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The Elephant in the Garden: Bunong Chamkars and Human-Elephant Conflict in Andoung Kraloeng, Cambodia

Megan English[1,2,3]* and Gabriel Silva Collins[4]

[1]*The School for Field Studies (SFS), Center for Environmental Research in Conservation and Development Studies, Siem Reap, Cambodia*
[2]*Taronga Conservation Society, Sydney, Australia*
[3]*University of Sydney, Sydney, Australia*
[4]*Williams College, Williamstown, Massachusetts, USA*
**Corresponding author's email: menglish@fieldstudies.org*

Abstract. Bunong farms (chamkars) of Andoung Kraloeng village in Cambodia's Keo Seima Wildlife Sanctuary are increasingly being raided by elephants, leading to human-elephant conflict. We conducted twenty interviews in November 2017 to obtain information concerning this issue. Regression analysis found positive correlations between elephant group size and raided chamkar size, and between group size and distance of raided chamkars from permanent water sources. Results also suggested a decrease in effectiveness of deterrence methods and locals' tolerance toward elephants. This study highlights the need to implement effective mitigation actions before conflict escalates.

Introduction

Asian elephants (*Elephas maximus*) inhabit regions of South and Southeast Asia that are under extreme anthropogenic stress. China, India, and Indonesia alone support some three billion humans, and other nations with Asian elephants also have high human populations. It is not surprising that the greatest threats to *E. maximus*' long-term conservation are habitat loss and fragmentation, human-elephant conflict (HEC), and poaching (Calabrese *et al*. 2017; Menon & Tiwari 2019). Crop-raiding is one of the leading causes of HEC throughout Asia (LaDue *et al*. 2021; de la Torre *et al*. 2021). These threats have halved the number of wild Asian elephants between 1945–2020 (Williams *et al*. 2020), with the current population estimated to be 48,000–50,000 individuals (Menon & Tiwari 2019). However, these estimates may not accurately reflect real-world populations, and several authors have pointed out the need for more reliable population size assessments (Blake & Hedges 2004; Gray *et al*. 2014).

The difficulties and immediate necessities of Asian elephant conservation are especially clear in Southeast Asia, which hosts a series of fragmented populations. This area is characterised by extreme environmental pressure and a lack of reliable information (Hughes 2017) and it has some of the world's highest rates of land transformation for anthropogenic purposes (Tölle 2020). Between the late 1980s and 2000, elephant populations in Thailand, Laos, Vietnam, Cambodia, and Myanmar dropped from an estimated 14,400 individuals to 7,980 (Stiles 2004).

In Cambodia, elephant conservation issues match the wider Southeast Asian trends of habitat fragmentation and HEC. The country's 400–600 remaining elephants persist in scattered populations: namely, two core populations with approximately 175 elephants in the southern Cardamom Mountains Landscape and 223–335 in the Eastern Plains Landscapes of north-eastern Mondulkiri and Ratanakiri provinces (Fauna and Flora International 2020). Natural habitats in these areas were relatively little influenced by human activity until the post-Khmer Rouge era. Yet even as globalisation becomes more prevalent, local and smallholder communities continue to exist as important actors on the Cambodian environmental stage (Singh *et al*. 2018). Cambodia's surviving

natural areas border small-holder communities, which sometimes are situated entirely within natural areas. Their impacts on the environment are closely linked to conservation successes or failures (Lonn *et al*. 2019; Riggs *et al*. 2020a).

Mondulkiri's Keo Seima Wildlife Sanctuary hosts one of Cambodia's larger remaining elephant populations, along with some twenty indigenous Bunong villages such as Andoung Kraloeng (Fig. 1). Keo Seima's 292, 690 ha are characterised by a mosaic of evergreen, semi-evergreen, and deciduous forests with a tropical monsoon climate that averages 2,200–2,800 mm of rain per year (Evans *et al*. 2012).

