The costs of human elephant conflict: understanding local perceptions, vulnerabilities and impacts associated with human elephant conflict in Subulussalam, Aceh, Sumatra

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Scared
Palm Oil
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Year
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Chief

Abstract

Human elephant conflict (HEC) poses a major threat to elephant conservation. As they lose their forest habitat, elephants are increasingly encountering humans and raiding farmland. Such events can be catastrophic for both local people and elephants, occasionally leading to fatalities. The importance of mitigating these conflicts is evident, but in order to do so effectively, the impacts of HEC on local communities needs to be better understood. This study investigates the costs associated with conflict between humans and Sumatran elephants in Subulussalam, Aceh, Indonesia, by interviewing 160 individuals in the region using semi-structured interviews. The results show both the visible (crop damage, property destruction) and hidden (psychological health, physical health, opportunity costs) impacts of HEC affecting the local people of Subulussalam. Individuals had experienced crop damage, and a majority expressed feelings of fear and anger towards elephants. There was also a sense of distrust of the government and abandonment by them, as individuals felt their suffering was being ignored. People were willing to try potential mitigation strategies to manage HEC, namely community group mitigation and chilli-grease fences. By understanding local perceptions, potentially successful and sustainable HEC mitigation can be put in place. Local people need to be involved in the planning and implementation of any such strategies, as they are the very people who will be impacted. By engaging with local communities, governing bodies and conservationists can work together with local people to build local tolerance towards elephants and achieve sustainable human-wildlife co-existence.

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Definitions

BKSDA – Balai Konservasi Sumber Daya Alam (The natural resources conservation centre). Part of the Ministry of Forestry of the Republic of Indonesia. In charge of managing conservation areas, and the species within them.

CRU – Conservation Response Unit. Made up of elephants and mahouts, who patrol forests to prevent illegal logging and poaching. Also involved in driving problem elephants away.

Forestry Department – Official title: Indonesian Ministry of Environment and Forestry. Cabinet-level government ministry of in Indonesia responsible for managing and conserving the forests of Indonesia.

USAID Lestari – United States Agency International Development. “Lestari” means everlasting in Indonesian

WCS – Wildlife Conservation Society

1 Introduction

Human elephant conflict (HEC) is a problem facing elephants throughout Asia and Africa. In Indonesia, the Sumatran elephant is classified as "Critically Endangered" by the IUCN, due to drastic deforestation and loss of elephant habitat, leading to HEC (Gopala et al. 2011). Strategies to mitigate HEC are needed, and for these to be successful, the impacts of HEC on local communities needs to be better understood. Often, HEC mitigation focusses on addressing direct impacts, such as crop destruction, with little consideration for hidden impacts, such as psychological distress to local people (Treves et al. 2006; Dickman 2010; Barua et al. 2013). The views and perceptions local people have of elephants, and the impacts living with HEC has on individuals, should be addressed and understood. With this information, effective mitigation against HEC can be implemented, benefitting both elephants and humans (Naughton-Treves and Treves 2005; Sterling et al. 2017).

1.1 What is human wildlife conflict

Human wildlife conflict (HWC) can be defined as "when the needs of wildlife impact negatively on the goals of humans or when the goals of humans negatively impact the needs of wildlife."(Madden 2004). The IUCN describe HWC as being "when animals pose a direct threat to the livelihood or safety of people…result[ing] in [the] persecution of that species"(IUCN 2018). In Sumatra, Indonesia, the critically endangered Sumatran elephant (*Elephas maximus sumatranus*) has increasingly conflicted with humans, mainly due to habitat loss; their potential habitat has decreased by 69% between 1985 and 2010 (Gopala et al. 2011). Sumatra has shown some of the fastest rates of deforestation in the world. Between 1985 and 2012, the island saw a 55% decrease in natural forest cover (Margono et al. 2012). The main drivers of this decline are illegal and legal logging, land clearing for agriculture (including large scale plantations, such as palm oil, and smallholdings), as well as an increasing human population and the associated expansion of villages and towns (Margono et al. 2012; Abood et al. 2015; WWF Indonesia et al.).

In Indonesia, smallholders now account for >40% of the country's planted palm oil areas. In the past 25-30 years, the area of land used for palm oil production in Indonesia has increased drastically, from 1.1 million hectares in 1990, to 11 million hectares in 2016 (Statistik 2013). As the world's top vegetable oil, demand for palm oil is high (Byerlee et al. 2017). It is easy to grow and requires little labour, making it a desirable choice for farmers. Indonesia is responsible for half of the world's palm oil production. Unfortunately, there is currently a lack of accountability and control over the management of land in Indonesia, with unclear laws over forest management. As a result, many palm oil businesses in Indonesia are illegal; by some estimates, as many as 80% (Lawson et al. 2014). Lack of law enforcement, in addition to high levels of corruption, have led to the uncontrolled clearing of forest habitats (Naylor et al. 2019). This problem is particularly rife amongst smallholders. Large multinational palm oil mills have the capacity to process more palm oil than they produce, meaning an increased demand for palm oil (Naylor et al. 2019). The most recent data suggests that 89% of palm oil producing households are independent of large companies (Statistik 2013). With increased palm oil demand, there is increased forest clearing, with little management from local authorities, such as local governments and wildlife organisations. In fact, governments often promote palm oil expansion, as it helps to boost the local economy (Gatto et al. 2017; Naylor et al. 2019). Smallholder farms often produce a much lower yield of palm oil than large organisations due

to the costs associated with fertiliser and expensive, specialist tools. This further drives deforestation as independent smallholders attempt to increase income by planting more crops (rather than increasing yield). Palm oil itself is highly productive, if managed properly. However, this is rarely the case for most smallholders, who often lack money to invest in ways to promote growth and crop yield (Glenday 2016). With palm oil currently cultivated in 2/3 of rural villages in Sumatra and Kalimantan (Indonesia's portion of the Island of Borneo), this poses a huge problem for wildlife (Naylor et al. 2019).

With such high rates of deforestation, HECs are an inevitable consequence (Nyhus and Tilson 2000). Elephants are forced into smaller, less suitable patches of habitat. The remaining groups of Sumatran elephants now live in fragmented environments as isolated sub-populations, due to drastic reductions in available habitats (Hedges et al. 2005). This is particularly problematic for a wide-ranging species like elephants. The home range of an adult Sumatran elephant is estimated to be between 275km^2 and 1352km^2(Moßbrucker et al. 2016). Despite their habitat being cleared, elephants tend to remain within their historic ranges. In response to a reduction of food availability in these fragmented environments, elephants exploit the available food - most often farm crops- to meet their dietary requirements (Desai and Riddle 2015). Research has shown that the incidence of crop raiding by elephants increases with habitat decrease (Chartier et al. 2011). This is highly damaging economically for farmers, whose livelihood often depends on a successful harvest (Desai and Riddle 2015). Hence, communities subjected to crop damage by elephants tend to show resentment towards the species, and raids can be followed by the retaliatory killing of elephants (Nyhus and Tilson 2000; Rood 2010). Across Sumatra, it is believed that 10% of the elephant population in the country has been killed in this way since 2012. In Aceh province, 57% of people are farmers, making the province a hotspot for human wildlife conflict (World Bank 2007). It is thought that 36 individual elephants have been killed here between 2012-2015, in retaliation by local people (Erwin 2015). In 2018, eleven elephants were reported to have died in Aceh, three of which were due to HEC, and three as a result of poaching (the remaining five reportedly died of "natural causes") (Xinhua 2019).

1.2 Hidden and visible impacts of HEC

HEC has both direct and indirect costs associated with it. Direct, or visible, impacts of HEC include crop raiding, property damage and injury. Indirect, or hidden, impacts of HEC can be defined as "costs characterised as being uncompensated, temporally delayed, psychological or social in nature" which include the health impacts and opportunity costs associated with crop raiding animals e.g. time lost farming as individuals are too afraid to tend to crops (Barua et al. 2013). Conservation biology has historically focused on the direct, ecological aspects of HWC, with little consideration for the hidden, social ones (Treves et al. 2006; Dickman 2010; Key 2016; Bennett et al. 2017).

Human wellbeing can be affected by HEC, with aspects such as physical health, psychological health and opportunity costs (personal security, and freedom of choice and action) impacted (Table 1) (Reid et al. 2005). Personal security can be diminished as the presence of elephants can cause people to feel unsafe. The economic impacts of reduced crop yield from crop raiding also limits financial and food security. In terms of freedom of choice and action, people in areas of intense HEC may face restrictions on movement, such as not attending farmland for fear of meeting elephants or being forced out of an area due to intense conflict. Additionally,

crop guarding can prevent children from attending school, as they are required to guard crops, or because financial insecurity as a result of HEC mean households cannot afford tuition fees. Similarly, HEC can prevent individuals from performing household tasks such as fuel and water collection (Mayberry et al. 2017). Physical health is impacted through injury as a direct result of elephant raids. HEC can also cause exhaustion, increased exposure to vector borne disease and reduced physical wellbeing due to lack of sleep and increased crop guarding sometimes associated with HEC (Barua et al. 2013)**.** The psychological wellbeing of people has been shown to be diminished in areas of high conflict with wildlife, particularly elephants (Ogra 2008; Barua et al. 2013; Nyhus 2016). Stressors associated with HEC, such as fear, anxiety, social isolation and economic insecurity all negatively impact on people's mental health**.** Studies have shown cases of psychological illness, such as alcoholism and depression, as well as high levels of fear and anxiety, in locations which experience HEC (Ogra 2008; Jadhav and Barua 2012; Mayberry et al. 2017).

Table 1 Definitions of phrases associated with human wellbeing (Reid et al. 2005; Barua et al. 2013)

Wellbeing impacts	**Definition**
Physical Health	"Being strong and free from disease or illness"
Psychological Health	"Being without psychological or emotional disturbance"
Opportunity Costs	Costs which prevent an individual from being able to lead the life they wish to lead, due to constraints on movement and activities
Personal Security	"Safety of self and possessions, secure access to resources and security from…disasters"
Freedom of Movement	"The ability to travel without constraints"

These impacts of HEC all feed into one another: for example, financial insecurity from crop loss can lead to increased stress, which in turn can cause lack of sleep. Tiredness and stress have been shown to impact the physical health of people, with tiredness causing greater stress, and stress causing less sleep (Ogra 2008; Barua et al. 2013). In turn, diminished physical health may prevent people from being able to work, thus leading to greater financial insecurity. Similarly, fear for safety means some people may avoid going to certain places, which could limit both community ties and financial security – for example, if a farmer neglects their farmland (Fairet and Maguy 2012). Diminished social ties have been shown to reduce the mental health of some people, as they do not have the support of others in stressful or intense situations (Weinmann 2018).

Understanding the human perspectives of HEC is vital, thus an integrated approach is needed to enable more effective mitigation and conservation.

1.3 Local perceptions and vulnerability to HEC

Single, catastrophic events, such as crop raids by elephants, can be seen as causing more damage than smaller, continuous raids by other species of wildelife, even if those lesser, more regular raids cause greater overall damage (Treves et al. 2006). In Ethiopia, researchers found that lions were incorrectly identified as the main source of cattle loss, despite other cumulative events, such as disease and livestock theft, causing greater long-term damage. This attitude was still seen even though the last recorded lion attack on livestock in the area was five years prior to the research (Gebresenbet et al. 2018). Similarly, in Tanzania, local people perceived elephants to be the greatest risk to their farms. This was true if considered communally, however on an individual level, only a few people suffered from crop loss to elephants during the study period. Contrastingly, almost all individuals faced daily damage from other pest species, as well as from drought, yet elephants were still said to be the greatest risk to individuals by local farmers (Hoffmeier-Karimi and Schulte 2015). The perceptions people have of wildlife affects their tolerance, opinions and expectations for wildlife and mitigation strategies (Treves et al. 2006). It has been suggested that hidden costs play the most important role in explaining human attitudes to wildlife. A meta-analysis found that hidden costs (e.g. feelings of fear or stress) were more significant drivers of local attitudes to wildlife for people living with HWC than hidden benefits (e.g. ecosystem services). This was also the case for direct costs of living with wildlife (e.g. property damage, crop loss), which were greater drivers of local perceptions towards wildlife compared to direct benefits (e.g. tourism). Thus, it is suggested that negative attitudes play a disproportionate role in affecting human perceptions and attitudes to wildlife when compared to positive events (Kansky et al. 2016).

Perceptions of wildlife have also been linked to the vulnerability of individuals. Vulnerability in this context can be defined as “the interactions of hazards of a place…with the social profiles of communities” (Carter 1997). Vulnerability looks at an individual’s or households’ ability to cope with risks – an individual who is more able to cope with risk is less vulnerable to that risk, even if their exposure is the same. For example, people who do not have enough money to pay for fertiliser may see a reduction in crop yield as a result. This leads to a reduction of income, meaning even less money to pay for tools to improve farming output. Such individuals, who are already struggling financially, will be more vulnerable, and less able to cope with, damage caused by wildlife. Costs associated with wildlife damage, and preventative measures, may further increase hostility felt by people towards animals (Dickman 2010). If people are unable to grow the crops they require, their earnings and economic stability will be reduced. Without a reliable source of income, their ability to adequately feed themselves and their family may be compromised. Similarly, elephants eating crops grown for subsistence farming will decrease food availability and economic income . In India, a reduction in food availability as a result of HEC meant women would eat less food to ensure their children received enough nourishment (Ogra and Badola 2008). As eluded to in the previous section, social ties can help lessen the impacts of HEC. Solo farmers may thus be more likely to have negative perceptions towards elephants than communal farmers because they are absorbing the costs of conflicts as individual units rather than as a community (Naughton-Treves and Treves 2005; Nyirenda et al. 2013).

Another aspect to consider is the cultural and religious beliefs of people in areas of HEC, which can impact how wildlife is perceived, both negatively and positively (Dickman and Hazzah 2016; Gebresenbet et al. 2018). In Sulawesi, Indonesia, local folklore, which says people can

turn into Tonkean macaques, means many people will not harm this species, despite regular crop raiding (Riley 2010). Conversely, in many areas of Madagascar, Aye-ayes are believed to be a bringer of doom, and thus are frequently killed as soon as they are seen in a village, with some people believing the entire village should be burnt (Glaw et al. 2008). Hence, cultural and religious beliefs are important to consider, in order to understand local perceptions and tolerance to HEC. In some cases, however, where HWC is rife, cultural and religious beliefs can have a limited effect, or be ignored entirely (Bhatia et al. 2017).

1.4 Mitigation and human inclusion

It is evident that more needs to be done to manage HEC. Successful mitigation will benefit both humans and elephants: preventing crop raids will save income for farmers and prevent human and elephant deaths**.**

In theory, implementing mitigation strategies should help mitigate HEC. However, reducing conflict alone rarely provides a long term solution (Sitati and Walpole 2006). The causes of HWC are often complex, and involve numerous environmental (e.g. land use, environment characteristics) and social (e.g. beliefs, distrust, vulnerability) factors (Dickman, 2010). The fact that HEC is a multi-dimensional problem highlights the importance of considering *all* influences of conflict- both direct and indirect ones (Treves et al. 2006; Dickman 2010; Barua et al. 2013).

The conservation of animals involved in HWC cannot be successful without including the very people who are at the forefront of the crisis (Treves et al. 2006; Barua et al. 2013). Community engagement has been shown to have many benefits to HWC mitigation implementation. These include:

1) Increased trust between stakeholders, be they local people, conservationists or governmental organisations. Establishing trust and a common goal between concerned parties may lead to a reduction in conflict between these bodies, in turn making conservation initiatives more likely to succeed (Treves et al. 2006)

2) Reduced marginalisation of local stakeholders, who are often left out of decision-making procedures. By including them in discussions and decisions about HWC resolution, there is an increased diversity of views and opinions and higher quality outcomes are often seen: outcomes better suited to the local environmental, social and cultural aspects of the conflict (Osborn and Parker 2002; Treves et al. 2006)

3) Enabling local stakeholders to “own” HWC mitigation strategies. With ownership and control, locals are more likely to support, uptake and maintain mitigation strategies implemented (Sitati and Walpole 2006)

4) Enabling communication between stakeholders. Such communication is important, as it allows stakeholders to learn from one another, build relationships and in turn, trust (Sitati and Walpole 2006)

All of these are intrinsically linked (Figure 1): allowing local stakeholder involvement in decision making reduces marginalisation, which in turn reduces resentment and conflict between stakeholders, helping to build trust, enabling communication between involved

parties and helping local people develop ownership of decisions made (Sitati and Walpole 2006; Minter et al. 2014; Sterling et al. 2017).

