kind of livestock is not mutually exclusive. A respondent owned two or three kinds of livestock. (3) Animals that are pastured near or inside the PA.

households earned above 10US$ per day during the good season (crop harvesting season or fishing season), only 18.7% earned the same amount in the bad season (crop growing season or fish spawning season) (Table 1). Household income collected in Myanmar Kyats were converted to the US$ based on the exchange rate at the time of the data collection period (1 US$ = 1,513 MMK).

Household dependency on the PA

(i) Extraction of resources from the PA

Local communities extracted PA resources for both household use and economic purposes. Most (90%, N = 230) of the villages consumed 15 types of extractive resources in total, 11 of which were obtained from the forests around the PA, while the other 4 resources were derived from inside the lake. The most common resources were timber and bamboo for construction, fuelwood for cooking, fruits and vegetables for food supplements, and fishes as a source of protein (Table 2).

For these resources, timber was occasionally extracted (82.2%, N = 207) to meet the need for building materials. Fuelwood was used for daily cooking and a sufficient amount for the home use was collected yearly (85.2%, N = 207). However, fish (87.4%, N = 207), and fruits and vegetables (60.9%, N = 207) were consumed daily. Of these PA resources, all forest resources were extracted for household consumption, whereas those from the lake (fish, prawns and molluscs) were aimed at income generation in addition to own use.

(ii) Income from the PA

More than half of the respondents (51.3%, N = 230) were economically dependent on the PA's resources. These dependent respondents (N =118) were asked to mention the share of income from PA resources in their total household income, to which 37.3% replied that it constituted almost all of their earnings, while 28.8% reported that it constituted about half, and 33.9% said that it constituted partially.

The household economic reliance on the PA varied with the residential distance to the PA ($\chi^2 = 37.6$, df = 3, $p < 0.001$). Income dependency was relatively higher in the intermediate village than those in the other villages, fringe, near and far. People who extracted resources from inside or near the PA ($\chi^2 = 72.0$, df = 1, $p < 0.001$) and fishermen more than other occupations ($\chi^2 = 55.7$, df

Table 2. Types of resources from the PA, and their relative importance to the local households.

Resources (N = 230)	Utilization % (Yes)
Forest Resources	
Timber	90.0
Fuelwood	90.0
Fruits and Vegetables	90.0
Bamboo	89.0
Mushroom	88.3
Bamboo shoot	87.8
Medicinal plants	71.3
Honey	63.5
Bushmeat	61.3
Thatches	57.0
Fodder	45.7
Lake Resources	
Fish*	89.6 (44.4)
Prawns*	68.3 (20.4)
Molluscs*	48.6 (12.6)
Birds	3.0

(*) denotes resources with economic importance, and their values are in the parentheses.

= 2, $p < 0.001$) generated more income. Males more than females ($\chi^2 = 4.8$, df = 1, $p = 0.027$), Bamar people more than Shan people ($\chi^2 = 7.6$, df = 1, $p = 0.006$), and landless individuals more than landowners ($\chi^2 = 5.0$, df = 1, $p = 0.025$) had higher dependency on the PA.

A GLMM was fitted to predict income dependency on the PA from five independent variables (resource collection place, ethnicity, gender, distance from the PA and occupation) as fixed factors, and the village as a random factor. Land ownership was excluded from the model because of its significant correlation with occupation ($\rho = 0.553$). As presented in Figure 2, the model was statistically significant only with the effect of the resource collection place, while other variables were no longer significant [F (8, 221) = 3.422, $p < 0.001$, Accuracy = 85.2%]. Again, the coefficient estimates of the model revealed that household incomes were significantly higher among those who collected resources from inside or near the PA compared to those who collected from outside the PA (coefficient estimate = 2.601, SE = 0.662, $p = 0.001$) (Figure 2).