HEC in Andoung Kraloeng typically occurs in the traditional Bunong chamkars, or family farms. Chamkar damage affects both subsistence farming and the rapidly increasing cash-crop economy (Webber *et al*. 2011; Sochanny *et al*. 2018; Chou 2019). There were 57 recorded instances of crop raiding in Andoung Kraloeng between 18th May and 13th June of 2015 (WCS 2015). A previous survey by WCS (2015) found that cashews, jackfruit, and bananas were the most targeted crops with chamkar farmers reporting annually worsening raids, including damage caused to structures in addition to crop damage. At the time of this survey, Andoung Kraloeng villagers had been unable to find successful deterrence strategies (Tyson 2016). Additionally, Bunong communities relied on gathering non-timber forest products (Chou 2019), which also led to encounters between residents and wild elephants.

Given the reported increase of HEC in the village, the potential for reprisals against raiding elephants, an increasing occurrence in other parts of Southeast Asia, is a concern (Webber *et al*. 2011; Oelrichs *et al*. 2016). Yet such action may be locally moderated by traditional Bunong culture, which highly values elephants (Erickson 2017). Domesticated elephants played a significant role in Bunong livelihoods until Khmer Rouge disruptions, and the animals feature in many Bunong mythologies and rituals (Bunthy 2014). Bunong traditions also emphasise ancestral forest and nature spirits that de-