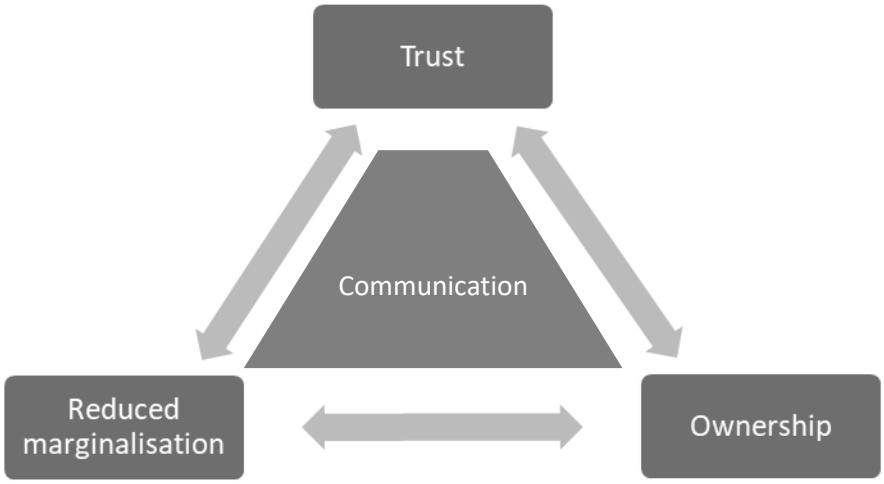


Figure 1 The link between the benefits of community stakeholder involvement in HWC resolution.

Research has suggested that people who experience negative impacts of living near a wildlife species are less tolerant towards this animal, and less likely to support conservation efforts (Struebig et al. 2018; van de Water and Matteson 2018). In Thailand, people who received no benefits from living near elephants were more likely to want elephants eradicated than those who did receive benefits (such as ecotourism and employment). Those with no benefits from living with elephants were also more likely to support conditional tolerance[1] than unconditional tolerance[2] (van de Water and Matteson 2018).

[1] *Conditional tolerance* = accepting elephants in their environment only if they did not destroy crops or property

[2] *Unconditional tolerance* = accepting elephants in their environment no matter what

2 Research Aims and Objectives:

This research aims to understand the views and perceptions of local people towards elephants, and the costs (such as opportunity and transaction costs), and impacts (such as health impacts) of living with HEC in Subulussalam, Aceh, Sumatra. It also aims to use this information to suggest future strategies to effectively mitigate HEC in the area whilst managing conservation objectives.

The objectives are:

- To investigate both the visible and hidden impacts of HEC on local people, and local vulnerability to these impacts
- To understand local perceptions of elephants and HEC
- To find what, if any, mitigation methods are currently used by local people, and their willingness to try alternative strategies to mitigate HEC
- To discuss the impact local perceptions may have on the conservation of elephants, and how successful mitigation strategies could be beneficial to both humans and elephants.

2.1 Addressing the Aims and Objectives

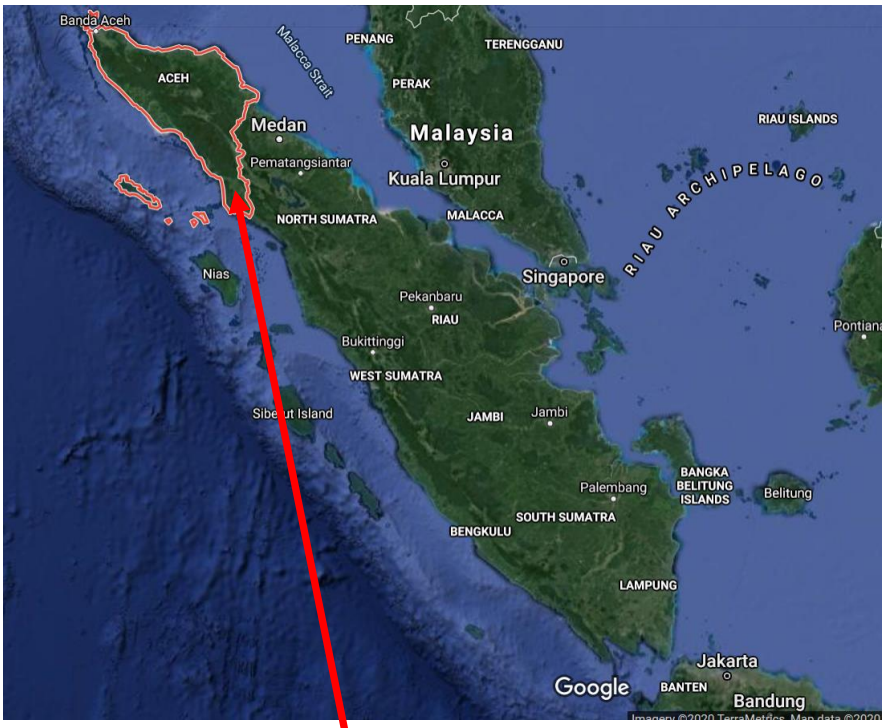
It has been suggested that baseline research into HWC should study the timings and locations of conflict between humans and wildlife, as well as the behaviours of both the animals and humans involved. Additionally, current perceptions and management strategies in place should be investigated (Treves et al. 2006; Weinmann 2018). To gather this information, semi structured interviews (SSIs) were chosen as they allow for flexibility when asking questions. If an unexpected or interesting answer is given by a participant, SSIs allow the researcher to ask further questions around responses, whilst still covering the same topics (Noor 2008). Furthermore, SSIs allow participants to explain their answers in their own words, giving them more control and freedom to express their views. SSIs are often seen as less threatening than questionnaires, which is important when investigating a potentially sensitive topic like HEC (Drury et al. 2011). Additionally, not all individuals targeted in this research are able to read and write, hence questionnaires would severely limit the participants ability to respond, and potentially skew the data. Finally, the more informal and unstructured nature of SSIs allows participants to feel more relaxed and open compared to structured interviews, as SSIs are more like a guided conversation. Thus, the interviewer is able to approach and undertake the conversation in a different way, depending on the respondent, whilst still obtaining the same data (Noor 2008). This in turn can lead to a broader range of perspectives and views being sampled (Drury et al. 2011).

3 Methods

3.1 Location

Subulussalam City is a municipality located in Aceh province (Figure 2). It is comprised of five districts: Simpang Kiri, Penanggalan, Rundeng, Sultan Daulat and Longkip. There are 74 villages in total between these districts, covering 1,391km^2. As of 2017, the population was 78,725 people. The highest work force in the municipality is agriculture, accounting for approximately 39.97% of all workers (Badan Pusat Statistik 2018).

a)



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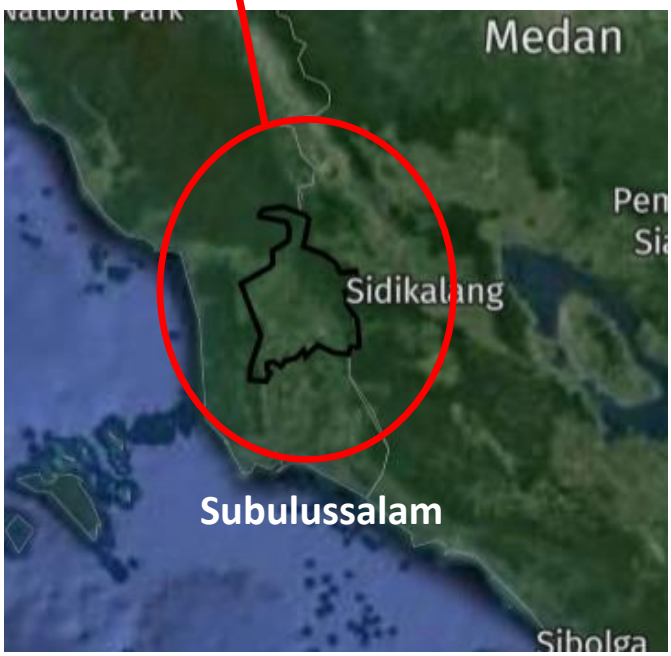


Figure 2 Map showing a) Aceh province and b) Subulussalam location within Aceh

Subulussalam has suffered significant reductions in tree cover, almost entirely due to commodity driven deforestation (Curtis et al. 2018). Between the years 2001 and 2017, 38.5kha (36%) of tree cover had been lost (Figure 3). The dominant driver of this has been commodity driven deforestation (Curtis et al. 2018).

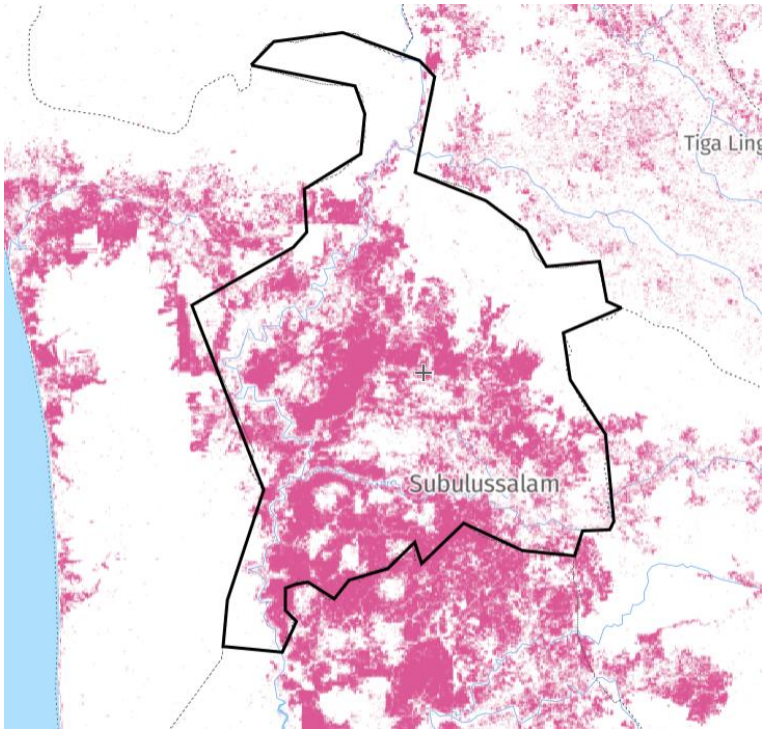


Figure 3 The pink shows where tree cover has been lost between the years 2001 and 2018 in Subulussalam (Curtis et al. 2018)

At the time of the interviews (September 2018-February 2019), there was one known elephant trapped within the area. Deforestation, urban development and the construction of a ditch surrounding large areas of palm oil plantations meant this elephant (originally thought to be two) had no access to forest areas, leading to regular crop raiding events (Rudi, personal comms.)

Interviews were gathered from participants living in 33 villages across seven districts within three regions of Sumatra- Subulussalam, Aceh Besar and Aceh Singkil. Only villages within Subulussalam were visited however some participants were not from the villages in which we interviewed them. Villages were visited based on local knowledge (such as those that had experienced HEC) and accessibility (Figure 4).

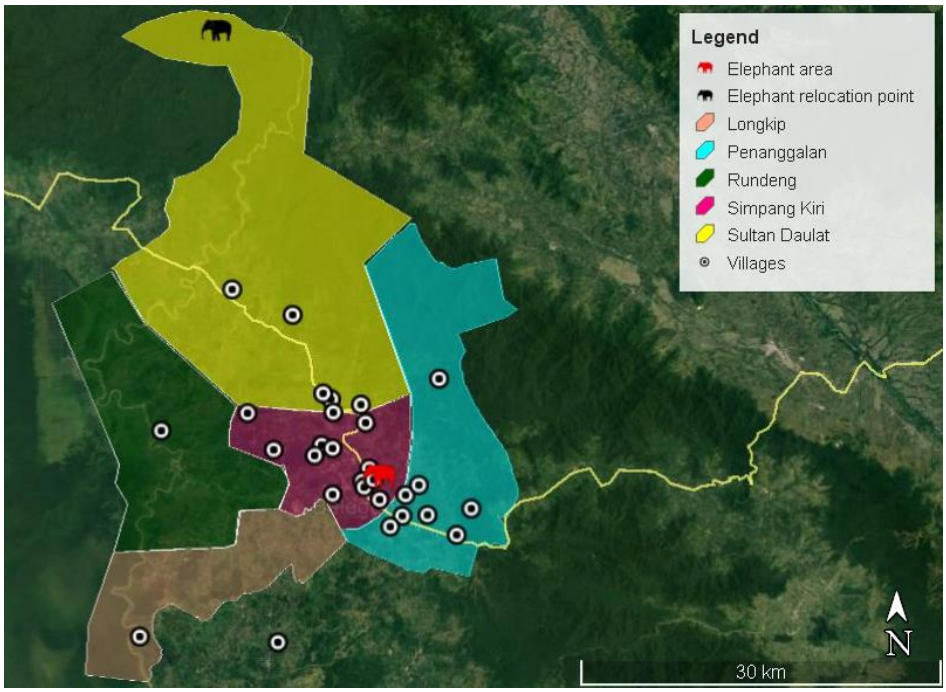


Figure 4 Village locations of interviewees within Subulussalam Regency, with all five districts highlighted. Approximate area which elephant was located shown as a red elephant icon, and area where elephant was later relocated to shown as a black elephant icon.

3.2 Data collection

3.2.1 Interviews

Semi-structured interviews were used to address the aims of this study, adapted from previous research (Treves et al. 2006; Weinmann 2018). These interviews allowed information to be gathered on:

a) Frequency and locations of HEC
b) Human and wildlife actions in HEC
c) Current perceptions
d) Any management strategies currently in place

3.2.2 Research Assistant

Since I am not fluent in Indonesian, and the impact and potential bias I would cause as a "buleh" (white person) conducting interviews alone, for each interview I was accompanied by at least one Indonesian counterpart: Pak Muhamad Roni Rahendra and/or Radiana Sofya**.** Roni is a local reporter who has extensive knowledge of the Subulussalam area and the HEC there. He is interested in wildlife conservation, and actively wishes to help when he can. Roni is well known and trusted by local people, and as such, has been an invaluable asset to this research. Radiana, my main research assistant, is a final year student from Universitas Syiah Kuala, Banda Aceh. She was recommended by Dr. Abdullah Abdul, my local contact at the university.

Roni helped translate the interviews to Indonesian. With both Roni and Radiana, I carefully went through each question, and we discussed any ambiguity. Roni assisted me with some of my first interviews, because Radiana had commitments at university. When Radiana arrived,

Roni was able to help me explain the process to her. Due to his experience of conducting interviews through his reporting career, Roni was invaluable in helping train Radiana. He attended the first few interviews Radiana conducted, to guide her through the process and give her tips on how to gain people's trust, such as building a rapport with interviewees. Interviews were conducted with at least two people present: myself and Roni or Radiana. Pilot interviews, with ten individuals, were done, after which adjustments were made to the wording of questions to avoid ambiguity. For example, terminology for "forests" was changed in the Indonesian language interviews (the ones read by the research assistsants) to clarify what was meant by the phrase. There was some confusion initially as "forest" was seen as any area with trees (be it farm crops or natural forests), hence the interview question described it as "jungle" rather than "forest".

3.2.3 Sampling and recruitment

In total, 160 interviews were conducted in local villages where we approached individuals we met. It was recommended that we avoid one village, Tanggah Besih, because the people there are particularly angry about HEC and it was deemed unsafe by Roni, as well as members of the CRU and BKSDA. We did, however, interview seven people from that village because they happened to be in another village when we were doing interviews. Quite often, when interviews were being conducted, other people would come over to see what was happening, and often we were able to interview them too. Sometimes, individuals were keen to take part, but unable to do so at the time, so we took their phone number and organised to meet later. Additionally, we gathered contact information of potential participants from acquaintances in the area.

3.2.4 Conducting the interviews

My research assistant conducted the interviews and helped translate the responses after each question. This was done so any further questions could be asked by myself in response to a participant's answer at the time of the interview. After each interview, participants were offered cigarettes, coffee or cakes as a thank you.

The project was outlined to potential participants, and then, if they agreed to take part, we sat down with them and explained it in greater detail. Participants were then asked to sign the consent form, which was discussed with them, before we began the interview (Appendix 1)

The interview consisted of two main sections (Figure 5). The first section gathered information on an individual's demographic, how they used the forest, and their experiences of HWC. When asking about crop raiding, we presented pictures of common crop raiding animals (following the example of Meryl Thompson, unpublished; Emma Hankinson, unpublished) to help with the identification of species (Figure 6). Some additional animals were mentioned to us during interviews, such as snakes and lizards, which were also recorded. The second section focused solely on HEC, and gathered information on experiences people had with elephants, any mitigation strategies in place and their views of elephants. When asking if people were willing to trial a new mitigation method, pictures of four techniques (chilli fence, beehive fence, salt licks and community patrol) were shown and briefly explained (Figure 7). Most questions asked were open ended, and all closed questions had an "other" option.

The four mitigation techniques chosen were based on the literature on different HEC mitigation techniques (Table 2). Their successes, limitations and potential feasibility for use in Subulussalam were considered.