Perceived benefits and costs from the PA

Benefits from the PA

Majority of the respondents (85.2%, N =230) reported that they received benefits from the PA. Among those agreeing with gaining benefits (N = 196), 31.6% acknowledged exploitable benefits (timber, fuelwood, food, etc.), while 18.9% appreciated non-exploitable services (that is, climate regulation, flood control, and aesthetic and cultural values), and the remaining 49.5% indicated that they received both. Participants living closer to the PA perceived more benefits than did those living farther from the PA ($\chi^2 = 126.18$, df = 3, $p < 0.001$). Fishermen more than farmers ($\chi^2 = 10.6$, df = 2, $p = 0.005$) and landless individuals more than landowners ($\chi^2 = 4.2$, df = 1, $p = 0.038$) placed significantly higher credit on the PA's value ($\chi^2 = 41.5$, df = 1, $p < 0.001$).

Benefits from the PA were predicted using a GLMM, with two independent variables (distance from the PA and occupation) as fixed factors, and village as a random factor. Land ownership was removed from the model, as it correlated significantly with the occupation ($\rho = 0.553$). The model demonstrated that only the distance from the PA had a significant effect on predicting variations in the acceptance of the benefits, while the effect of occupation was not significant [F (5, 224) = 9.023, $p < 0.001$, Accuracy = 93.5%) (Figure 3). The coefficient estimates of fixed effects from the model indicated that the perception of benefits followed the distance gradient, in which the villages near the PA received significantly more benefits (fringe: 5.166, SE = 0.880; near: 4.935, SE = 0.876; and intermediate: 3.348, SE = 0.858, respectively; all at $p < 0.001$) than did those of the far village (Figure 3).

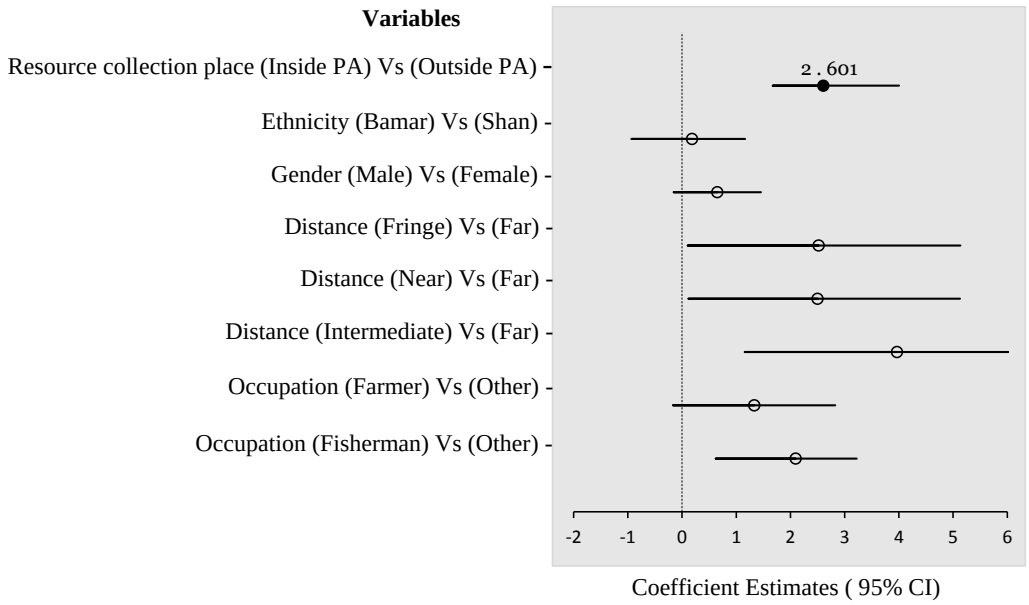

Figure 2. Coefficient estimates of predictors of the income dependency on the PA. Filled circles represent significant predictors and unfilled circles denote non-significant predictors. Positive effects were on the right side and negative effects were on the left side of the dotted line. Coefficient estimates were reported for only significant predictors.