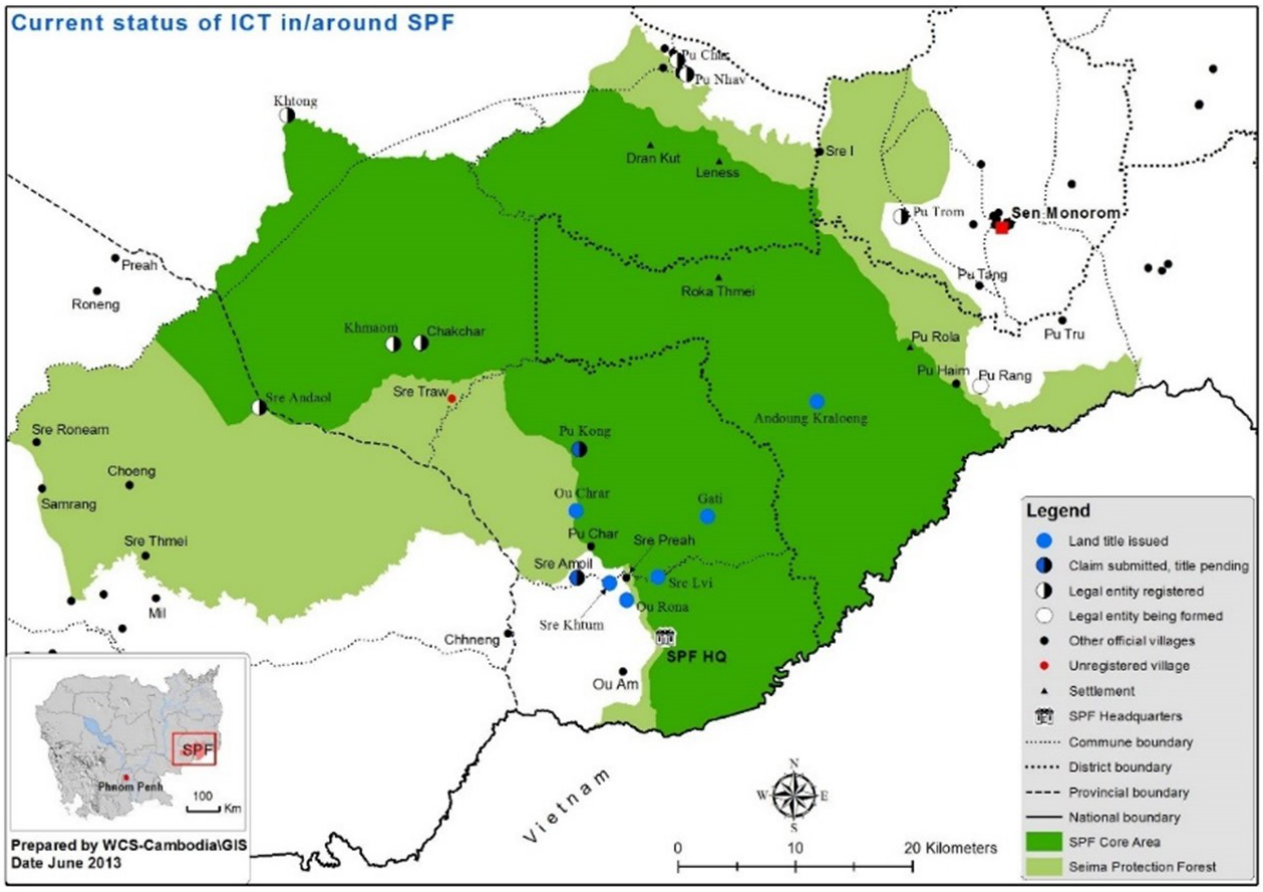

Figure 1. Andoung Kraloeng's position within Keo Seima Wildlife Sanctuary, Cambodia. This map also shows the other known communities within the wildlife sanctuary (WCS 2013).

serve protection (Leemann 2021). These beliefs mean that many villagers in Andoung Kraloeng actively search for non-lethal elephant deterrence strategies (WCS 2015). Populations of ethnic Khmer farmers also exist in and around Keo Seima, and these groups are also known to experience HEC. However only Bunong farmers were interviewed in this study.

Livelihoods in Cambodia are changing rapidly, and Mondulkiri is no exception. The environment has been modified by major road constructions, population growth, and shift towards cash crop farming (O'Kelly *et al*. 2018; Riggs *et al*. 2020b). These factors are not direct causes of HEC but can cause resource changes that may influence elephant movement. In Cambodia, environmental impacts of development and change have often been poorly managed (Hensengerth 2015). As a result, competition for space between humans and wildlife has increased.

Methods

Andoung Kraloeng village consists of 25 households and 101 individuals (pers. comm. Jahoo Gibbon Camp, 2021). The village's chamkars are usually separate from dwellings, although some farms have small huts for occasional use and storage of equipment. Most chamkars are unfenced and unirrigated. In chamkars that have fences, they are constructed using sticks and wood. Individual chamkars are clearly delineated from adjacent natural areas, but an irregular pattern of chamkar plots creates a ragged and unclear boundary between farms and wilderness.

The study was conducted in November 2017. Ethics approval for interviews was obtained from the School for Field Studies Institutional Review Board, Beverley, Massachusetts (IRB approval number CA-014-17). Semi-structured interviews were conducted with key informants using snowball sampling, whereby respondents recommended further individuals affected by human-elephant conflict to be interviewed. All respondents were chamkar owners from different households. Because most individuals in Andoung Kraloeng speak Bunong, discussions went through both, a Bunong-Khmer interpreter followed by a Khmer-English interpreter. Respondents were asked about what cash and subsistence crops they grow, the size and age of their chamkars, the location of their chamkar in relation to ongoing human disturbance, the average number of elephants entering a chamkar and timing of raids, the type of damage caused to their crops, and the distance from chamkars to water sources. Respondents were also asked about previous and current deterrence methods that they used to keep elephants away.

Inferences and resulting statements drawn from qualitative data were based on Wells' (1995) idea of grounded theory. Crops that had fewer than two mentions – soursop, avocado, and sugar cane – were excluded from analyses, as were cashews, which were grown in all respondents' chamkars except for one.

A Pearson Correlation analyses SPSS (version 23) was used to determine correlation between independent variables: chamkar size (ha), location (related to distance (m) to human disturbance such as permanent roads, homes, and farm huts), age (years since chamkar established), cash crops, and subsistence crops. Cash crops were made up of bananas, cashews, jackfruit, and cassava and were analysed separately, while subsistence crops included pineapple, rice, papaya, and multiple vegetables were combined into one variable for analysis due to their smaller individual sample sizes. A Linear Regression was then used to determine if there was a relationship between the dependent variable - elephant group size - and the remaining independent variables. Distance of chamkars to permanent water sources (m) was analysed separately as this variable had sample limitations. Elephant group size was selected as the dependent variable as farmers had expressed interest in understanding why some crops and chamkars attracted larger groups compared to others.