Table 2 A description of the four mitigation methods mentioned in the interviews. The pros and cons of each method are also shown, with reference to previous studies

Method	Description	Pros	Cons
Chilli grease fences	• Two strands of rope put as fencing around farmland with squares of cloth between • Ground chilli, tobacco and oil mixed and rubbed over rope and cloth • Capsaicin in chilli peppers creates a pungent aroma which acts as irritant to elephants – covers smell of crops and acts as deterrent (Graham and Ochieng 2008; Karidozo and Osborn 2015)	• Studies have shown high levels of avoidance behaviour at chilli fence sites (Karidozo and Osborn 2015; Chang'a et al. 2016) • Cheaper than alternative fences e.g. electric fence (Davies et al. 2011) • May be effective at deterring other crop raiding wildlife (Hill and Wallace 2012) • Does not require active, night time guarding (Graham and Ochieng 2008)	• Requires regular, sometimes daily, application of chilli grease, and lack of maintenance can make it ineffective (Graham and Ochieng 2008; Chelliah et al. 2010; Hans Enukwa 2017) • High levels of rainfall can make ineffective (Chelliah et al. 2010) • Elephants may become accustomed to smell of chilli (Chelliah et al. 2010)
Beehive fences	• Hollowed out logs or preconstructed hives smeared with wax and left to be colonised by bees • Strung on wire fences, so each hive linked • If elephant tries to push through wire fence, disturbs bees which then irritate or sting elephant (King et al. 2009)	• Shown to be effective when implemented properly (King et al. 2011; Hans Enukwa 2017) • Provide source of income from honey (King 2013) • Bees increase pollination and yield production of crops (King 2013) • Elephants in Sri Lanka shown to retreat from sound of bees (King et al. 2018)	• Requires sufficient training to ensure correctly implemented and maintained, otherwise not successful (Hans Enukwa 2017) • Most trials in Africa, and Asian honey bee considered less aggressive than African honey bee (King 2013) • More expensive than chilli fencing (Chelliah et al. 2010)
Salt licks	• Area of land away from village cleared, however mature trees are left • Minerals and rock salts are mixed and spread over the area with watering (Wahed et al. 2016)	• Can help prevent crop raids due to lack of minerals in elephants' wild diet (Hans Enukwa 2017) • Can help prevent damage to property from elephants searching for salt (Wahed et al. 2016)	• Little research into the effectiveness of this method • Labour intensive to build, and requires regular maintenance (Wahed et al. 2016)
Community groups	• Local communities taught about local wildlife and ecosystem, as well as how to safely drive raiding elephants away (Fernando et al. 2008; USAID LESTARI 2016)	• Helps community become able to manage conflict independently (Osborn and Parker 2002) • Helps improve attitudes to wildlife and conservation (Fernando et al. 2008) • Enables local people to have a say in mitigation management and improves communication between governments and conservationists (Redpath et al. 2013; Neupane et al. 2017)	• Requires continued engagement from local people • Requires a shift in attitudes away from relying on external bodies to manage conflict • Needs sustained effort over long period of time for an organisation to gain trust of communities and run regular workshops (Osborn and Parker 2002)

3.2.5 Interviews and picture guides used when conducting interviews

The semi-structured interviews were used to gain information on HEC in Subulussalam. Information on the demongraphics of participants was gathered, followed by questions about forest use, crop raiding, elephant encounters, mitigation strategies and current perceptions of elephants.

Semi Structured Interview Guide

Researcher: Date:
Questions asked by: Village:

Section 1: Basic information

1) Name
2) Age
3) Number of people in household
   a) Who (*wife/husband/children/parents and how many of each)*
4) Main source of income:
   If cultivation…
   a) How large is your cultivated area?
   b) What do you grow?
   c) How far is your cultivated land from the jungle? *GPS of location*
   d) Have you noticed a difference in crop yield in the past 10 years?
      i) If yes, how so?
      ii) If yes, why do you think this is? (*If they need help e.g. climate, pests (animals, insects, weeds), lack of equipment (fertilizer, tools), lack of labour)*

Section 2.1: Land use, jungle use and general crop raids

1) Do you go into the jungle? Yes/No
   a) If yes, what do you collect from the jungle?
      - ☐ Wood
      - ☐ Food
      - ☐ Water
      - ☐ Medicine
      - ☐ Other (*Please specify)*……
2) Do you own the jungle area? How so? Why?
3) Do you like living near the jungle?
4) Do animals come into your village or agricultural lands? Can you name them or point them out? *(bring pictures)*

- ☐ Wild Boar
- ☐ Pig tailed macaque
- ☐ Long tailed macaque
- ☐ Orang utang
- ☐ Thomas Languar monkey
- ☐ Gibbon
- ☐ Other (please specify)……

- ☐ Tiger
- ☐ Samba Deer
- ☐ Mouse deer
- ☐ Porcupine
- ☐ Sun bear
- ☐ Elephant

5) How often do each of these animals come into your village or agricultural land?

- ☐ Every Day
- ☐ Every week
- ☐ Every month
- ☐ Every 6 months
- ☐ Less than once a year
- ☐ Every few days
- ☐ Every few weeks
- ☐ Every few months
- ☐ Once a year

6) Which animals cause most damage? *please rank in order of damage cause with most damaged cause scoring 1 (top 5)*

Rank	Species
1	
2	
3	
4	
5	

7) What do the animals do in the village/ agricultural lands? (*Specify for top 5 species identified above)*

Species	Activity(ies)
1)	
2)	
3)	
4)	
5)	

<u>Section 2.2: Elephant encounter</u>

Can you describe your most recent encounter with an elephant?

1. When did this happen?
2. What time did this happen time?
3. Where did this happen?
4. How many elephants were there?

5. What did the elephant do? *If crop raiding mentioned…*
   a) Crop type
   b) How much (km2)
   c) Number of trees (sugar cane/banana)
6. How did you react (if at all)

7. Is this a frequent occurrence?
    a. How often does it happen?
        - ☐ Every Day
        - ☐ Every week
        - ☐ Every month
        - ☐ Every 6 months
        - ☐ Less than once a year
        - ☐ Every few days
        - ☐ Every few weeks
        - ☐ Every few months
        - ☐ Once a year

    b. Have raids changed in the past 10 years? (*Increased/decreased/same frequency? Change in raiding behaviour e.g. crops consumed/amounts damaged?)*

<u>Section 2.3: Livelihood and wellbeing impacts</u>

1. How do you feel living with elephants nearby?
2. Does living with elephants nearby effect you or your daily activities? How so?

<u>Section 2.4: Mitigation strategies</u>

1. Do you have any strategies in place to reduce any problems caused by elephants?
2. Which strategies are used?
3. Do they work?
    a. Why/ why not?
4. Who is responsible for reducing problems caused by elephants? (*You? Your community? Forestry department? CRU? Government? Palm oil company? Everyone?)*
5. Who do you think should be responsible?
6. Would you be willing to try new methods to reduce elephant crop raiding?

    - ☐ Beehive fences
    - ☐ Chilli fences
    - ☐ Salt licks
    - ☐ Community patrol

    a. Why/why not?
        i) If no, would more information about new methods maybe make you change your mind?

<u>Section 2.5: Perceptions of elephants</u>

1. How do you feel about elephants?
2. Have your or your community's opinions about elephants changed in the last 10 years?
    a. How so?
3. Is there anything else you would like to add?

Figure 5 Semi-structured interview (in English) used for collecting data

Wild Boar

Sumatran Tiger

Pig Tailed Macaque

Long Tailed Macaque

Sambar Deer

Mouse Deer

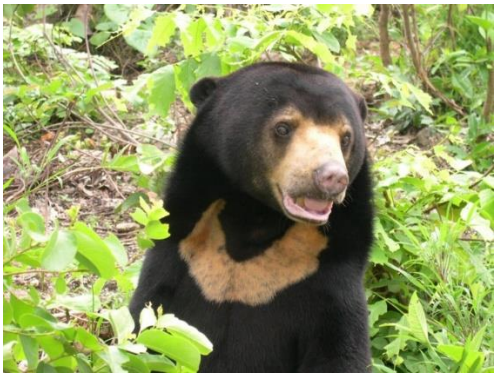
Porcupine

Sumatran Elephant

Thomas Langur Monkey

Gibbon

Orang utan



Sun Bear

Figure 6 Pictures used to help participants identify species which enter their farmland and/or village *(Baker 2001; Fredriksson 2007; Houston 2007; Nonprofit Organisations 2008; Levg 2011; Sprag 2011; Prince 2014; Rushenb 2014; Sharp 2017)*

Beehive fences

- Hollow logs or built beehives smeared with wax and hung on rope, 10m apart
- Colonised by bees
- Elephants scared of bees
- Can harvest honey

Chilli Fence

- Ground chilli, tobacco and oil mixture rubbed onto rope
- Rope put around crops/grain store
- Smell masks that of crops and is an irritant for elephant

Salt lick

- Artificial salt lick built away from village
- May help attract elephants-often a reason for crop raiding is lack of salt in wild diet

Community patrol

- Community taught how to scare away elephants
- Call each other when elephant nearby and scare away together
- Patrols at night – take it in turns

Figure 7 Images shown to participants when describing potential mitigation strategies against HEC. Descriptions were given in Indonesian to participants by my research assistant. (Graham et al. 2009b; Elephants and Bees Project 2016; IUCN and Farahat © 2016)

3.3 Analysis of results

The answers to each question were coded and sorted into categories (Table 3), as described by the "Grounded Theory" approach to analysis of qualitative data (Bernard 2017). For example, Section 2.3 Question 1 asked "How do you feel living with elephants nearby?". Answers for this were open ended, so responses were never identical. Responses were sorted into "negative" and "positive" categories; if an individual had both negative and positive views, then they were put in both categories. Answers were further summarised by grouping similar responses together into sub-categories. For example, many participants said living with elephants made them "scared". Responses like scared, such as "terrified" or "afraid" were put into the same sub-category. In this research, categories were decided based upon respondents' answers to questions. If a response did not fit into any of the pre-existing categories, a new category was made. Some responses fitted into multiple categories; in which case the response would be put into all applicable categories. For example, if a respondent said elephants made them feel "scared and angry", then their response would be put into both "scared" and "angry" categories. Once in categories, the frequency of each response was calculated, as well the percentage of each response. Putting responses into categories allows themes to be identified that arise from the data, providing easier analysis (Bernard 2017).

Such data analysis allows complex themes and interactions to be better understood (Drury et al. 2011) . This approach is suitable for studies like this, as it enables the measurement of processes and meanings of complex realities which would not be measured through quantitative analysis alone. Qualtitative data analysis, in combination with quantitative analysis, allows a broader, more in depth and holistic view of the issues faced by local people (Noor 2008). Quantifying people's responses once in categories enables themes to be clearly identified: a category with a higher frequency of responses suggests this view is strong within the community. Quantifying responses can strengthen and support suggestions made from the data. Combining quantitative and qualitative research analysis allows greater insights into people's perceptions and experiences (Bernard 2017).

Table 3 To analyse the responses of individuals, answers were sorted into categories. The first column shows the section and question number based on the interviews, and column two indicated what the question was asking. The remaining columns are the categories used for each question. Categories were created after responses had been given and decided upon based on the responses of participants. If a participant gave a response which did not fit into a category, a new category was made. Responses did not have to be identical to be put into categories, for example if an individual said they were "terrified" of elephants, their response would be categorised as "scared". Answers sometimes fitted into more than one category, so some respondents had more categories associated with their answers. For example, if a participant said elephants made them feel "angry and scared" their response would be categorised in both "angry" and "scared" categories

	Question	Category (cat) 1	Cat 2	Cat 3	Cat 4	Cat 5	Cat 6	Cat 7	Cat 8	Cat 9	Cat 10	Cat 11	Cat 12	Cat 13	Cat 14
S1 Q4 dii	**Change in crop yield**	Animals (not elephant)	Elephants	Price of fertiliser being high so using less	Climate change	Having less money to buy more crops or tools	Value of crops lower	Take good care	Use fertiliser	Learning better farming	Other				
S2.1 Q1a	**Human forest activity**	Wood	Water	Medicine	Food	Do not go into forest	Cuts down trees for farming	Likes nature/ camping	Attend to farm	Collect Rotan	Other	Collect Bamboo	Hunting		
S2.1 Q7	**Activity of ranked animals**	Eat Crops	Damage farmland	Damage property	Eat livestock	Just passing	Eating food from house								
S2.2 Q2	**Time of day of elephant encounter**	Night	Afternoon	Evening	During the day	Morning	Day and night	Don't know							
S2.2 Q5	**What did the elephant do**	Eat Crops	Damage farmland	Damage property	Just passing	Washing									
S2.2 Q6	**Reaction to elephant? Negative**	Scared	Join Comm group/ start own patrol	Angry	Pity for farmers/ self	Try to scare away	Upset	Run away	Shocked	Worried	Call BKSDA /CRU	Dis-appointed	Pray	Wanted to shoot	Kill
S2.2 Q6	**Reaction to the elephant? Positive**	Happy	It's ok	Watched	No reaction	Pity for elephant									
S2.2 Q7b	**Change in raids**	More	Less	No raid	No change	Don't know									

	Question	Category (cat) 1	Cat 2	Cat 3	Cat 4	Cat 5	Cat 6	Cat 7	Cat 8	Cat 9	Cat 10	Cat 11	Cat 12	Cat 13	Cat 14
S2.3 Q1	**How do you feel living with elephants nearby? Negative**	Trauma	Discomfort	Stressed	Worried	Angry	Scared	Dislike	Disturbs peace	Annoyed at authorities	Have no option				
S2.3 Q1	**How do you feel living with elephants nearby? Positive**	Like	Happy	Lucky	Tame ok	Pity	They are ok	If don't disturb then ok	Like if far away	Elephants are friends	Used to it	Think positive then elephant won't harm			
S2.3 Q2	**Elephant effects on daily activities?**	More scared	Angrier	More worried	Loss of income	Go to field as a group	Stopped growing crop	Always thinking about it	Spend more time on farm guarding crops	Afraid to go to forest	Avoid farm/ go to farm less	Moved to a new house/ move village	Lack of sleep	Not here so no problem	No effect
S2.4 Q2	**Current mitigation**	Noise	Comm group	Fireworks	Report	Fencing (of some sort)	Chase away	Fire	Positive thinking	Relocation	Put up red flag	Go to field as group	Other		
S2.4 Q4	**Who is responsible for HEC?**	Gov	Comm	Local people	Humans	Elephant	Village chief	Everyone	Palm oil	Forestry depart-ment	NGO	BKSDA/CRU	No one	No idea	
S2.4 Q5	**Who should be responsible for HEC?**	Gov	Stake-holders	Farmers	BKSDA/ CRU	Palm oil company	Police	No idea	Forestry depart-ment	NGO	Village chief	Comm			
S2.4 Q6ai	**Why not Comm**	Takes too long	Not a comm here	People scared of elephant	Won't work	Elephant moves	Danger to people	People might be asleep-don't know when elephant will come	Elephant won't fear people	Elephant will just come back	Tried and didn't work	Need money to do			
S2.4 Q6ai	**Why Comm**	Will gain knowledge	Temporary solution but willing to try	Sense of Comm and support	Every has duty to mitigate	Work together better/ more effective	Possible here	Already works here	Save farms and elephants	Looks interesting	Quick/ simple	Local people already have knowledge	With support and/or money from gov	Fun to work together	

	Question	Category (cat) 1	Cat 2	Cat 3	Cat 4	Cat 5	Cat 6	Cat 7	Cat 8	Cat 9	Cat 10	Cat 11	Cat 12	Cat 13	Cat 14
S2.4 Q6ai	**Why not chilli**	Need to learn new things	Need money	Elephant not in one place	Too small, elephant will push over	On own, scared to be alone	Doesn't believe it will work								
S2.4 Q6ai	**Why chilli**	Have tools/ equipment	Looks interesting	Easy/ simple	It is a fence, so elephant won't come in	Lots of chillies for sale in market	Only need to work for short time	Already has one that works	Cheap	Keep other animals away too	Can do alone				
S2.4 Q6ai	**Why not bees**	Complex	Scared of bees	Need money	Need to be expert	Not know how	Elephant not in one place	Doesn't believe elephant will be scared	Lone method- scared to be alone	Dangerous					
S2.4 Q6ai	**Why bees**	Make money	With support and teaching	Effective against many animals	Looks interes-ting	Effective long term	Fast and simple	Will make elephant scared of people as well as bees							
S2.4 Q6ai	**Why not salt lick**	Need to learn new things	Need budget/ money	Elephant not in one place	Need lots of people	On own, scared to be alone	Doesn't believe it will work	Large area, elephant will be hungry	Don’t have land to make it	Make elephant fat/not healthy for elephant	Too much work				
S2.4 Q6ai	**Why salt lick**	Looks interesting	With support/ funding from gov	Thinks will be best	Easy/ simple	Quick/ work for short time	Work together	Can do alone							
S2.4 Q6ai	**Why none**	Gov duty	Current strategy works	No problem	Has own strategy	Doesn't think any will work	Elephant needs to be moved								
S2.5 Q1	**How do you feel about elephant Negative**	Scared	Discomfort	Angry	Dislike	Danger	Worried	Disturbed	Wants it to be moved if it comes	Does not want to answer					