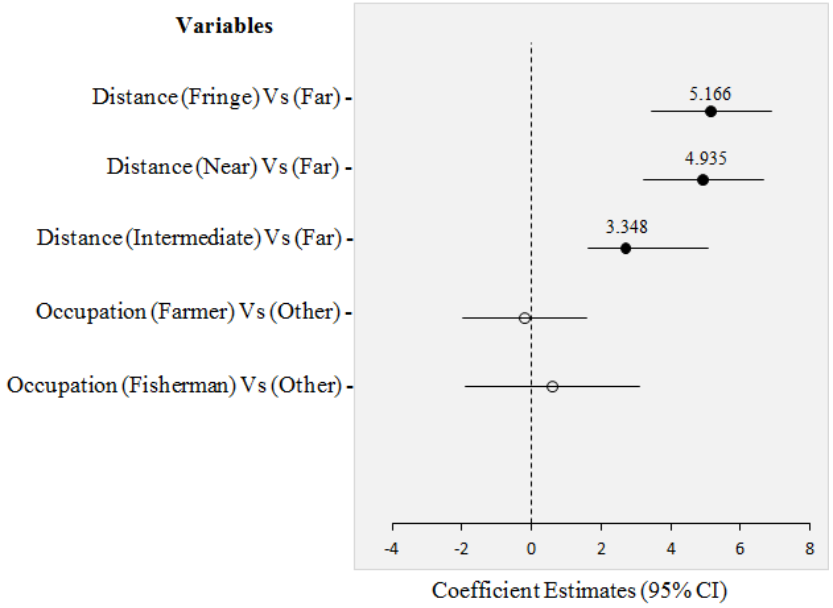

Figure 3. Coefficient estimates of predictors of the perceived benefits from the PA. Filled circles represent significant predictors and unfilled circles denote non-significant predictors. Positive effects were on the right side and negative effects were on the left side of the dotted line. Coefficient estimates were reported for only significant predictors.

Costs from the PA

More than half of the respondents (53.9%, N = 230) claimed losses incurred by the presence of the PA in their vicinity. Of those who suffered the costs (N = 124), 87.9% experienced only one kind of loss, whereas 12.1%

