Developing a spatially-explicit, sustainable and risk-based insurance scheme to mitigate human–wildlife conflict

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ABSTRACT

Insurance may encourage coexistence between farmers and wildlife by reimbursing farmers' losses. China introduced an insurance scheme to mitigate human–elephant conflict in Xishuangbanna Dai autonomous prefecture in Yunnan Province, where elephants cause damage to rubber plantations. However, recent experience has suggested that the present insurance system exhibits poor performance related to funding shortfalls, undervaluing of plantations and insufficient payouts, and by limiting community involvement. To address these shortcomings we conducted attitude surveys with farmers, and developed an actuarial (risk-based) insurance model for rubber loss that incorporated spatially-explicit risk of depredation and net present value of rubber at damage, in order to calculate fair payouts at village and town levels for the year 2011. Farmers were largely dissatisfied with the current insurance system, and their level of satisfaction was associated with the compensation ratio (percentage of lost rubber reimbursed by insurance). The illustrative results based on 2011 rubber loss data revealed high variability in risk and therefore payouts (and further, premiums) and that fair insurance payouts would be approximately five times the current levels. To improve compensation and support long-term program sustainability, we considered an insurance cost-sharing mechanism that incorporated shared payments from government, rubber farmers, and Chinese tourists. We found that multiple stakeholders were willing to pay for elephant conservation, which could make significant contributions to insurance premiums over the long term. Importantly, this proposed insurance model could be broadly applicable to livestock and long-lived cash crop compensation systems.

1. Introduction

Human–wildlife conflict (HWC) is an important driver of population declines of many threatened species (Banerjee et al., 2013; Woodroffe et al., 2005). In order to conserve species that generate conflict with people, there is a need to secure the rights and livelihoods of rural residents who face the conflicts, bear the cost imposed by wild animals, and may want the "pests" to be eradicated (Dickman, 2010). To reduce hostility of farmers towards wildlife, and the resulting retaliatory or pre-emptive killing, compensation schemes may be implemented, often in combination with other mitigation such as deterrents and barriers to prevent damage, and awareness campaigns to increase people's tolerance to wildlife (Nelson et al., 2003; Woodroffe et al., 2005).

Compensation—the reimbursement to individuals or their families who have experienced wildlife damage to crops, livestock, or property, or who have been injured, killed, or physically threatened by wildlife (Nyhus et al., 2005)—can incentivize coexistence, especially when HWC is chronic and the economic impact of wildlife-attributed loss is substantial. While several successful compensation schemes have been reported across a range of human–wildlife settings (e.g. Maclennan et al., 2009; Nyhus et al., 2005), some compensation programs have failed to encourage coexistence and sometimes even worsened HWC (e.g. Gusset et al., 2009; Mishra, 1997; Naughton-Treves et al., 2003; Ogra and Badola, 2008). Reasons for failure are various and include inadequate compensation, lack of sustainable funding and the creation of incentives detrimental for conservation—so-called 'moral hazards' that may include over-reporting of losses (Bulte and Rondeau, 2007, 2005; Dickman et al., 2011; Nyhus et al., 2005).

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Insurance is a form of compensation that requires participants to pay a premium for their involvement (Dickman et al., 2011); this mechanism is gaining recognition as a potential improvement to traditional compensation, for several reasons. First, if based on actuarial (risk-based) analyses, insurance can promote fair payments by incorporating in the premium the spatially-explicit risk of HWC with the fair market value of the insured goods. For example, HWC incidents could potentially be linked to a predictable set of habitat features such as wild prey/food availability and livestock/crop accessibility (Hill, 1997; Naughton-Treves, 1998; Redpath and Thirgood, 1999; Sitati et al., 2005, 2003; Stahl et al., 2002). Moreover, net present value (NPV) could be incorporated to estimate an actual/potential cost of losing an animal or long-lived cash crop (e.g. rubber, oil palm, coconut), including the expected future profitability (Yi et al., 2013), Considering risk heterogeneity and fair market value could lead to spatially variable, effective and equitable premium estimates and payouts. Third, an insurance-based compensation system could be sustainable if it were supported by multiple stakeholders, such as community funds and locally-generated wildlife revenues through, for example, ecotourism. Local generation of funds reduces dependence on external sources, allocates responsibilities for conflicts among stakeholders, and spreads risk among households when wildlife damage to individual farmers is highly stochastic and unpredictable (Dickman et al., 2011; Madhusudan, 2003). For example, a cost-sharing mechanism has been used to mitigate human-snow leopard conflict in Pakistan and India (Hussain, 2000; Mishra et al., 2003). Finally, insurance may also prevent moral hazards by generating incentives for farmers to protect their assets and reduce false claims as premiums increase with risk, and because farmer's eligibility for insurance can be made conditional on their adoption of best practices for damage prevention (e.g. Woodroffe et al., 2005).