	Question	Category (cat) 1	Cat 2	Cat 3	Cat 4	Cat 5	Cat 6	Cat 7	Cat 8	Cat 9	Cat 10	Cat 11	Cat 12	Cat 13	Cat 14
S2.5 Q1	**How do you feel about elephants Positive**	No problem with them	Like	Ok if not here/ causing damage	Concern for elephants / wants them to be saved	Empathy/ pity	Like tame elephants	If we angry with elephant, it will be angry with us	Curious about	Eco-tourism from them	They are ok				
S2.5 Q2a	**Comm Perception**	Worse	Better	No change	No idea										

3.4 Limitations of methodology

a) *Translation*

As mentioned previously, I am not fluent enough in Indonesian to conduct interviews. Thus, my Indonesian research assistant was my translator too. At times, it was difficult to find direct translations for people's responses, though we discussed the need for translations to be given in context as best as possible, in order to get a more accurate translation. We also discussed the importance of them telling me all of what the participant said, and not embellishing responses, with my research assistiant, which can help minimise issues with translation (Williamson et al. 2011). However, the accuracy of this is difficult to assess.

b) *Outsider effect*

As a foreign researcher, people may not have responded honestly (Drury et al. 2011). In Indonesian culture, politeness is very important, to the extent that they can say what they think you want to hear, rather than the truth (Evason 2016). It was explained to all participants that I wanted to know the perspectives of local people on HEC and was interested in their honest opinions. Inevitably, I was perceived as a "buleh" (white person) due to the unescapable fact that I am not Indonesian, and this research was conducted in an area where people see very few foreigners (during my time there, I only met a handful of non-Indonesians in Subulussalam, all of whom were there for short periods of time). Having the interviews conducted by a fellow Indonesian may have helped people be more open and honest as they were not directly talking to me. Although some people may have said what they thought I wanted to hear (non-Indonesians, particularly Caucasians, are often associated with conservation and so it is assumed that we only care about the animals), many people still told us they hated elephants, wanted to kill them, and that they did not want elephants nearby, suggesting that people were being relatively honest in their responses.

c) *Cultural differences*

Through talking with Roni and Radiana, and conducting the interviews, it became apparent that the concept of timeframes was not the same between myself and the participants. For example, despite Q1.4d mentioning a 10-year timeframe, people often gave answers with a timeframe that varied widely. Mostly, it only appeared to cover a shorter period, but sometimes it covered a much longer period. This discrepancy often did not become clear until later into the interview. All attempts were made to clarify this, and rectify answers, however it is likely not all cases were clarified. Hence, for the purposes of analysis, I will not give a timeframe to responses; rather, responses will be seen as giving a *historical* account of events, without a specific timeframe.

d) *Sampling and recruitment*

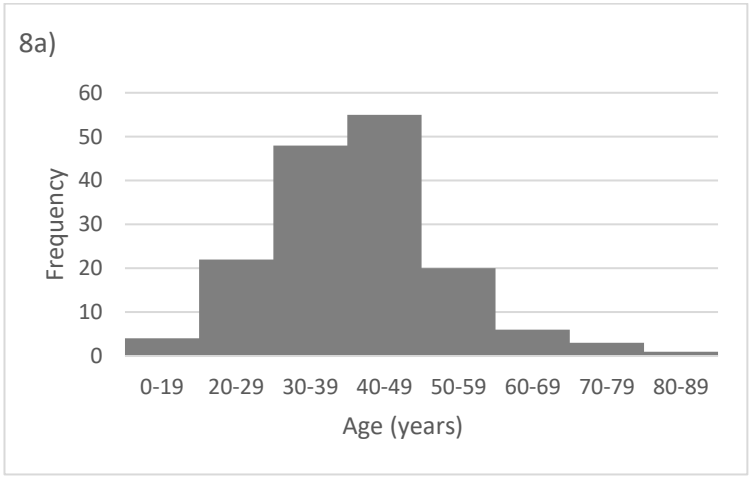
Sampling was based on ease of access and people's willingness to be interviewed. On many occasions, other people were present during interviews, which could have influenced responses. Also, by only interviewing people we came across when driving through villages, we may have only sampled the more sociable or "visible" individuals. Additionally, snowball sampling (i.e. asking people to refer us to other potential

interviewees) could also make the sample biased to more sociable individuals, meaning that people with less social ties, and hence less support when coping with HEC, were not as well represented in the study. Additionally, we were not selective regarding gender or age of individuals, leading to potential bias. In situations of a husband and wife, the husband was most likely to answer the questions. Males also tended to spend more time on farmland, so when we came across people on their farms, it was most often males. Thus, males appeared to have encountered elephants more, and then seemed more likely to share that experience.

4 Results

4.1 Demographics of respondents

Of all participants, 113 were male and 47 were female. The age of participants ranged from 18 to 86 years, with the mean age being 41 ± 12, and the modal age 43 (Figure 8a). The number of people per household varied from one person (living alone) to fourteen – the average number of people per household was 5 ± 4, with the modal number being four (Figure 8b).



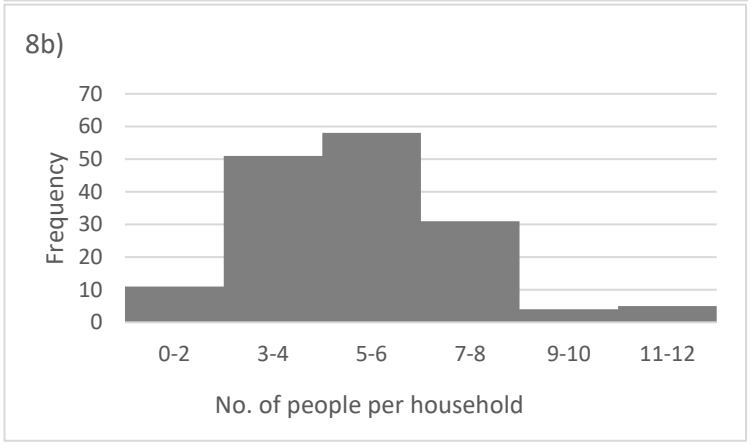


Figure 8a The number of participants within each age group. The mean age was 41 ± 12, and the modal age 43 years old.
Figure 8b The number of people living with participants. The mean number of people per household was 5 ± 4 indivduals, with the modal number being four people per household.

The main form of income for participants was farming (both owning their own farm or working on other people's land) with 153 participants citing farming as a source of income (Table 4). Of these, 108 stated farming as their only source of income, with eleven having farming as their main income, with another form of work too. Thirty-four people had another main source of income, but also made some money through farming, although farming was not their main income source. Six respondents earned their income through non-farming work, such as shop keeping, office work and manual labour. One individual was unemployed.

Table 4 Sources of income for participants. Farming is then split into sub-categories: only farming, farming as the main source of income but with an additional income, and having another job as the main source of income but also making some income through farming. Individuals with alternative jobs to farming, and no income through farming, were catergoried in "Other job". One indivudal was unemployed.

Income	Frequency
Farming	**153**
Farmer	*108*
Farming main + other job	*11*
Other job main + farming	*34*
Other job	**6**
Unemployed	**1**

Smallholders of farmland who currently grew crops made up 145 of participants, with three more borrowing land to farm on; 97% of these had five hectares or less of land to farm on, with the mean size of land being 2 ± 1.68 hectares.

In total, 148 of the 160 interviewees grew crops, and of these, almost three quarters grew palm oil (Table 5). The next most frequently grown crop was sweet potato, with just under one fifth of participants growing it. Overall, 46 different crops were grown by participants.

Table 5 Top 10 most frequently grown crops by participants (n=148). Frequency refers to the number of participants who grew that crop, and the percentage of respondents is the percent of individuals that grew each crop out of the 148 participants who grew at least one crop. Participants were able to list as many crops as they wished.

Crop type	Frequency	Percentage of respondents (%)
Palm oil	110	74.32
Sweet potato	28	18.92
Jengkol	18	12.16
Banana	17	11.49
Chilli	14	9.46
Long beans	13	8.78
Rice	13	8.78
Cucumber	12	8.11
Corn	10	6.76
Carrot	9	6.08

Participants were asked if they ever entered the forest area. In total, 52 said they did not enter the forest at all. The remaining 108 participants gave a variety of answers as to why they entered the forest. 55% said they undertook deforestation activities, such as collecting wood or clearing forest to convert to farmland. A further 8% already had farmland in the forest which they attended to.

Participants were asked about their current crop growth, and how it had changed in the past few years (Figure 9). The reasons for this will be discussed in section 5.3.1.

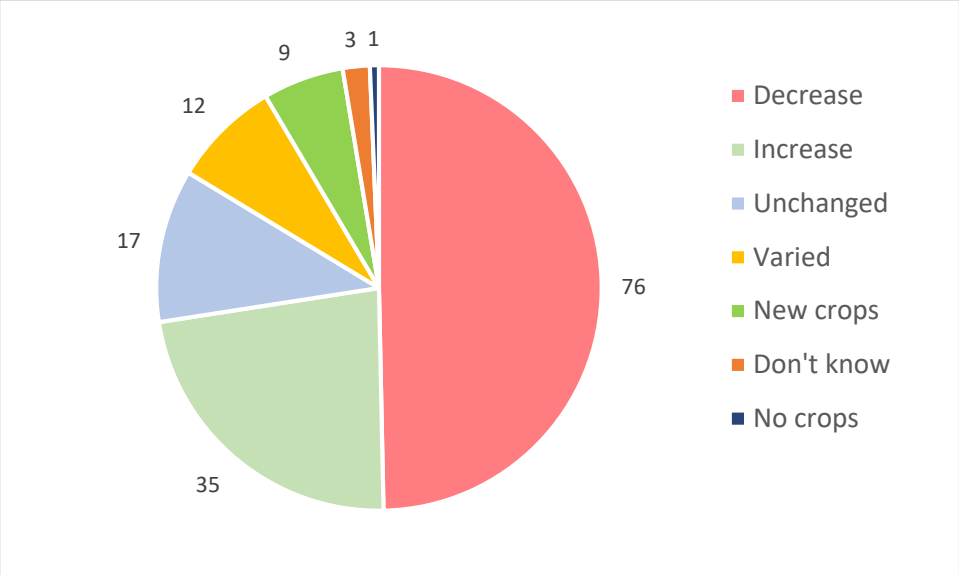


Figure 9 How crop abundance has changed over time for local people. Responses given were that crop yield had decreased; that crop yield had increased; that crop yield had remained unchanged; that crop yield varied each year; that the respondent had newly planted crops, meaning they could not comment on changes in yield; that they did not know; and that they had farmland but no crops on it. The numbers represent the number of respondents who gave each answer (n=153).

4.2 Impacts of wildlife

4.2.1 All wildlife

Animals were said to visit villages or farmland by all participants, bar one – this individual had only just bought land in Subulussalam and was going to start farming soon; they lived in Singkil, on the coast, where they had been a fisherman all their life (they were 77).

In total, 19 different animals were mentioned by participants as visiting their farmland and/or village. Wild boar were identified by 94% of participants, being the most frequently reported animal (Table 6). Crop raiding by elephants was reported by 52% of participants, making them the fifth most frequently reported animal. For all animals, 97% of participants suffered negative impacts for at least one species, such as crop consumption, crop damage or property damage. All individuals who had elephants on their farm or village identified at least one other animal as visiting.

Table 6 The number of respondents who said each animal came to their farmland and/or village, and the percentage of respondents who reported each animal. n=159

	Frequency	Percentage of respondents
Wild Boar (*Sus scrofa)*	149	93.71%
Pig tailed macaque (*Macaca nemestrina*)	121	76.10%
Long tailed macaque (*Macaca fascicularis*)	108	67.92%
Porcupine (*Hystrix sumatrae)*	91	57.23%
Sumatran elephant (*Elephas maximus sumatrensis*)	83	52.20%
Sumatran orangutan (*Pongo abelii*)	28	17.61%
Sambar deer (*Rusa unicolor*)	19	11.95%
Sumatran tiger (*Panthera tigris sumatrae*)	19	11.95%
Thomas's langur monkey (*Presbytis thomasi)*	14	8.81%
Gibbon	12	7.55%
Mouse	11	6.92%
Lesser mouse deer (*Tragulus kanchil)*	10	6.29%
Snake	8	5.03%
Sun bear (*Helarctos malayanus*)	7	4.40%
Asian water monitor (*varanus salvator*)	6	3.77%
Squirrel	4	2.52%
Bird	2	1.26%
Asian palm civet (*Paradoxurus hermaphroditus*)	2	1.26%
Rat	2	1.26%

Of all the animals mentioned, pig tailed macaques were the most frequently ranked as a problem animal, with 98% (n=118) of respondents who had pig tailed macaques on their farmland ranking them as one of the five most problematic animals (Table 7). Elephants were ranked by 82% (n=68) respondents who had mentioned they had had elephants on their farmland, making them the fifth most likely to be ranked. However, elephants were ranked first most frequently. This suggests that, for people who experience elephants as a problem animal on their farmland, they are more likely to perceive them as highly destructive, when compared to other wildlife. This was the case even if elephants came less frequently than other wildlife species such as wild boar or macaques.

Participants ranked the five most destructive crop raiding animals in their farmland or villages. Elephants were most frequently ranked first, with 51% of participants who ranked them giving them rank one. Comparatively, the other four most frequently ranked animals, wild boar, pig tailed macaques, long tailed macaques and porcupines were ranked first 38%, 31%, 17% and 29% of the time respectively (Table 7).

Table 7 The number of participants who recorded the top 5 most frequently mentioned animals on their farmland, and the percentage of those who then ranked each animal as being problematic on their farm. Animals were given rank one through to five, with rank one being the animal that causes the most damage on the farm. Participants who mentioned more than five animals were asked to only rank the top five damage causing animals. If a participant had mentioned less than five animals visiting their farmland or village, they only gave ranks to these animals. Additionally, if an animal came to farmland but did not cause any damage, they were not ranked.

	Wild Boar	**Pig Tailed Macaque**	**Long Tailed Macaque**	**Porcupine**	**Elephant**
Total who had on farm	149	121	108	91	83
% who had on farmland and then ranked between 1 and 5	96%	98%	92%	90%	82%
Rank 1	38%	31%	17%	29%	51%
Rank 2	36%	33%	34%	23%	12%
Rank 3	18%	18%	26%	28%	22%
Rank 4	7%	15%	14%	13%	7%
Rank 5	0%	3%	8%	6%	7%
Total who ranked	**143**	**118**	**99**	**82**	**68**

4.2.2 Elephants

Participants were asked specifically about past elephant encounters: 102 had had encounters in the past five years. Just over three-quarters of respondents (78%) had seen an elephant, the remainder had seen signs of them-such as footprints or dung. Nine participants had had an experience with elephants in the forest in the past five years; comparatively eleven experiences occurred in villages, and 82 were reported on farmland. Over half of these incidents involved elephants eating crops. Crops were damaged, but not eaten, in 39% of encounters, and damage to property occurred in 22%; 13% of respondents reported no damage after an elephant had visited farmland or villages.

Individuals who had had an encounter with elephants in the past five years (n=102) most frequently reported elephant encounters as being “rare”, (31%) . Of the 52 people who reported encounters happening within the last year, 98% stated that elephants came to their farmland or village at least every 6 months, and 12% of people who experienced elephant encounters in the past year stated that such an experience was “rare”. Overall, 48% of respondents said elephant raid frequency had increased in the past few years in their area, compared to 34% noting a reduction.

4.3 Local Perceptions of HEC

Despite not being asked directly, 63 participants mentioned at some point during the interview that the elephants crop raided because they had lost their habitat and needed to eat. Participant 26 said *“Elephants are the same as us, they just want food”.* Another, participant 160 showed a conflicting opinion, stating *“I am angry with the elephant, but it needs to eat”.* One participant described feeling empathy towards elephants:

"I feel pity [for elephants] because their habitat has gone, which is why they come to the village. The elephants don't plan to come to farms [but] they have no choice because they need to eat"

-Participant 142

Seventeen of the people interviewed stated they were part of PakPak communities. This is a belief system of some village communities, described by Participant 12:

"*Local culture in this community is PakPak. Local wisdom of this means locals believe they cannot kill or harm elephants. There are old stories of elephants: our ancestors would clear the jungle for farming. Before clearing, they would always ask permission of animals and spirits, and would provide a gift. When people do that, no bad thing will happen to the community. That is why, historically, PakPak people have no problem with wildlife. Elephants are called Nenek Benar ["True Grandma"]…if you don't disturb the elephants, the elephants won't disturb you. If you think negatively about elephants, then the elephant will disturb you."*

There were slight variations of PakPak between different communities, for example participant 101 described the elephant as being called "*Datok Benar*" (True Grandpa) as opposed to *"Nenek Benar",* but all had the same fundamental beliefs that negative thoughts or feelings towards elephants, or wildlife in general, would lead to the animal doing something bad to you. Participant 101 also said:

"[PakPak] think the elephant is clever and does not want to disturb people…Our community like elephants even if they destroy our things. Elephants always do the right thing if it has a choice…it only disturbs humans when it has no other option"

Participants with PakPak beliefs suggested that elephant crop raiding had become worse because people no longer respected wildlife:

"[The] elephant is an honest animal…Maybe the elephant [comes because] it is angry we have cut down the jungle. Or maybe people are thinking bad thoughts about the elephant"

- Participant 103

Participant 21 described an incident to "prove" that disrespecting animals causes bad events to occur:

"A few years ago, an elephant was seen around the rice paddies of villagers. It was not raiding, just in the area. One villager made a trap of nails in wooden planks, pointing up, and put it around their farm. That night, the elephant raided this farmers paddy and no one else. We are [a] PakPak community, who believe that if you do something bad to the elephant, it will do something bad to you, which is why only that farmer's field got raided."