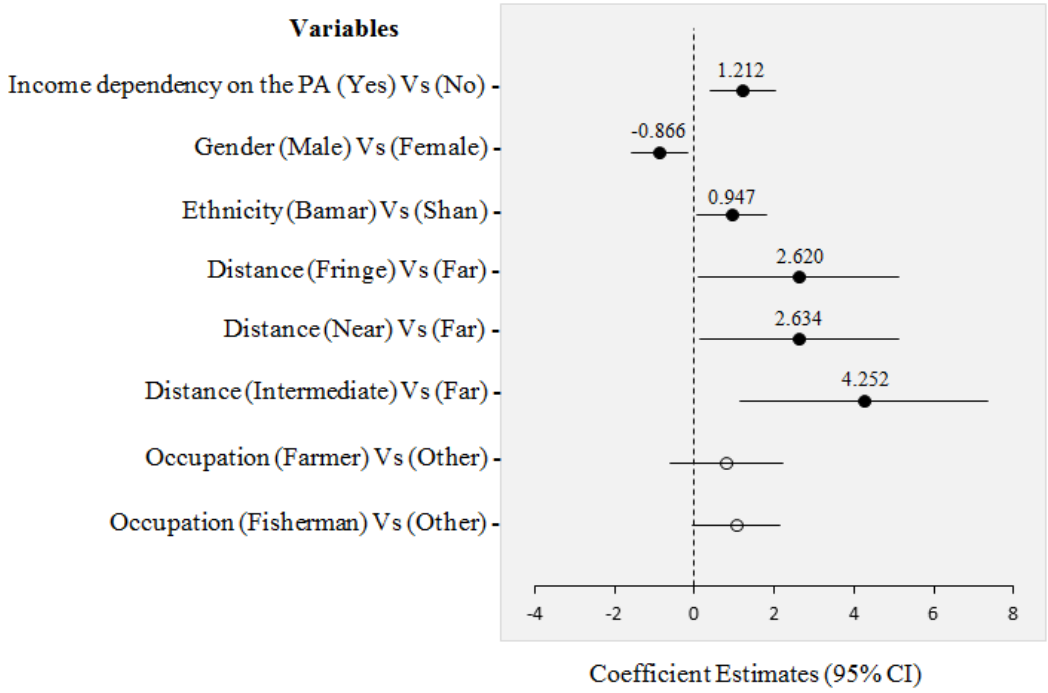

Figure 4. Coefficient estimates of predictors of the perceived costs from the PA. Filled circles represent significant predictors and unfilled circles denote non-significant predictors. Positive effects were on the right side and negative effects were on the left side of the dotted line. Coefficient estimates were reported for only significant predictors.

encountered two or more problems. Different kinds of problems included crop damage by wild animals and birds (N = 74), restricted resource access (N = 60), and the other problems, such as conflicts with PA staff concerning land use, flooding agricultural land and erosion along the river bank (N = 7).

The costs of living near the PA were significantly higher to the respondents who depended on the PA resources for household income (χ^2 = 35.1, df = 1, p < 0.001). These PA-induced costs were relatively higher in the intermediate village located in the alluvial area of the PA than those were in the other villages, fringe, near and far (χ^2 = 36.2, df = 3, p < 0.001). Fishermen and farmers more than other business owners (χ^2 = 9.7, df = 2, p = 0.008), and peanut cultivators more than rice cultivators (χ^2 = 13.1, df = 2, p = 0.001) experienced more problems. Furthermore, gender (χ^2 = 3.7, df = 1, p = 0.052) and ethnicity (χ^2 = 10.7, df = 1, p = 0.001) were also significantly related to the perceived losses.

A GLMM was constructed, in which the costs from PA were set as the dependent variable, while five independent variables (income dependency on the PA, gender, ethnicity, distance from the PA and occupation) were set as fixed factors, and the village was set as a random factor. Crop type was not included in the model, as it was significantly correlated with occupation (ρ = 0.631). The model confirmed that all the variables other than occupation were significant predictors of the perception of costs [F (8, 221) = 3.972, p < 0.001, Accuracy = 74.3%] (Figure 4). The coefficient estimates of significant variables indicated that distance had the strongest influence on the cost of the PA (fringe: 2.620, SE = 1.276, p = 0.041; near: 2.634, SE = 1.271, p = 0.039; intermediate: 4.252, SE = 1.575, p = 0.007), followed by income dependency on PA (1.212, SE = 0.411, p = 0.004), ethnicity (0.947, SE = 0.444, p = 0.034) and gender (-0.866, SE = 0.351, p = 0.014) (Figure 4).

DISCUSSION

Household dependency on the PA

It was found out that timber and bamboo were used as the main construction materials in the IWS. Than (2011) also reported that timber and bamboo houses were predominant house structures, and 70% of those houses used bamboo as a walling material, while 41% used timber as a flooring material. Timber and bamboo were also used as fencing materials in agricultural fields because livestock was pastured in the open grazing system in the IWS. Fuelwood was the primary source of energy for cooking and the annual household consumption ranged from 2 to 20 bullock carts (1 bullock cart = approximately 0.4 ton). Wood fuel requirements for cooking food to feed domestic livestock (pigs) increased the consumption rate (Than, 2011). The high consumption

of fuelwood can also be explained by the lack of alternative energy sources (Aung et al., 2015), inaccessibility or unaffordability of high installation costs (Badola, 1998) and higher electricity charges (Baral and Heinen, 2007).

Although the majority of respondents were farmers, they switched their activities between fishing and farming alternately (Than, 2011). Fish was not only the main source of protein but was also a source of income. Seasonal variation of household incomes was also detected between fishing and off-fishing seasons. Such differences in household incomes were more acute among fishermen and farmers than among other types of occupations. The results of the GLMM also revealed that people who collected resources from inside the PA generated significantly higher income than did those who collected from outside. Since no commercial exploitation of forest resources was allowed inside the IWS, this income variation relative to the resource collection place could be inferred to only lake resources.