1.1. Human–elephant conflict in southern China

Driven by the transition to a market-driven economy since the 1950s, lowland forest conversion into rubber (*Hevea brasiliensis*) plantations has become the hallmark of tropical southern China, especially in Xishuangbanna Dai autonomous prefecture. Xishuangbanna is home to China's remaining 190–236 wild Asian elephants *Elephas maximus* (Chen et al., 2012). The expansion of rubber has occurred at the expense of wildlife habitat and the simplification of local livelihoods (Fu et al., 2010; Li et al., 2009; Ziegler et al., 2009), and has led to an increase in human–elephant conflict (HEC) owing to frequent damage to rubber plantations. Elephant damage to rubber is characterized by the killing of seedlings and young saplings as elephants pass through the plantations to raid agricultural crops (rice, maize, banana). Feeding on rubber seedlings and saplings may also happen, as Malaysia reported rubber being raided by wild elephants to take in minerals deficient in their diets (Blair et al., 1979). Because of the high economic value of rubber, depredation by elephants inspires extreme local hostility (Chen, 2012). Farmers are least tolerant of damage to high-value cash crops (Messmer, 2000), so the increase in the market value of agricultural land further worsens the HEC found in China. From 1918 to 2005, 67 elephant deaths and 7 injuries were recorded as the result of retaliatory killing and poaching, and from 1991 to 2004, 21 human deaths and 91 injuries were attributed to elephants (Chen et al., 2012).

A host of technical measures to mitigate HEC have been implemented in China since the1990s, including electric fences, trenches and walls (Chen et al., 2012). However, those attempts proved infeasible to use at a large scale in Xishuangbanna for various reasons. Building and maintaining trenches and walls incur high costs, may have short lifespans in the mountainous landscape, or may

not allow for expansion of private agricultural land. Electric fences, while effective to mitigate HEC in many situations, have often been poorly designed and require maintenance, making them ineffective and/or costly. Moreover, fences erected around protected areas could disrupt elephant movements through critical conservation corridors in Xishuangbanna, which link Mengla and Shangyong protected areas; and Shangyong and Nam Ha (Lao PDR) nature reserve (Xi, 2009).

In 2009 Chinese authorities in Xishuangbanna began incorporating insurance as a HEC mitigation tool, by replacing the traditional technical tactics with compensation to farmers for agricultural losses caused by elephants. Wildlife mitigation funding from the national government to Xishuangbanna prefecture is budgeted towards payments to a private insurance company. Once crop damage occurs and is reported, insurance agents are responsible for loss verification and compensation.

Although the existing insurance scheme has brought positive changes of local attitudes towards wild elephants (Chen, 2012; Chen et al., 2012), recent experience has suggested that centralized insurance exhibits poor performance by limiting community involvement, by not utilizing other conservation funds to support the payments, and by not considering the spatial heterogeneities of conflict intensity and market value of crops (e.g., compensation for each lost rubber tree is US$ 2/tree regardless of age or productivity; Chen, 2012). Furthermore, funding shortfalls for the HEC insurance scheme threatens its long-term sustainability. For example, in 2010 there was a budget of US$ 450,000 for the HEC insurance scheme; and in 2011 there was a budget of US$ 1 million for all HWC insurance (although the amount allocated to HEC was not specified in the governmental budget, HEC compensation accounted for 87% of the actual cost of the HWC insurance in this year; Chen et al., 2012). The allocated budget, in any case, was insufficient to cover HEC-compensation, which was as much as US$ 693,000 in 2010 and US$ 1,371,000 in 2011 (Chen et al., 2012). The insurance company, thus, lost money in both years and therefore an improved system to fund this insurance scheme is needed to help mitigate HEC in China.

The costs of rural residents living alongside threatening wildlife may be shared by the wider beneficiaries, such as tourists (Dickman et al., 2011). Tourism, as one of the "non-consumptive but sustainable" uses of wildlife, can help to achieve conservation goals by offsetting local costs of coexistence and enhancing supportive conservation attitudes. As a charismatic flagship species, elephants attract tourists and may support a successful and sustainable ecotourism project (Kruger, 2005). In Xishuangbanna, tourist visits to Elephant Valley, a famous elephant-oriented attraction, nearly doubled from 2007 to 2012 (0.68 million in 2007, 0.83 million in 2008, 1.04 million in 2009 and 2010 and 1.21 million in 2011; Xishuangbanna Nature Reserve Bureau, unpublished data). At present, tourism revenues are not allocated to HEC, nor has there been assessment of tourists' willingness to pay for wild elephant conservation. Tourism revenues may represent a significant opportunity to relieve the financial deficiency of the current insurance scheme in Xishuangbanna.

In this paper, we propose an actuarial insurance system to help mitigate the conflict between farmers and wild Asian elephants in Xishuangbanna. Our objective in this study was to develop an improved insurance-based compensation system by taking into account the spatial heterogeneity of conflict intensity and market value of rubber trees, and by distributing the costs of HEC mitigation across multiple stakeholders who have a vested interest in the program's success. We calculated the full-indemnity insurance payouts at both the village and town level based on spatially-explicit HEC risk and rubber NPV at damage, estimated insurance payouts for HEC in the area, and used the results along with willingness-to-pay data to recommend a sustainable cost-sharing