Despite this, individuals from the PakPak community showed no difference in perceptions towards elephants, both individually and as a community compared to those who were not (Figure 10). However, as this research did not specifically ask about cultural beliefs, more respondents may have been PakPak but had not mentioned it. Therefore, these results, although interesting, are not conclusive.

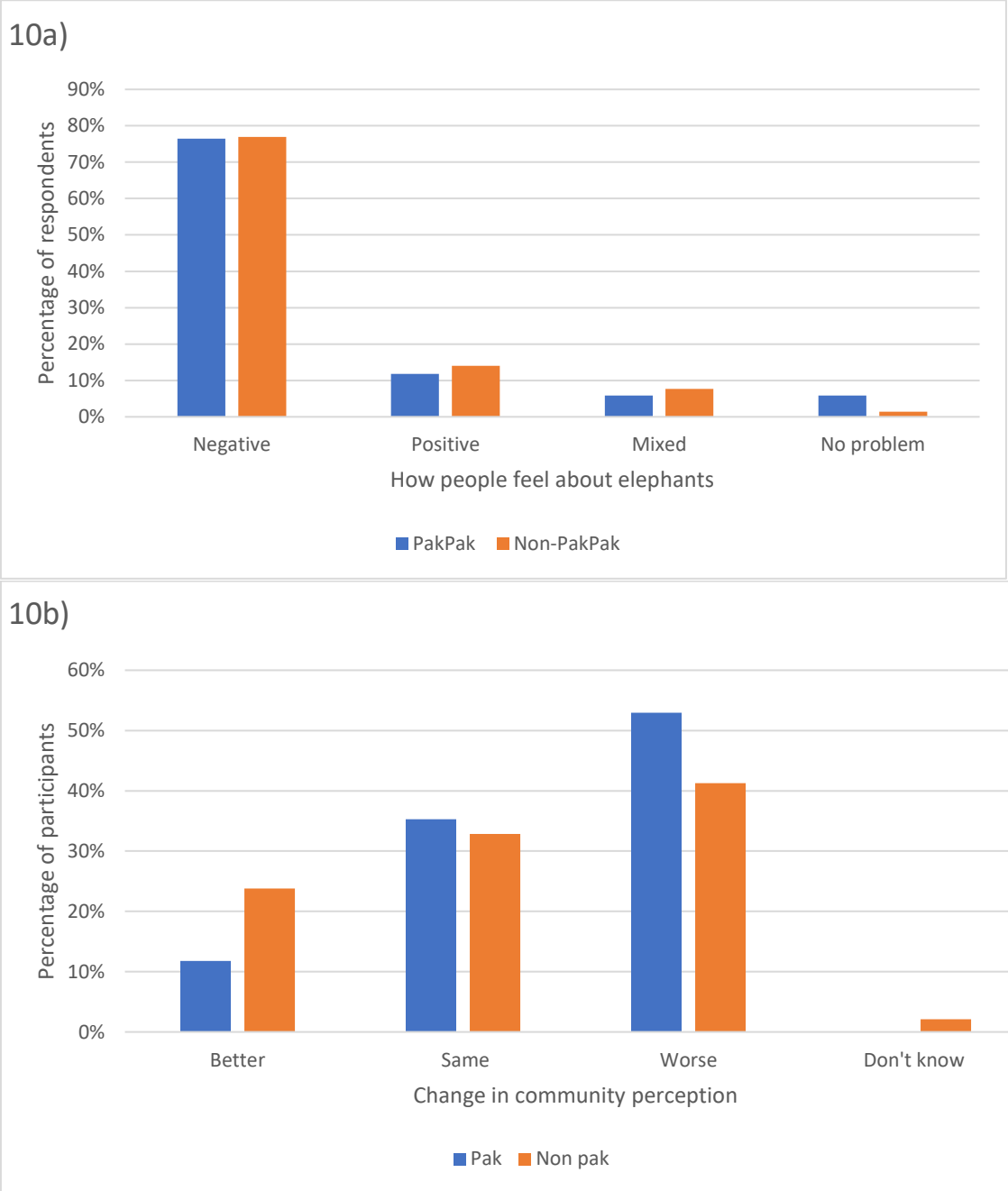


Figure 10 Responses of individuals who said they were PakPak and those who did not to the questions a) *How do you feel about elephants living nearby?* and b) *How have community perceptions of elephants changed?* In total, there were 17 participants who said they were PakPak and 143 who were not or had not stated that they were PakPak.

Some respondents believed that elephants were just vengeful and angry towards humans, which was why they crop raided: *"The elephant is angry at people [for cutting down the forest], it is getting revenge"* -Participant 148; and *"Fireworks make elephants come back more angry"* -Participant 18

4.4 Economic vulnerability facing local people

Overall, 153 respondents had farming as a source of income, with 108 relying solely on farming for money. Some individuals had abandoned their fields all together. Many farmers were scared to attend fields, and reported attending to crops less, because of the fear of elephants coming. All of this leads to decreased financial security.

Many farmers noted a decrease in crop abundance (n=76), which was putting them under financial strain, with a variety of reasons given to explain this loss. The main reasons mentioned by farmers as causing a reduction in crop abundance were animals (other than elephants, such as porcupines, wild boar and macaques (n=38), using less fertiliser because it is expensive (n=24), elephants (n=18), having less money to buy more crops or tools (n=14), climate changes (n=7) and the value of crops being lower than before (n=6) (participants were able to give more than one answer). Many factors were interlinked; participant 16 said "*I have no money to buy fertiliser or tools because I have to spend it all on the damage caused by animals"*. Farmers also faced a combination of problems leading to a fall in crop production, as described by participant 40: *"Animals come to my farm and eat my crops. Also, fertiliser is too expensive now".* A number of respondents described facing an imbalance between the price of fertiliser and the price they now receive for crops: *"The price of fertiliser is increasing but the price of crops has gone down so it is hard to make money"*- participant 30. Participant 94 gave their own explanation for this imbalance:

> *"The problem is price of palm oil and rubber- it is not balanced with the price of fertiliser. We don't earn enough to pay for fertiliser. Since the last president was elected 4 years ago price of crops has gone down."*
>
> -Participant 94

4.5 Visible impacts of HEC

4.5.1 Crop damage

A loss of income as a result of HEC affected at least 35 of respondents: "*I am earning less money [now] because I have less palm oil because the elephant [is eating it]"* – participant 90. The stress of living near elephants, and how that limits an individuals' abilities to tend to farmland, was identified by 34 people as causing a loss of income. Participant 35 said: *"I am more worried, so I can't take care of my farm and I go less often, [so] now my income has gone down"*. Similarly, participant 16 stated:

> *"I am afraid to go to my planation alone. We go as a group of three normally. My main income has become less because if the elephant is around, I will spend less time in the field".*

With a shortage of income, people will have less money to pay for basic items, including food. Participant 117 described how historical crop raiding effected their ability to have enough food: "*The elephant would have a full stomach and I was hungry", and* stated that, after moving to a new house "*I can grow more palm oil so I have money to buy rice and [other] food".*

Additionally, farmers use their own crops as a source of food, so damage to them could impact their diet. Participant 23 described how elephants had physically taken their food:

> *"The elephant is eating my crops, which is my income…It has already destroyed my house and taken my food…It comes and takes rice and sugar from inside the house"*

The presence of elephants was preventing at least five participants from planting more crops or specific crops. Participant 9 stated "*After the elephant came a few years ago, I stopped growing rice";* and participant 90 said *"[We] plant [crops] and the elephant comes and eats them. Many people have abandoned their farms now"*. Participant 100 stated "*I want the elephant relocated so I can grow more sweet potato"*. Another said:

> "*I have more than 1 hectare of land in the forest [where I would] plant coconuts, palm oil and nankar, but now, because of the elephant, I have abandoned it and it is now [overgrown]"*
>
> -Participant 88
>
> -

4.5.2 Property Damage

Of the 102 people who had experienced an encounter with an elephant in the past five years, 22% had had property damaged- be it their home or farmhouses (Figure 11). This included broken windows and damaged walls, as well as whole structures being knocked down. As a result of damage to their house, one participant had to move to a property loaned to them by a friend.

Figure 11 Images displaying the after-effects of HEC in Subulussalam, showing damaged crops and property (own images)

4.6 Hidden Impacts of HEC

4.6.1 Personal Safety and freedom of movement

Respondenrs expressed suffering psychological impacts from elephant crop raiding. They described themselves as being ”scared” (n=118) , “angry” (n=27), “stressed” (n=4), “traumatised” (n=3), and “unable to sleep” (n=3).

When asked how elephants made them feel, 117 (73%) participants felt anxiety towards elephants, such as: *“I feel annoyed, worried and stressed. I worry the elephant will attack us”*- Participant 1. The dangers of living with elephants were clearly felt by some people, with participants 71 stating “*I am scared, elephants are dangerous”*. Some people showed extreme fear towards elephants, such as participant 83, who said *“Elephants make me scared, just hearing the word elephant makes me afraid”*

Unrealistic fears of elephants were expressed by four participants, with two believing that elephants could eat humans: “*I am scared, the elephant could eat me!”*- participant 129; one that an elephant would come and carry them away, and one thinking elephants would eat their chickens.

Having elephants living nearby also limited the movements of respondents. Fifty participants described being too scared to visit their farmland and/or the forest when the elephant was nearby. “*I am afraid to go to my farmland. If the elephant is near, I will not go”* - participant 47. Similarly, participant 25 stated: *“The elephant affects me a lot. My community and I don't want to go to our plantations often, and when the people are in their plantations, they are worried”*

In three cases, individuals had moved house as a consequence of HEC:

> *“We moved house because the old one was destroyed [by elephants]. Four months ago, the elephant ate all of our corn, rice and peanuts. There are marks of the elephant in the doorway of our [new] house, from 2 weeks ago”*
>
> -Participant 61

One family moved village after a group of elephants came:

> *“In 2003, two days after the elephants came, we left our village and now live here. Many of our friends did the same*.”
>
> -Participant 53

4.6.2 Health Impacts

Both physical and psychological health have been shown to be impacted by HEC. Participants in this study showed examples of both.

4.6.2.a Physical

Diminished physical health was suggested by five respondents as a consequence of HEC. Participant 154 described being ill for two weeks after an elephant came and raided their farm: “*I was terrified [after the elephant came] and was sick for 2 weeks after*”. Participant 2

described how having to constantly replant crops after elephant raids was making them "so tired".

4.6.2.b Psychological

In this study, 140 participants suggested suffering from both psychological and emotional upset due to HEC. Words used to describe how elephants made them feel were associated with stress and anxiety, such as "scared" (n=104), "worried" (n=32) and "angry" (n=7). Participant 2 noted: *"I am so scared [of the elephant], I am traumatised. You have no idea how traumatised I am".* Furthermore, some individuals stated that living with elephants nearby affected their sleep "*I cannot sleep because of the trauma"* – participant 3. The son of an elderly couple who had just had their garden raided by an elephant said: *"[I am] scared and worried [that] the elephant…comes to my parent's house. I cannot sleep"* – participant 74.

4.7 Ownership of wildlife

Participants suggested that wildlife, particularly elephants, were the property of the government and/or the forestry department; very few individuals expressed any ownership or responsibility towards wildlife: "*The elephants are government owned"* – Participant 154. This was a widely held view (n=52):

> *"The forestry department are in charge of the forest and the animals in it….The government should save elephants…humans are in charge of their farms"*
>
> - Participant 45

> *"Elephants are the government's responsibility…the government need to be responsible [for the elephants] because [they are] dangerous to people"*
>
> -Participant 68

> *"Local people are not responsible for elephants…the elephant has no habitat or food, which is why it comes to our farmland and villages. The forestry department is in charge of the forest and its animals"*
>
> -Participant 76

Ownership or responsibility for wildlife was expressed by 31 participants. They felt "local people", "local communities", "humans" and "everyone" should be responsible for elephants and HEC (Figure 12). All these people, however, stated that they would need support from other organisations, such as the government, forestry department or NGOs, and none stated that it was the responsibility of local people alone.

"*HEC is our community's fault because we destroyed the elephant's habitat…[but] the Forestry department should be responsible for mitigation"*

-Participant 60

Participant 130, saw elephants as "*a gift from God",* however she still felt the government should oversee moving elephants away from villages when they come.

Local people felt a lack of control over managing HEC and did not see the resolution of conflict as being their responsibility (n=112), stating instead that other organisations, such as the BKSDA or government, are responsible for HEC.

4.8 Lack of Faith in organisations to resolve Human-Elephant Conflict

Some participants (n=23) felt ignored by the government and conservation organisations, and that elephants were favoured over local people:

> "*We have reported the problem to the local government, and they have done nothing"*
>
> -Participant 2

> *"If I hurt the elephant, I would be arrested. The government takes it so seriously if we were to harm the elephant, why not take it seriously when an elephant damages people's property and farms?"*
>
> -Participant 82

The implementation of conservation strategies can have knock-on effects for locals – for example, making it illegal to kill or harm elephants has left people feeling unable to protect their farmland (Naughton-Treves and Treves 2005).

> *"Local people always ask for help but get no response from the government. If it was up to local people, they would kill the elephant but don't because the police would come [if they did]"*
>
> -Participant 59

> "*I have no idea what to do [to mitigate conflict]. I can't make a trap because it is illegal*"
>
> -Participant 97

> *"I want to use poison [on the elephant] but can't because I will be arrested"*
>
> -Participant 90

> *"If local people kill or poison the elephant, they would be arrested…They have no way to protect their farms"*
>
> -Participant 125

> *"Wildlife problems in villages should be controlled by the government, BKSDA and CRU…It is the villagers who are suffering, they don't know how to mitigate conflict"*
>
> -Participant 19

In total, 85 people felt at least one governmental organisation were currently responsible for mitigating HEC- be it the government, BKSDA, CRU or the forestry department.

People stated that at least one of these organisations, plus the police and village chiefs, *should* be responsible for mitigating HEC, even if they were not currently responsible (n=125) (Figure 12).

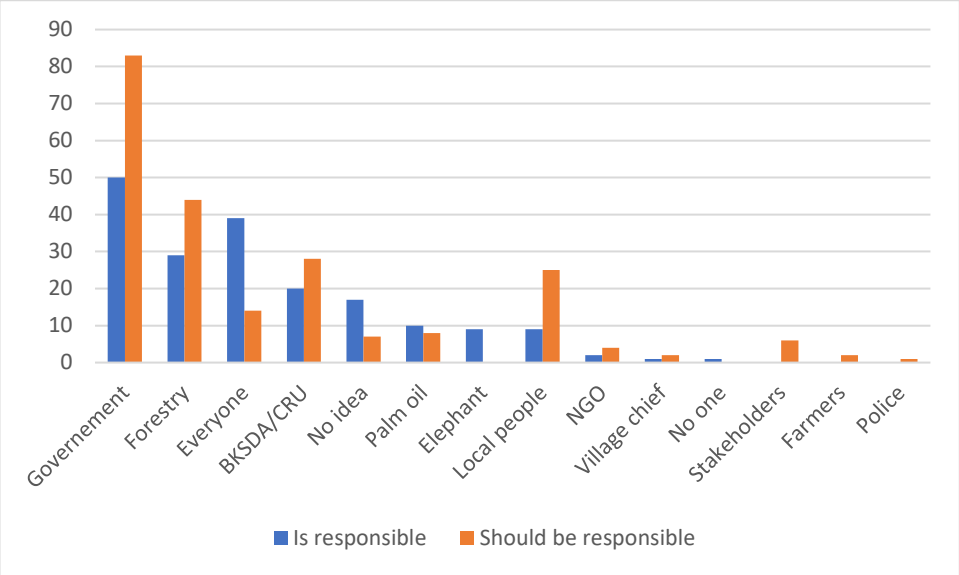


Figure 12 Who participants thought is currently responsible for mitigating HEC in Subulussalam, and who they think should be responsible for mitigation.