Our results showed that income dependency on the PA was relatively higher in the intermediate village than were those in the other villages. Although this finding contradicts the common phenomenon that decreasing resource dependency with increasing distance from the PA (Shrestha and Alavalapati, 2006; Rahman et al., 2017; Kyando et al., 2019), it concurs with the finding of Ambastha et al. (2007) that household dependency differed depending on the geographic characteristics of the locality which facilitated different land uses. The intermediate village (Chaung Wa) is in the alluvial outflow basin in the northern edge of the sanctuary. Most of Chaung Wa villagers were landless and their livelihoods depended on fishing in the lake and peanut cultivation on the alluvial plain when the water level lowers during the open dry season. Such effects of geographical distinction on the main livelihoods might cause a higher dependency in Chaung Wa than those in other villages. Similar results were also reported in Myanmar and elsewhere. Aung et al. (2015) in Nat Ma Taung National Park in Myanmar and Parker and Thapa (2012) in the Kanchenjunga Conservation Area of Nepal found that landless people with limited livelihood options were more dependent on the PA's resources because of their lack of capital to invest in other income sources. Additionally, the non-significant effects of distance in the GLMM explained that the distance was not the main influencer of community resource dependency. Therefore, our hypothesis (H1) that communities living closer to the PA are more dependent on the PA's resources is not supported.

Perceived benefits and costs from the PA

A strong recognition of PA's benefits was found among local communities. Communities' perceptions of benefits were associated with the proximity to the PA. Residents living on the fringe and near the PA perceived higher benefits than did those of the intermediate and far villages. This finding is consistent with those of other studies by Thant (2017) in Chatthin Wildlife Sanctuary, Myanmar, and Shrestha and Alavalapati (2006) in Koshi Tappu Wildlife Reserve, Nepal. Likewise, Sarker and Røskaft (2011) conducted case studies in four PAs in Bangladesh, and their results also indicated that the perceived level of PA benefits was 1000 times higher in villages closer to the PA than in those far away.

Possible explanations behind the maximized benefits in the communities adjacent to the PA are the convenient access to the resources, short travelling distance and time (Sarker and Røskaft, 2011). Furthermore, nearby villages benefit from community support programmes of the PA such as loans or financial assistance during economically hard times, especially during the off-fishing seasons. This kind of funding support is limited to the accessible villages closer to the PA excluding those located relatively far. Although the tourism benefit was not significant in the current study, villages bordering the pagoda generated tourism income through providing homestay services, selling souvenirs, transports and logistics supplies to the visitors, and operating restaurants (Forest Department, 2018b). Such unequal benefit streams among the villages might result in their different acknowledgements of PA benefits (Coad et al., 2008).

It was found that income dependency on the PA was not a significant predictor of the perception of benefits. However, its significant effects on the costs explained that these resource-dependent households perceived PA-induced losses. These findings suggest that although people extracted resources from the PA, they did not recognize those as the benefits. Allendorf et al. (2006) also indicated that negative perceptions of rural communities were primarily rooted in the limitation to the resources which they freely used before PA notification. In this study, resource-dependent communities claimed that they were impoverished due to denied access to the resources that were economically important to them. Notably, greater losses were brought to the migrated Bamar fishermen who usually lacked land and alternative livelihood options. Some poor fishermen complained about annual registration fee for fishing licenses at the fishery department to extract fish resources.