Results

Twenty interviews were conducted with respondents ranging from 26–70 years old, with a median age of 47. Information was obtained related to 24 chamkars (as some farmers owned more than one). The mean chamkar age was 10.13 years (SD = 7.46, SE = ±1.52) with a

mean size of 2.03 ha (SD = 1.24, SE = ± 0.25). Elephants mainly raided chamkars from April to June, with raids occurring during both the day and the night. The mean number of elephants per raid was 8 individuals (SD = 4.56, SE ± 0.93). The number of elephants entering chamkars on average was significantly correlated with chamkar size (p = 0.00) (Fig. 2). Elephant group size was larger in chamkars located further away from a permanent water source (p = 0.005) (Fig. 3).

Correlation analyses between the seven variables found a significant positive correlation between chamkar age and chamkar size (p = 0.026), chamkar age and cassava crops (p = 0.014) and the presence of cassava and subsistence crops (p = 0.002). Therefore, chamkar age and cassava were removed from further analysis in order to maintain independence between variables. Regression analysis found a significant relationship between elephant group size and the size of the chamkar raided ($F(5,18) = 10.32$, p = 0.00) with an R^2 of 0.74. Larger chamkars were visited by larger elephant groups (Fig. 2). No correlation was found between elephant group size and the location or crop-type.

Distance of chamkars to permanent water sources was analysed separately due to having a smaller sample size of 15 respondents who could confidently report this distance (Fig. 3). A positive correlation was found, with larger groups visiting chamkars farther away from a

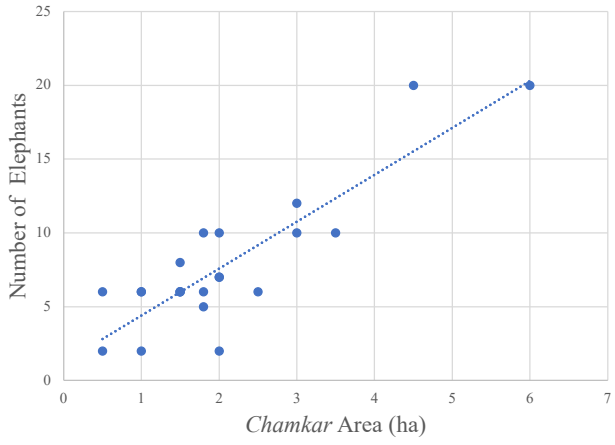

Figure 2. The number of elephants entering chamkars and chamkar size.

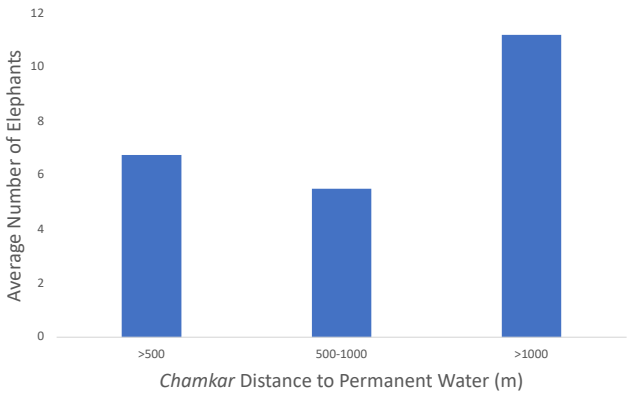

Figure 3. Elephant group size and distance of chamkars to a permanent water source. Distance >500 m (n = 8), 500–1000 m (n = 2) and >1000 m (n = 5).

permanent water source ($F(1,14) = 11.67$, p = 0.005) with an R^2 of 0.47.