Overall, people felt governmemntal organisations should be accountable for HEC but currently were not taking responsibility for the conflict (n=79). Comparitively, 41 respondents thought a governmental organistation was currently responsible for HEC mitigation and belived they should be. Nine participants felt a governmental organisation was currently responsible for mitigating HEC but believed that another organisation should be instead. For example, 83 people said the government *should* be accountable for HEC yet 54% of these people thought the government was not currently taking responsibility for HEC. Similarly, 44 people stated the forestry department *should* be responsible for HEC mitigation, but 61% of these people felt they currently were not. A lack of trust and support towards the government, as well as anger and resentment, were expressed by 37 people:

> *"The elephant conflict needs to be taken care of by BKSDA, the forestry department and the government. They need to come and talk and socialise with local people and teach them about mitigation. I am so angry with government, why don't they care?"*
>
> -Participant 49

> *"The government, NGOs and stakeholders need to take this conflict seriously. People are getting angry, maybe they will kill the elephant. If they [the government] were serious, they would respond quickly, but they don't"*
>
> -Participant 82

> *"I always ask the government [for help] but get no response. If people reacted to the elephant and killed it, they would immediately be arrested by police, so why do they do nothing to solve problem?"*
>
> -Participant 59

> *"[I am] very angry, sick of being told things will happen [by the government] when they don't."*
>
> -Participant 90

4.9 Current Mitigation

Overall, 98 participants said they had no ways to mitigate against elephant crop raiding. The remaining 62 described several different strategies they used or would use to mitigate against HEC. The success of these strategies varied. 35 people said the strategies they used were successful at mitigating against HEC, with the methods used shown in Figure 13.

Three participants from PakPak communities claimed that thinking positively about elephants and respecting them prevented elephant crops raids. Participant 154 said:

> "*[My husband] offered the elephants white and yellow rice [when they were coming to our farm] and asked them to leave and not come back. It worked – they did not return".*

Similarly, participant 86 described his successful mitigation method:

> *"I put up a red flag [on my farmland] and think positive about elephants. My neighbours who say bad things about elephants have had their farms damaged, but the elephant does not damage my farm".*

Another participant, however, contradicted the claims of this method stating:

> "*I was told to put up a red flag [to keep the elephants away], but the elephant just pushed it over!"*
>
> – Participant 84.

One participant said they had a chilli-rope fence around their farmland in Kutacane (although there are no elephants in Kutacane (Rudi Putra, pers. comms)). They said:

> "*I have never had an elephant [on my farmland] but I was told by other farmers [the chilli fence] was good at keeping all animals out, including elephants"*
>
> – Participant 67.

The success of chilli-grease fences at deterring crop raiding elephants has been widely studied; see also Table 2, Section 3.2.4.

Another man from Suka Makmur described how he would use a trip alarm fence to protect his farmland:

> "*I used to have a trip alarm fence around my farmland. The alarm would scare the elephant a bit [and alert locals]. We would then push the elephant away. I don't have it anymore because there are no elephants [here now]."*
>
> - Participant 29

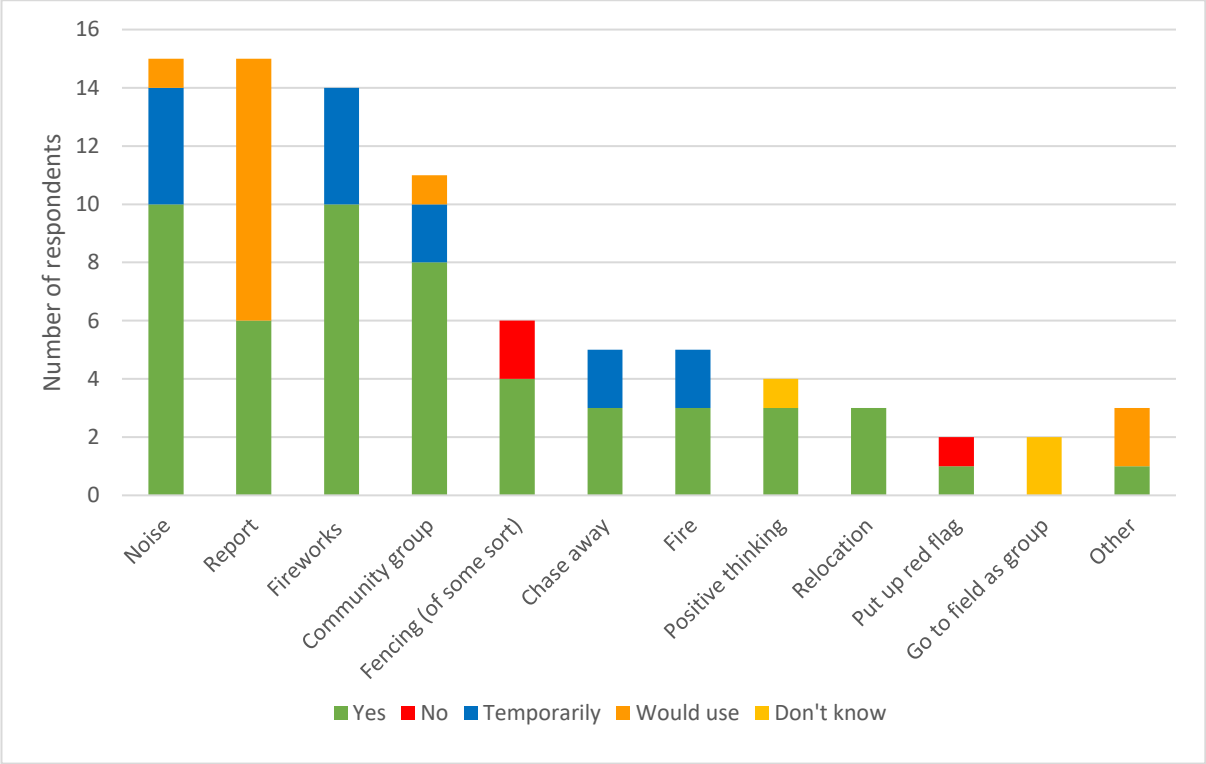


Figure 13 Types of mitigation used by participants to mitigate against HEC, and whether the methods were successful at deterring elephants. "Noise" describes shouting, banging against items and using boomers to scare elephants away; "Report" means an individual reports HEC to an organisation, be it the government, conservation organisation, village chief etc.; "Fireworks" means using fireworks to scare elephants away; "Community group" describes a community group formed where local people have been taught how to safely deter elephants and scare elephants away together; "Fencing" includes chilli fence, barbed wire fence, lemon trees, traps/snares and trip-wire alarm fences around farmland; "Chase away" describes people running at and chasing elephants away; "Fire" describes people setting fires near farmland to keep elephants away, as well as using fire-torches; "Positive thinking" means people think good thoughts about elephants to keep them away from farmland; "Relocation" means problem elephants are moved away from villages by an organisation; "Putting up a red flag" described a technique where a farmer places a red flag in their farmland to keep elephants away; "Go to field as group" is when farmers do not go to their farms alone in case they come across elephants and "Other" includes shooting at elephants, throwing stones and offering rice to the elephants.

The killing of elephants may have occurred more often than was reported to me, due to it being illegal. However, one individual described killing a baby elephant in retaliation to a crop raiding incident:

> *"One year ago, three elephants came to our village, pulling up and eating palm oil. Local people ran at them and killed one with a machete. [The elephant killed] was the size of a cow"*
>
> -Participant 106

For some people, methods used only provided temporary relief from HEC: overall ten people stated this was the case (Figure 13). Participant 12 in Lae Mbersih said *"I use fireworks [to scare elephants away], but it only works for a few days before the elephant comes back*". Two respondents who said that CRU and WCS came to push the problem elephant away from their village, described this as successful at protecting their village, however the problem was transferred elsewhere in Subulussalam:

> *"WCS and CRU came [to Namu Buaya] to push the elephant away. It worked for us [and has kept the elephants away] but moved the problem to Tangga Besih"*
>
> -Participant 139.

Three individuals said their mitigation strategies did not work, and twelve people told what they would do should HEC occur in their village (Figure 13). A further three people had mitigation strategies, but they did not know if they worked or not (Figure 13).

Fifteen respondents said their mitigation was to tell an organisation, with the hope that they will sort out the problem. People felt clueless as to how to protect their farmlands, due to current laws which prohibit traditional mitigation of conflict – through killing or trapping problem elephants: "*I have no idea what to do [to mitigate conflict]. I can't make a trap because it is illegal*"- participant 97.

4.9.1 Case Study: Community group in Batu Napal

In one village, Batu Napal, a community group had been set up by USAID LESTARI programme, with collaboration from the Wildlife Conservation Society (WCS) and BKSDA in 2016. Here, members of the community were facing intense HEC. Local people were taught about the forest, elephants and how to mitigate HEC independently (USAID LESTARI 2016, 2017) "*Using fireworks and noise…and we have a night patrol"* – Participant 9. The "Community Patrol" group was set up, and currently has "*26 local people, who work with the local government and forestry department*". They continue to describe the patrol group:

> "*The community patrol group formed. We scare elephants away with fireworks. Everyone takes part, and we call each other if the elephant is nearby"*
>
> – Participant 5

Almost all participants - 91% (n=10/11) - who lived in Batu Napal or had farmland there, said that HEC had fallen since the community group formed. In fact, the last encounter reported by any of these people was in 2016 – two years prior to these interviews. "[*The frequency of raids has become] less because the group has already scared the elephants away and protects our farms"* -Participant 33. This suggests that the community patrol has been successful at mitigating HEC in Batu Napal. The people spoken to were positive about the community group. As well as helping to mitigate against HEC, local people expressed a new-found interest in wildlife and the forest, and more understanding about elephants:

> "*Now, I like elephants. I didn't like them before the community group formed. Now, I know that they are rare, and I appreciate them more"*
>
> -Participant 6

> *"I didn't like elephants. Since the group has formed, I am interested in them and want to know more. I [now] know they are rare…I feel happy to have seen them"*
>
> -Participant 7

Two individuals stated that the community patrol brought other, unexpected positives to their community, and wanted to share their success with other people:

> *"Everyone works together, and the community is closer now. I hope we can tell other [people] about the community patrol group and help them too. After this group formed, I am happier. If elephants come, the group always comes together and scares it away…Being taught about nature made a big difference to me. Now I care about all wildlife"*
>
> -Participant 7

> Participant 5 said: "*[The group] makes people come together and brings community spirit [to the village]";* and participant 33 said *"The group gives people courage"*

However, five people still noted they felt afraid of elephants, and that living with elephants nearby affected their daily lives. Participant 10 said "*I am more worried…about going to my plantation"* with Participant 123 stating "*I am always scared but I still go to my farm"*.

Almost all individuals (n=10/11) from Batu Napal were happy with the outcomes of the community patrol group and deemed it successful at mitigating HEC.

4.9.2 Case Study: Historical crop raiding, relocation and changes in perspectives

Some respondents wished problem elephants were relocated (n=36). This had happened before, in Jontor. Here, the problem elephants were reportedly relocated after causing damage in both Jontor and nearby Sikelang.

From Jontor, two elephants were relocated in 2006 by BKSDA (personal comm.). Of the 15 interviewed from Jontor and Sikelang, twelve said that, before the relocation, elephants would come often – between every day and every month- to eat crops and damage property (of the other three people, two had never seen an elephant and one had seen an elephant but not in Jontor or Sikelang). They described feeling negatively towards elephants: *"[I was] scared, sad and worried the elephants would attack me*" – Participant 116. Subsequently, nine participants stated that elephants did not impact their daily lives anymore, but went on to describe how they used to:

> *"Before [the relocation], I would not plant things for fear it would be raided [by the elephants], but now they have been moved, I have no problem"*
>
> -Participant 43

> "*Now, it is ok as [the elephants are] not here but when they were, I wouldn't go into the jungle or to my farm*"
>
> -Participant 114

Improved community perceptions of elephants since the relocations were reported by ten participants: "*[Our perceptions of elephants are] better now because they are not here causing problems"* – Participant 117*,* and:
"[Our perceptions of elephants are] better since the relocation because now, the palm oil is growing well." – Participant 158

Ten participants suggested that now the elephants were gone, they felt more positive about them, however would dislike elephants to return:

> *"If [elephants are] here, I hate them and am angry because they eat my food. But now they are not here, I feel pity. Elephants are endangered. When they were taken away [during relocation] some people cried-we like elephants but don't like them if they are here"*
>
> -Participant 114

Another said "*I used to be angry with elephants but I also know elephants need to eat. Now they are not here, I feel ok"* – Participant 157*.* Four individuals said they were still afraid of elephants, despite them being relocated: "*Elephants make me scared-I get goosebumps thinking about them…they could eat me!"* – Participant 40

Overall, 80% (12/15) people from areas where elephants had been relocated after historical crop raids suggested that the relocation had been successful at stopping HEC.

4.10 Willingness to try mitigation

Over three quarters of participants were willing to try at least one of the proposed mitigation strategies: beehive fences, chilli grease fences, saltlicks and community patrol (Table 7). Of these, community patrol was most frequently cited as an option local people would be willing to try, with 46% of participants willing to try mitigation methods choosing this. Most often, people felt that mitigating against HEC would be more successful if everyone worked together: "*If we work together, we can learn from each other*" – Participant 111. Another stated "*If we work together, we can keep elephants away from multiple communities…and know about everyone's needs*" -Participant 118. Some people also liked the idea of working with other people to bring about companionship and a sense of community "*Working together means we will be less lonely and scared*" – Participant 133.

Table 7 Willingness of participants (n=160) to try at least one mitigation strategy, and the percentage of respondents who gave each response. The mitigation strategies briefly explained to participants were Community patrol, Chilli fences, Beehive fences and a Salt lick. Community patrol is when a group of local people are taught about wildlife, and how to safely scare elephants away. The group of people call each other when elephants are seen nearby, and they all chase the elephant away using the techniques they have been shown. At night, community members take it in turns to patrol local farmland and the village to protect against crop raiding. Chilli fences are where a ground chilli, tobacco and oil mixture rubbed onto rope, which is put around crops. The smell masks that of crops and is an irritant for elephant. Beehive fences are where hollow logs or built beehives are smeared with wax and hung on rope, 10m apart around farmland. These are then colonised by bees, which elephants are scared of. Farmers can also harvest the honey. Salt licks are where an artificial salt lick is built away from villages. This may help attract elephants, as a lack of salt in elephants' wild diet has been shown to often be a reason for crop raiding.

Willing	Frequency	Percentage
Yes	**123**	**76.88%**
Community patrol	*57*	*35.63%*
Chilli fence	*52*	*32.5%*
Beehive fence	*28*	*17.5%*
Salt-lick	*12*	*7.5%*
No	**35**	**21.88%**
Don't know	**1**	**0.62%**
Maybe	**1**	**0.62%**

Chilli fences were the second most popular choice of people willing to try at least one mitigation method, with 42% of respondents saying they would be willing to trial this method to mitigate human elephant conflict. The most frequently given reason for wanting to try chilli fences was because people believed it would be simple and easy in comparison to other options. Of those who said they would be willing to try beehive fences, the main reason given was that they could make money from honey. Salt licks were the least popular option, but of those who would be willing to try it, the main reason given was that it looked simple.

Some respondents (n=39) gave reasons why they did not choose certain mitigation methods. Bees were feard by 15 respondents, and three stated that bees were dangerous, hence they would not be willing to trial the beehive fences. Four participants rejected the salt lick because

they believed it would make the elephants fat. Sixteen respondents did not believe any strategy would work; two already had successful strategies in place (positive thinking and lemon trees surrounding crops) so did not want to try any others.

4.11 Relocation of problem elephants

Since this research was conducted, the problem elephant in Subulussalam has been relocated. The female elephant was moved to forest in Bangkung, only 10-15km from the nearest village, and approximately 30km from Sultan Daulat district, where the majority of conflicts occurred in the past five years in Subulussalam (USAID LESTARI 2019). She was fitted with a radio collar and her movements monitored. Just one month after her relocation, she moved from the forest towards human settlements, eating crops there. She was recaptured and is currently in an elephant training centre (ETC)- Pusat Pelatihan gajah – in Saree, Aceh Selatan. Unfortunately, it seems that she will not be re-released, instead being trained at the camp (Regar 2019)(Rudi Putra, pers. comms.). This is thought to be the last remaining elephant in the Subulussalam area (Rudi Putra, pers. comms.).

5 Discussion

This study showed how HEC in the Subulussalam area had indirect impacts on the physical and mental health of people, and direct impacts on people's property and livelihoods, even though most communities were rarely visited by elephants, and it seems that there was only one trapped elephant left. Despite this, the study highlighted how people considered elephants dangerous and that attitudes were mostly negative towards them. People expressed feelings of helplessness when it came to mitigating HEC, as well as distrust and anger towards governing bodies.

5.1 Drivers of human elephant conflict in Subulussalam

5.1.1 Land use in Subulussalam

Over half of all respondents said they were involved in deforestation activities. With this comes increased HWC, especially for people farming inside or close to the forest (Naylor et al. 2019). Studies have shown how increased deforestation and habitat fragmentation lead to rises in HEC and negatively impact on elephant populations (Songer et al. 2016). Areas with greater smallholder farms have been shown to be utilised more than large scale farms by crop raiding elephants (Graham et al. 2009a). In the Subulussalam area, most of the conflict experienced was with animals other than elephants, as there was only one left in the area. Subulussalam has seen significant deforestation, and most farmers around Subulussalam were smallholders, making the people here particularly vulnerable to HWC – from elephants and other wildlife- and its subsequent negative effects.