Sarker and Røskaft (2011) found that socio-economic costs of a conservation area were directly related to its protection level, and the stricter the conservation status, the higher were the costs to the local community. Our finding that the highest costs of PA in Chaung Wa village well supports this assertion. Since before the PA establishment, Chaung Wa villagers have been using the fertile alluvial plain for growing peanuts during the dry season. The loss of customary land use rights due to the PA establishment in 2004 created land-use conflicts between the PA and Chaung Wa villagers. Although

some extent of land (384 acres of cultivated lands) were excluded as the local privilege (Forest Department, 2018b), villagers claimed that this was not the same amount of land that they lost to the PA. Additional costs implied when the PA was designated as a UNESCO Man and Biosphere Reserve in 2017, and agricultural activities within 2 km from the PA boundary were prohibited. The villagers also reported that they suffered land-charged extra costs and reduced crop yield because the replaced land was fallow vacant land with low fertility.

Women were more sensitive to land loss issues. Even though women are titled as dependents in rural Asian households, they contribute to the household economy by working together on the farm or by collecting NTFPs in the forests (Allendorf and Allendorf, 2013). As women had limited income streams, they felt more disadvantaged by land loss and resource restriction (Marshall et al., 2010). Our findings suggest that the socio-economic costs of the PA are greater when the impacts directly affect the main livelihood from which household income is generated. If the costs are too large at the expense of economic benefits, conservation will be compromised. Therefore, the hypothesis (H2) that highly resource-dependent communities are affected by higher costs of resource restriction is supported. However, dependency on the PA was not significant enough for the local communities to recognize as the benefits.

CONCLUSION AND RECOMMENDATIONS

The resources from IWS play an important role in the livelihood of communities living in its vicinity. Rather than the distance, landscape ecology of the residential place is more likely to define the main livelihood strategies and has a stronger effect on household dependency on the PA. Among the villages around the PA, the intermediate village located in the alluvial basin relies the most on the PA resources. This level of dependency on the PA governs how people perceive the benefits and costs from it. Highly resource-dependent households suffered higher costs from the PA, and the highest was in the intermediate village. However, fringe and nearby villages perceived more benefits and fewer costs in comparison with the intermediate village. Among all village categories, the perception of both benefits and costs seems to be the lowest in the far village.

Since the dependency on the PA is different among the villages according to the geographic characteristics and main livelihood strategies, provision of benefits from the conservation programmes should be compatible with each village's economic needs. Alternative livelihood options should be diversified to the people who are entirely dependent on PA resources (Khaine et al., 2014). Enhancing ecotourism opportunities may be helpful as a sustainable option. To reduce people's dependency on forest resources, more alternative sources of energy such as electricity at a low cost, and energy-saving cooking stoves should be supported (Htun et al., 2017). Rice is the major crop grown in IWS, and rice husk pellets are very promising as a substitute for fuelwood. Moreover, tenure rights or land titles outside the PA should be secured to the communities to reduce land-use conflicts and future encroachment into the PA land (Hantun, 2018). PA authorities should coordinate with responsible government departments.

Furthermore, communities' awareness regarding the PA's zoning management and systematic resource utilization in the respective zones should be promoted. Such zoning management should also be a supplementary to local community basic needs (Aung et al., 2015). For example, the introduction of fish species that are not only viable on the market but also less in adverse ecological impacts into the lake, would support local community subsistence needs and conservation effectiveness of the PA. Similarly, the increased establishment of community forests in the degraded areas of the forest buffer zone could fulfil local needs of housing poles and posts (Htun et al., 2017).

This study provides insights on communities' use and perceptions of benefits and costs from the IWS in support of future PA management decisions. However, cautions should be taken for the interpretation of the economic contributions of PA resources. As the economic exploitation of forest resources is illegal, people are reluctant to answer questions. Therefore, income dependency on the PA applies only to lake resources which were officially allowed for use for the household's subsistence. This directs future research for more detailed assessment and quantification on PA's resources that contribute to local communities' economy. Furthermore, unequal sample weights among the four distance categories might influence the relationship between income dependency and distance from the PA. Although we did not find any significant relationship between them, further studies should be followed with higher sample sizes to reach a more comprehensive conclusion.

CONFLICT OF INTERESTS

The authors have not declared any conflict of interests.

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