Responses to the types of crops grown and frequency of damage was analysed from all 24 chamkars (Fig. 4). Respondents indicated that cash crops were generally affected more than subsistence crops, with cashews particularly targeted. For example, all respondents grew cashew and 90% said they were damaged by elephants. In comparison, rice was grown by 70% of farmers and listed as damaged by only 25%. Respondents listed six crops that elephants damaged, consisting of cashew, banana, cassava, jackfruit, pineapple and rice. Four of them (cashew, banana, cassava, and jackfruit) were cash crops, and the majority of crops not mentioned as damaged were grown for subsistence.

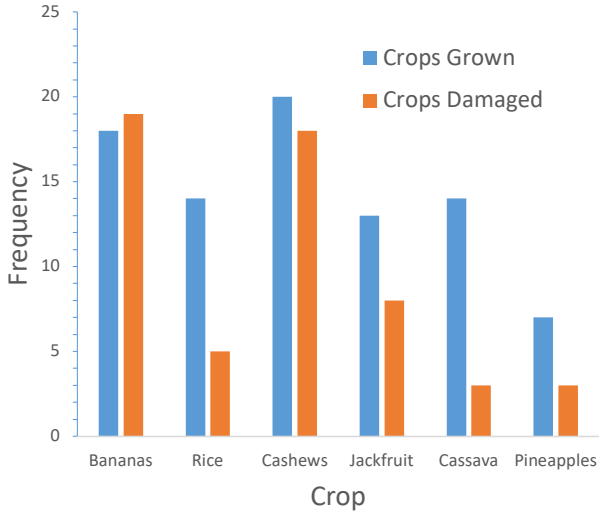

Figure 4. Frequency of crops cultivated by respondents and mentioned as damaged (n = 24).

Banana, cashew, and jackfruit trees were most commonly raided (in 19, 18 and 8 chamkars respectively). Two farmers had stopped growing banana owing to the elephants' preference for them. While cashew and jackfruit were not damaged as often as banana, farmers stated that their economic value was significantly decreased by elephant raids. Farmers stated that elephants only ate the young leaves and ripe fruits from cashew and jackfruit trees. Nevertheless, trees often had branches broken or were pushed over and uprooted. Elephants left rice, cassava, and pineapple relatively unharmed. Farmers said that the timing of crop damage was not random and claimed that the raids were noticeably concentrated at the end of dry season and onset of the wet season (between April and June). Eight respondents claimed that the raiding period overlapped with cashew and jackfruit fruiting times, which occurred at the end of the dry season (April or May).

Respondents mentioned nine deterrence methods. Four of them - blowing buffalo horns known as 'nong', using domestic elephants to keep raiding groups away, burning oil rags, and overnight stays where farmers slept in huts located on their chamkars, were used previously but no longer. Fifty-five percent of respondents indicated that they currently had no effective methods for discouraging elephant raids on their chamkars. Farmers who attempted to scare elephants away sometimes used multiple methods. Forty percent of farmers who tried to chase elephants away said that they attempted to scare the elephants away by individually making noise without fireworks, such as by shouting, banging pots and pans, and hitting sticks together, 25% said they used fireworks, and 5% used either fires or groups of fellow farmers and villagers who gathered to scare elephants away. Fifteen percent of respondents also mentioned that they had used offerings, such as pig carcasses, to appease the spirits who they believe will protect them and their crops from the elephants. Respondents agreed that all these strategies were more prevalent and successful in the past. The ineffective nature of current deterrence efforts may play a role in interviewees' frequent statements about having been more tolerant and fonder of elephants in the past.

Discussion

Elephant raids in Anduong Kraloeng come on the heels of growing stressors in surrounding elephant habitats. Namely, road construction and large cash crop plantations have contributed to the deforestation and fragmentation of Protected Areas near Keo Seima, as best exemplified by Snuol Wildlife Sanctuary becoming degazetted in 2019 (Clements *et al*. 2014; Schoenberger 2017). Negative pressures forcing elephants out of previous habitats are coupled with positive attractants bringing elephants toward Andoung Kraloeng, perhaps most importantly, the presence of cashews, jackfruits, and other nutritious cash crops.