Several participants indicated that they had land in the forest, with only two individuals indicating this land had been provided by the government. The remaining 47 people did not appear to have obtained this land legally. Clearing forest without a permit is illegal in Aceh, however almost all participants claim to have done so. None indicated any knowledge of this law. Illiegal logging and forest encroachment have been reported as an issue in Aceh and the Leuser Ecosystem (Simanjuntak 2019). Continued illegal forest clearing will only exacerbate HWC, as well as flooding and landslides (Simanjuntak 2019). The apparent ignorance towards the law regarding deforestation should be addressed, in a bid to limit the activities of local farmers and thus forest clearing.

5.2 Local perceptions of elephants and HEC

5.2.1 Negative attitudes

Previous studies have suggested that tolerance towards wildlife is shaped more by the amount of damage done rather than the frequency of events; the devastation of elephant crop raids, even the *risk* of such destruction, heavily impact upon local attitudes towards elephants and make people less tolerant towards them (Hoare 1999; Naughton-Treves and Treves 2005; Dorresteijn et al. 2016). This research supported these findings, with most participants expressing negative attitudes towards elephants. In this study, elephants were the most likely crop-raiding species to be ranked as the most destructive by those who experience elephants on their farmland, even if other species came more frequently. The perceptions people had of conflict animals can be more of an issue than the damage caused by these species. Negative attitudes towards elephants makes people less tolerant towards them, and reduces the support of local people to conservation (Hoare 2015).

5.2.2 PakPak community

Although not directly asked, some participants in this study revealed their cultural beliefs associated with the PakPak community. Positive cultural beliefs have been shown to lead to a greater tolerance towards crop raiding animals (Balodi and Anwar 2018; Struebig et al. 2018). However, continued crop destruction and consequential resentment can override cultural and religious beliefs: in Assam, India, where many people worship the elephant (such as Ganesh in Hinduism), there were still retaliatory killings of elephants (Zimmermann et al. 2009). In this study, the perceptions of PakPak individuals towards elephants did not vary from those who were not PakPak. Further studies could focus more on the cultural beliefs of the people of Subulussalam, in order to gather a more conclusive result on how, if at all, cultural beliefs impact wildlife perceptions. This could be useful knowledge for future mitigation, as including cultural belief systems into mitigation can help engage people in conservation (Dorresteijn et al. 2016).

5.3 Factors impacting local perceptions

5.3.1 Economic vulnerabilities facing local people

Most participants in this study relied on farming as a source of income, with the majority relying on farming as their sole income. Such people are more vulnerable to the impacts of crop raiding by elephants, as the value of farmland and associated properties is high (Naughton-Treves and Treves 2005). Their whole livelihoods rely on the successful growth and harvest of crops, thus destruction by elephants can have a devastating impact on their income and food security.

Farmers suggested a mismatch between the price of fertiliser and the price they received for crops. A lack of fertiliser leads to a reduced crop abundance (Naylor et al. 2019). Less crop yield means lower income for farmers, making them even less able to pay for fertiliser to help increase their harvest. Many farmers stated to have suffered from reductions in crop abundance in the past few years from multiple factors, including high fertiliser costs and wildlife crop raiding. Hence, local people are already facing economic imbalance and lack of financial security. Add to this the problem of elephant crop raids, which are often devastating and can wipe out whole fields in a single night, several individuals were suffering an even greater financial strain due to increased crop loss. Cash generated through farming is often used to buy commodities such as soap, clothing and oil, which individuals cannot make at home. If people face economic hardship, which can be exacerbated by HEC, they may be unable to buy these basic materials, which in turn leads to a decrease in people's quality of life (Fairet and Maguy 2012). Similarly, this loss of income can result in people being unable to pay for tools required to protect against future crop raiding events (Fairet and Maguy 2012). As such, people end up trapped in a downwards spiral of crop raiding and financial insecurity, where they are losing income through HEC, leaving them with less money to invest in ways of preventing future raids.

As well as crop raiding, elephants have caused damage to property, including farm shelters and family homes. In this study, three individuals have had to move house as result of elephant raids. Many participants here had also suffered destruction of farm-shelters, the value of which is likely to be high for people who rely on farming for income (Naughton-Treves and Treves 2005). To repair such damage is costly, both financially and physically, which puts further strain on families.

Almost all the farmers spoken to had their own area of farmland and did not farm as a community. This has been identified as a factor in making farmers more vulnerable to crop raiding, as they absorb the costs individually, rather than as a group (Naughton-Treves and Treves 2005). This, in combination with both pre-existing financial strains and those as a result of HEC make many of the people of Subulussalam more vulnerable to the impacts of HEC. Crop raiding, with its associated loss of food and economic security can weaken possible safety nets in place for times of hardship in the future (Fairet and Maguy 2012). Vulnerability to HEC has been shown to make individuals less tolerant towards elephants and conservation initiatives (Naughton-Treves and Treves 2005). In Thailand, it was found that poorer households were less likely to support unconditional tolerance towards elephants than wealthier households, highlighting how a lack of economic security impacts local tolerance (van de Water and Matteson 2018). It is important for future mitigation to increase people's tolerance towards elephants, and wildlife in general, and to do so, economic vulnerabilities need to be addressed. Possible ways to do this will be discussed in section 5.4.

5.3.2 Hidden impacts of HEC

A loss of income and associated shortages of food have been shown to lead to stress and lack of sleep. Inability to get enough sleep due to the worries about HEC were discussed by several participants. Furthermore, many individuals lived in fear of elephant attacks, and felt their personal safety was at risk, which also lead to anxiety and sleeplessness. It is an ongoing cycle: the less sleep people get, the more stressed they become, and stress can cause a lack of sleep (Fairet and Maguy 2012). Studies have shown that people who have experienced elephant attacks and crop raids show higher rates of psychological illness such as depression (Chowdhury et al. 2008; Ogra and Badola 2008; Barua et al. 2013). The health risks associated with disturbed sleep and stress are well documented, and have been linked to cardiovascular illness, compromised immune function and increased mortality (Meerlo et al. 2008; Mullington et al. 2009; Thoits 2010; Ganz 2012; Morey et al. 2015). Stress and sleeplessness have also been linked to a reduced ability to cope with stressors in everyday life (Meerlo et al. 2008). Hence, the potential health impacts HEC has both in the short and long term on the people of Subulussalam is evident.

Additionally, tiredness has further opportunity and economic costs for individuals, as they may have less energy to tend to farmland or carry out other daily activities. It may also limit individuals from being able to find alternative incomes, as they do not have the energy to actively search for them (Mackenzie and Ahabyona 2012; Barua et al. 2013; Weinmann 2018).

Opportunity costs associated with HEC were evident in Subulussalam. People's fear of elephants limited them from going about their daily lives: the threat of HEC prevented people from visiting farmland or reduced the time people spent in the field. This in turn leads to reduced productivity, and a decrease in crop yield, further impacting financial strains. Additionally, the ability to travel freely has been described as an important factor impacting human wellbeing (Reid et al. 2005; Barua et al. 2013). As such, the limits imposed by people's fear of elephants in Subulussalam may be negatively impacting wellbeing too.

Three participants in this study mentioned having to move to a new house and/or village because of elephant raids. Such displacements could have additional social consequences for people, breaking social bonds and family ties, as well as the disruption to the lives of the family. Although this did not appear to be the case with the respondents of these interviews,

the potential social isolation and upheaval of relocating needs to be considered, especially as research has shown that the impacts of stressors on health decrease if people have good social support (Thoits 2010).

5.3.3 Ownership of wildlife and lack of control

If people see risks as non-voluntary, they may be less tolerant of that risk (Naughton-Treves and Treves 2005). Here, 62% of respondents regarded someone else as being responsible for the HEC they were experiencing – such as the government, BKSDA and forestry department. This demonstrates a lack of ownership felt by some local people towards HEC management. As such, these individuals may be less tolerant to HEC as they see it as an imposed problem – that is, they do not feel responsible for the conflict. Furthermore, people saw elephants as being owned by the government. Studies have shown that such attitudes intensify hostilities felt towards elephants, lessening local tolerance towards them (Madden 2004; Naughton-Treves and Treves 2005).

Additionally, government enforced regulations prohibiting the traditional methods of conflict mitigation, such as trapping or killing problem animals, has left people feeling unable to control HEC. Few people had successful alternative mitigation strategies in place, rendering people defenceless against elephant raids. Lack of control has been attributed to increased resentment towards problem animals, and impacts local perceptions of vulnerability to crop raiding (i.e. people feel more vulnerable when they do not know how to mitigate against a conflict) (Madden 2004; Naughton-Treves and Treves 2005; Hill 2015).

Future mitigation needs to address these issues, to help improve local tolerance towards elephants (Madden 2004; Struebig et al. 2018). Providing people with the knowledge and tools to mitigate against HEC, as well as education about the benefits of elephants to human livelihoods, would help improve tolerance towards elephants, reduce local vulnerability to HEC and improve overall perceptions of elephants (Madden 2004; Naughton-Treves and Treves 2005; Davies et al. 2011; Slagle et al. 2013).

5.3.4 Lack of faith in organisations to resolve Human-Elephant Conflict

In this study, many respondents expressed distrust towards governing organisations and NGOs, and suggested a failure of such bodies to mitigate HEC. It has been suggested this can leave people feeling helpless and vulnerable against HEC, and cause increased distrust towards governments (Redpath et al. 2013; Mayberry et al. 2017). Studies have suggested that the alienation of local people from decision making with regards to conservation and HWC mitigation leads to increased resentment from local people towards wildlife and conservation (Goldman et al. 2013; Redpath et al. 2013). Distrust is one of the main barriers to local collaboration with governing bodies to mitigate against HWC (Redpath et al. 2013). Perceptions of failure to mitigate against conflict can be a major hindrance towards local support for conservation; perceived lack of care from authorities has been shown to lead to retaliatory killings of wildlife (Dorresteijn et al. 2016).

5.4 Future mitigation

5.4.1 Improving financial security

Farmers in Subulussalam face a financial mismatch between the price of crops and the price of fertiliser. To help lessen the impact of crop raiding events, there should be a better balance between fertiliser price and the price they get for crops. A decrease in fertiliser price will also help increase the productivity of crops for farmers, helping to increase their income and potentially reduce deforestation (Naylor et al. 2019).

Additionally, helping local people to mitigate crop raiding by wildlife including elephants may help increase farmers' income, making them less vulnerable. Many participants reported wild boar as being a major crop raider. Research has suggested that human presence in fields is enough to act as a deterrent for wild boar and help limit crop raiding incidences(Cai et al. 2008). However, participants here reported spending less time on farmland due to a fear of elephants. Consequentially, there is the possibility that HEC in Subulussalam is having a knock-on effect on other HWCs, such as that with wild boar. Although the testing of this theory is beyond the scope of this research, the fear resulting from HEC and consequential reduction in field attendance by farmers may be leading to an increase in crop raiding incidents from other species. If that is the case, then these farmers are suffering from even greater crop damage.

Providing farmers with alternative sources of income could increase their tolerance and ability to cope with crop raiding incidents. One participant's view was particularly interesting: they attributed HWC to deforestation due to illegal logging which stemmed from economic insecurity. As a result, they started a group where they work with local people to help solve their economic problems by teaching them how to make furniture, such as chairs, tables and mats, from Rotan from the forest. They then sell the items in their shop. They said:

> "*When the economy is solved, locals will not continue illegal logging…People can make more money from forests natural resources with the forest still there…this is only one solution. People could also harvest bamboo [to make and sell things] …socialisation and education needed about this for local people"*

This programme gives a promising glimpse of how local people can use the forest sustainably, which in turn could reduce deforestation and improve people's understanding of the importance of protecting it. Local, sustainable business projects need support from donors to encourage the further development of similar programmes (Oelrichs et al. 2016). Encouraging people to use the forest and its resources sustainably for income as well as traditional uses, such as medicine, has shown success through programmes impletmented by Non- Timber Forest Products (NTFP). Through community organistations and NGOs, NTFP helps empower local people residing in and near forests to sustainably use their local environment (Pandey et al. 2016). By offereing an alternative or supplementary form of income for local people instead of farming, the resilience of local people to HEC may increase due to improved economic security. If villagers have multiple, diverse forms of income, the threat posed by crop raiding is less severe (Oelrichs et al. 2016).

In summary, the financial security of local people in Subulussalam should be addressed. This would involve looking at the disproportionate pricing differences between fertiliser price and crop price, as well as providing farmers with alternative sources of income.

5.4.2 Addressing beliefs

Some participants expressed naïve beliefs of elephants, such as the fear that elephants would eat people or livestock. The fact that some people held these views suggest a lack of knowledge of elephants. Teaching people more about the ecology of elephants may help to lessen the fear people feel towards them, with education about conservation cited as an important first step in improving local attitudes (Bandara and Tisdell 2003; Dickman 2010; Gebresenbet et al. 2018). The role misconstrued attitudes and beliefs towards wildlife has on local perceptions has been widely studied. Attitudes of Slovakian students towards bats were found to be significantly influenced by knowledge of the ecology of bats; students with less knowledge of the biology of bats showed a greater belief in myths associated with bats, such as vampirism, bats getting tangled in hair, and bats biting humans. Conversely, biology majors who had knowledge of the biology of bats showed significantly more positive attitudes towards bats and less belief in myths (Prokop et al. 2009). Addressing beliefs through education has been shown to help improve local perceptions towards wildlife. Perceived risks associated with HWC can have a greater influence on local perceptions towards wildlife than actual negative experiences with the animal (Dorresteijn et al. 2016).

5.4.3 Willingness to try mitigation strategies

The preliminary findings of this research provide promising results: local people appeared willing to try ways to mitigate HEC. All views given regarding the willingness to trial mitigation strategies were based on limited information given to participants. Such a high number of participants showing a willingness to trial mitigation strategies, with minimal information, is promising for future HEC mitigation in the area. With more information about how to successfully implement some of the strategies, more individuals may be willing to try new techniques. It is important that the views of local people regarding ways to mitigate HEC are heard and understood to ensure the successful uptake and maintenance of these strategies (Gunaryadi and Hedges 2017).

5.4.4 HEC mitigation, community involvement and reduced marginalisation

People were most willing to trial the community patrol groups. Community-based mitigation has already seen success in Subulussalam, in Batu Napal village. Local people here reported a reduction in raids since the group was formed, despite the village being 5-10km from the areas facing intense HEC in Subulussalam. Further afield, studies have shown the effectiveness such initiatives can have at managing HEC. In Way Kambas National Park, Indonesia, community crop guarding was shown to be effective at keeping elephants out of crop fields in at least 80% of instances, when used in combination with early warning systems. As well as providing local people with the tools and knowledge to safely deter elephants and guard farms, ‘self-reliance’ groups were set up in villages, enabling farmers to discuss HEC and learn about mitigation. After the trial period, many farmers voluntarily adopted this method (Gunaryadi and Hedges 2017).

The second most popular mitigation strategy was chilli grease fences. The success of these has varied in different trials. When used in combination with a community-based group, chilli fences have been shown to be a successful mitigation strategy. In Tanzania, community-based organisations (CBOs) were set up to organise communities and discuss issues with government and NGOs. They also managed a micro-finance village system, where money was saved for HEC and chilli fences. Initially, the programme provided funding to trial farms to set up chilli grease fences. Over a nine-year period, none of the trial farms with chilli grease fences suffered from elephant crop raids, despite it happening nearby. The programme also supported a farmer-to-farmer exchange network, where farmers could teach other communities about their use of CBOs and chilli fences, as well as awareness programmes in schools. Through the farmer-to-farmer exchange, 24 new chilli fences were put up in a year. After funding stopped for chilli fences, communities continued to use the fences and CBOs (Chang'a et al. 2016). Programmes such as this show that if mitigation programmes are trialled and demonstrate that the costs associated are outweighed by the benefits (i.e. preventing HEC), communities are likely to continue such programmes, even after the funding has stopped. This programme enabled communities to become involved in mitigating HEC and have ownership and independence in managing conflict. Although not directly measured, the participants in Assam spoke of being "proud" to be conservation advocates, and there was a decrease in retaliatory action towards elephants (Chang'a et al. 2016) . Both of these studies highlight the importance of community engagement, and how demonstrating successful mitigation techniques can lead to an uptake of methods (Gunaryadi and Hedges 2017).

Chilli fences, have been shown to be effective deterrents for blue monkeys (*Cercopithecus mitis*) and red-tailed monkeys (*Cercopithecus Ascanius*) in Uganda (Wallace and Hill 2016). As both pig tailed and long tailed macaques were reported regularly as raiding farms by participants, the potential of chilli-grease fences to deter other crop raiding wildlife could be beneficial to farmers in Subulussalam.

The vulnerability of individual farming has been highlighted (Treves et al. 2006). Community based mitigation enables more effective guarding because the costs associated are spread between many people, instead of individual farmers or families (Desai and Riddle 2015). In this research, people liked the idea of a community patrol, stating it would mean they could work together, making them less scared. Community crop protection, for example, could mean taking it in turns to guard crops, allowing individuals to have better sleep, as they are not having to guard their crops every night, which in turn could mean they feel less stressed and better supported. All of this would reduce the vulnerability of an individual to the effects of crop damage (Alcamo and Bennett 2003; Dickman 2010). It could also help protect farms from crop damage from other wildlife, such as wild boar, as human presence can help reduce crop raiding by wild boar (Cai et al. 2008)

For successful mitigation of HWC in Subulussalam, the lack of trust people have towards the government needs to be addressed. Building trust between local people, governing organisations and conservationists, as well as empowering local people with leadership roles in decision making surrounding HWC, can help improve local support for conservation initiatives and HWC mitigation (Hoare 2015). This gives people ownership of mitigation strategies, which in turn provides people with a greater motivation to commit to and maintain HWC mitigation methods (Zimmermann et al. 2009; Madden and McQuinn 2014; Chang'a et al. 2016). By including local people in decision making, the diversity of ideas may be better, as social, cultural and economic issues can be considered, making mitigation better adapted to local communities (Madden and McQuinn 2014). Furthermore, such collaborations can lead to a

deeper understanding of local concerns, which in turn helps improve trust between the public and those in power (Young et al. 2012).

Based on the findings of this research, adopting a programme like the one in Assam may be beneficial to the people of Subulussalam region. Community based mitigation and chilli grease fences were the most popular options chosen for HEC mitigation in this study, which likely means people are more willing to engage in an initiative involving such strategies. Support and engagement would also be needed from members of governing bodies, in order to help build trust and communication between authorities and local people (Young et al. 2010). Co-management of wildlife conflict has been shown to increase tolerance towards problem species through combating feelings of disempowerment and giving people a sense of ownership over the problem (Dorresteijn et al. 2016). As elephants are intelligent animals, any mitigation strategy needs to be adaptable. For example, some research has suggested habituation to chilli can occur over time (Ngama et al.)**.** Thus, a community group with good communication between local people, conservationists and government means that if problems with certain methods arise, discussions can be had, and resolutions found to manage such problems. Even if no elephants remain in Subulussalam, community groups would still be beneficial to help local people mitigate other HWC problems.

5.4.5 Removal, relocation and taming of problem elephants

Relocation of problem animals is rarely regarded as an advisable option to mitigate against HWC in scientific literature (Massei et al. 2010). Despite this, wildlife governing organisations often turn to translocation as a non-lethal method to resolve HWC issues faced. Such bodies can face intense demands from local people for problem wildlife to be moved. Many cases have shown the strong homing abilities of elephants (Fernando et al. 2012), with one bull elephant reportedly travelling over 100 km to its original location (Sukumar 2003). Furthermore, almost all translocated elephants are associated with post-release HEC, thus transferring the problem (Massei et al. 2010; Fernando et al. 2012). This was seen in the relocation in Subulussalam. The elephant was relocated before barriers and ditches to keep the elephant away from farmland were finished (Umar 2019). Subseqeuntly, she reached nearby farmland within a few weeks of being moved. In Indonesia, the removal of wild elephants into captivity is deemed illegal (Azmi and Gunaryadi 2011), however this still happened to the elephant relocated in Subulussalam. As previously mentioned, the translocated elephant was recaptured and is now in an ETC. The longer she is in there, the more likely it is she will stay. Images of the elephant in the ETC, and further news reports suggest she has already started to be domesticated (Umar 2019; Untung 2019) and it has been suggested that her subsequent re-release is “unlikely” (Rudi, personal comms.). The removal of wild elephants is a loss to the wild population, thus narrowing the gene pool of the already limited population. Some captive females are impregnated by wild males, but these calves remain in captivity, and so do not directly contribute to the wild population (Fernando et al. 2008). Translocation is also expensive, and has high mortality rates for elephants (Fernando et al. 2008). It is thus recommended that alternative ways to mitigate the conflict are used, with the translocation of problem elephants used only with extensive planning and in depth cost-benefit analysis (Massei et al. 2010; Fernando et al. 2012).

It has been argued that the trained elephants are used as part of HEC mitigation via CRU, thus they are helping the conservation of wild populations. Some cases have demonstrated the

success of these elephant drives, suggesting they help minimise damage done by wild elephants by pushing them back into the forest (Community for Sumatran Nature Conservation 2017). However, the use of these drives has been criticised. Studies suggest that using trained elephants can cause more damage to farmland – elephant drives can cause the wild individuals to scatter, which can lead to increased crop trampling from both tame and wild elephants (Davies et al. 2011). Additionally, the use of such units can be counterproductive, causing local people to become reliant on external organisations (such as the CRU) to mitigate HEC and discourages them from adopting other self-sufficient mitigation methods (Riddle 2007).

5.4.6 Land use management

Overall, the most sustainable long-term solution to HWC is effective land use management. All the above mitigation strategies treat the symptom of HEC but fail to address the underlying cause, namely habitat loss (Davies et al. 2011). There needs to a concentrated effort from authorities to limit the clearing of Sumatra's ever decreasing forest habitat. Wildlife corridors could be a vital method to connect the remaining fragments of forest in Aceh, and Sumatra as a whole. This may prevent wildlife from entering farmland and causing damage to people's crops and property. Animals such as elephants, with large ranging habitats, have been consistently shown to crop raid more as their forest habitat diminishes. With less forest habitat, and thus less food sources, elephants are forced to raid farmland for nutrients. Elephants can then become regular crop raiders when they learn the ease at which nutrient rich food can be found on farmland (Wilkie and Douglas-Hamilton 2018).

6 Conclusion

This research highlights the importance of understanding local perceptions when trying to mitigate HEC. It showed the disconnect many people felt between themselves and the government and highlighted other unexpected consequences people were suffering. Local people were “hidden victims” of the conflict. Although the elephant has been moved, many people still suffer crop raiding from other wildlife. Strategies to mitigate against these could help improve the wellbeing of the people of Subulussalam. It could still be beneficial for community groups to be formed in the area, and for local people to be taught about the importance of conserving the forest and its wildlife. Subulussalam has suffered high rates of deforestation, and as such, conflicts between humans and wildlife will only get worse. Providing people with the knowledge of the importance of forest ecosystems will give people a better understanding of why these areas need to be conserved. Furthermore, such groups could help teach skills which would enable people to find alternative sources of income, so they are not so reliant on farming. With many people suffering financially due to increased fertiliser price, reduced crop price and intense HWC, the need for this is evident. Giving people alternative livelihoods may help mitigate against deforestation, as individuals would not need to clear land to make more money. This would involve collaboration between local people, conservationists and government organisations. By having a participatory approach to conservation and HWC management, tolerance towards wildlife and feelings of distrust felt towards authorities may be improved in Subulussalam. It is important the issues facing local people, as well as elephants and their environment, are addressed for long term and sustainable conservation.

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8 Appendices

Appendix 1 : Participant agreement and consent form

Participant Agreement Form

Full title of project: Local perceptions of human elephant conflicts in Aceh, Sumatra, Indonesia

Name, position and contact details of researcher: Lucy Twitcher; Masters student and lead researcher; email: ltwitcher@bournemouth.ac.uk; Phone: +6281264251546

Name, position and contact details of supervisor: Professor Amanda Korstjens; Professor of Behavioural Ecology and project supervisor; email: akorstjens@bournemouth.ac.uk ; Phone: +44 1202 965167

PART A

In this Form we ask you to confirm whether you agree to take part in the Project. We also ask you to agree to some specific uses of your identifiable information, which we will only do with your consent.

You should only agree to take part in the Project if you understand what this will mean for you. If you complete the rest of this Form, you will

be confirming to us that:

- You have read and understood the Project Participant Information Sheet and have been given access the BU Research Participant Privacy Notice (https://www1.bournemouth.ac.uk/about/governance/access-information/data-protection-privacy) (Printed version attached)

- You have had the opportunity to ask questions;

- You understand that:

    - Taking part in the research will include having your responses written down and used for data analysis
    - Your participation is voluntary. You can stop participating in research activities at any time without giving a reason, and you are free to decline to answer any particular question(s).
    - If you withdraw from participating in the Project, we will delete all of your responses and information. This may not be possible, however, if you have chosen not to reveal your personal information initially in the project (ie. If you request to be an anonymous source during the interview)
    - Data you provide may be included in an anonymised form within a dataset to be archived at BU's Online Research Data Repository

- Data you provide may be used in an anonymised form by the research team to support other research projects in the future, including future publications, reports or presentations.
- Your photograph will only be taken and used with your consent (see Part B)

Consent to take part in the Project	***Yes***	***No***
I agree to take part in the Project on the basis set out above	☐	☐
I agree to take part in the Project on the basis set out above, however I wish to remain anonymous from the start, and do not wish to have my name or personal information stored. I understand this will make it impossible to withdraw my data after the questionnaire has been complete.	☐	☐

PART B

Consent to participating in specific Project activities	***Yes***	***No***
I agree to be photographed during the Project.	☐	☐

Consent to use of information in Project outputs	**Yes**	**No**
I understand that my words may be quoted in publications, reports, web pages and other research outputs. Please choose one of the following two options: I am happy for my responses to be quoted in an anonymised form I do **not** want my responses to be quoted in any way, even if anonymised	 ☐ ☐	 ☐ ☐
I agree for my photograph to be included in research outputs.	☐	☐

PART C Signature

Name of Participant Date Signature

Name of Researcher Date Signature

This Form should be signed and dated by all parties after the participant receives a copy of the participant information sheet and any other written information provided to the participants. A copy of the signed and dated participant agreement form should be kept with the project's main documents which must be kept in a secure location.

Appendix 2 : Number of responses for each category

S1 Q4dii Reasons for change in crop yield	Animals (other than elephants)	Elephant	Price of fertiliser being high so using less	Having less money to buy more crops or tools	Climate change	Value of crops lower	Take good care	Use fertiliser	Learning to be a better farming	Other	New plants so can't say	No change	NA
Total responses	37	19	71	77	8	86	97	15	10	32	3	12	9

S2.1 Q1a Human activity forest	Water	Wood	Medicine	Other	Food	Do not go into forest	Cuts down trees for farming	Looking at trees/being in nature/camping	Attend to farmland	Collect Rotan	Collect bamboo	Hunting
Total responses	6	92	22	18	60	104	12	36	14	36	2	10

S2.1 Q7 Activity of ranked animals	Damage farmland	Eat Crops	Just passing	Damage property	Eat livestock	Eating food from house
Pig tailed macaque	19	114	4			1
Wild Boar	91	109	2		1	
Long tailed macaque	12	91	3		2	6
Porcupine	55	75				
Elephant	43	59	2	24		
Mouse	5	10				
Thomas's langur monkey	1	7	1			
Sambar		3	4			
Gibbon	3	3				
Squirrel		3				
Orang-utan	1	2	2			
Bird		2				
Rat	2	2				
Civet		1				
Squirrel		1				
Water monitor lizard			1		2	

S2.2 Q2 Time of elephant encounter	Night	Afternoon	Evening	During the day	Morning	Day and night	NA
Total responses	36	37	12	18	14	4	40

S2.2 Q5 What did the elephant do?	Eat Crops	Damage farmland	Damage property	Just passing	Washing
Total responses	75	7	35	36	1

S2.2 Q6 Reaction to elephant (negative)	Scared	Join community group/ own patrol	Angry	Pity for farmers/ self	Try to scare away	Upset	Run away	Shocked	Call BKSDA/ CRU	Worried	Disappointed	Pray	Wanted to shoot	Kill
Total responses	45	6	14	4	13	9	4	29	6	6	4	2	1	1

S2.2 Q6 Reaction to elephant (positive)	Happy	Ok	Watched	No reaction	Pity
Total responses	3	13	4	8	3

S2.2 Q7b Has frequency of raids changed?	More	Less	No raids	No change	Don't know
Total response	50	51	47	7	5

S2.3 Q1 How feel living with elephant nearby? Negative	Trauma	Worried	Stressed	Discomfort	Angry	Scared	Dislike	Disturbs peace	Annoyed at authorities	Have no option
Total responses	3	32	4	6	7	104	4	2	1	2

S2.3 Q1 How feel living with elephant nearby? Positive	Like	Happy	Lucky	Tame ok	Pity	They are ok	If elephants don't disturb me then they're ok	Like if far away	Elephants are friends	Used to it	Think positive then elephant won't harm us
Total responses	5	4	2	1	4	17	7	4	1	1	1

S2.3 Q2 How does living near elephants effect daily activities?	More scared	Angrier	More worried	Less income	Go to field as a group	Stopped growing crop	Always thinking about it	Lack of sleep	Afraid to go to forest	Avoid farm/go to farm less	Moved to a new house/ move village	Spend more time on farm guarding crops	Not here	No effect
Total Responses	34	1	20	35	7	3	3	3	3	28	3	2	23	39

S2.4 Q2 Current mitigation	Noise	Community patrol	Fireworks	Report	Fencing (of some sort)	Chase away	Fire	Positive thinking	Relocation	Put up red flag	Go to field as a group	Other
Total responses	23	9	12	15	4	8	5	3	4	2	2	9

S2.4 Q4 Who is responsible for HEC	Government	Community	Local people	NGO	Elephant	Village chief	Everyone	Palm oil	Humans	BKSDA/ CRU	Forestry	No one	No idea
Total responses	48	4	5	2	9	1	24	10	15	22	29	1	17

S2.4 Q5 Who should be responsible for HEC	Government	Stakeholders	Farmers	BKSDA/ CRU	Palm oil company	Police	NGO	No idea	Forestry	Community	Village chief
Total responses	83	6	2	27	8	1	4	7	44	25	2

S2.4 Q6ai Why not Community	Takes too long	Not a Comm here	People scared of elephant	Won't work	Elephant moves	Danger to people	People might be asleep-don't know when elephant will come	Elephant won't fear people	Elephant will just come back	Tried and didn't work	Need money to do
Total responses	1	2	1	2	1	1	1	3	1	2	1

S2.4 Q6ai Why community	Fun to work together	Local people already have knowledge	With support and/or money from gov	Quick/ simple	Will gain knowledge	Looks interesting	Save farms and elephants	Already works here	Possible here	Work together better/ more effective	Everyone has duty to mitigate	Sense of comm and support	Temporary solution but willing to try
Total responses	2	3	3	6	4	1	2	8	1	35	3	9	1

S2.4 Q6ai Why not chilli	Need to learn new things	Need money	Elephant not in one place	Too small, elephant will push over	On own, scared to be alone	Doesn't believe it will work
Total responses	1	2	1	4	1	7

S2.4 Q6ai Why chilli	Have tools/ equipment	Looks interesting	Easy/ simple	It is a fence, so elephant won't come in	Lots of chillies for sale in market	Only need to work for short time	Already has one that works	Cheap	Keep other animals away too	Can do alone
Total responses	8	3	43	2	2	1	2	4	2	2

S2.4 Q6ai Why not bees	Complex	Scared of bees	Need money	Need to be expert	Not know how	Elephant not in one place	Doesn't believe elephant will be scared	Lone method- scared to be alone	Dangerous
Total responses	1	15	2	3	1	1	1	1	3

S2.4 Q6ai Why bees	Make money	With support and teaching	Effective against many animals	Looks interesting	Effective long term	Fast and simple	Will make elephant scared of people as well as bees
Total responses	19	3	1	4	1	1	1

S2.4 Q6ai Why not salt lick	Need to learn new things	Need budget/ money	Elephant not in one place	Need lots of people	On own, scared to be alone	Doesn't believe it will work	Large area, elephant will be hungry	Don't have land to make it	Make elephant fat/not healthy for elephant	Too much work
Total responses	1	2	1	1	1	7	1	1	4	3

S2.4 Q6ai Why salt lick	Looks interesting	With support/ funding from gov	Thinks will be best	Easy/ simple	Quick	Work together	Can do alone
Total responses	3	1	1	6	1	1	1

S2.4 Q6ai Why none	Gov duty	Current strategy works	No problem	Has own strategy	Doesn't think any will work	Elephant needs to be moved
Total responses	1	3	14	4	6	6

S2.5 Q1 How do you feel about elephants (positive)	No problem with them	Like	Ok if not here/ causing damage	Concerned for elephants/ wants them to be saved	Empathy/ pity	Like tame elephants	They are ok	If we angry with elephant, it will be angry with us	Curious about	Eco-tourism from them
Total responses	23	22	22	12	39	6	3	5	3	1

S2.5 Q1 How do you feel about elephants (negative)	Scared	Uncomfortable	Angry	Does not like	Dangerous	Worried	Disturbed	Wants it to be moved if it comes	Does not want to answer
Total responses	40	4	24	13	9	6	4	4	1

S2.5 Q2a Comm perceptions	Worse	Better	No change	No idea
Total responses	68	36	53	3