The April/May dry season turning point coincides with the April – June time range that the villagers gave for the majority of elephant raids. Based on cashew and jackfruit fruiting times and ripeness, Keo Seima's elephants appear to be raiding at the height of productivity of those crops. This may be a strategy to offset foraging difficulties that are most pronounced at the end of the dry season, when wild plants may be suboptimal sources of food (Owen-Smith 2008).

Our results indicated that chamkar size and proximity to water were positively correlated with the number of elephants coming to farms. One explanation for higher elephant numbers at larger chamkars may stem from Asian elephants' preference for forest-grassland or forest-agriculture ecotones where food plants become more abundant and accessible (Fernando & Leimgruber 2011). Larger chamkars may have larger ecotone boundaries, along with more understory growth interspersed with crops, providing combined graze and browse opportunities that draw larger elephant groups. Additionally, groups with more individuals require more food, which could also explain why larger chamkars are visited more by larger groups. While it is also possible that larger chamkars border smaller ones, thus creating extra-large crop areas for groups to raid, our results found significance in elephant numbers in relation to individual chamkar size, which was also correlated with chamkar age. Elephants are known to respond to long-term patterns of pro-

ductivity, more so than immediate forage conditions in familiar locations (Tsalyuk *et al*. 2019), which maybe reflected in the preference for raiding larger, older chamkars.

Along with larger chamkars, those more than 1000 m from water experienced the highest numbers of elephants. Larger elephant groups traveling to farms further from water may indicate elephant grouping strategies that mitigate perceived threats or discomfort in areas with more human influence. While streambeds provide natural and protected paths for elephants, reaching chamkars more distant from those routes, requires movement through more anthropogenically modified zones. By congregating in larger groups, elephants may feel safer to travel farther in order to reach larger chamkars i.e. higher risks leading to higher rewards (McArthur *et al*. 2014).

While there may be a correlation between distance to water and the size of the chamkar, due to sample size differences we were unable to assess it. More data across more locations is required to assess the relationship between the number of elephants visiting chamkars and their sizes or distances to water. Other variables also may play important roles that were not clear in this data set due to sample limitations. For example, larger chamkars may contain a greater quantity of cash crops compared to smaller plots. Elephants' disproportionate preference for cash crops, evident from the interview responses, may result in groups raiding larger chamkars not because of their size but because of what is grown there. Despite our results showing that crop type did not correlate with group size, there are likely other factors at play that were not within the scope of this short-term study. Additionally, while interviews suggest that larger chamkars are generally located farther from Andoung Kraloeng village, our data did show that the location of the chamkar (i.e. its distance from ongoing anthropogenic disturbance) was not correlated with group size of raiding elephants. Determining the chamkars' relative isolation from one another and the age of individual crops within the chamkar may provide further insights.

Respondents indicated that Andoung Kraloeng residents employed a decreasing range of strategies to discourage elephant raids. Prior to this study, most respondents indicated they had received little or no advice or aid with HEC issues, aside from information shared amongst locals. Those who did note outside organisations' aid were discouraged by the quality of that advice: some villagers were simply told to "chase the elephants away." Subsequent to this study, a dedicated human-wildlife conflict mitigation team was established by the Wildlife Conservation Society, and additional support provided to villages.

Along with their frequent explicit statements valuing elephants, Keo Seima residents' patience in withstanding raids without resorting to drastic retaliation suggests that they are averse to harming them. Analyses of integrated biological and ethnographic methodologies' effectiveness in studying human-animal conflict has concluded that combined approaches produce results which help promote sustainable interspecies coexistence (Setchell *et al*. 2017). These factors emphasise the need for a deeper understanding of Bunong spiritual beliefs and their impact on mitigation strategies. We recommend that farmers receive adequate training in mitigation from experts sensitive to these cultural influences and a program is put in place for monitoring the effectiveness of these strategies over the long-term. Immediate action to mitigate chamkar farmers' losses in Andoung Kraloeng is also suggested. Villagers are bearing the accumulated costs of reduced income from several years of damage by elephants. Although they are currently opposed to harming them, the situation is untenable and may change for the worse with time.

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